

## A middleware framework for managing transactions in group-oriented mobile commerce services

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### ABSTRACT

The emerging group-oriented mobile commerce services are receiving significant interest among researchers, developers, wireless service providers, and users. Some of these services, including mobile auctions, mobile financial services, and multi-party interactive games, are transaction-oriented and will require the network and protocol support for managing transactions. In this paper, we focus on technical challenges of managing transactions in group-oriented mobile commerce services by presenting a framework, which includes requirements, membership-management and support for dependable transactions. More specifically, we present several group-oriented mobile services, characterize transaction requirements of group-oriented m-commerce services, present protocols for membership management to support both distributed and centralized processing, and present multi-network access and agent-based system for dependable transactions.

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### 1. Introduction

The emerging mobile services, including mobile commerce services, are receiving significant attention in terms of identifying new applications, designing frameworks, and engineering networking solutions [8]. A more recent review of these services can be found in [3] and personalization for mobile commerce service is presented in [13]. Many m-commerce services including mobile auctions, multi-party games, mobile financial applications, mobile advertising, and mobile entertainment services will require group communications, where several users have to simultaneously interact for an outcome or the same information is sent to multiple users [2]. These group-oriented m-commerce services are likely to be transaction-oriented with significant monetary value of some transactions. These also have the potential to generate billions of dollars in revenue due to their business, entertainment, and monetary values. Before group-oriented m-commerce services can be implemented and widely deployed, many challenges, including transaction support, must be addressed. The support for transactions is inherently complex due to the need to co-ordinate group membership, manage user inputs, and implement application synchronization. The support for transaction may become even more difficult challenge due to brief dis-connectivity or intermittent connectivity in the underlying infrastructure and ad-hoc wireless networks, user mobility, and the varying performance of wireless links. These limitations will lead to poor transaction performance in terms of increased delays and lower transaction completion probability.

We first overview some of the related work in this area. Although routing and related issues for wireless group-oriented services have received considerable attention [2], very little work exists for transactions in mobile services. So far, the transaction support primarily deals with database access under connectivity problems. This includes using synchronization [1], performing recovery for transactions [4], and using recovery protocol [7]. A preliminary simulation-based performance evaluation of group-oriented mobile services using basic time-out mechanisms has been presented in [9].

It can be observed that most of the work done so far primarily deals with database access and recovery for mobile transactions after an occurrence of wireless connectivity problem or failure. The following issues have not been addressed in the literature so far: (a) detailed requirements of group and transactions-oriented mobile commerce services, (b) support for group membership for mobile transactions under user mobility and wireless connectivity problems, and, (c) support for dependable transactions. Therefore, there is a need to address many of the above challenges in group and transactions-oriented mobile commerce services. The research questions we attempt to address are:

- (i) What are the major requirements of group and transactions-oriented mobile services?
- (ii) How to provide networking and protocol support for managing continued membership in group-oriented mobile services under user mobility and wireless connectivity problems?
- (iii) How to design networking support for ensuring the reliability of important and highly-valued transactions?

Although each of the above questions may take a separate paper to provide necessary details, we attempt to address these issues here in

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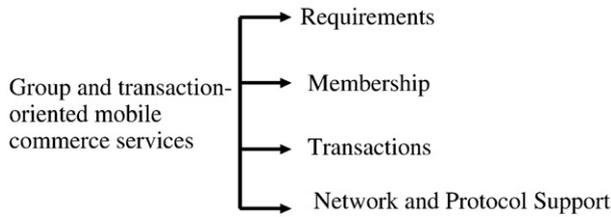


Fig. 1. The components of the proposed framework.

the form of a framework [11]. This can be considered as the part of future decision support systems [5]. The challenges in the group and transactions-oriented mobile commerce services include (i) how to provide group management for mobile users who may even experience connectivity problems, (ii) how to support transaction performance such as reliability, (iii) how to charge for transactions and other business model and strategies issues for wireless service providers, and, (iv) user issues including adoption, training and trust issues. Although all of these challenges are very important, we have decided to focus on requirements and technical challenges as shown in Fig. 1.

The group management deals with how to maintain group membership for mobile users even when they experience brief disconnectivity and/or intermittent connectivity. The group management process can be implemented using network protocols, which can perform pre-processing, manage user inputs, check for failures, and offer support for multi-stage transactions. The group management process can be implemented by either distributed or centralized processing. For each of these scenarios, we present a protocol for group membership management.

The support for dependable transaction requires that mobile users are allowed to complete their transactions even when not able to access a certain wireless network. For this requirement, we propose that mobile users can access one of several different wireless networks to complete their transactions. To support such multi-network access, we present network architecture and protocols for group members and coordinator.

The major contribution of this paper is a framework for managing transactions that includes requirements of group-oriented m-commerce services, protocols for membership management, and network support for multi-step dependable transactions. The paper is formatted as follows: in section 2, we discuss group-oriented mobile commerce services, and the details of the proposed framework are presented in section 3. A discussion of current research and conclusion is presented in section 4.

## 2. Group-oriented m-commerce services

Some examples of group-oriented m-commerce services are mobile auctions, mobile multi-party interactive games, and mobile financial services [8]. Next, we present an overview of mobile

auctions, mobile multi-party games, and mobile payment/financial services.

### 2.1. Overview of group-oriented m-commerce services

Mobile auctions will involve users with hand-held devices joining one or more groups. A demanding service due to a number of users in several locations, auctions will require co-ordination of user inputs, continued connectivity, and symmetric real-time multicast. The transactions are likely to occur few times in a week lasting from seconds to minutes. Using mobile agents, a user could become part of several auctions and mobile agents can also reduce the increased bidding traffic as the auction progresses.

Mobile auctions can be modeled using multiple stages and participants with significant interdependency between stages (Fig. 2). Pre-processing involves service advertisement and discovery, joining and verification of members, and setting up of auction rules and regulations, while post-processing will involve wrapping up the transaction including any verification. In between pre- and post-processing, a typical stage involves single request and/or multiple responses (one from each participant) and requires a subset of mobile users to provide inputs/actions in reaching a consensus or outcome.

The duration of mobile auction transactions could vary significantly depending on number of users involved, type of auction, and number of bids per user. Since the lack of input from a certain user in a stage could result in a different outcome of the auction, safeguards must be put in place to avoid such problems. There are auctions with specific rules, which could be included to avoid unintended outcomes. However, we instead rely on network and protocols to provide support for group-oriented applications including mobile auctions. In some cases, it is possible to identify both the number and actual “critical” users whose response will be sufficient for the correctness of application. Other potential safeguards could include (a) use of timeout and acknowledgement based inputs and response, where each input is timed and acknowledged, (b) use of multi-step protocols where “intention” is indicated and responded before actual input can be transmitted, and (c) where all or none inputs are considered in moving forward or backward on individual stages. Our future work will address correctness of group-oriented transactions using modifications in auction rules and protocols.

Multi-party interactive games include variety of games to mobile users in a user- or application-defined group. The games could involve millions of users worldwide and utilize location-based information in forming user groups. These will require continued connectivity, very low delays for producing real-time or near real-time performance for mobile participants, and symmetric real-time multicast with active participation from multiple users. The transactions are likely to occur few times in a week lasting from seconds to minutes. Some games could last longer to several hours and may only be limited by the energy level of players, device battery power and/or continued connectivity of wireless networks.

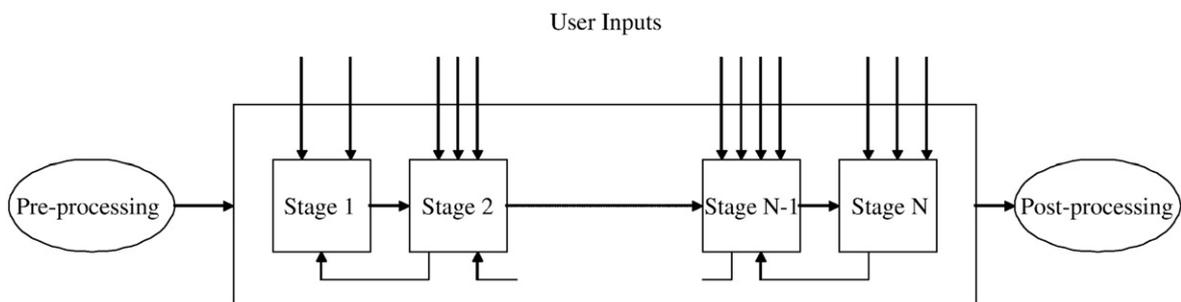


Fig. 2. Stages and participants in group-oriented mobile commerce.

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