M-Computing for Real-Time Negotiation Support

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Abstract

Mobile computing (or m-computing) technologies have recently made sufficient progress making it possible to seamlessly integrate communications and data processing in m-commerce applications. Using telemedicine as an illustration of m-commerce, we propose a system analysis and design method to formulate communications, knowledge management and transaction processing requirements for each of the business processes in a mobile application workflow. We also discuss various technological supports to implement these requirements. We advocate the use and design of process-oriented software agents to support a highly distributed and loosely-coupled federation of wireless and legacy information systems to support decision, bargaining and negotiation in a real-time environment.

Keywords: *mobile computing, decision support, enterprise computing, software agents, real time economy, workflow design, telemedicine*

1. Introduction

With the continued release of new and less expensive, more powerful Internet-based hardware and software products for mobile computing, wireless commerce is expected to rapidly catch on with the success of online trading, auctions, and real-time decision making. It is no secret that companies are experiencing a large-scale invasion of handheld and wireless devices, reminiscent of the days when laptops and the Internet began to mobilize workers. A number of technology experts even predict that the costs of wireless communications will soon be as affordable as the cost of the Internet, making m-commerce the next major adoption of information and communications technologies.

In mobile computing, the "space and time shrinking" dimension of the Internet-based economy is closed to the concept of virtual proximity has flexible and secure mobile infrastructure. As such, m-computing provides the potential ability to conceive an information-timely, multi-user, and real-time decision, bargaining and negotiation support. From an engineering perspective, m-computing using wireless networking and telecommunications allows full integration of technologies to provide decision makers with multi-media, interactive and instantaneous decision support methodologies. As a telemedicine application example, an automated process can be built in a software agent to alert a hospital if the pacemaker of a patient starts to malfunction. And another independent software program can be triggered to set up a video teleconference between a patient and his/her healthcare providers. Simultaneously, a search engine can be activated to help doctors find the latest statistics on an outbreak.

Table 1 highlights a number of benefits as well as potential shortcomings associated with m-computing activities.

Advantages	- Mobility (Anywhere)
	- Availability (Anytime)
	- Wireless
	- Data Exchange
	- Communication improvement
	- Easy to carry data (light machine)
	- Access to right information at right time
	- Instant data synchronization between co-workers
	- Paperless
	- Time saving
	- Personalization
Disadvantages	- Limited I/O interface (e.g., screen, keyboard)
	- Lack of security (e.g., hackers, robbers)
	- Speed (data transfer – computer speed)
	- Battery life
	- No real presence of a programming standard
	- Cost of the equipment
	- Takes time to learn how to use
	- Memory still limited compared to desktop
	- Small devices: easy to lose or to forget
	- Radiation danger (?)

Table 1. Advantages and disadvantages of m-computing

Building a federated system requires, however, a system analysis and design methodology that (i) provides

a structured and standardized approach to specifying the functionalities of each software agent involved in the market-oriented decision making process, and (ii), offers a loosely-coupled, task-driven and seamless integration of communications and processing. Conventional techniques for systems analysis and design have dealt with a single and comprehensive software application (for example, the design of an online trading system located in a server). As such, they fall short in providing a requirement analysis that is comprehensive at the process level – providing specifications for object-like agents that are conceived to execute only one or a few processes. In this paper, we stress the necessity of supporting decision support systems that are capable of providing three levels of integrated support – communication support, knowledge management and modeling, and transaction support. We introduce the use of the ICOM (input-control-output-mechanism) structure to specify requirements of autonomous and mobile software agents.

2. Wireless technologies for integrated support of decision processes

Kersten [1] provides a comparison of seventeen decision support technologies that could be used to conduct e-negotiation. Most of the systems he reviews tend to focus on supporting the negotiation using a software-driven, structured set of processes. Only six out of these systems have some built-in mechanism to support information exchange between negotiating parties – to include email, or chat functions.

We classify three major supporting functions that a negotiation support system should possess:

1. **Knowledge-based information processing**
   In the real-time economy, the timeliness and relevancy of information is crucial to decision quality. With the risk of being overloaded with information, let alone the display limitations of current handheld devices, the role of information processing is to get the right information at the right time and even perhaps at a precise cyberplace. M-computing for negotiation support should be driven by a context-sensitive information search, processing and delivery to offer the user with a timely competitive advantage.

   The wireless technology enables a bi-directional and almost instant flow of information both in push and pull modes. Messages can be sent and received at the same time. It is interesting for companies to be able to send advertisements and to be sure that the m-user (i.e., a person who uses a mobile device) will get it. If coupled with a geographic information system (GIS), context-sensitive information delivery can very effective. In fact, a person, who is looking for a place to have lunch, can use his mobile device (PDA or cell phone) to select a restaurant based on his preferences that is not too far from his current location. M-computing is used here in an information processing purpose. The method employed is based on the "pull" method. The "push" method will be used by the restaurant for example. It will send an advertisement via Short Messaging Service (SMS) to all potential customers nearby. Then the mobile device will display all offers made so far.

2. **Communication processing** refers to the ability to use digital networks to provide two way interactive communications in m-commerce. Communications remain the most important element of any business activities. Parties involved in a bargaining or negotiation need to exchange information regarding their preferences and their offers. They need to engage in the discussion in a variety of conversational modes (one-to-one, one-to-many, private and public broadcasting, mobile-to-mobile, mobile-mediator with back office support-mobile) (See Figure 1).

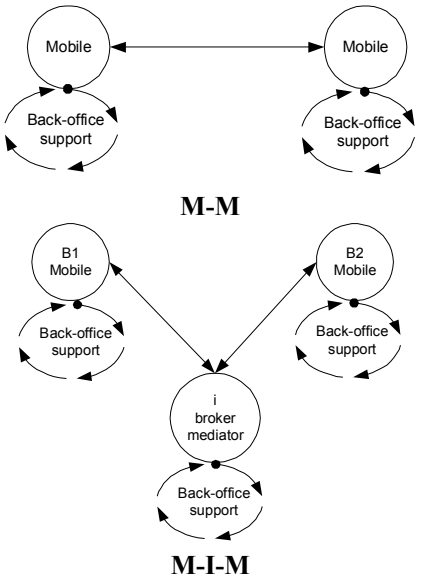

Figure 1. Examples of communication and interaction structures in m-computing

3. **Transaction processing** allows users to execute in a timely and orderly manner business processes to finalize a business transaction. Examples of such activities include information search and filtering, computation of bookkeeping and accounting data, authentication and verification of identities of authorized parties, generation of business contracts.

M-computing offers a powerful marketing vehicle in B2C relationships. A good m-computing platform should be able to provide these three categories of support in a timely and coordinated manner. In the following section, we briefly provide an update of the current status of wireless technologies.

3. An update of m-computing technology

The infrastructure to enable m-computing is composed of mobile devices such as cell phones, PDAs (Personal Digital Assistant), pagers, laptops, GPS; protocols and standards; programming languages and applications.

It is estimated that there will be 100 million 802.11 users by 2003, a 700% increase over today. Major equipment firms have rushed into the WLAN market: Intel, Proxim, Apple, Linksys, Cisco, Buffalo and 3Com. Business-related wireless Internet users will grow from 2.6 million in 2000 to more than 49 million in 2005. Forrester Research [2] and IDC [3] project a $3.2 billion wireless LAN market by 2006; their estimates have risen over time. Already today, estimates are that 10 percent of American businesses have either installed WLANS or tested WLAN pilot projects.

With the emergence of 802.11a and 802.11g, these improvements are sure to continue. Linksys, D-Link and others have brought access point technology down to a successful price point for home and business users. Small and medium enterprises have seen very significant growth, with WLANs now becoming pervasive in such sectors as universities, hospitals and the hospitality industry. "Hotspots", public areas such as cafes and airports offering wireless LANS, currently number 1,200 in the U.S, 300 in Hong Kong, and are growing rapidly worldwide.

Wireless LAN equipment sales reached $1.47 billion for the year 2001. This represents an increase of over 150% from the year 2000. According to market analysis by Synergy Research Group [4], Worldwide Wireless LAN equipment sales in the first quarter of 2002 reached over $460 million and second quarter sales were $454 million. Corporate WLAN installations have doubled in the past year according to the Yankee Group's [5] 2001 Corporate Wireless Survey. According to the report, 700,000 U.S. businesses, including 11,000 large establishments, use approximately one million WLAN access points.

One of the most important components is the mobile device which usually is a cell phone, a PDA, a pager or a laptop. Cell phones are widely used. The tendency is that in a normal family home, there is one wired phone and many cell phones. Cell phones offer a greater level of personalization compared to the shared house phone. We should also underline the efforts of manufacturers to provide attractive and light features. Cell phone models are changing very fast which gives users a greater desire to replace older models. New features are not always very crucial but they can make a difference to customers. Big steps are made when new phones that use latest communication standards or protocols provide a better quality of voice and improved data transfer speed. When the speed is increased, new services can be offered by the network provider. But the most important factor is still that cell phones can be used everywhere and anytime. Mobility is an attractive feature but it would not work if there were not any standards and protocols to enable communication between devices. The table below describes the current and future standards for mobile networks [6].

Name	Description	Comments
GSM **(Global System for Mobile communications)**	A 2nd generation digital cellular communications network technology that has been established as a worldwide standard except in North America and Japan. Corresponds to PCS in services offered, but its standards are different. Speed from about 9.6 to 14.4Kbps.	Because GSM is nearly universal, Europeans don't really want to substitute it with a newer and faster standard. The result is that upgrades (GPRS, UMTS) are getting more popular because they don't interfere with the basic system.
GPRS **(General Packet Radio Services)**	Upgrade of GSM. Designed as a temporary stage between the 2G and 3G phones. (2.5G)	Most companies preferred to wait for the 3G upgrade to avoid this expense. Up to 144kbps.
PDC **(Personal Digital Cellular)**	The wireless telecommunications standard used in Japan	It employs TDMA digital technology and is based on the American D-AMPS.
TDMA **(Time Division Multiple Access)** ***CDMA*** **(Code Division Multiple Access)**	Technology used in the USA for cell phones.	Launching pad for such 3G technologies as WCDMA and CDMA2000.
UMTS **(Universal Mobile Telecommunications System)** ***W-CDMA*** **(Wide-band Code Division Multiple Access)** ***CDMA2000*** ***EDGE*** **(Enhanced Data rates for GSM (or Global) Evolution)**	Standards for the 3G phones. The third generation refers to the imminent wave of cutting-edge cellular technology.	The speed will be a lot faster. Still in the development stages and not yet available in large numbers.

Table 2. Standards in mobile networks

A new tendency is that manufacturers are trying to sell phones which combine voice communication, data transfer and an organizer. They realize that people cannot always fill their pockets with a wallet, a cell phone, a PDA and keys. Many PDA companies such as Palm and Handspring as well as cell phone manufacturers like Nokia and Ericsson have tried to build an all-in-one mobile device. Some of them have had a degree of success but the high price of these devices discourages most of the m-users. Major technical limitations are due to the small screen size and the lack of a good input device such as a keyboard. These caveats can slow down the deployment of m-computing until manufactures create a new design for their products. There is also somewhat of a decline in the introduction of new mobile technologies due to the fact that network providers are currently financially preoccupied with paying off debts associated with past infrastructure investments. Almost no major changes were brought this year on the mobile market. However, a major effort for the future is to try to use packets transmission like GPRS. This will allow the use of a powerful technology called voice over Internet Protocol (VoIP). The basic concept is to put a phone system on the Internet [7]. In the near future, people will be able to talk directly to their computer assisted by a voice recognition technology such as VoiceXML. Partially solving the input problem, however, the output problem still remains.

In addition to mobile devices and standards and protocols used by cell phones network providers, programming languages and applications are also important because they give unlimited possibilities to create business services and products using computer code. XML, XSL, WML, HTML, cHTML, XHTML, WAP, SMS, MMS, GPS, HTTP, TCP/IP, Bluetooth, WLAN(802.11) and others are involved m-computing. They provide the technology that enables wireless networking. Some of these are used for publishing (markup languages: e.g., XML, WML and HTML) and others for the transportation (e.g., SMS, MMS, HTTP, TCP/IP and Bluetooth). We have to emphasize that these technologies are not new but are just waiting to be exploited by a killer application. Bluetooth is the perfect example to illustrate this argument. Some manufacturers of computer mainboards (e.g., MSI [8]) are only recently implementing Bluetooth chips in their product.

Nowadays the tendency is for the standard programming language to be Java, although Sun Microsystems is trying to impose its language as the standard for mobile devices [9]. Some manufacturers like Nokia and Sharp have already built some cell phones and PDAs java-enabled. The power and advantage that Java has over every other common language, is related to its portability because it runs on a virtual machine.

For now, there is not really a standard chosen because PDA and cell phones manufacturers use different operating systems and each tries to impose its own standard (e.g., Microsoft with its Windows CE .NET). Frequent changes of hardware prevent any operating systems from lasting. Moreover, Palm, Inc. announced that it will use a very powerful microprocessor with its new operating system (Palm OS 5) which will provide possibilities of exploitation [10]. As we can see, trends are still emerging and it is still too early to talk about any single dominant cutting-edge technology.

4. M-computing as a real-time market signaling mechanism in bargaining and negotiation

The intuitive reason for gathering information is to reduce uncertainty about the future and to make choices that have better chances for better payoff. Negotiators who face uncertain prospects search for information with the intention of reducing uncertainty. In reality, perfect information can seldom be obtained. Furthermore, information sources are limited and sometimes some information about market or business activity might not be updated at the decision time.

Market signaling allows a situation of incomplete information to become closer to that of complete information. Signaling will also help establish equilibrium in any industry where it is commonly and extensively used. Market signaling has been used in the development of an intelligent clearinghouse as an incentive structure of the negotiation process [11]. This allows real-world negotiations to take place in a market environment where the players are constrained by imperfect, incomplete and often asymmetric information. The competitive advantages of market signaling are many. Signaling provides efficiency and ease of communication among negotiators. It renders the negotiation process more efficient and transparent, which eventually reduces the possibility of deadlock.

Mobile computing pushes the information delivery to a higher dimension – close to real-time mode and wherever the location of the decision maker is. More importantly, technologies provide the solutions for dealing with information at different levels of abstraction and in varying media forms, fusing overlapping information from multiple sources into integrated ones, monitoring and reacting to changes or patterns of changes, and occurring across the networked information sources. In other words, providing access to heterogeneous sources based on a general customer base is an important design criterion. The active and integrated exploitation of

information from these sources is one of the real concerns to applications of online information sources. What we propose here is to use software agent technology [12] to accomplish information gathering and analysis to make the market closer to one with complete information. Thus, with the help of a network of information sources that contains data resources to track and trace market events and activities in special application domains, such as, real estate and financial investment; as well as utilizing information agents that perform query/ statistical data analysis activities over dynamically changing, distributed, and heterogeneous resources to collect texts and image data, one can transmit market signals more efficiently to help negotiators to evaluate each counter offer.

We view an intelligent market as one that allows negotiators to send signals to opponents to create favorable impressions, or more precisely, to affect the opponents' subjective probabilistic beliefs about their positions and market condition.

In the telemedicine application, market signalling is the ability of a system capable of providing real-time support of the three functionalities which were mentioned earlier. A possible market activity channel is one that supplies information on all healthcare providers (i.e., medical doctors, nurses, paramedics, pharmacies, and insurance companies). Another channel would provide state-of-the-art, last-minute developments related to medical achievements and newest realeases of pharmaceutical products. When a patient seeks medical help, the searching agent retrieves all the qualified candidates to form the candidate set. The patient can choose a number of healthcare providers to form the negotiation set. Simultaneous negotiations with several providers can be activated to create higher competition. There are particular situations where results of each round of negotiation can be intentionally "leaked" to the opponents to create pressure to keep the negotiation process moving toward the direction of the negotiation parties. In sum, channels for information processing, communications processing, and knowledge management and decision modeling have the potential to deliver market signals to support negotiators when they evaluate offers.

In a competitive and transparent market, we look at market signaling as a feature that would provide the users with context-sensitive and instantaneous information using software with embedded heuristics.

5. A development lifecycle for building agent-based DSS

We view the M-DSS as an integral part of the corporate information system that supports task-driven business transactions. In m-computing, we seek to develop DSS components to deliver relevant, fast and reliable support for all the phases of the decision making process (see Table 3). Finally, we envision a M-DSS platform in which DSS components are designed and coordinated in such a manner that would best fit the workflow of a business decision or activity by providing support to all involved parties.

		Mobile Computing Functions	**Example** *In Telemedicine*
PRE DECISION	- *Needs analysis*	Track and anticipate user's needs.	PDA analyzes user's health permanently.
	- *Prioritizing*	Organize and adapt schedule according to the priority.	the PDA is able to take an appointment depending of the gravity of the problem
DECISION	- *Intelligence (gathering information)*	Search online	The PDA looks for a doctor available and qualified for the problem.
	- *Design (compare)*	Ability to list the results of the research in line with the user needs.	The PDA lists the doctors he found.
	- *Choice (formula)*	Algorithm which can propose the right choice to make according to the preference selected.	Then it proposes several solutions for the choice of a doctor. The user has to choose some criteria for the selection. The PDA is able to sort the doctor's list and give the best compromise.
POST DECISION	- *Buy*	Secure reservation and payment online	If the user agrees with the research and the proposition he can take an appointment online.
	- *Maintain*	Possibility of ongoing evolutions	The PDA takes contact automatically with the health insurance to update their database.
	- *Use*	Works anywhere and anytime.	The PDA tracks every medical intervention and reminds the user when he has to take medication for example
	- *Resell*	Data Exchange	In case of emergency the PDA can provide all the important information about the user's health

Table 3. Examples of software agents' supporting functions

As suggested in Figure 2, we advocate a two-tier approach to designing an agent-based DSS. The first tier is in essence an assignment model that consists of searching, identifying and selecting the agent(s) that are most appropriate to accomplish required tasks (the first three phases of the lifecycle in Figure 3) [11]. The second aims at devising a coordination and collaboration strategy for all the involved agents to work together (the last two phases of the lifecycle).

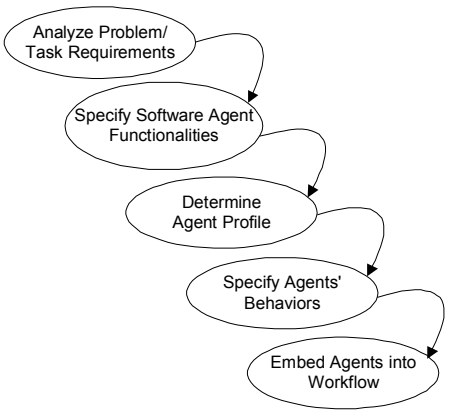

Figure 2. A development life-cycle for agent-based applications

Each of the phases of the lifecycle is described below:
Analyze problem task: This phase consists of performing decision support requirements and devising a detailed breakdown of all decision processes. Processes are sets of partially ordered steps intended to reach a particular goal. Process steps are the most primitive, atomic processes.

Specify agents' functionality: This step involves iterative search of eligible agents or creation of new agents that satisfy the requirements as determined in the previous steps. Selection criteria include agent's competence, reliability, and costs. Competence refers to the question how can the agent be built to possess the knowledge to decide when, with what, and how to perform a process step.

Specify agents' behavior: A number of behaviors are specified in this phase. Instructions are prescribed for showing identifications, following exclusion standards/protocols, and using Web resources cost-effectively (e.g., request global information first, do breath-first search first, use same agent for repetitive tasks to minimize transportation costs, or retrieve/broadcast only what information is needed at an opportune time). Specification and execution of the agent's problem solving and data management functionalities are tested locally for each of the selected agents. Agent ethics can also be reviewed here.

Coordinating Agents in Problem Solving Flow: Selected agents are assigned to various tasks, given notification mechanism (e.g., agent notification or self-identification) along with synchronization protocols. The execution plan is outlined here for the entire problem solving flow.

6. Defining functional requirements for mobile agents

In a process-oriented workflow, we expect that mobile agents will be developed and coordinated to interact seamlessly to support a distributed decision making and negotiation problem solving. We expect the workflow to be engineered at the most detailed level, i.e., at a level where each and very single (primitive) processes can be assigned to mobile agents.

We propose the use of a coding technique used in process modeling for business process engineering [13]. For each software agent, the following specifications should be formulated to execute a process:

- *Inputs*: What information is required to execute the process at hand? In what format? Where can the data be gathered from(e.g., what input data (patient's SSN, patient's complaints or what format),
- *Mechanism*: What are the guiding models to be used for each process? What resources are required to execute the process (e.g., computational cost) (e.g., estimate the effectiveness of a particular treatment)
- *Control*: What are the contextual objectives or constraints that the execution of the process should observe (e.g., Is the agent authorized to conduct a particular process (diagnosis)? Is the result or computing output executed before the deadline? Are the data been authenticated?)
- *Outputs*: What results to send out? In what format? Where should they be sent to? Is any acknowledgement of output reception required?

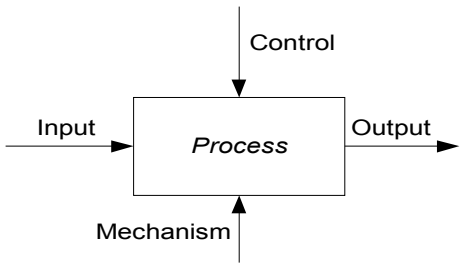

Figure 3. Process modeling using ICOM for process-oriented mobile agent

7. Modeling m-agents for web-enabled telemedicine

As a new form of organizational connectivity, telemedicine can be seen as a special form of "virtual hospital" in which the patient can benefit from a medical team that is put together from various healthcare providers that are geographically dispersed. When the patient logs in with a medical complaint, at the intervention of his/her personal healthcare providers (e.g., family doctor or advising nurse), each of the medical team members assigned to a patient can be contacted instantaneously. The patient can also be connected, whenever the needs require it, to other specialists throughout the Internet-based network[1] of medical care. This would typically happen if the patient's problems go beyond the expertise of the currently assigned medical teams.

Benefits of telemedicine include using m-computing:

- flexible organization infrastructure with the ability to locate and contact healthcare providers whenever needed.
- ability for patients to seek medical help almost instantly (e.g., a pacemaker can notify the hospital if it begins to malfunction, or an airbag could call 911 if it is set off).
- greater access to healthcare with a handheld used to update onsite patient's record and instant notification when an organ donor is identified.
- improved quality of healthcare due to quick availability of the best facilities regardless of geographical boundaries, and synchronization of data with the hospital's central database, available to anyone with access clearance.
- reduced costs of healthcare thanks to economies of scale, scalable organization structure.

Due to space limitation, we illustrate the use of our framework only on the development of an agent-based information systems for telemedicine.

Figure 4 depicts a series of processes for a telemedicine application. The patient is using his personal mobile device (wearable computer for automatic sensing) to communicate wireless with his/her nurse for emergency care. The nurse is connected in real-time mode with a number of software agents that support her business interaction with other healthcare providers (e.g., family doctors and medical specialists). Seven processes in the figure involve software agents. For illustration purposes, we describe below three representative processes. Table 4 describes the mobile agents' processes with specifications on data, models and supporting technologies. Table 5 specifies process' requirements with regard to communications, transaction and knowledge processing. Taken together, the tables and the ICOM charts (Figure 5) should provide sufficient business specifications to the software developer for implementing m-applications.

[1] For the purposes of this paper, we do not make a differentiate between the Internet and the Intranet as we do not address the administrative and security issues across organizational units.

8. Summary

This paper proposes a system analysis approach to designing mobile computing to support business decision making, in particular, negotiation and bargaining. In a real-time environment with any-time, anywhere decision making requirements, we argue for an integrated computing platform that consists of handheld devices, Web-based front-end systems, and legacy management information systems. To support the negotiator for real-time e-negotiation, we have identified three major supporting functions: communications support, information management support, and decision and negotiation support. In a m-computing platform operated by process-driven software agents, we advocate the use of the IDEF process engineering framework that defines process requirements using the ICOM principle. We use a typical scenario in a telemedicine application as an illustration of the concepts outlined in this paper. The key success factor is the ability of the system developer to break down negotiation activities into processes that can be programmed and run independently in a mobile platform.

Perhaps one of the most important challenges of the proposed analysis and design methodology is its adoption – or the adoption of one that shares similar concepts – by all the developers of autonomous systems that are part of an integrated m-commerce platform. The example of the telemedicine workflow described in this paper assumes that the agents were designed and built by the hospital I.T. staff. As such, the virtual hospital is in essence a centralized legacy system whose functionalities are distributed over a mesh of wireless networks. In true m-commerce, one should envision an electronic marketplace that involves numerous providers and consumers of products or services with independent market strategies and tactics, and with specific requirements for m-agents' support. If m-DSS is to succeed in this context, it is important that developers agree on a design and coding standard that allows agents conceived by different actors to interact which each others. We hope that the design elements discussed in this paper is a first step toward the definition of a simple, yet practical, approach to designing agent-based m-commerce.

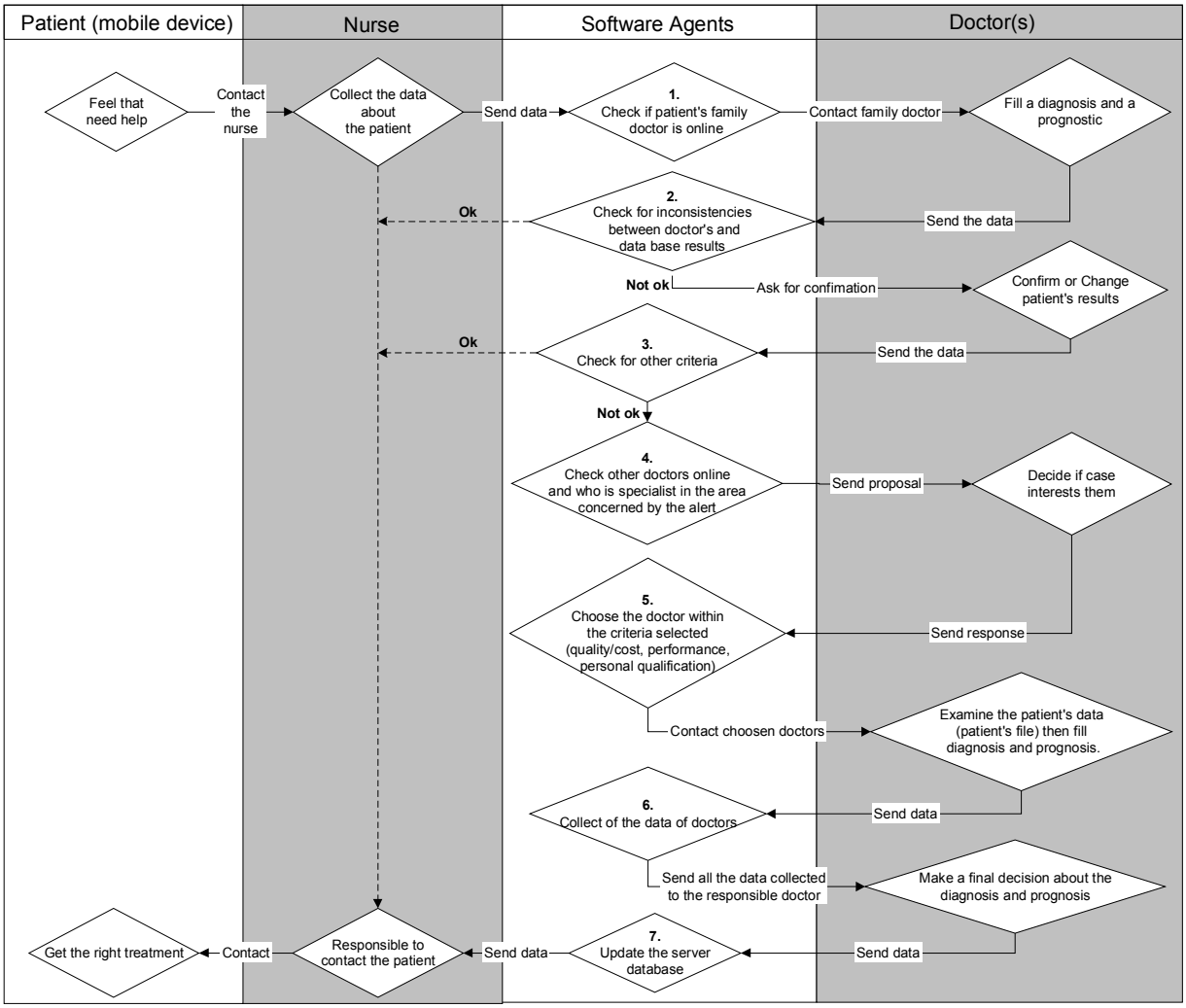

Figure 4. A telemedicine workflow with seven processes

DSS process	Actors' interaction type	Modeling	Data	Supporting technologies
Process 2	Server (software agent)	Check if no disparity in doctors' diagnoses and prognosis	- Diagnosis and prognosis of the patient's family doctor - Database with standard diagnosis	- Agent based software (logic programming) - Database (MySQL) - Message (XML)
Process 4	Server (software agent)	Check which doctor is online and who is a specialist in the area concerned by the alert	- Database with all the doctors and status	- Agent based software (logic programming) - Database (MySQL)
Process 6	Server (software agent)	Choose the doctor within the criteria selected (quality/cost, performance, personal qualification)	- Information about doctors	- Agent based software (logic programming) - Database (MySQL)

Table 4. Description of mobile agents' processes with specifications on data, models and supporting technologies

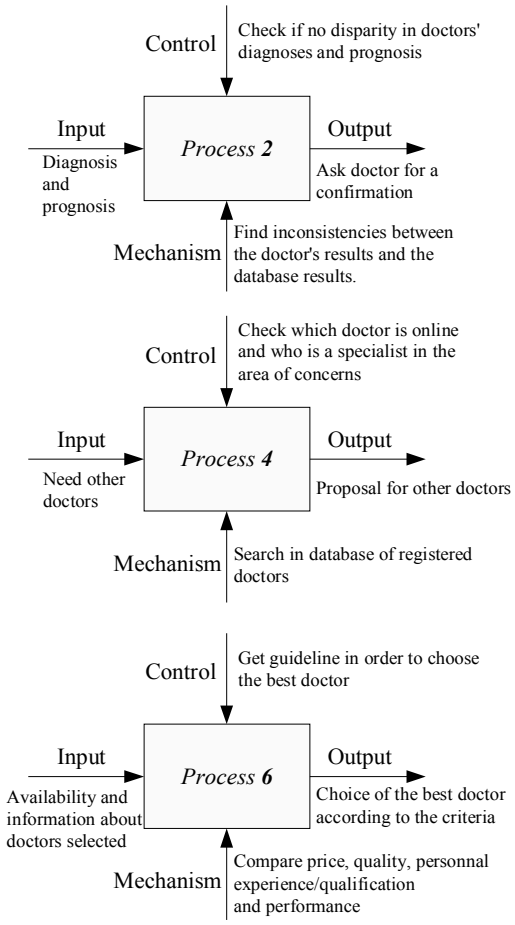

Figure 5. ICOM specifications of selected processes

Process 2	
Communication processing	- Query the database
Transaction processing	- Compare doctor's results to standards in database.
Knowledge processing	- Use case-based reasoning to ascertain the validity of the diagnostics.
Process 4	
Communication processing	- Query the database of doctors (directory)
Transaction processing	- Check availability
Knowledge processing	- Rank-order the medical doctors according to the service quality
Process 6	
Communication processing	-Query the database of doctors' information
Transaction processing	- List doctors
Knowledge processing	- Decide which doctor meets needs and criteria.

Table 5. Communication, transaction and knowledge processing requirements for selected processes

9. References

[1] Kersten, G., "The Science and Engineering of E-negotiation: Review of the Emerging Field", *INR05/02*, University of Concordia, Working Paper, 2002

[2] Forrester Research web site: http://www.forrester.com/

[3] IDC web site: http://www.idcresearch.com

[4] Synergy Research Group web site: http://www.synergyresearchgroup.com/

[5] Yankee Group web site: http://www.yankeegroup.com/

[6] Zilliox D., *The Get-Started Guide to M-Commerce and Mobile Technology* , 2002

[7] Wrolstad J., "In Search of Voice-over-Internet Cell Phones", *Wireless NewsFactor,* September 2002

[8] MSI web site – introduction to PC2PC™-- Bluetooth: http://www.msi.com.tw/html/e_service/techexpress/tech_column/pc2pc_bt/page1.htm

[9] The Sun Microsystems' JavaPhone API web page: http://java.sun.com/products/javaphone/

[10] Introduction of the new Palm OS 5: http://www.palmsource.com/palmos/intro_os5.html

[11]Bui, T., J. Yen, J. Hu and S. Sankaran, " A multi-attribute negotiation support system with market signaling for electronic markets", *Group Decision and Negotiation*; 2002

[12]Bui, "Building Agent-based Corporate Information Systems: An Application to Telemedicine", *European Journal of Operations Research*, April 2000

[13] Mayer, Richard J., et al., "IDEF Family of Methods for Concurrent Engineering and Business Re-engineering Applications", *Knowledge-Based Systems, Inc*., 1992.