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Abstract

Both the number and types of mobile applications have been seeing a significant increase in the last few years. Such an increase can lead to an overwhelming situation for researchers, users, and developers who are trying to understand them from many different viewpoints. One way to create a more tractable treatment of both the current as well as the emerging mobile applications is to develop a taxonomy of mobile applications. This paper describes an on-going work towards developing such a taxonomy, which could also lead to the design and development of new mobile applications to fit in the voids identified by the taxonomy.

Keywords

Taxonomy, Mobile Applications, M-Commerce, Mobile Business

Introduction

The first decade of the 21st century is arguably the decade in which wireless/mobile technology has lead the way to new computing applications. With these applications, users are no longer tethered to the wired Internet for their email, e-commerce, or e-business. Instead they use mobile clients such as mobile phones, PDAs, and similar highly portable devices to access mobile services. These services, however, provide applications that often go beyond wireline applications, offering not just anytime computing but also anywhere computing that sometimes is location or user-identity based.

New mobile applications appear regularly. Indeed, we now talk about m-commerce, m-business, m-banking, m-ERP, m-dating, and m-auctions, just to name a few. With this rapidly expanding cornucopia of mobile applications, it becomes difficult to identify where new applications belong in the ever-expanding milieu. Users, researchers, and developers need to be able to determine where a new mobile application fits with existing applications in order to determine if it is something entirely new and unique, a significant variation of an existing application, or just a retread of what we already have. A concise, sufficiently inclusive, comprehensive, and extendible taxonomy of mobile applications would provide a basis for making this determination. Such a taxonomy could also point out voids where new applications might be developed.

The purpose of this paper is to explore the characteristics of a taxonomy of mobile applications. By a taxonomy, we mean a "classification into ordered groups or categories" (MS Bookshelf 2000). We do not proposed to present a final classification scheme, but instead to examine some of the dimensions and categories of mobile applications that could lead to a taxonomy. In so doing we hope to foster a discussion among researchers, practitioners, and users about the important characteristics that distinguish different types of mobile applications.

We define a mobile application as a use of a mobile technology by an end-user for a particular purpose, e.g., purchase a ring tone, check a weather forecast, transfer funds at a bank, make an airline reservation, etc. Mobile applications are provided by mobile services that have the infrastructure necessary to deliver the application. A mobile service, however, may provide several different applications under the umbrella of one service. For example, a mobile service may provide information about popular music and sell MP3 music files. For this paper we would view these as two different applications – one, an informational application, and the other, a transactional application – both provided by one service.

We view mobile applications in the broadest sense as those applications in which the user is connected to the mobile application via a wireless link. These include m-commerce, but also include other applications that might not be considered to be "commerce" applications. We could call these m-business applications but we choose the simpler designation of mobile application.

The paper is not concerned with the technology needed to deliver a mobile application. Clearly wireless technology – mobile clients, wireless networks, mobile software, WAP gateways, etc. – are needed to make mobile applications function. This technology, however, is constantly changing and improving. A mobile application is built on top of and largely independent of the wireless technology, and does not change as rapidly as the technology.

This paper is organized as follows. First, we review the literature of how taxonomies have been developed and utilized in IS research. Then, we present our on-going work on developing a taxonomy in terms of several candidate dimensions. Next, we classify several current and emerging mobile applications using these dimensions to explore how they may fit in the proposed taxonomy. Finally, we make some concluding remarks.

Literature Review

Suitable taxonomies play an important role in research and management because the classification of objects helps researchers and practitioners understand and analyze complex domains. The reduction of complexity and the identification of similarities and differences are major advantages provided by taxonomies (Bailey 1994). Furthermore, they enable researchers to study the relation among objects and, therefore, to hypothesize about these relationships. As a vocabulary of a domain and as a set of defined constructs, taxonomies can add to the IS knowledge base and therefore lay the basis for future research approaches (Hevner et al. 2004; March and Smith 1995).

The importance of taxonomies has been well recognized in the field of mobile commerce and mobile business research (e.g. Lehmann and Lehner (2002); Okazaki (2005)). However, until today only a few taxonomies have been proposed, and so there is still a lack of general taxonomies of mobile applications that could stimulate future academic endeavors.

Kemper and Wolf (2002) propose a taxonomy based on a three-dimensional classification scheme. The chosen dimensions are *degree of innovation*, *speed of development* and *risk,* and a set of corresponding characteristics focuses on mobile application development. The taxonomy is narrowed down to the development process, and the generic approach does not feature the specific characteristics of mobile applications.

Leem et al. (2004) develop a hierarchical classification scheme based on mobile business models. In a first step, they partition into the two dimensions of B2C and B2B/B2E business models. They subdivide each of these two dimensions into further dimensions. Their approach enables practitioners and researchers to classify mobile applications from a business model perspective. It can therefore support managerial decision-making and can lay the basis for mobile business model-oriented research. Their approach, however, focuses on a specific perspective and does not feature general mobile application classifications.

A basic two-dimensional classification scheme of mobile services is suggested by Nysveen and Thorbjørnsen (2005), which groups services by the *type of interactivity* and *process characteristics*. Both dimensions feature binary categories (person-interactive vs. machine-interactive and goal-directed vs. experimental) only and therefore, the resulting fourfold scheme provides limited descriptive power.

Heinonen and Pura (2006) developed a classification scheme for mobile services from a customer-centric perspective that is based on the four dimensions of *type of consumption*, *context*, *social setting* and *relationship*. Identifying industry specific

classification as a limitation of their taxonomy proposed, they suggest further research towards a more general taxonomy of mobile applications.

Taxonomy of Mobile Applications

We proposed that a taxonomy of mobile applications be based on characteristics of the interaction between the user and the application. For example, the user could interact in real-time with an application or in non-real-time. This interaction could involve only information retrieval or it could involve a financial transaction.

Characteristics of a Mobile Application Taxonomy

We define the taxonomy in terms of dimensions, by which we mean the major characteristics of the interaction between the user and the mobile applications. Within each dimension we define categories that have the following characteristics:

- They are collectively exhaustive. All existing mobile applications fall into one of the categories within a dimension.
- They are mutually exclusive. No application falls into more than one category within a dimension.

As we will see, most dimensions that we propose have binary categories, although this is not required.

To be useful, a taxonomy should have the following desirable characteristics:

- It should be concise. It should not contain too many dimensions or too many categories in each dimension, because an extensive classification scheme with many dimensions and many categories would be difficult to comprehend and difficult to apply.
- It should be sufficiently inclusive. It should contain enough dimensions and categories to be of interest. For example, a taxonomy with only one dimension and two categories within that dimension would not be very interesting or useful. Note that this characteristic can conflict with the conciseness characteristic.
- It should be comprehensive. It should provide for classification of all current applications.
- It should be extendible. It should allow for additional dimensions and new categories within a dimension when new types of applications appear.

Candidate Dimensions of a Mobile Application Taxonomy

With this background, we now present a list of candidate dimensions of a mobile application taxonomy. We do not propose that these dimensions form a final taxonomy, only that they serve as a basis for discussion. For each dimension we list the categories of applications based on the dimension.

Temporal dimension. The user can interact with some mobile applications in real time, meaning that the application services the user's request almost immediately, whereas the interaction between the user and the application may be deferred in other applications. The temporal dimension identifies when the user and the application interact.

- Synchronous: user and application interact in real time
- Asynchronous: user and application interact in non-real time

Communication dimension. Information may flow uni-directionally between the user and the application or bi-directionally. The communication dimension relates to which way information flows between the user and the application.

- Informational: information flows only from the mobile application to the user; uni-directional information flow to the user; information push from the application to the user
- Reporting: information flows only from the user to the mobile application; uni-directional flow from the user; information pull by the application from the user
- Interactional: information flows in both directions between the user and the mobile application; bi-directional flow between user and application; information push and pull

Transaction dimension: Some mobile applications provide capabilities for purchasing goods or services, normally through a financial transaction, while others do not. The transaction dimension captures this characteristic.

- Transactional: user can purchase goods or services through the application
- Non-transactional: user cannot purchase goods and services through the application

Public dimension: Mobile applications may be available to the general public, or their use may be limited to members of specific groups, such as certain employees of a business. The public dimension relates to whether the application is generally available.

- Public: application can be used by any user; may be limited to a group but any user may self-select to be part of the group that uses the application
- Private: application can only be used by a pre-selected (by a third party) group of users

Multiplicity (or participation) dimension: Although mobile applications can be used by many users simultaneously, users are often not aware of this characteristic and view their use of the application as singular. With some applications, such as multiple user mobile games, the user knows that he or she is part of a multiple-user community using the application. The multiplicity dimension captures this concept.

- Individual: one user; user experiences the application as if he/she were the sole user
- Group: multiple users; users view use of the application as part of a group

Location dimension: Some mobile applications provided customized information or functionality based on the user's location, whereas other applications do not depend on where the user is located. The location dimension deals with whether the location of the user is used to modify the application.

- Location-based: mobile application uses the user's location
- Non-location-based: mobile application does not use the user's location; note that the mobile application may know the user's location but it does not use this knowledge to modify the way the application functions.

Identity dimension: Like the location dimension, some mobile applications adjust their information or functionality based on an awareness of who the user is, whereas other applications do not depend on the user's identity. The identity dimension relates to whether the identity of the user is used to modify the application based on the user's identity.

- Identity-based: mobile application uses the user's identity
- Non-identity-based: mobile application does not use the user's identity; note that the mobile application may know the user's identity but it does not use this knowledge to modify the way the application functions.

Categorization of Sample Mobile Applications

To explore the efficacy of these candidate dimensions and categories, we now apply them to a variety of mobile applications. For each application, we give its category within each dimension.

Purchasing location-based contents (*local information, routing, etc.*): synchronous, informational, transactional, public, individual, location-based, identity-based (although anonymous version may be developed to address privacy concerns)

Mobile inventory management for a company: asynchronous, reporting, non-transactional, private (used by a company authorized person), individual, location-based (location of inventory items), identity-based (only a few authorized users can perform and manage such inventory)

Product location and tracking for individuals (e.g., searching for a certain plasma TV in a given city): asynchronous, informational (information moves from sensors to the service and then to the user), non-transactional, public (can be searched by anyone), individual, location-based (finding location of the searched items near the user's location), non-identity-based (user identity is not important for the application)

Mobile auctions: synchronous, interactional, transactional, public, group, non-location-based, identity-based (anonymous mobile auctions could be developed in the future)

Mobile games: synchronous, interactional, transactional, public, individual (simple mobile games) or group (multi-user interactive mobile games), non-location-based (although a few games use the users' location to initiate the game), identity-based (user's identity may be virtually represented as avatars, service providers only have user's your identity for billing purposes)

Mobile financial services (mobile banking): asynchronous, interactional, transactional, public, individual, non-location-based (although locating the closest ATM machine may need user's location), identity-based (bank has to verify user's identity)

Mobile advertisement (both user-specific and location-specific): asynchronous, informational, non-transactional (mobile shopping that may follow a mobile advertisement is transactional), public, individual, non-location-based for non-location-specific advertisements and location based for location-specific advertisement, non-identity-based for location-specific advertisements and identity-based for user-specific advertisement

Mobile entertainment services (stored contents-on-demand, live events): synchronous, informational, transactional (specific contents or live events must be requested and purchased), public, individual, location-based (the network needs to use the user's location to "optimally" stream the contents), non-identity-based (due to privacy concerns depending on the type of contents)

Mobile personal services (mobile dating): asynchronous, interactional, transactional (depends on what people are looking for), public, individual, non-location-based (but if the user wants to be alerted every time a potential date comes within a certain distance of the current location, it will become a location-based service), non-identity-based (at least in the beginning due to privacy concerns)

Mobile distance education (synchronous and asynchronous versions): asynchronous (off-line) or synchronous (on-line), interactional (to be most effective it should be), non-transactional (unless the user needs to pay for each lecture or assignment), public (some distance education may be open to anyone) or private (limited to paying students/executives), individual, non-location-based (that is why we are interested in mobile distance education), identity-based (unless no student evaluation is required)

Mobile product recommendation systems: asynchronous, informational, non-transactional, public, individual, non-location-based, non-identity-based (the user needs to know about some products but does not want anyone to know that he/she asked for this service)

Wireless patient monitoring: synchronous, reporting, non-transactional (although a set of steps may have to be followed based on patients vital signs), public (home monitoring) or private (limited to the residents of a nursing home), individual, location-based (needed to help the patient under monitoring), identity-based (service does not want to get sued if service delivers the needed healthcare to some other patient by mistake)

Mobile telemedicine: synchronous, interactional, non-transactional (a set of steps may have to be followed based on patient condition), private (limited to patients of a hospital or a nursing home), individual, non-location-based (mobile telemedicine is suppose to free-up locational constraints), identity-based (patient-centric care or consultation by experts)

Conclusion

This paper describes our on-going work towards developing a taxonomy of mobile applications based on dimensions that characterize the user's interaction with the applications. We present multiple candidate dimensions that describe the main characteristics of mobile applications. We use these dimensions to characterize several mobile applications including location-based services, mobile financial services, mobile personal services, mobile entertainment services, and mobile telemedicine in an effort to show how the applications may fit in the proposed taxonomy. Our next steps in this research are to refine the proposed dimensions, possibly by adding, deleting, changing, or combining dimensions, and to continue to test their efficacy at categorizing mobile applications in an effort to develop a useful taxonomy of mobile applications. For example, we are exploring whether the communication and transaction dimensions should be combined into a single task dimension, and whether a general user context dimension should be added to the taxonomy, possibly subsuming the location and identity dimensions.

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