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Mapping the mobile landscape in Australia

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Abstract
The wireless economy is expanding internationally, led by the popularity in mobile phones. We view the wireless economy as growing in three distinct, but inter–related areas: consumer transactions (mCommerce), enterprise solutions (mEnterprise); and, other services to individuals and organisations (mServices). This paper surveys the wireless landscape, specifically from a non–technologist's perspective, while providing wide–ranging and contemporary examples of mobile applications in Australia.

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Introduction: Untangling the terms

The development of a mobile but interconnected world has gained significant momentum following advancements in the technology of mobile phones, portable computers and wireless data communications. Wireless applications show vast potential, ranging from personal e–payment services and intra–business operations to inter–business supply–chain integration. Many applications require a complex network of providers and intermediaries to deliver the product or service offered, while others are based on simple intra–organisation networks. Roger Clarke (2003) provides a comprehensive outline of wireless transmission and mobile technologies that clarifies some of these complexities. However, generally, wireless applications have one or more of these seven types of characteristics: time critical services, location–aware and location–sensitive services, identity–enacted services, ubiquitous communications, content delivery services, business process streamlining, and mobile offices and personal information management (Liang and Wei, 2004). These characteristics are discussed in this paper.

In this paper, we view the wireless eCommerce landscape as growing in three distinct, but inter–related, areas: consumer transactions (including sales of goods and services, which most people would associate with mCommerce), enterprise solutions (mEnterprise; for example, supply chain solutions or logistics applications), and other services to individuals and organisations (mServices; such as mobile banking and wireless communications in health). The paper discusses activities in these three areas and identifies the regulatory challenges to be addressed by governments and by industry as these areas expand.

Untangling the terms: mCommerce, eCommerce and the mobile Internet

The wireless environment is sometimes described as mobile commerce (mCommerce) or mobile Internet but is broader than these terms. Although the terms *mobile* and *wireless* are often used interchangeably, *mobile* pertains to the ability of an entity to be on the move, while *wireless* refers to the technology that allows transmission of voice, data and other content through radio waves over the air (Deshpande, 2002).

Electronic commerce
(eCommerce) is a broad concept covering any trade or commercial transaction effected via electronic means; this would include such means as facsimile, telex, EDI, Internet, and the telephone. For the purpose of this report, the term is limited to those commercial transactions involving computer–to–computer communications whether utilising an open or closed network (Electronic Commerce Expert Group, 1998).

Mobile commerce
(mCommerce) has been defined as the ability to use mobile wireless devices as a secure method to purchase goods, services or digital content (Australian Communications Authority, 2003). Specifically, eCommerce involves computer transactions while mCommerce involves transaction via a mobile device, although there is some overlap with laptop computers. There are broader definitions of mCommerce, which use the term to include services involving communication, information, transaction and entertainment (Schwiderski–Grosche and Knospe, 2002). In this latter definition the 'mCommerce' label is used to describe all things 'wireless'. The narrower definition of mCommerce is used in this paper.

At a conceptual level, eCommerce and mCommerce share fundamental business principles, including similar business models based on remote transactions, and, as such, mobile commerce could act as another channel through which to add value to eCommerce processes (Coursaris, *et al.*, 2003; Narasimhan and Geetha, 2002). For both eCommerce and mCommerce, users are commonly required to buy hardware and pay a service provider for a connection, while transactions are generally conducted through a wireless portal for mCommerce or a World Wide Web site for eCommerce (Consumer Affairs Victoria, 2004).

Although eCommerce and mCommerce share a number of characteristics, there are differences between the concepts. For instance, Stafford and Gillenson (2003) argue that eCommerce is different because it is mostly transactional (buying and selling of tangible goods and services), while mCommerce is largely driven by sale of data products (such as ringtones or information services). In addition, there appears to be clear consumer preferences in mCommerce and eCommerce; for instance, a significant preference to purchase low–risk items using the mobile devices (Chae and Kim, 2003). In addition, low–intensity content is generally preferred for mobiles (*e.g.* ringtones) while high–intensity content (*e.g.* games) are more prevalent on personal computers.

Mobile devices
differ significantly from personal computers. Although mobile phones are the most common mobile device, they also include wireless–enabled handheld computers (palmtop, pocket, tablet computers and personal digital assistants or PDAs), wireless laptop computers, vehicle–mounted technologies, personal message pager devices, and other wireless products including watches, pens and music players (Tarrasewich, *et al.*, 2002; Dholakia and Dholakia, 2004). Each has certain characteristics affecting the services the end user can receive (*e.g.* display, input device, memory and processing power) (Schwiderski–Grosche and Knospe, 2002).

Mobile devices are far more limited in terms of processing capabilities and content display than personal computers. However, Dholakia and Dholakia (2004) suggests that mobile networks have many advantages over personal computer data networks. On the provider side, there are lower infrastructure and development costs, while networks are more scaleable than fixed lines. For consumers, mobile telephones incur lower fixed costs, while pre–pay and term payment mechanisms mean that they are available to people on restricted budgets.

Mobile devices are also used to connect to the Internet; a process often termed the *'mobile Internet'*. Essentially, the mobile Internet is only different from the fixed Internet in that it offers mobility to users. Personal computer access to the Internet is generally provided through a wired connection or a wireless router to a local area network (LAN) or Internet service provider. The mobile Internet, on the other hand, is connected through a cellular framework, which works on a network of low–power antenna subsystems dispersed in geographical units called cells (Tan and Teo, 2001). As a result, users can travel across jurisdictions and maintain

connectivity.

Advancements in wireless technology do mean, however, that the divide between the Internet and mobile networks is decreasing. For instance, General Packet Radio Service (GPRS) communications can facilitate access to the World Wide Web via mobile devices. Mobile data communication protocols such as WAP and i–mode are optimised for mobile usage. However, as foreshadowed by Khare (1999), many of their claimed advantages have been implemented within an Internet Protocol (IP) framework. Indeed, GPRS, Wideband Code Division Multiple Access (W–CDMA) and Enhanced Data rates for Global Evolution (EDGE) technologies can all support IP directly, and thus all the Internet services. Lawton (2005) provides a useful overview of the technologies and future trends.

Nevertheless, a number of essential characteristics differentiate the mobile data network other than merely 'mobility'. They are immediacy, context and location.

Immediacy
refers to the ability to access the Internet and communicate voice and data information instantly, without being bound to a fixed location. Communications networks such as those utilising satellite technologies also mitigate the restrictions on mobile devices in remote areas. Globalstar (2005), for example, offers 'satphones' which operate to geostationary satellites using either Global System for Mobile communication (GSM) or Code Division Multiple Access (CDMA), and are operated in a manner similar to a mobile phone.

The issue of *context*
is also greatly enhanced in relation to the use of mobile devices (Ryan and Gonsalves, 2005). In fact, one of the most important issues for wireless application developers is the perceived dynamics between the user and context (Dholakia and Dholakia, 2004; Coutts, *et al.*, 2003). Context can include environmental factors (e.g. physical location, distraction, crowding), social context (*e.g.* need for privacy and interaction with others) and personal factors (*e.g.* emotion, time on hand, movement) (Lee, *et al.*, 2005). Mobile devices can be used in a variety of contexts; travelling to work, relaxing in a café, or, waiting at an airport. As a result, mobile device users have a tendency to accomplish specific tasks that have meaning within that particular context. For instance, Lee, *et al.*, (2005) found that consumers most frequently used mobile devices when they had more time on hand or were off duty, and had little social interaction, distraction or crowding. Moreover, mobile devices are not normally shared, so they tend to carry some personal identity (Chae and Kim, 2003). For instance, the huge revenue from sale of mobile phone ringtones and logos illustrates users' attempts to personalise generic handsets. In fact, Coutts, *et al.* (2003) argue that the mobile device is 'not just a personal computer without wires', contending that users perceive there to be different values associated with personal computers and mobile devices, and as such they have different relationships between the two.

Mobile devices can also enable user *location*-identification. Not only can users engage in 'where am I' and 'where is this' –type services, but network providers are able to identify the user's location. Thus, in some circumstances, this information can be passed on to third parties, such as emergency services. Of course, this unique aspect of wireless communication has significant implications for privacy and security.

Mobile device application developers face many new challenges, not least that users may be unable to conceptualise innovative mobile services, limiting demand to the same types of services offered by the Internet (Narasimhan and Geetha, 2002). In other words, the conceptual leap between personal computer services and mobile device services may prove too great for some users, in some instances.

What is mobile commerce?

In this paper we have chosen to map the wireless landscape not in terms of the wireless technology used, as many studies have, but by focusing on the type of product or service wireless technology can deliver. This perspective allows us to place the 'transaction' – in whatever form it may take – at the centre of our studies. Wireless applications show vast potential, ranging from personal e–payment services and intra–business operations to inter–business supply–chain integration. Many applications require a complex network of providers and intermediaries to deliver the product or service offered, while others are based on simple intra–organisation networks. However, generally, there are seven types of wireless applications (Liang and Wei, 2004):

Table 1: Overview of the seven general types of wireless applications

Application	*Examples*
1. Time–critical services.	SMS alerts for stock prices.
2. Location–aware and location–sensitive services.	'Where am I?' type services. Point of need information (targeting advertisements). Niche consumer applications (golf course assistant). Corporate applications (fleet tracking). (Rao and Minikakis, 2003)
3. Identity–enacted services.	Mobile banking and micro–payments.
4. Ubiquitous communications.	Voice and data products.
5. Content delivery services.	Wireless news subscription service.
6. Business process streamlining (*e.g.* RFID technology).	Enterprise resource planning. Supply chain management applications. Enhanced customer relationship management. (Evans, 2002)
7. Mobile offices and personal information management.	PDAs.

While mobile devices (particularly mobile phones) have been widely adopted, the growth of mobile commerce has been limited due to a number of factors. Most of these centre around the technology and the security of the transactions. These are not absolute limits. They are bottlenecks that have slowed down the adoption of mobile commerce. They include:

- *Device Limitations*
  In comparison to desktop computers, wireless devices such as PDAs and mobile phones generally feature limited processing power, memory and battery life, which, along with design features such as small display screens and simple input mechanisms ensure that application developers face huge challenges in designing around these limitations.

- *Technology*
  Technological issues faced by the wireless industries relate to mobile devices (software requirements, inter–operability and protocols accepted) and communications infrastructure (optimisation and efficiency of bandwidth, communications interface, interference from other communications technologies now and in the future, and infrastructure costs) (Tarrasewich, *et al.*, 2002; Wu and Wang, 2005).

- *Security*
  Device limitations, along with different network configurations mean that wireless technologies present a higher risk from eavesdropping and hackers (Coursaris, *et al.*,, 2003). In fact a survey of 270 IT professionals in May 2002 found that the most significant barrier to the industry was unresolved security issues (Ware, 2002).

  However, the security problems inherent to wireless devices are not merely related to technical interference. A 2002 report suggests that 700,000 mobile phones are stolen each year in the U.K. alone (Schwiderski–Grosche and Knospe, 2002), highlighting the danger of increasing mobile device capabilities.

- *Reliability and Useability of Applications*
  Social issues, such as acceptance of mobile devices (Tarrasewich, 2003) and cultural fit with wireless applications, are also a primary consideration for the

> wireless markets. Interestingly, Wu and Wang (2005) found that perceived risk, cost, compatibility (degree to which the innovation is consistent with users' existing values, previous experiences and needs), and perceived usefulness of a wireless application all affected behavioural intention, which was strongly related to actual use. Of particular note, however was that compatibility of the application with the user's lifestyle was found to have the most significant effect on intention to use, while cost had the least influence.
>
> Furthermore, not only can SMS text messages be unreliable, network limitations can affect reliability (*e.g.* service drop–out).

Despite these issues, there is a growing demand for wireless network services, based on five primary needs:

- Connectivity – a need to be connected to the Internet anytime, anywhere
- Communication – a need for ubiquitous communication
- Information – a need for unrestricted access to dynamic or static information (personal and enterprise related)
- Consumer entertainment needs
- Commerce needs – requiring flexible presentation of product/service information and payment mechanisms not limited to fixed locations (Coursaris, *et al.*, 2003).

Developing mobile commerce: mCommerce, mEnterprise and mServices

We see wireless applications as developing in three broad areas; mCommerce, mEnterprise, and mServices. As such, *Table 2* provides examples of the seven types of wireless applications identified in *Table 1*, within these three areas. MCommerce, mEnterprise, and mServices are discussed below in further detail.

Table 2: Examples of wireless applications by characteristic and usage

	mCommerce	mEnterprise	mServices
Time critical	SMS alerts for parking meters	Share price SMS alerts for stockbrokers	SMS for appointment reminders
Location aware location sensitive	Remote road toll payments using RFID technology	Fleet tracking using global positioning systems	Automatic recognition of caller's location by emergency services
Identity–enacted	Dial–a–Coke via mobile phone at dispensers	Container and pallet–tracking using RFID technology	Remote keyless entry systems
Ubiquitous communication	Rural areas with limited fixed networks use mobile technology to trade online	Transport drivers use mobile phones using satellite communication in rural areas	Defence and military use secure mobile networks to communicate while in the field
Content delivery	Subscription–based media and content delivery to mobile devices (*e.g.* news)	Mobile access to specialized technical manuals by repair techs	Mobile TV
Business process streamlining	Mobile point of sale/ ordering systems (*e.g.* in restaurants)	Retail sales linked to inventory system	PDAs used by hospital staff to quickly access patient records
Mobile offices	Mobile financial lenders with real–time access to credit info	Mobile banking	PDAs enabling vehicle inspectors to access national vehicle database

Mobile Commerce (mCommerce)

The Australian Communications Authority (ACA) describes mobile commerce as:

> the ability to use mobile wireless devices as a secure method to purchase goods, services or digital content. This excludes traditional financial transactions such as bill payment and the use of a credit card to make a purchase via a mobile phone voice call. (Australian Communications Authority, 2003)

In this definition, the term excludes simple mobile voice communications, but that the term 'consumer' is not restricted to an individual.

Mobile commerce first appeared during the 'tech bubble' of the late 1990s. The new mobile devices promised to transform the eCommerce paradigm (TelecomWeb, 2000). In 2000, the then head of Amazon said that by 2005–2010 almost all of eCommerce would be on wireless devices while analysts at Nokia estimated that, by 2002, a greater number of people would be linked to the Internet via mobile devices than through traditional fixed lines (Clarke III, 2001).

Predictions about mobile commerce growth were based on the premise that because both mobile devices and the World Wide Web were highly successful technologies, mobile Internet would be even more so (Coutts, *et al.*, 2003). However, not only did the dotcom crash in 2000 create an equal downturn in the telecom market, but also the early mobile commerce products, which were based on limited content, were disappointing.

The technology was unreliable, the devices unwieldy, and the cost to consumers was high. There were limited mobile commerce applications, and those that existed were often less convenient than other channels, and so offered poor value to the consumer. As a result, widespread frustration was followed by market scepticism and consumer disinterest (Coutts, *et al.*, 2003). Consumer Affairs Victoria (2004) estimates that in Australia alone, enthusiasm for mobile commerce dwindled from 29 percent of consumers who said they would use it in 2000, to just two percent in mid–2003.

Today, with a few exceptions, the consumer mobile commerce markets appear to be characterised by conservative business models based on low-value payments and the simple provision of digital products and services. In fact, in Western Europe – the forerunners in this area - mobile commerce represented less than one percent of mobile data revenues in 2004, which in turn are estimated to be around 20 percent of the total mobile market (Frost and Sullivan, 2005).

MCommerce has predominantly been targeted at users aged between 16–30, whom Accenture (2001) refer to as 'the mCommerce Generation.' In fact, a 2005 report suggests that mobile phone expenses account for 10 percent of youth disposable income (mobileYouth Report, 2005). However, as technology advances and more innovative applications are developed, mobile commerce has a potentially far wider reaching audience.

Mobile Enterprise Solutions (mEnterprise)

While mCommerce encompasses business–to–business (B2B) and business–to–customer (B2C) transactions, the second aspect of the wireless eCommerce landscape concerns the use of mobile devices in inter– and intra–business operations, commonly referred to as mobile enterprise solutions, or what we term, 'mEnterprise'.

Mobile enterprise computing applications have rapidly grown in popularity, driven by advancements in mobile technologies, and an increasing mobile workforce population (Frolick and Chen, 2004). Examples of such applications include logistics and supply systems, mobile offices and personal information management systems. The benefits of mEnterprise applications may vary, but commonly include a reduction in costs, the enabling of a mobile workforce/users, improvement of intra– and inter–organisational communications, a decrease in reliance on location–limited telephone lines, improvement of the efficiency of business processes, an increase in channels to market or enabling access to new markets, and improvement of customer service.

Some work has been done to review Australian mEnterprise projects in the health sector (Gururajan and Murugesan, 2005). However, most studies have reported on trial projects only. There is little research that has explored intently the actual impact of the technology on the individuals that ultimately use the devices (Chau and Turner, 2004). Interestingly, a study on wireless field force automation (FFA) in New Zealand also reported that research into this area (mEnterprise) is sparse, and little is known about wireless FFA impacts (Innes, *et al.*, 2005). This suggests a fruitful line of enquiry for further research.

The following provides short examples where mEnterprise applications have led to benefits.

Benefits of mEnterprise

1. *Reducing costs and/or increasing revenue*
   By streamlining processes and improving business efficiency, wireless technology can help to reduce fixed costs such as employee wages, or overheads such as communication expenses. Moreover, wireless applications can even increase business revenue. An example of this is the use of wireless scanning for parcel shipping, which tracks a package's every move, and which has undoubtedly transformed the industry. By collecting package location and status data wirelessly and integrating it with backend customer management systems, FedEx have dramatically improved the service they are able to offer to customers, resulting in huge increases in package shipping volume, a willingness from customers to pay premiums for package tracking, and a significant reduction in customer service costs (Good Technology, 2005).

2. *Enabling a mobile workforce/users*
   For many, work demands and lifestyle preferences have meant that the traditional 9am–5pm working routine has evolved into something more flexible, and mEnterprise applications can help to facilitate this, as well as move jobs away from being desk–bound. Moreover, IDC estimated that around 750,000 Australian workers spend substantial periods on the road (Lemon and Doyle, 2003), therefore wireless technology increases an organisation's efficiency by reducing the amount of employee 'down time', such as unproductive time spent in airports by providing access to communications and network applications.

3. *Improving intra– and inter–organisational communications*
   One of the most important benefits of wireless applications is the improvement of intra– and inter–organisation communications, including access to time–critical and/or enterprise information. Wholesaler Rose and Hillcrest have streamlined gift giving using GPRS mobile technology and software which enables sales staff to input purchase orders on a handheld device and transmit them directly to the central accounting database at head office (Ericsson, 2002).

4. *Decreasing reliance on location–limited telephone lines*
   In comparison to wireless networks, fixed telephone networks can seem expensive. For instance, the bandwidth available with GPRS is significantly higher than that of analogue networks. As a result, businesses such as the communications company, George Patterson, are eliminating fixed telephone networks in favour of mobile voice and data systems. George Patterson switched to a wireless voice solution to provide a cost–effective way to keep staff contactable by clients. Previously, staff had to divert fixed line calls to their mobile phones, costing the company around $100 a month each, which, with additional mobile call costs when employees were not at their desks, amounted to a significant monthly expense (Alcatel, 2003). Wireless networks such as GPRS may also lead to cost savings, as usage is based on data transferral, rather than call duration.

5. *Improving efficiency of business processes and accuracy of information*
   Automation of data entry will enhance the accuracy of reporting processes, and wireless technology provides a means to extend this function out into the field, as well as streamline business processes. For instance, Fuji Xerox Australia's service agents use wireless devices to access customer data, collect meter readings and record service history (Lemon and Doyle, 2003), while the Chocolate Buddha restaurant in Melbourne, Australia incorporates wireless PDAs into their point–of–sale system to improve the efficiency of the customer ordering process. Radio frequency enables orders from multiple devices to be transmitted simultaneously to the kitchen, eliminating the need for a 'food coordinator' and decreasing the possibility of an incorrect or lost order (Carey, 2005).

6. *Increase channels to market or access new markets*
   Wireless applications may increase channels to market, or enable organisations to access new markets. For instance, SMS marketing solutions have been widely used by Australian companies and leading international brands such as Coca–Cola and McDonalds to target the highly lucrative youth markets. Niche wireless application such as SMS voting for television shows and competitions have also been made popular through prime–time television shows such as Big Brother (Invest Australia, undated).

7. *Improving customer service*
   By providing real–time data to customers, wireless technologies can provide real improvement to the customer service function, and significantly reduce transaction time. For instance, Ray White Financial Services has deployed wireless technologies that enable Head Office staff to efficiently communicate with their mobile lending managers across Australia and New Zealand, and eliminating the need to 'get back' to customers (Optus Business, undated).

Essentially, the benefits from mEnterprise applications are centred on improvements in organisational efficiency, and to many businesses, this may lead to competitive advantage. This has not gone unrecognised by industry, to the extent that, although messaging and e–mail are viewed as the 'killer' applications in the mobile environment as of 2004, this may not remain the case. The CEO of PalmSource, developers of the Palm operating system, predicts that with their associated benefits, customised mEnterprise applications may soon dominate (Ellison, 2004).

Mobile Services (mServices)

We define the final aspect of the wireless eCommerce landscape as 'mServices'. These encompass a wide range of wireless applications that may involve individuals or enterprises, but for which there is no ransfer of property or digital objects (such as ringtones), and which cannot be described as mEnterprise. These may include services such as mobile banking services for individuals, niche RFID applications such as those used in sports–timing, or ubiquitous personal communication (such as services provided to Blackberry devices).

Mobile devices can inject mobility into any organization, at any level. For example, Melbourne's William Angliss Institute of TAFE is equipping its teachers and students with PDAs. The college will deliver its hospitality, tourism and culinary courses through customised games, multimedia assignments and assessments so the PDAs will allow students to absorb theory and practice skills in their own time. In class, students can download files from the school's servers over the campus' wireless network, while data can easily be transferred onto, or from, a home PC. The aim is to reduce the average number of hours students spend on campus from 400 hours per semester to just 100 (Timson, 2005).

Aside from mobility, mServices may bring about the same benefits that are associated with mEnterprise applications. For instance, wireless technologies enabled Dubbo Council in Australia to deliver a capable, low–cost street surveillance solution in 2002. The CCTV system uses a wireless local area network (LAN), which offers cost savings and more flexibility than traditional systems (Adams, undated). The health care industry has also embraced wireless solutions, equipping doctors and nurses with PDAs and other hand–held devices to provide access to patient files from the bedside, and increasing operational efficiency. More innovative applications include patches, which when applied to the skin, continuously monitor patients' vital signs such as heart rate, and transmit it to their doctor's computer using a Bluetooth connection.

A final example which serves to not only illustrate the pervasiveness of mobile devices, but the synergistic effect of the use of multiple wireless technologies, is that many luxury cars, such as Lexus and BMW, have Bluetooth–enabled GPS navigation, which when used in tandem with RFID technology can track the car's location in the event of theft.

Challenges

To some extent, mCommerce, mEnterprise and mServices can also be differentiated by the challenges that they face. While standardisation and privacy must be addressed in all areas, each part of the wireless eCommerce landscape faces its own challenges.

Challenges common to all areas

- *Technical and price standardisation*
  Communication protocols and content languages vary widely. While the Internet uses HTTP and HTML, wireless technologies add WAP and i–Mode, WML and cHTML, presenting issues of compatibility. In addition, many Internet technologies, such as cookies and JavaScript, are not compatible with WAP or i–Mode, resulting in a number of functional limitations (Coursaris, *et al.*, 2003).

  Not only is there a lack of standardisation worldwide, demand for services also differs from country to country. In addition, access pricing policies also differ worldwide, thus although mobile communications are hugely expensive in the U.S., they are relatively cheap in Europe (Tarrasewich, *et al.*, 2002).

- *Privacy*
  Mobile commerce raises new privacy concerns for users, both in terms of intrusion (*e.g.* through unsolicited communications during browsing of mobile Internet portals, and uniquely, location–specific marketing such as contextual offers pushed to consumers) and through the collection and transfer of personal information (*e.g.*
  demographics and purchase data, clickstream patterns and browsing history, physical location information and purchase context) (Milne and Rohm, 2003). SMS spam is also a growing problem (Consumer Affairs Victoria, 2004), despite Australia's Spam Act 2003 (Commonwealth of Australia).

  In particular, RFID technology raises significant privacy concerns, as each chip has a unique identifier. For example, RFID chips embedded in clothing could be linked to a customer's personal details (via a customer loyalty program) at the point of sale. This would allow the retailer to automatically identify that customer whenever they passed by or entered the store wearing that clothing.

  Given the detrimental effects that privacy concerns have had on e-commerce, it is imperative that businesses are aware of these issues so that mobile commerce applications are designed for privacy.

Challenges for mCommerce

While mobile commerce faces similar issues to those relating to e–commerce, wireless technologies add additional challenges. In brief, they consist of standardisation issues, regulatory issues, privacy issues, and the need for an effective micro–payment system.

- *Regulatory Issues*
  In Australia there are a number of federal and state legislative instruments and bodies that play a part in regulating the mobile commerce industries, including federal acts such as the Telecommunications Act 1997, Banking Act 1959, Broadcasting Services Act 1992, Corporations Act 1999, Privacy Act 1988, Electronic Transactions Act 1999, Interactive Gambling Act 2001, Spam Act 2003, Trade Practices Act 1974. Whether such a regulatory framework will be sufficient for the needs of future mobile commerce models, given the cumulative advances in technologies and applications, is likely to be a future issue. Other mobile commerce regulatory issues also relate to fair–trading and dispute resolution, content provision, tax collection, the use of camera phones and mobile payment systems.

  Moreover, there are limited statutory protections in Australia to protect consumers against financial loss in e–commerce or mobile commerce, which, compounded with an observation that many consumers do not know how they can protect themselves (Consumer Affairs Victoria, 2004) is a considerable issue for mobile commerce.

- *Mobile Payment Systems*
  Alongside revenue generation issues, one of the most significant factors inhibiting the development of mobile commerce is the lack of a standard payment and billing system. A standard system will need to fully address security requirements while being convenient to both the consumer and the payee. As of 2002 there were nearly 100 different e–payment systems, which are differentiated by a number of factors including:

  - Time of payment (*e.g.* pre–pay, pay–now and post–paid).
  - Payment amount (*e.g.* micro [US$1 or less], small and macro–payments).
  - Anonymity issues.
  - Security requirements.
  - Off–line validation (Schwiderski–Grosche and Knospe, 2002).

  However, most of these systems can be categorised under the following payment models:

  1. Carrier billing, where telecommunication providers bill on behalf of third parties (possible for post and pre–ppaid services).
  2. Credit card payments (*e.g.*
     Visa have a trial where phone subscribers download a soft version of their credit card details or insert a SIM–size chip into special mobile commerce phones, which transmit payments to infrared ports).
  3. Direct debiting from bank accounts, enabled by PINs.
  4. Electronic person–to–person payments (*e.g.* Paypal for phones is being developed).
  5. Stored–value phones, using a smart phone, where money can be electronically loaded onto a SIM card, or 'e–Wallet' in the phone and used by the consumer to make remote or proximity purchases (*e.g.* in the Netherlands Moxmo provides customers with a mobile wallet facility that is charged or decharged by the customer via a settlement bank account) (Consumer Affairs Victoria, 2004; Mallet, *et al.*, 2004; Clark, 2001).

  Other payment classification models have been suggested, including a user–centric model that concentrates on the experience of using a phone to make a payment (Zmijewska, *et al.*, 2004). All models point to a range of payment systems with little evidence of convergence.

  The Australian Securities and Investment Commission (ASIC) is the government body responsible for the regulation of non cash payment (NCP) facilities under the Corporations Act 1999 which includes the above mobile payment systems. ASIC's policy statement on non–cash payment facilities (Australian Securities and Investment Commission, 2005) adopts a flexible approach to the regulation of NCP facilities. The Australian Prudential Regulatory Association (APRA) has also introduced guidelines for providers of purchased payment facilities (PPF), a new class of authorised deposit–taking institution (ADI). PPFs are new forms of payment instruments such as stored–value cards and Internet–based payment systems or 'electronic purses' (Australian Prudential Regulatory Association, 2005).

- *Security and authentication*
  Before a standard electronic payment system is adopted in mobile commerce, significant security issues will need to be addressed. Macro–payments and account transfers require higher levels of authentication, which was not achievable using WAP technology in 2001, hence the predominance of micro–payments in the mobile commerce markets. Authentication issues in e–payment systems will also need to be addressed; not only to determine appropriate identification methods, but the need to develop a model which will allow authentication independent of mobile devices (Clark, 2001).

Challenges for mEnterprise

Aside from traditional IT implementation issues such as physical hardware/software requirements, financial commitment, and skills and training required, there may be additional challenges for wireless enterprise applications. The academic literature provides little insight into these issues. However they may include limited technology 'shelf life', high implementation costs and problems with user acceptance.

Wireless technology is rapidly advancing, which, alongside the many wireless network options organisations are offered, means that mEnterprise applications may become obsolete and insufficient in a relatively short time span. The lack of standards for wireless technology increases this risk. It is further compounded by potentially high implementation costs, although this depends on the extent that the application is integrated into the organisation. There is also no guarantee that the benefits will outweigh these costs, and therefore the decision should be a strategic one. Finally, users such as employees, may not fully embrace the technology, or use the application to its fullest potential. For instance, a 2005 IT article reported that the biggest problem in equipping field sales staff with PDAs was reluctance from users to share their address books and diaries with the company (O'Neill, 2005).

Challenges for mServices

The challenges for organisations implementing mServices are likely to be similar to those relating to mEnterprise adoption. However, in providing mServices,

organisations may not be as connected to the user as with mEnterprise, which elevates the problem of user acceptance. It does mean, however, that users will take up those services that they find most useful, rather than trying to work with the enterprise solutions provided by their employer. The unique challenges to this segment of the wireless landscape are not clearly understood and further research is required in this area.

In addition, content provision to a wide audience demands higher fidelity than in an mEnterprise application. While the introduction of third generation (3G) wireless networks is providing greater bandwidth, it remains to be seen if video and television fidelity will meet user expectations.

Given the significance of mEnterprise and mServices applications, further research using a case study approach is necessary so that solutions to these issues can be identified, or that the lessons learned by organisations that have implemented wireless technologies can be shared.

International adoption of wireless

In terms of adoption of wireless technology and mCommerce in particular, Japan leads the way with i–Mode, then Europe, with the United States lagging well behind (Clarke III, 2001; Dholakia and Dholakia, 2004). Despite this, analysts have predicted that the value of the global mCommerce market will reach US$40 billion by 2010 (Viliers, 2004).

One clear example of mobile commerce success is the i–Mode in Japan. Launched by NTT DoCoMo in 1999 as an interim product before 3G, and utilising a new mobile protocol and language, its main advantages were that devices could stay connected without the need to dial–up, while remaining cost effective for everyone. DoCoMo emphasised simple content, with low initial cost allowing simple trialling. Equally, the technology appealed to Japanese cultural values that typically welcome new technology (Barnes and Huff, 2003). As of 2005, i–Mode has 45 million subscribers around the world, 42 million of which exist in Japan (www.iMode.com, 2005). Users access i–Mode through a portal page which links to approx 3,000 partner sites, with 50,000 additional unofficial sites, all overseen by DoCoMo (Barnes and Huff, 2003). i–Mode development has placed Sony's FeliCa non–contact smart card in mobile phones to act as a 'mobile wallet'. Users add money to their handset using an ATM–type machine and pay with a sweep of their phone over a point–of–sale scanner (Malik, 2004).

One of the most functional new technologies to be introduced to the mobile commerce market is the radio frequency identification device (RFID). Similar to a bar code system, RFID devices can be attached to objects (such as mobile phones, security passes, or consumer products) in order to transmit data to a receiver. Consumer schemes already exist; for instance, in the U.S., 6,000,000 'Speedpass' customers can pay for petrol and store items at Mobil and Exxon outlets by swiping a key tag linked to their credit card at wireless payment terminals (Speedpass, 2005).

Some mobile commerce applications can best be described as being unconventional – one of the latest 3G mobile games in Japan is the Virtual Girlfriends based on intelligent animated 3–D characters (avatars) that live in a virtual mobile world. The virtual girls can be contacted and seen using a 3G phone at any time and gamers are encouraged to buy their girlfriends 'presents' to keep them happy (3G, 2004).

Outside of Japan, some countries have embraced mobile commerce to a greater extent than others. In Austria, for instance, seven percent of car parking tickets are purchased via mobile handsets (Frost and Sullivan, 2005). Of course, there may be cultural issues that affect a country's uptake of mobile commerce, (*e.g.*, see Hofstede, 2001), however it is beyond the scope of this paper to do more than merely than note the influence of culture on technology adoption.

Wireless use in Australia

Australian adoption of wireless can be described as less than enthusiastic to date. The relative newness of the technology to the public, a lack of compelling product offerings, and the small number of providers are inhibiting the uptake of mobile commerce (Consumer Affairs Victoria, 2004) and at present the largest market is content provision, only associated with low–value payments. Despite these setbacks, the short–messaging and picture–messaging service (SMS and MMS) markets have continued to grow, which may indicate an untapped market for mobile commerce. 3G networks have been rolled out by Telstra, Optus, Vodafone, Hutchinson and Telecom New Zealand, while plans for 4G mobile communications networks are expected to reach commercial markets by 2008–2010 (Consumer Affairs Victoria, 2004). Meanwhile, on the other side of the wireless field, mEnterprise and mServices are steadily being adopted by a wide range of Australian organisations.

As of 2006, the following table represents a selection of wireless applications being developed or in use in Australia across the healthcare, manufacturing, telecommunications and media, logistics, transport and utilities, government and defence, retail and services, banking and finance and education sectors, in the mCommerce, mEnterprise and mServices domains:

Table 3: Examples of mCommerce in Australia

Sector	Company	Activity	Type
Banking and Finance	National Australia Bank	SMS payment security to enable customers to use their mobile phone as a security device during the authentication process for online payments in Internet banking.	Identity
Retail and Wholesale	Telstra	Customers can call a 'Dial–A–Coke' phone number at special vending machines to purchase soft drinks using their mobiles (Manuel, 2003).	Ubiquitous
	Mobi–tickets	A bar code is sent as a picture message to a mobile handset, to be scanned by typical POS infrastructure (Pearce, 2003).	Streamlining, identity
Telecomm and Media	Telstra	Australia became the first English–speaking country to launch i–Mode in November 2004, enabling mobile users to access more than 165 content sites including eBay, Citibank and CNN, across shopping, news, banking, travel and entertainment categories (Maslog–Levis, 2004). There are doubts that the success enjoyed by i–Mode in Japan will be repeated in other countries (Coutts, *et al.*, 2003; Accenture, 2001).	Content
	Optus	Partnerships with mobile content providers, such as the FujiPrint photo print service, Lonely Planet's *CityPicks* travel guides and MTV music downloads so that purchases can be added to a customer's mobile phone bill or deducted from the pre–paid credit account (Optus Personal, undated).	Content
Logistics, Transport and Utilities	Jetstar	SMS flight–ticketing service, allowing customers to book flights via text messaging on their mobile phones (Jetstar, 2005).	Streamlining
Government and Defence	Various	Electronic road toll payment systems have been in use in Australia for a number of years, where scanners detect an electronic tag attached to customers' cars and deduct a toll from a prepaid account.	Location
Other	i–Park	The scheme enables customers to pay for their parking and receive SMS reminders via their mobile phone (i–Park, 2005).	Streamlining

Table 4: Examples of mEnterprise in Australia

Sector	Company	Activity	Type
Banking and Finance	Ray White Financial Services	Head Office staff can efficiently communicate with their mobile lending managers across Australia and New Zealand (Optus Business, undated).	Communicate
	Banks and financial institutions	Stream real–time financial and stock market trading data to traders' and clients' mobile devices.	Time–critical
	MobilePay (Commonwealth Bank) Veripay mPOS	Allows a business to accept credit card payments using a standard GSM mobile phone through SMS.	Streamlining, identity
	Various	Mobile EFTPOS is enabled using Telstra networks and hand–held devices.	Streamlining
Manufacture Construction and Resources	Various	RFID technologies are widely used by forklift truck drivers to simplify inventory processes, as well as in product authentication.	Streamlining, Location
	Various	Wireless technologies have been used in automated manufacturing systems.	Streamlining
Retail and Wholesale	Schwarzkopf & Henkel; Rose and Hillcrest	Wireless applications, in conjunction with bar–scanning technology, transfer field data to a central database to keep track of daily sales and aid the inventory function.	Streamlining
	Various	Mobile Point of Sale systems (*e.g.* Veripay mPos) and Mobile EFTPOS are common in the retail trade.	Streamlining
	Woolworths and Coles	RFID applications for pallet tracking (pilot studies).	Streamlining, Location
	Fuji Xerox Australia	Service agents who perform on–site maintenance and replace consumables for customers use handheld devices to provide them with real–time call management services. These not only enables agents to access corporate data, but also collect meter readings and record parts used.	Streamlining
Telecomm and Media	George Patterson	Eliminated fixed networks in favour of mobile voice and data systems (Alcatel, 2003).	Mobile office
	FedEx	The logistics and transportation industries were amongst the first adopters of wireless technologies. For instance, worldwide software despatch systems for parcel tracking, delivery status reporting and two–way despatch messaging. GPS enables fleet tracking, while satellite phones are also being used to facilitate communication in remote areas of Australia.	Streamlining, Location
	Various utility firms	Utility firms have for some time employed the GSM mobile network for machine–to–machine communications including meter reading, inventory checks and security monitoring.	Streamlining
	Virgin Blue	RFID for airline baggage tracking (under consideration, although this technology has already been taken up by other airlines overseas).	Location
	Yarra Valley Water	maintenance field staff use portable PCs using a wireless network to enable them to access company data including area maps, in the field and work from 'mobile offices'.	Content, mobile office

Transport and Utilities			
Government and Defence	ACT Department of Urban Services	Police officers, parking inspectors and on–road vehicle inspectors have real-time access to national vehicle registration and driver licensing information wirelessly from the curbside. GPRS technology provides swift connections to their central database.	Content, streamlining
Other	Various restaurants	Wireless point–of–sale systems and handheld waiters are frequently used in the restaurant industry.	Streamlining

Table 5: Examples of mServices in Australia

Sector	Company	Activity	Type
Manufacture Construction Resources	Various luxury cars (*e.g.* Lexus and BMW)	Bluetooth–enabled GPS navigation systems and RFID for vehicle theft prevention.	Location, Streamlining
Telecomm and Media	Telstra, Optus, Vodafone, Hutchinson and Telecom New Zealand	3G networks. Plans for 4G mobile communications networks are expected to reach commercial markets by 2008–2010 (Consumer Affairs Victoria, 2004).	Content
	Sydney Morning Herald and *The Age*	Daily media are available in a number of portable formats for an array of new devices.	Content
	Nokia	Mobile TV trials have commenced in Sydney (Poropudas, 2005).	Content
Education	Various schools	Many education providers are implementing wireless networks to aid teaching and increase student access to education resources. For instance, 75 Catholic schools in Sydney are being linked in a wireless network project, while wireless network infrastructure is being rolled out in 1600 primary and secondary schools in Victoria (Connolly, 2005).	Content
	Various universities	Eduroam allows people from one university to use the campus wireless network at another university.	Mobile office Communicate
Healthcare	Various	Wireless PDA access to patient information. For instance, the Monash Medical Centre's neurology ward in Melbourne is trialing the use of wireless and healthcare mobility applications for patient care — wireless handheld devices are being used by doctors and nurses to obtain pathology and patient history reports, while tablet PCs enable them to receive and display larger reports such as X–rays at the patient's bedside (Versweyveld, 2005).	Streamlining
Government and Defence	Various	Wireless technologies have been used for many years by the military and defence organisations, not only for weapons systems, but to enable ubiquitous mobile communications in the field. For instance, the Australian armed forces R&D organisation has developed wireless technologies to produce reliable and secure communication for Australia's air, ground and naval defence forces. Examples include the modification of PDAs to deliver high–bandwidth tactical information over satellite services (Invest Australia, undated).	Communicate
	Victorian Metropolitan Fire and Emergency Services Board	Alarm signalling system for commercial, residential and industrial premises (ADT Wireless, 2003).	Streamlining
	Dubbo City Council	CCTV system in the city's shopping precinct, based on wireless network infrastructure (Adams, undated).	Streamlining
	Adelaide City Council	WiFi network, using lampposts and traffic lights as base stations (Blackwell, 2003).	Communicate
Other	Various	RFID is used for passive entry/remote keyless entry systems.	Identity
	Various sports events	RFID is used extensively in sports timing, while wireless technologies facilitate the communication of *in situ* data wirelessly from athletes (*e.g.* wireless transponders relay heart rates and other specific information).	Streamlining, identity

Conclusion

While the broad term 'mobile commerce' is often used as an all–encompassing phrase to describe all things 'wireless', it can be separated into three distinct, but inter–related areas: mobile commerce (mCommerce) involving transactions; mobile enterprise (mEnterprise) applications; and, mobile services (mServices). A review of the wireless landscape suggests that although wireless technology may have experienced a disappointing start in most countries, including Australia, profitable – albeit conservative – business models have emerged since. As well, mEnterprise applications can help to deliver multiple benefits in terms of organisational efficiency. This has not gone unrecognised by many industries, and therefore mEnterprise is a significant area of potential growth. Finally, the many examples of mServices illustrate the pervasiveness of wireless technology, and is testimony to its potential fit with modern lifestyles.

However, before wireless applications are universally adopted, a number of issues need to be resolved. Although technological hurdles such as compatibility of networks and standards are diminishing, they remain a challenge. Other challenges to mCommerce, mEnterprise and mServices remain, including mobile device limitation, privacy and security issues, and payment problems.

There are few academic studies relating to these issues, especially within the mEnterprise and mServices domain, and therefore further research is required.

Finally, there also remains a need to discuss the efficacy of regulation for wireless technologies, in particular, whether there is sufficient provision for consumer protection and whether convergence of the regulatory bodies is desirable.

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