

Towards a Reference Model for M-Commerce over Ad Hoc Wireless Networks

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Abstract

Wireless trading outside established computer networks is an emerging class of mobile application for which there seems to be a growing demand. However, better understanding of the complex issues at stake is needed before effective systems of this kind can be designed and built. Developing a reference model is one way to provide this understanding.

Keywords: ad hoc m-commerce, e-commerce, mobile computing, online auctions.

1 INTRODUCTION

Performing m-commerce transactions over ad hoc wireless networks or ad hoc m-commerce can be considered as wireless trading outside established computer networks. The use of ad hoc wireless networks enables users to engage in m-commerce transactions anywhere at anytime, by utilizing computing resources available on other devices in their proximity without the need for infrastructure support from a network service provider [1].

However, to make ad hoc m-commerce a reality, it is important to clearly understand ad hoc wireless networking as well as m-commerce concepts, requirements and challenges. Therefore, having a reference model should help to grasp the key issues involved in trading wirelessly among computing nodes in the absence of a network service provider. It will facilitate discussion on distinguishing aspects and issues of ad hoc m-commerce as well as be useful in identifying and facilitating Research and Development (R&D) for a wide range of ad hoc m-commerce applications. A reference model will:

- Establish a taxonomy of terminologies, concepts and definitions required for describing ad hoc m-commerce.
- Identify all the functional elements in ad hoc m-commerce systems and clarify dependencies among them.
- Identify any issues that might restrain the development of ad hoc m-commerce systems that need to be addressed to realise it practically.

2.0 M-COMMERCE

2.1 M-Commerce Definition

The term m-commerce has been defined in a variety of ways in different literatures [2-7]. Some of these definitions seem to restrict m-commerce to business transactions that are conducted solely over a mobile telecommunication network and involve the transfer of monetary values. However, m-commerce transactions do not necessarily involve the transfer of money and can be conducted over other means of wireless communication. Furthermore, all commercial transaction steps need not be carried out electronically. While some transactions are initiated and completed electronically, some transactions may be initiated electronically but completed off-line.

Therefore, in this paper, m-commerce is defined as a set of activities relating to the exchange of information, services and goods for either money or other information, services and goods, which is conducted fully or partly online over wireless technology using mobile devices. In a fully online transaction, all transaction processes, which include the advertising, negotiating, ordering, payment and delivery processes, are conducted electronically. In a partly online transaction, the transaction may be initiated electronically but not completed electronically. Steps like the advertising, negotiating and ordering processes may be done online but other steps like payment and delivery processes may be done off-line.

M-commerce has several unique characteristics. Based upon different literatures [4, 8-10], m-commerce's distinguishing characteristics can be summarized as follows:

- *Location Independence*
The use of mobile devices allows users to access m-commerce applications regardless of the time and their place.
- *Motion Independence*
The portability of mobile devices, the pervasiveness of mobile network access and widespread m-commerce service availability makes m-commerce transactions possible even when users are on the move.
- *Localizability*
Technologies like Global Positioning System (GPS) enable users and mobile network operators to locate each other and to make access to information and services specific to their location.
- *Personalisation*
Mobile devices are usually not shared among users. This enables users to extensively customise these devices to their individual informational and service requirements.

2.2 M-Commerce Functional Components

M-commerce systems involves various disciplines and technologies [11]. In order to have a clear understanding of m-commerce systems, it is essential to identify all the components that comprise the system as well as to recognize their functions and also their dependencies with one another. To facilitate this, Hu, Lee and Yeh in [11] have divided m-commerce systems into six components as illustrated in figure 1.

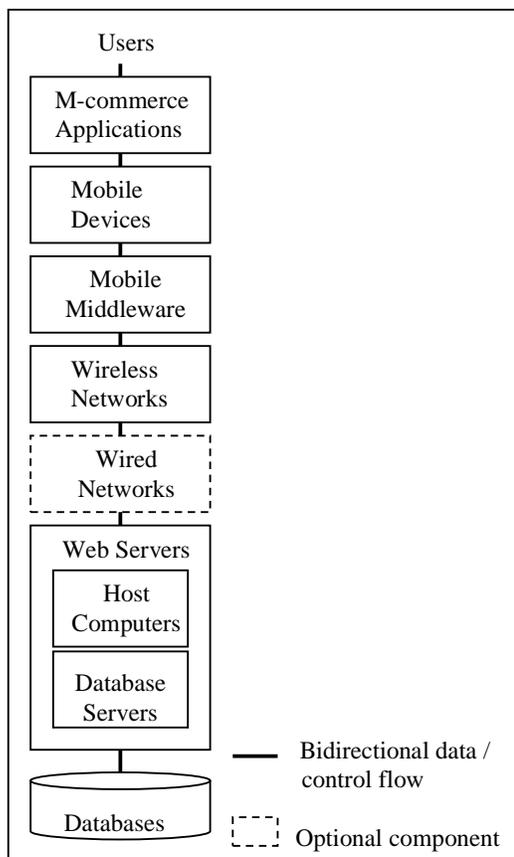


Figure 1: A Mobile Commerce System Structure (Hu, Lee and Yeh, 2004)

i. Mobile Commerce Applications

There are a wide variety of existing and potential m-commerce applications. These applications can be classified into several classes as listed in table 1.

Class of Applications	Examples
Information	News and Weather Maps and travel related information Logistical information Emerging service information
Entertainment	Sports, Games and Gambling e-Books, e-magazines Movies, images and music Streaming media
Financial	Banking Mobile Auctions Booking and Reservation Online shopping and stock trading
Marketing and Advertising	Mobile coupons and promotions

Table 1: Classes of M-commerce Applications

- ii. Mobile Stations or Devices
Mobile devices with sufficient power in terms of memory, display and communications functionalities enable consumers to engage in m-commerce transactions regardless of time or location. Mobile devices include cell phones, personal digital assistants (PDAs), laptop computers, vehicle mounted computers and so on.
- iii. Mobile Middleware
Mobile middleware can be defined as an enabling layer of software that joins together different mobile applications, networks and technologies via a common set of interfaces [12]. Mobile middleware enables m-commerce applications to function with greater reliability as well as to provide better response times. This includes middleware that supports intelligent restarts where information transfer will continue from the break point after a network connection disruption [12].
- iv. Wireless Networks
In addition to mobile devices and middleware, networking support from wireless networks plays an important role in realizing m-commerce applications as mobile users need to go through a wireless network connection in order to perform m-commerce transactions. There is a broad range of wireless networking technology that is available to provide a network support required by m-commerce which includes operator-driven networks like GPRS and UMTS, wireless LAN via Wi-Fi (Infrastructure and Mobile Ad Hoc Wireless Network and wireless PAN via Bluetooth.
- v. Wired Networks
Although this component is an option, most computers or servers that are used to execute transaction processes and store all the transaction information usually reside on wired networks.
- vi. Host Computers
Host computers are computers or servers that are used to process and store m-commerce transaction related information such as Web servers, database servers and so on.

2.3 Main Entities in M-Commerce System

Generally, there are four main entities in m-commerce systems [13].

- i. Customer
The person who is mainly mobile and makes use of the m-commerce system for the purpose of obtaining and paying for contents, products or services offered by merchants or content/service providers.
- ii. Merchant or Content/Service Provider
The entity that provides the contents, products and services to customers either directly or through a mobile network operator.
- iii. Mobile Network Operator

The entity that provides the network connectivity that links customers, merchants and financial institutions.

iv. Financial Institution

The entity that provides the payment mechanism such as EFTPOS or ATM service.

2.4 Entities Relationships in the M-Commerce Value Chain

Entity relationships in an m-commerce value chain can vary depending on the types of transactions. For example, a relatively simple transaction such as buying a soft drink from a vending machine would only involve a customer, mobile network operator and the vending machine that supplies the soft drink as illustrated in figure 2 [13]:

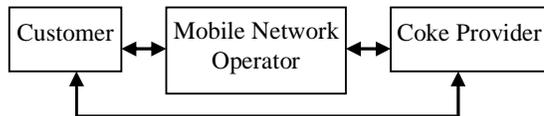


Figure 2: Relationship involving customer, mobile network operator and vending machine.

In this scenario, the customer has relationships with both the mobile network operator and the vending machine. The mobile network operator charges the customer for using its service to purchase the soft drink by adding the cost of the soft drink to the customer's mobile phone bill.

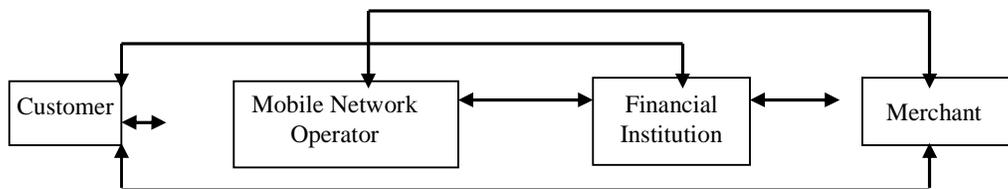


Figure 3: Relationships involving financial institutions

Figure 3 shows a more complex m-commerce transaction involving a financial institution. In this scenario, the customer has a relationship with the mobile network operator, the financial institution and also the merchant [13]. The mobile network operator enables the transaction to take place by providing mobile services to the customer. To purchase products, the customer needs a relationship with the financial institution that handles the transaction payments. The customer will also need a relationship with the merchant for the goods purchased.

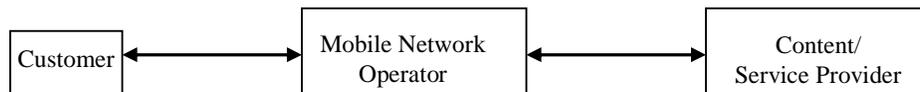


Figure 4: Relationship involving customer, mobile network operator and content provider

Another scenario as shown in figure 4 is a relationship between a customer and mobile network operator and also a relationship between a network operator and content provider [14]. The customer obtains the content or service from its provider through its mobile network operator and pays the operator who remunerates the content or service provider in turn.

2.5 M-Commerce Requirements

Although different m-commerce applications have different requirements, in general m-commerce applications have the following requirements:

- Adequate quality of service in the wireless network to avoid delays that may affect the performance of m-commerce applications.
- Reliability in the wireless network so that users can access m-commerce applications, even under varying degrees of network failure.

- Ability to roam across multiple heterogeneous networks so that users can access m-commerce applications from anywhere.
- End-to-end security supported so that trading parties can trust the other trading parties to provide their service at an acceptable level of risk.
- Convenience and usability so that users can perform m-commerce transactions easily and unproblematically.

3.0 M-Commerce Issues

i. Mobile Devices

Mobile devices have limitations in terms of battery life, resources and display capabilities.

- **Battery life**
Mobile devices have limited battery lifetimes and thus there is a limited time during which they can operate without recharging their energy resources. This limitation restricts mobile devices from performing complex and energy intensive computations because such computations would require and consume more power and thus would drain the battery faster. Moreover, the use of a wireless medium for data transmission can make the battery life shorter as it consumes significant energy [3]. Therefore, mobile devices cannot be expected to be always available in a network like stationary computing devices. Users may cut their wireless connection to the network in order to reduce power consumption or the battery of a mobile device may lose all its charge.
- **Limited resources**
Mobile devices have limited resources in terms of CPU capacity, storage capacity and processing space due to their small size and portability. These limitations restrict the amount of computation that can be performed and also the amount of data that can be stored on these devices.
- **Small screen and keypad**
The small screens and limited text input capabilities of mobile devices limit the size of information that can be displayed and make data entry more difficult. Also, they offer limited capabilities for high quality graphical display as the images have to be little enough to fit onto the small screens [3].

ii. Wireless networks

- **Bandwidth**
Wireless networks have limited bandwidth. Although they are expected to come to have higher bit rates, the transmission rates in many wireless networks such as in cellular or satellite networks are still low as compared to wired networks [3]. This is partly because wireless communications are rather more error prone and require much redundancy in the channel coding of the payload [3].
- **Connectivity**
Wireless networks are less reliable due to their frequent network disconnections. Factors that can cause network disconnections include lack of network coverage, cell interference, changes in the signal strength and limited battery lifetime of mobile devices. In some m-commerce applications such as mobile financial, mobile entertainment and so on, continued network connectivity is one of the most important requirements as discontinued connections may affect the result of transactions.
- **Variant tariffs**
Different networks have different network access charges. In some networks, network access is charged per connection-time for example in cellular telephones, while in some other networks, it is charged per message or per session and so on [3].
- **Asymmetric Communications**
Channels in wireless networks may be asymmetric [15]. The bandwidth available for uploading data may be rather lower than the bandwidth available for downloading data.

iii. Security

There are at least three aspects of security that need to be considered: the security of mobile devices, the radio interface and payment systems.

- **Mobile devices**
Due to their small size and portability, mobile devices are prone to be stolen, lost or accidentally damaged. Since these devices are highly personalized and are often used to store confidential user information, it is important to protect not only the data that is transmitted through the network but also the data that is stored on the device itself. However, due to their limited computation capabilities and memory size, it is difficult to utilize high level security schemes on those devices.
- **The radio interface**
Performing electronic transactions over wireless networks is inherently insecure as compared to wired networks [14].
 - a) The use of a radio interface as a communication medium introduces additional security attacks. The broadcast nature of the radio transmission medium makes it easier for attackers to intercept and spoof on going traffic if no security mechanisms such as communication encryption are employed. With regard to communication, there are three common attacks that are likely to occur [16].
 - i) **Disclosure attacks**
Disclosure attacks are where the confidentiality of data transmitted over the network is compromised by its contents being revealed to other parties that are not involved in the communication. Such attacks can occur in a variety of ways which include eavesdropping, masquerading, traffic analysis and so on.
 - ii) **Integrity attacks**
Integrity attacks are where the contents of a message being transferred over the network is illegally altered or deleted or resent.
 - iii) **Denial of service attacks**
In this kind of attack, access to the network is made impossible by flooding and overloading the network with either valid or invalid messages.
 - b) Frequent handoffs and disconnections due to path loss, fading and interference can degrade the service levels of security services.
 - c) The mobility of mobile devices introduces an additional difficulty in identifying and authenticating those devices in the network.
- **Payment System**
M-commerce applications, especially those involving mobile payments require secure information exchange as well as safe electronic financial transactions. Without a secure payment system, neither customers nor merchants may be prepared to engage in monetary m-commerce transactions. For instance, both parties that are involved in a financial transaction would want to authenticate each other before committing to any payment. Also, they would want assurance on the confidentiality and integrity of the sent payment information as well as effective support for non-repudiation to prove that a transaction has happened.

iv. Social, Ethical and Legal Issues

To avoid risks such as legal actions, brand damage and so on, entities that are involved in m-commerce transactions must ensure that all m-commerce activities such as services, transactions, payments and so on, comply with government and industry regulations as well as their internal policies [17]. Below are some of the regulatory issues that need to be addressed:

- **Data protection and data breaches**
Regulations related to the protection of subscriber data, identity theft and the reporting of data breaches.
- **Digital rights**
Digital content such as music, clip art, videos and so on are subject to intellectual property (IP) constraints such as copyright, trademarks and so on.
- **End-user privacy**

Regulations related to consumer protection and privacy laws in order to ensure consumer privacy is not violated.

- Child protection
Regulations related to offering, accessing and purchasing of adult related content, products and services. For example, age verification is required before accessing or purchasing any adult related content, products or services.
- Money laundering and gambling
Regulations related to electronic money transfers, money trafficking issues and so on.

4.0 M-Commerce over Ad Hoc Wireless Networks or Ad Hoc M-Commerce

Unlike infrastructure-supported m-commerce, ad hoc m-commerce takes place between 2 or more mobile devices that are in the vicinity of each other without relying on the services of any infrastructure. These devices are peers. They communicate and cooperate with each other by utilizing their local resources and also their neighbours', without relying on any support provided by a network service provider, to accomplish the transaction or any other tasks.

Thus, ad hoc m-commerce can be said to have the following characteristics:

- i. No network service provider
Because ad hoc wireless networks lack a network service infrastructure and are self-organized, a network service provider cannot be relied upon to be present to provide security or payment services whenever nodes engage in m-commerce transactions. Unlike GPRS and UMTS mobile networking, there is no telecoms operator available to underpin m-commerce transactions as a value added service to the basic communication service.
- ii. Limited communications scope
IEEE 802.11 (Wi-Fi) and Bluetooth have limited communication ranges. The effective range for Bluetooth is 10m although it can cover up to 100m radius [18] while the transmission range for Wi-Fi is 100m in buildings and can cover up to 300m radius in open spaces [19]. Therefore, such networks are suitable for short range node to node communication. While nodes can bridge gaps by routing information over multiple hops via nodes in between themselves and so extend the range of such networks, those ad hoc connections via intermediaries may not be long lasting and may not be available much of the time due to the dynamic topology of the network. So, much of the time it is not to be expected that there can be a suitable third party service available that is trusted by communicating peers to support security and/or payment in real-time among the peers.
- iii. Limited time online
Due to limited battery lifetimes and the mobility of mobile devices as well as frequent network disconnections, there is a limited time during which these devices can be online, which restricts them from engaging in lengthy and complex transaction processes. This means that transactions need to be completed in a fairly short period and only comprise a few simple stages if they are to have a good chance of success. Therefore, realistic transactions must not involve long sessions or complex processes. Since mobile devices are peers and these devices themselves can become the service or information provider as well as the consumer, the limited time online restricts a trusted service or information provider from providing ubiquitous services or information to other devices in the network. Moreover, it is impossible to have long-term third party security or payment services available all the time in the network. However, it is possible to have intermittently available third party services although often not in real time.
- iv. Spontaneous decisions in Ad Hoc Settings
The self-organizing characteristic of an ad hoc wireless network allows users that are equipped with mobile devices to spontaneously engage in m-commerce transactions when the need arises while they are on the move. For example, passengers in two cars near each other in slow traffic can establish an ad hoc wireless network connection and exchange video clips while within range of each other.

v. Low cost

An ad hoc wireless network provides a low cost wireless connection for users to engage in m-commerce transactions. No additional device is required to perform m-commerce over an ad hoc wireless network as mobile devices that form the network will utilize their local resources and also resources on other devices that are in their proximity area in order to accomplish the transactions. The cost of purchasing or renting additional devices such as special server(s) that are used to process the transaction as well as to store transaction information is eliminated. Also, buyers or traders save on network access charges as there is no subscription fee required to access the network.

vi. Confidentiality

Because no third party needs to be involved to realise network communication, the range of wireless communication is limited, and can be conducted on the move, ad hoc m-commerce is suitable for confidential commercial exchanges where the trading parties do not wish their exchange to be known or guessed at by external parties. For example, two or more parties may exchange their confidential corporate or business information such as business proposals, marketing strategy information deals and so on while they encounter or merely pass close by each other.

4.1 Functional Components

It is likely that only the first four functional components discussed in section 2.2 above are required to construct an ad hoc m-commerce system. This is due to the fact that the network is often spontaneously and temporarily created when the need arises among mobile devices that are in close proximity to each other without relying on any infrastructures.

However, there is a slight difference in the fourth component where an ad hoc wireless network like mobile ad hoc network (MANET) or Bluetooth is used as a medium to carry out the transactions as shown in figure 5.

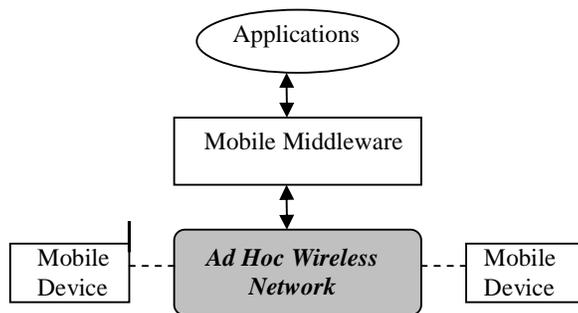


Figure 5: Four Main Functional Components in an Ad Hoc M-Commerce System

Therefore, the design and development of m-commerce applications as well as mobile middleware must consider the unique characteristics of an ad hoc wireless network.

4.2 Main Entities

Since the transactions involve only mobile devices that are peers and have no guarantee of infrastructure support from a network service provider, there are only two essential entities involved in ad hoc m-commerce.

i. Customer or Trader

The person who is mainly mobile and make use of the ad hoc wireless networks to buy the digital contents, products or services offered by the seller or to trade contents, products or services for others.

ii. Seller or Trader

The person or entity that provides the digital contents, products or services directly to customers via ad hoc wireless networks for money or who trades contents, products or

services for others. In this situation, the seller may also be stationary for example, a vending machine.

Nevertheless, as different type of transactions would have different entity relationships, there are several possible essential entity relationships in the ad hoc m-commerce value chain as illustrated in figures 6 -11.



Figure 6: Transactions between two mobile devices

Figure 6 illustrates a relatively simple transaction involving two mobile devices. For example, two people who are commuting in a train agree to exchange their e-magazines while they are within transmission range of each other.

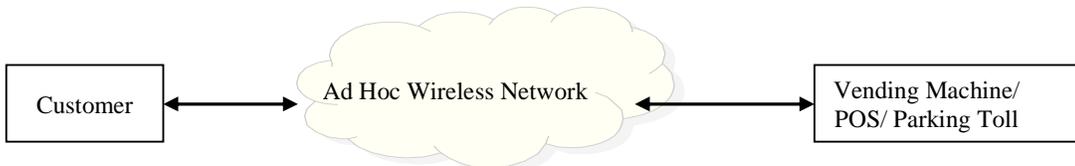


Figure 7: Transactions between a mobile device and a vending machine.

Figure 7 shows that mobile devices such as mobile phones and PDAs can also be used to purchase drinks or snacks from a vending machine, or make payment at Point of Sales (POS) or parking tolls, without the need for cash. E-cash credits can be preloaded and used via a Bluetooth or Wi-Fi technology to communicate with the vending machine, POS or parking toll.

In a more complicated scenario where more than two mobile devices are involved in a transaction such as an auction, the entity relationship can be illustrated as below.

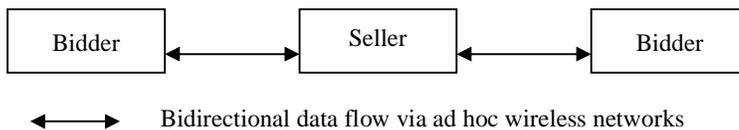


Figure 8: Transactions involving more than two mobile devices.

Figure 8 is also applicable in a mobile gaming or gambling scenario involving more than two players. For example, in a blackjack scenario, where one party will act as the dealer of the game and the other parties who join the game will be the players.

Figures 9 and 10 illustrate two scenarios involving the formation of an ad hoc trading consortium among mobile users who are in the vicinity of each other and agree to band together for a specific purpose, for example to make a collective purchase (figure 9) or to involve in a group trading (figure 10).

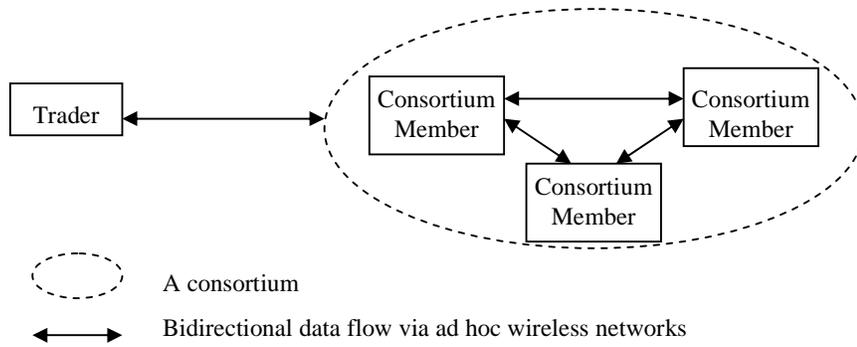


Figure 9: A group of individuals forming a consortium for trading

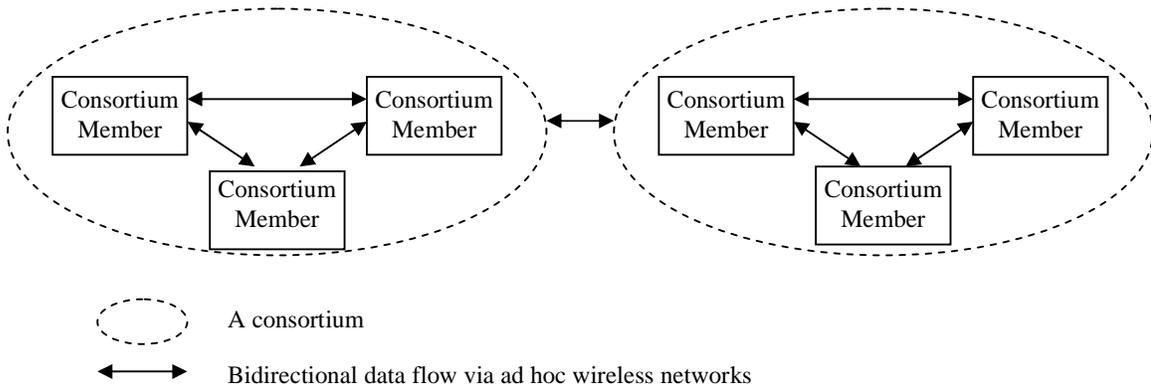


Figure 10: Trading between two consortiums

Figure 11 shows a delegated trading scenario where an electronic I Owe U (IOU) is used to acknowledge debt between two parties trading via an ad hoc wireless network. As an example, figure 11 below illustrates a scenario in a local community where Trader 1, who has a toaster, wants to trade it for an electric kettle. Trader 2, who is within Trader 1's communication range and owns an electric kettle, agrees to trade his electric kettle with Trader 1 but does not want a toaster. So, Trader 1 issues an electronic IOU signed by himself to Trader 2 as an acknowledgement of his debt to Trader 2. Trader 2 can later use that electronic IOU to trade for another item such as a pram that she wants with Trader 3, who wants a toaster. Trader 3 will then use the electronic IOU signed by Trader 1 and Trader 2 to settle with Trader 1 for his toaster.

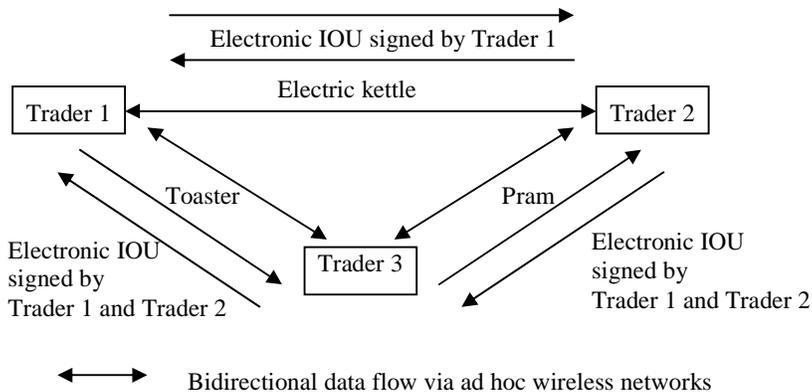


Figure 11: A delegated trading scenario.

As such, to represent different entity relationships in ad hoc m-commerce value chain, a generic view of ad hoc m-commerce transactions is illustrated as figure 12.

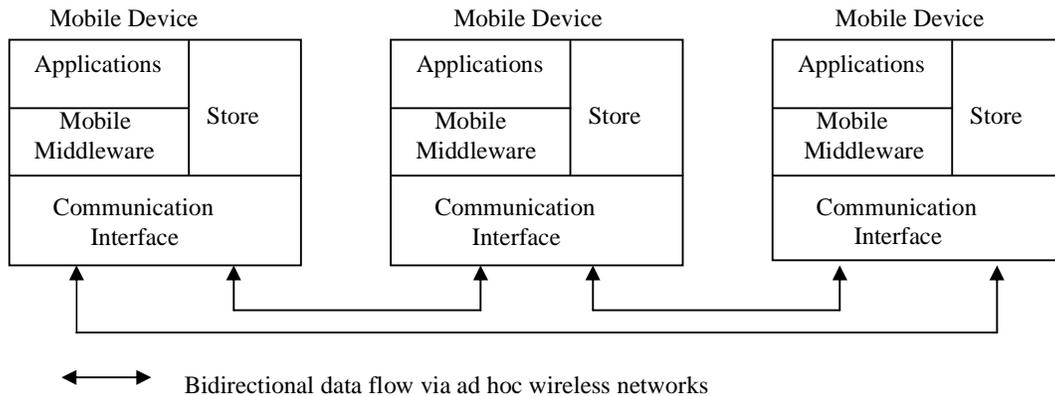


Figure 12: A generic view of ad hoc m-commerce transactions. The ad hoc m-commerce store will held certificates, attestations, offers and IOUs.

4.3 Types of Applications

There are several distinct types of m-commerce transactions that can be carried out over ad hoc wireless networks:

- i. **Swapping of digital resources**
Swapping of digital resources such as ebooks, videos, music files etc. For example, two people who meet by chance at an airport may agree to exchange an MP3 pop song for an amusing video clip.
- ii. **Mobile Auction**
The process of buying or selling certain items could be realised by an auction among a local group of people. An auction process can be created anywhere as soon as a group of at least three persons with mobile devices and shared software agree to participate. This type of activity is amenable to short term participation by individuals and a rapid turnover in its membership as long as enough are usually present to create a critical mass of bidders. Multicasting among participants can disseminate bids and information about what is on offer.
- iii. **Mobile Entertainment**
Interactive gaming and gambling among small groups of people is another kind of application suited to ad hoc networking. Applications running on mobile devices realise the game or gambling scenario, manage its communications and handle the turnover in participants. For example, people play blackjack over a mobile ad hoc wireless network using mobile devices like laptop computers, PDAs or computers in cars.
- iv. **Transacting with Machines**
Transactions that use mobile devices that are preloaded with E-cash to make payment at a vending machine, point of sales (POS), parking tolls and so on via technologies such as Wi-Fi and Bluetooth.
- v. **Confidential Exchanges**
Two or more parties who meet at a certain place or pass in the vicinity of each other may agree to exchange their confidential information resources or services for a specific purpose as mentioned in the example given in section 4.0 (vi).
- vi. **Consortium Trading**
A group of individuals who are in the vicinity of each other and equipped with mobile devices can spontaneously and temporarily form a consortium for a specific purpose. For example, a group of football fans at a football ground, band together as a single buyer to purchase a discounted group ticket in order to get cheaper ticket for each of them to watch a match. Another example would be a group of football fans who form a consortium during a football match to engage in betting on the outcome with another group of football fans as illustrated in figure 10 above.

vii. Electronic IOUs

'I Owe U' or its abbreviation 'IOU' is an established means to acknowledge a small debt usually among friends or family members. This form of acknowledgement can be passed electronically via an ad hoc wireless network among trading parties who are in close proximity with each other. It can be signed to verify its authenticity and the identities of all handling parties.

4.4 Issues

Performing m-commerce transactions over ad hoc wireless networks introduces additional issues and challenges. In addition to the above issues, ad hoc wireless networks have specific issues that need to be considered. However, issues related to variant tariffs are not applicable to ad hoc wireless networks as no access fee is required to access the network.

Other issues that need to be considered when performing ad hoc m-commerce:

i. Transaction management

Due to its unique characteristics such as lack of infrastructure, having a dynamic network topology and using resource constrained devices, it is a challenge to implement efficient transaction processing and updates in purely ad hoc wireless networks. Most solutions used in infrastructure based m-commerce depend on a client/server model where data is primarily placed on servers located within the wired network and mobile devices act as clients accessing the services provided by the servers [20]. However, in ad hoc wireless networks, all devices are peers and normally have similar constraints on their resources. Thus, those devices act as both servers and clients. The mobility of mobile devices that provide services (servers) to other devices is an important issue as the services are prone to becoming unavailable due to network disconnections. Also, the atomicity of a transaction can be difficult to enforce as network disconnections can cause a particular service in a transaction sequence to fail and thus the transaction would be considered incomplete and be aborted [20].

ii. Service Discovery and Delivery

A service discovery and delivery protocol enables devices to advertise their services to other devices as well as to discover services offered by other devices in the network. However, due to the unique characteristics and complexities of an ad hoc wireless network, existing service discovery and delivery protocols do not seem to suit the needs of an ad hoc wireless network, making them unsuitable for m-commerce oriented scenarios. Service advertisements and deliveries may need to be disseminated by a mix of a store and forward strategy as well as local multicasting to cope with intermittent online connectivity.

iii. Trust

Trust is essential in any online transactions as it helps the participating parties to feel confident to engage in such transactions by mitigating uncertainty and risks involved in the transactions, such as uncertainty about trading partners' behaviour in fulfilling the transaction agreements [21]. However, as ad hoc m-commerce cannot rely on a network service provider to provide security services such as certification authority (CA) that can help to establish trust among nodes in the network, nodes have to rely on their peers in the network to provide trust evidence in order to evaluate other nodes' trustworthiness. Yet, the nature of an ad hoc wireless network such as lack of infrastructure services, having a dynamic network topology, using resources constrained devices and so on, makes trust establishment in this network difficult to achieve.

4.5 Security Requirements

To create a significantly secured and trusted environment for a transaction to take place as well as to give confidence to trading parties to engage in a transaction, the following security services are essential.

i. Confidentiality

Confidentiality ensures that transaction information sent across the network is unreadable by unauthorized third parties such as eavesdroppers or peers acting only as communication relays.

- ii. Authentication
Authentication enables trading parties involved in m-commerce transactions to confirm the identity of each other before any transactions are made among them. This service provides assurance that an unauthorized third party is not masquerading as a legitimate party.
- iii. Integrity
Integrity guarantees that a message being transferred is not illicitly altered or destroyed during the transmission without this being detectable at the receiver side of an m-commerce system.
- iv. Non-repudiation
Non-repudiation ensures that if an entity sends a message, it cannot get away with denying having sent the message. In m-commerce transactions, neither sender nor receiver should credibly be able to repudiate offers or bargains struck between them. The sender should not be able credibly to deny having sent the transaction message and the receiver should be able to prove that the transaction message can only have been sent by the specified sender and thus able to prove that a transaction has taken place between them.

In addition to the above, as m-commerce transactions involve the risk of misbehaviour among the trading parties, they need support in gauging the level of trustworthiness of other trading parties. Hence, attestation is another important security service for ad hoc m-commerce.

- v. Attestation
Attestation enables ad hoc m-commerce peers to vouch for the identity, trading history or transaction reputation of other peers. It helps mitigate risks in transacting with previously unknown parties. Figure 13 illustrates a transaction involving trust established through a third party.

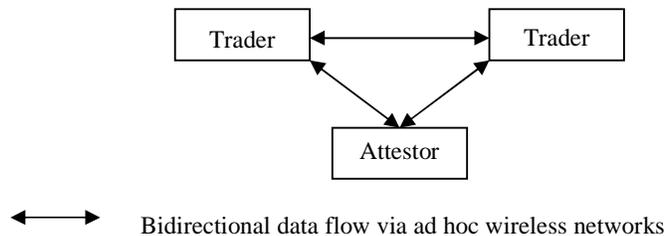


Figure 13: A transaction involving trust established through a third party

5.0 Conclusion

Wireless trading outside provider networks seems most suited to fully online resource swapping and also to online launched trading in local communities where parties can easily meet to transfer goods and payment as agreed. However, as discussed above, supporting such trading is more challenging as compared to wireless trading within provider networks.

Therefore, the elements of a reference model have been proposed to serve as a basis for understanding the nature as well as the requirements for performing such trading.

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