Chapter 14
COADA:
Leveraging Dynamic Coalition Peer-to-Peer Network for Adaptive Content Download of Cellular Users

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ABSTRACT

This paper argues that Dynamic Coalition Peer-to-Peer (P2P) Network exists in numerous scenarios where mobile users cluster and form coalitions, and the relationship between sizes of coalitions and distances from mobile nodes to their Point of Interest (PoI) follows exponential distributions. The P2P coalition patterns of mobile users and their exponential distribution behavior can be utilized for efficient and adaptive content file download of cellular users. An adaptive protocol named COADA (COalition-aware Adaptive content DownloAd) is designed that (a) blends cellular and P2P (e.g., WiFi or Bluetooth) wireless interfaces, (b) leverages the clustering of people into P2P coalitions when moving towards PoI, and (c) utilizes exponential-coalition-size function of the Dynamic Coalition P2P Network to minimize the cellular download and meet content file download deadline. With COADA protocol, mobile nodes periodically sample the current P2P coalition size and predict the future coalition size using the exponential function. In order to decide how much file data is available in P2P coalition channels versus how much file data must be downloaded from the server over the cellular network, Online Codes techniques are used and tune cellular download timers to meet the file download deadline. The simulation results show that COADA achieves considerable performance improvements by downloading less file data from the cellular channel and more file data over the P2P coalition network while meeting the file download deadline.

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1. INTRODUCTION

Besides the traditional cellular communication interface, smart phones currently come equipped with ad hoc wireless interfaces such as Bluetooth and Wifi (i.e., peer-to-peer) enabling creation of mobile P2P networks. This offers a novel opportunity in which smart phones can collaboratively communicate in a peer-to-peer (P2P) fashion to improve performance of network protocols. As a result, recent research in designing content distribution protocols for smart phones starts to take the P2P communication into consideration (Luo et al., 2007; Jung et al., 2007; Yoon et al., 2008; Stiemerling & Kiesel, 2009). However, leveraging P2P communication remains challenging since the P2P communication is limited by a short transmission range and thus becomes broken under mobility of cellular users.

More importantly, cellular users may not have the intermediate incentive to communicate in the P2P channel, which is highly energy-consuming. Let us consider a shopping street scenario where customers walk to their interested shops and download the product preview video to their cell phones using the cellular connectivity, and at the same time they exchange the video via the Bluetooth or 802.11 wireless interfaces of the phones. Given two co-located customers *A* and *B*, according to previous protocols (Luo et al., 2007; Jung et al., 2007; Yoon et al., 2008), *A* and *B* are required to collaboratively exchange/forward messages. However, *A* and *B* may have different targeted shops, so they may move towards different directions in very near future, causing their wireless connection to break. Further, if *A* is interested in jewelry and *B* is interested in digital cameras, what is the immediate incentive for *A* to disseminate the packet about digital cameras from *B*, and vice versa? We therefore believe that sharing mutual content interest is crucial to motivate people (with their smart phones) to collaboratively exchange content messages.

Interestingly, we observe numerous scenarios where co-located people motivate themselves to collaborate since they share mutual content interests. For example, smart phones of co-located audiences or co-located soccer fans may form coalitions to exchange data via the P2P channel, while these mobile users are heading towards the same Points of Interest (PoI) such as the concert theater or the soccer stadium. In this context, these smart phones form a communication network called *dynamic coalition P2P network*.

In this paper, we exploit the transition of coalition pattern when the nodes move from the sparse areas to the dense areas in the dynamic coalition P2P networks to design an adaptive content download protocol named COADA. Particularly, we first study the relationship between the size of coalitions formed by mobile nodes and the distance from the mobile nodes to the PoI on three real maps taken from Google Map (Google, n. d.). Our study shows that the coalition size distribution follows an exponential function with respect to the distance from the mobile nodes to the PoI. This result is further confirmed by our model of coalition pattern using Mobius modeling tool (Deavours et al., 2007). Relying on this exponential coalition size distribution, we present COADA, a novel adaptive protocol that blends cellular and P2P interfaces of the mobile devices to improve content distribution. COADA uses the Online Codes (Maymounkov & Mazieres, 2003) technique to estimate the available data in P2P channel so that we can efficiently plan the download in cellular channel. We evaluate our protocol using simulation and the results show that COADA achieves considerably better performance than the current state of the art protocol, meets the file download deadline, and reduces message overhead significantly.

In this paper, we first present the dynamic coalition P2P networks in Section 2. Then, we study the coalition pattern on three realistic maps taken from Google Map in Section 3. In

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