A Discussion of Current Issues Integrating Mobile Agent in Web

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ABSTRACT

With the development of enabling technologies such as wireless networking and various types of hand held-mobile devices, Mobile intelligent agent has been widely applied to various fields. Different views on capabilities, advantages, and disadvantages of mobile intelligent agent providing an ubiquitous access are brought by field researchers and practitioners recently. The purpose of this paper is thus to provide the discussion of the comtemporary development of mobile intelligent agent in the contexts of the Infosphere, focusing especially on developing and nurturing the future research grounds such as information scalability, and information security. The results of this study would improve the applications of mobile intelligent agents in web transaction, especially mobile business surroundings where many interest groups have to adjust their point of issues rapidly due to the changing business environment, i.e., customer's change the order item in web.

Key word : Mobile Intelligent Agent, Information Scalability, Information Security

1. Introduction

Mobile intelligent agent has been widely applied with the development of enabling technologies such as wireless networking and various types of hand held-mobile devices. With mobile intelligent agent, the possibilities of mobile data communication using wireless networks are getting more attention[5]. In order to be able to access the data anytime and any where, this mobile technology will also become more integrated into the Infosphere including the web. The combination of mobile technology with the network

infrastructure is one important step toward a global information sharing[1][3].

Programs can migrate from host to host in a network, at times and to places of their own choosing, often called mobile computing or mobile intelligent agent, in which the state of the running program is saved, transported to the new host, and restored, allowing the program to continue where it left off[5][21].

Mobile-agent systems is different from process migration systems. In a process-migration system, the system decides when and where to move the running process (typically to balance CPU load), whereas the mobile intelligent agents move when they choose, typically through a "jump" or "go" statement. Mobile intelligent agents are also different from "java applets", which are programs downloaded as the result of a user

action, then executed from beginning to end on one host[21][23].

For many applications, to improve in latency and bandwidth of client-server applications, mobile intelligent agents will work very effectively.

However, many applications face daunting tasks such as information overload, bandwidth gap, latency, formating, server-side versus proxy-side customization in mobile programming environment. Thus, it is important to recognize the major steps /procedures, merits and demerits, and current issues apply mobile intelligent agents[5][7].

The purpose of this paper is thus to provide the discussion of the comtemporary development of mobile intelligent agent in the contexts of the Infosphere, focusing especially on developing and nurturing the future research grounds such as information scalability, and information security.

The results of the current study would, it is hoped, improve the applications of mobile intelligent agents in web transaction, especially mobile business surroundings where many interest groups have to adjust their point of views rapidly due to the changing business environment, i.e., customer's change the order item in web.

In addition, this research may enhance the network information infrastructure by providing the mainstream of mobile research as well as hosting the different aspects of contemporary technology development issues so that it will find mobile agents the most proficient implementation technique for all or part of their tasks although not all applications will need mobile agents. Several technical and non-technical hurdles must be addressed even though current trends in internet technology and usage lead to the use of mobile agents. These hurdles represent significant but not insurmountable challenges.

2. Prior Research

Communication Framework of Mobile Intelligent Agent System is shown in <Figure 1> where the multiple mobile intelligent agent cooperate with their functions through communication networks in the Information space.
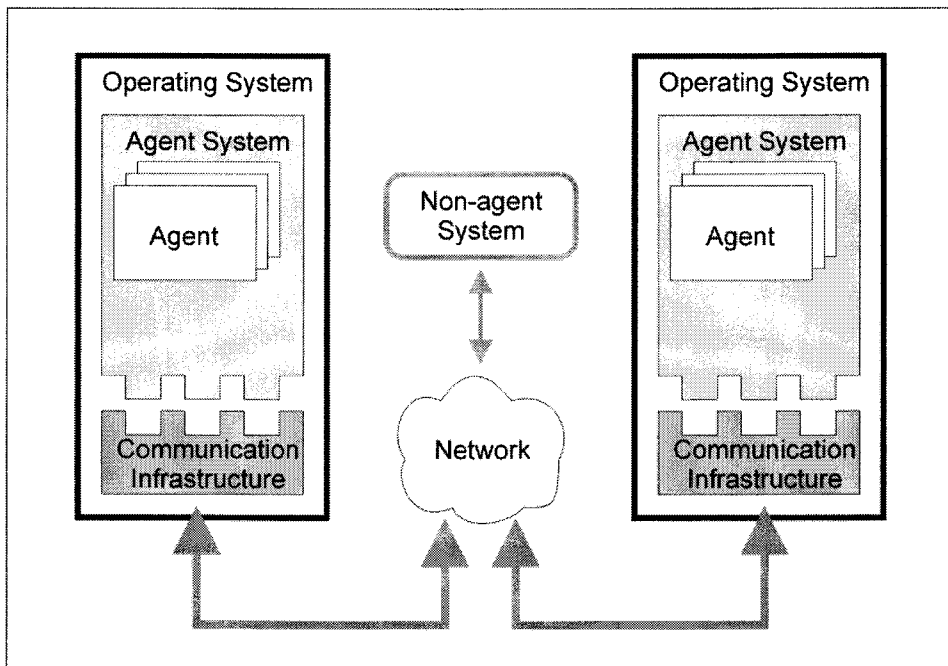

<Figure 1> Communication Framework of Mobile Intelligent Agent System

We first explain how these mobile intelligent agent interact with other objects in the Internet space. Mobile agents will be a critical near-term part of the Internet. Other than the reasons that mobile code makes new applications possible, and it leads to dramatically better performance than combinations of traditional techniques, the main reason is that it provides a single, general framework in which distributed, information-oriented applications can be implemented efficiently and easily, with the programming burden spread evenly across information, middleware, and client providers[11][12]. In other words, mobile code gives providers the time and flexibility to provide their users with more useful applications, each with more useful features[17][19].

With the alphabet number in <Figure 2> where the interaction process of mobile intelligent agent is shown, we will illustrate the procedure of how these mobile intelligent agent cope with various issues for example, information overload, customization. Numbers are growing rapidly for both the amount of information available on the Internet(a), and the number and diversity of its users. This diverse population of users(b) will demand personalized presentations and access methods, and will not settle for a uniform interface to the information. This personalization(c) will range from different presentation formats to complex techniques for searching, filtering and organizing the vast quantities of information(d). Such personalization facilities are now provided at the information source in a site-specific manner at a proxy Web site as client software(f)[9][10][17].
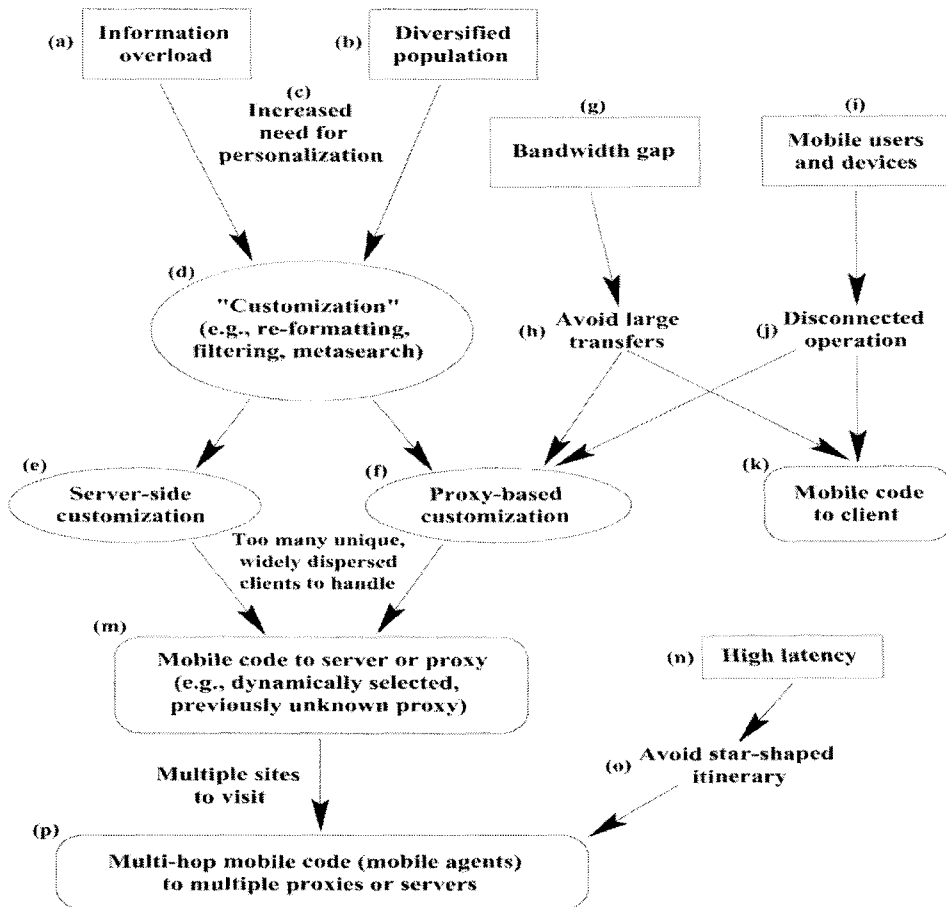
<Figure 2> Interaction Process of Mobile Intelligent Agent in Web

In the meantime, the network technology will lead to an increased gap in the bandwidth of the core Internet(g) versus the edges of the Internet. Therefore, most client hosts will avoid large transfers of data(h). This trend encourages the migration of application functionality from clients(k) into proxy sites, which are presumably better connected to the core Internet, and need send only the final results over the slower connection to the client. The core bandwidth will allow these proxy sites to be aggressive in gathering, pre-fetching, and caching information on behalf of their clients(m)[6][7].

Mobile users(i) will frequently disconnect from the network, and perhaps connect later at another location with poor bandwidth. This tendency again leads to the use of proxies(j). It also encourages application programmers to choose a mobile-code solution to dynamically install the necessary client code onto the Web terminal or portable device(k). Moving code to the client allows a high level of interaction with the user despite a high-latency(n), low-bandwidth, or disconnected network [14][15][22].

Web sites and other Internet services will not be able to efficiently provide the full range of customization desired by their clients, and clients will want to use the same information filtering and organizing tools across many sites. Moreover, fixed-location, application-specific proxies will become bottlenecks, and as user needs change, may no longer be at the best network location for accessing the proxied services[2][16]. As a result, customization tools will be specified as software, in the form of mobile code that runs either on the server, or on a dynamically selected proxy site near the server (m). Mobile code is necessary, rather than client-side code, since many customization features (such as information monitoring) do not work if the client is disconnected, has a low-bandwidth connection, or requires frequent communication with the server. Mobile code is beneficial, since servers and proxy sites need provide only a generic execution environment ; the actual customization tools can be written by the services themselves, by third-party middleware developers, and even by the end user[4][13][18][20].

Finally, many clients will wish to send mobile code to multiple information sites as part of a single task(p). Although there will be applications for which the mobile code can be sent in parallel, many tasks require a sequence of sub-tasks, each at a different site. To avoid latency, the application programmer will often want to avoid a "star-shaped graph" where mobile code goes out to the first site and sends its results back to the client or proxy, the same or different piece of mobile code goes out to the second site, and so on, and the programmer will always want to be able to select the best migration strategy for the task and current network conditions. In other words, the mobile code must be able to hop sequentially through multiple sites; such multi-hop mobile code is a mobile agent

3. Research Design

In order to identify the current major issues related to the subjects of mobile intelligent agent, we conducted a search for all resources that contained the key words combination of "mobile", "intelligent", or "agent". This search was conducted on the online database provided by University of Incheon, an educational catalog of containing more than ten world renowned database pool including academic search premier(ASP), Business Source Premier(BSP), MathSciNet, ProQuest ABI/INFORM, SAGE, SpringerLink, etc., using the search engine provided by that database[24].

The search yielded a listing of about 232 sources. We physically reviewed the abstracts of each to identify those that specifically addressed the major issues, advantages, or disadvantages, consideration of framework, or system development of mobile computing. We then reviewed a wide cross section of literature on mobile agent application, mobile systems theory, distributed systems and applications in a bid to find whether the current meta literature studies can identify the major issues and future direction of system development practices and efforts guided into a more efficient way.

4. Research Findings

We classify and present the result of this meta-study into three groups as the major benefits, the drawbacks and the possible improved areas in the future, and the current endeavors by research institution and academia.

4.1 Main Benefits for Mobile Agents

Major advantages of mobile intelligent agent suggested by practitioners and scholars are epitomized into two sources: network-related and efficiency-enhanced. Network-related issues include distributing ability, reduced network load, overcome network latency, operate asynchronously, autonomously, and advanced telecommunication while efficiency-enhanced issues contain information retrieval, robust, fault-tolerant, flow of information, dissemination, using multiple processors, security, etc.

When data is exchanged in a distributed system, each host owns the code that implements the protocols needed to properly code outgoing data and interpret incoming data. Ability of distributing.

Multiple mobile agents have the unique ability of distributing themselves among the hosts in the network to maintain the optimal configuration for solving a particular problem.

Mobile agents allow users to package a conversation and dispatch it to a destination host where interactions take place locally. Mobile agents are also useful when reducing the flow of raw data in the network.

Critical real-time systems, such as robots in manufacturing processes, need to respond in real time to changes in their environments. Mobile agents offer a solution, because they can be dispatched from a central controller to act locally and execute the controller directions directly.

Mobile devices often rely on expensive or fragile network connections. Tasks requiring a continuously open connection between a mobile device and a fixed network are probably not economically or technically feasible. To solve this problem, tasks can be embedded into mobile agents, which can then be dispatched into the network. After being dispatched, the agents become independent of the process that created them and can operate asynchronously and autonomously. The mobile device can reconnect at a later time to collect the agent.

Instead of moving large amounts of data to the search engine so it can create search indexes, agent creators can dispatch their agents to remote information sources where they locally create search indexes that can later be shipped back to the system of origin. Mobile agents ability to react dynamically to unfavorable situations and events makes it easier to build robust and fault tolerant distributed systems. Mobile agents are especially useful here, because, in addition to mobility, they provide a degree of autonomy to the workflow item. Individual workflow items fully embody the information and behavior they need to move through the organization independent of any particular application.

Mobile agents embody the so-called Internet push model. Agents can disseminate information, such as news and automatic software updates, for vendors. The agents bring the new software components, as well as installation procedures, directly to customers computers where they autonomously update and manage the software.

Given that mobile agents can create a cascade of clones in the network, another potential use of mobile agent technology is to administer parallel processing tasks. If a computation requires so much processor power that it must be distributed among multiple processors, an infrastructure of mobile agent hosts can be a plausible way to allocate the related processes.

Mobile agents are well suited for e-commerce. A commercial transaction may require real-time access to remote resources, such as stock quotes and perhaps even agent-to-agent negotiation. Different agents have different goals and implement and exercise different strategies to accomplish them. We envision agents embodying the intentions of their creators, acting and negotiating on their behalf. Mobile agent technology is a very appealing solution for this kind of problem.

Mobile agents ability to execute on remote hosts makes them suitable as assistants performing tasks in the network on behalf of their creators. An interesting

application of mobile agents is in collaborations in which not all the collaborators are trusted. The parties could let their mobile agents meet on a mutually agreed secure host where collaboration takes place without risk of the host taking the side of one of the visiting agents[8].

4.2 Major Issues for Mobile Agents

There are several issues that may deter the widespread adoption of mobile-agent technology. Internet sites must have a strong motivation to overcome inertia, justify the cost of upgrading their systems, and adopt the technology. Some notable issues that academicians mention are implementation practice, stardardization issues, evolution, scalability, security, and financial issues.

The most important challenge is that there is no good application for mobile agents. The "mobile agent" paradigm is in many respects a new and powerful programming paradigm, and its use leads to faster performance in many cases. Nonetheless, most particular applications can be implemented just as cleanly and efficiently with a traditional technique, although different techniques would be used for different applications.

Once a clear quantitative argument is made, a few major Internet services can be convinced to open their sites to mobile agents, since they will recognize that agents will lead to more applications based around their services and hence more users. From there, more Internet services will follow.

Nearly all mobile-agent systems allow a program to move freely among heterogeneous machines, e.g., the code is compiled into some platform-independent representation such as Java bytecodes, and then either compiled into native code upon its arrival at the target machine or executed inside an interpreter. For mobile agents to be widely used, however, the code must be portable across mobile-code systems, since it is unreasonable to expect that the computing community will settle on a single mobile-code system. Making code portable across systems will require a significant standardization effort.

It is unlikely that any Internet service will be willing to jump directly from existing client-server systems to full mobile-agent systems. A clear evolutionary path from current systems to mobile-agent systems must be provided. In particular, although full mobile-agent systems involve all the same research issues (and more) as more restricted mobile-code systems, we must be careful to demonstrate that the switch to mobile agents can be made incrementally. Critical evolutionary path is the migration of agent technology from intranets to the Internet. Mobile-code technologies will appear first in the relatively safe intranet environment, particularly intranets that are built on high-latency networks such as a WAN or a wireless network for mobile computers.

Current mobile-agent systems save network latency and bandwidth at the expense of higher loads on the service machines, since agents are often written in a (relatively) slow interpreted language for portability and security reasons, and since the agents must be injected into an appropriate execution environment upon arrival. Thus, in the absence of network disconnections, mobile agents (especially those that need to perform only a few operations against each resource) often take longer to accomplish a task than more traditional implementations, since the time savings from avoiding intermediate network traffic is currently less than the time penalties from slower execution and the migration overhead.

It is possible now to deploy a mobile-agent system that adequately protects a machine against malicious agents. Numerous challenges remain, including, protecting the machines without artificially limiting agent access rights; protecting an agent from malicious machines; and protecting groups of machines that are not under single administrative control. An inadequate solution to any of these three problems will severely limit the use of mobile agents in a truly open environment such as the Internet. Fortunately, groups are now exploring many new techniques, each of which addresses (or partially addresses) one of the three problems (e.g., agents paying for resource usage with electronic cash [19], which allows them to live and propagate only as long as their cash supply holds out). Although many

technical advances (and user-education efforts) must be made before these three problems are solved adequately for all Internet applications, current work is promising enough that, within a few years, mobile-agent systems will be secure enough for many applications.

Revenue flow and commercial image also causes problems. For example, although it is not yetclear whether advertising is a viable economic foundation for Web sites, many Web sites earn money solely from advertisements. If these sites allow mobile agents to easily access the content of the site, the number of human visits to the Web pages will presumably decrease, and the advertisements will not be seen. How, then, will the site earn revenue? Similarly, when users are accessing a service with a front-end backed by mobile agents, the distinction between the service and the front-end agents starts to blur. Since the agents will likely be provided by middleware developers, the Internet service will no longer have complete control over its image.

4.3 Current Research on Mobile Agents

There are a growing number of centers conducting research on mobile agents. Such pioneers in providing agent frameworks as GeneralMagic[12] and Dartmouth College have been joined, and sometimes surpassed, by IBM (Aglets), Mitsubishi (Concordia), ObjectSpace (Voyager) and others[5]. Research flourishes in many application areas [21][22][23]. In spite of being identified as one of the primary application areas of agents by the Foundation for Intelligent Physical Agents (FIPA) and the Agent Society, Network Management is still relatively terra incognita as far as the use of mobile agents in concerned. Nevertheless, a number of centers are actively pursuing research on various aspects of mobile agents and mobile code for managing telecommunication networks. The Perpetuum Mobile Procura group at Carleton University applies several types of mobile code in a pursuit of its ultimate goal, a plug-and-play network [5]. Interesting research on applications of and the tradeoffs in using mobile code for Network Management has been conducted by

the Computer Networks Group at Politecnico di Torino [7]. The Astrolog group at the Institut de Recherche en Informatique et Systemes Aleatoires (IRISA) uses mobile agents for the Mobile Network Manager [17]. This manager can be used from any location to manage a network remotely, for example, from a laptop connected through a modem.

The research at the Intelligent Mobile Agent Center of Competence (IMA-CC) of GMD Focus concentrates on specification and development of agent platforms and applications based on state-of-the-art Intelligent Mobile Agent technology including applications in Network Management. Another group, Intelligent communication Environments (ICE) attempts to augment the standard open networking architectures, like Telecommunications Information Networking Architecture (TINA), by incorporating technologies based on mobile code (Krause and Megadantz). Active Networks[17], which originated at MIT's Software Devices and Systems Group (SDS), but now spread to a number of research centers, is another interesting research activity advocating the use of programmable packets. Such packets constitute an additional soft layer on top of the hardware and fixed communication protocols, which can provide dynamic configuration, improved security, flexible interoperability, extendable protocols, etc. This research is relevant in this context, because programs carried by communication packets can be considered mobile agents.

5. Conclusions/Future Research

In this paper, we examine the major benefits and drawbacks of using mobile intelligent agents and showed the current research efforts in mobile technology by conducting this meta-study. In this process, we tried to come up the more viable application tools in terms of technical and economic considerations.

Questions still need to be answered before any definitive remarks can be made. Nevertheless, mobile intelligent agents present a technology that will become very useful and perhaps even critical, in many areas of

system and network management. There is a strong case for the use of mobile intelligent agents in many Internet applications. Moreover, there is a clear evolutionary path that will take us from current technology to widespread use of mobile code and agents within the next few years. Once several technical challenges have been met, and a few pioneering sites install mobile-agent technology, use of mobile agents will expand rapidly.

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