

# **Performance Enhancement in Mobile Computing Using Replicated Cache Agent**

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## **Abstract**

With the rapid advances of wireless communications and portable computing devices, a new computing paradigm which is called "mobile computing" has evolved. In mobile computing environment, users carrying portable devices have access to data and information services regardless of their physical location or movement behaviour. Wireless LANs (WLANs); allow greater flexibility and portability than traditional wired local area networks (LAN). This environment is called MANET. In MANETs, however, there are many unsolved problems so far:

- (1) The mobile resource constrains such as limited wireless bandwidth and limited battery life.
- (2) The mobility of nomadic users and their computers.
- (3) The intermittent disconnection of mobile users and their computers, etc.

Therefore, the methods used in conventional distributed systems and wired systems are not appropriate in mobile computing systems. This research paper makes a comparison of replicated cache agent to that of normal cache agent. Simulation is used to compare the performance of mobile system using metrics like throughput, end-to-end delay & packet delivery fraction. NS2 (Network Simulator version2) is used as simulator here. With the help of an Agent-based cache strong consistent validate strategy, result shows that replicated cache agent improves not only battery life & connection but also the writing delay.

**Keywords:** WLANs, LANs, MANET, Replicated Agent, NS2.

## **1. Introduction**

A technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link is called mobile computing. Mobile voice communication is widely established throughout the world and has had a very rapid increase in the number of subscribers to the various cellular networks over the last few years. An extension of this technology is the ability to send and receive data across these cellular networks. This is the principle of mobile computing. Mobile data communication has become a very important and rapidly evolving technology as it allows users to transmit data from remote locations to other remote or fixed locations. This proves to be the solution to the biggest problem of business people on the move - mobility. In mobile computing environment, users carrying portable devices have access to data and information services regardless of their physical location or movement behaviour.

**1.1 Requirements:** The major requirements for a mobile computing environment are:

1. Facilities that permit mobile host to be connected from different access points and to stay connected while on movement.
2. A good bandwidth for fast reliable communication.
3. Since the battery life sets a limitation, we need some kind of facilities that will permit disconnection and save power without affecting the performance and reliability of the whole system.

**1.2 Characteristics:** Various important characteristics in a mobile computing environment are:

1. Non-symmetrical nature of communications between mobile hosts and fixed servers.
2. Long disconnection from mobile host to save power and to permit the user to work at his will.
3. The mobility of host also implies the availability of a virtual server that is available to provide an efficient service to the mobile host.

The question that always arises when a business is thinking of buying a mobile computer is "Will it be worth it?" In many fields of work, the ability to keep on the move is vital in order to utilize time efficiently. Efficient utilization of resources can mean substantial savings in transportation costs and other non-quantifiable costs such as increased customer attention, impact of on-site maintenance and improved intercommunication within the business.

### **1.3 Applications:** Various applications of Mobile Computers are:

- **For Estate Agents:**

Estate agents can work either at home or out in the field. They can provide clients with immediate feedback regarding specific homes or neighbourhoods, and with faster loan approvals, since applications can be submitted on the spot. Therefore, mobile computers allow them to devote more time to clients.

- **Emergency Services:**

Information regarding the address, type and other details of an incident can be dispatched quickly, via a CDPD system using mobile computers, to one or several appropriate mobile units which are in the vicinity of the incident.

- **In Courts:**

When the opposing counsel references a case which they are not familiar, they can use the computer to get direct, real-time access to on-line legal database services, where they can gather information on the case and related precedents.

- **In Companies:**

Managers can use mobile computers in, say, and critical presentations to major customers. They can access the latest market share information. Therefore, mobile computers can leverage competitive advantages.

- **Stock Information Collation/Control:**

The use of small portable electronic databases accessed via a mobile computer would be ideal. Data collated could be directly written to a central database, via a CDPD network, which holds all stock information. This ensures that from the time that a stock count is completed, there is no inconsistency between the data input on the portable computers and the central database.

- **Credit Card Verification:**

At Point of Sale (POS) terminals in shops and supermarkets, when customers use credit cards for transactions, the intercommunication required between the bank central computer and the POS terminal, in order to effect verification of the card usage, can take place quickly.

- **Electronic Mail/Paging:**

Usage of a mobile unit to send and read emails is a very useful asset for any business individual, as it allows him/her to keep in touch with any colleagues as well as any urgent developments that may affect their work.

### **1.2 Agents:**

Agent is a term used to describe autonomous, "intelligent" programs that can be deployed through a WAN, to provide services to a mobile user. An agent is an encapsulation of code, data and execution context that is able to migrate autonomously and purposefully within a computer network during the execution. An agent is able to react on external events. It may be persistent in the sense that it can suspend execution and keep local data in stable storage. After resuming activity an agent's execution is continued. Agent is an object it contains:

a. Cached data

b. Methods for access

c. State information

d. Consistency rules

e. Tolerance parameters for time and attributes

#### **1.2.1 Properties:** An agent has the following properties:

1. **Delegation:** A user or a program can delegate tasks to an agent and vest it with an authority (power of attorney) to act on their behalf by providing terms of reference and time dead-lines.
2. **Autonomy:** Agent can make its own decisions, based on rules, goals, policies and preferences set by its owner.
3. **Communication:** Agents can interact with host environment and owners.
4. **Co-operation:** Agents can cooperate with each other to achieve common goals.
5. **Equity:** Agents can support peer-peer model for distributed computing.
6. **Flexibility:** Agents can vary their roles-may act as clients or servers, observers, seekers.
7. **Intelligence:** Ability to reason and learn from interactions with other agents, owners and environment.
8. **Mobility:** Agents can move across networks and accomplish tasks assigned.

### 1.2.2 Types of agents:

#### a. Buyer agents(Shopping Bots):

Buyer agents travel around a network (i.e. the internet) retrieving information about goods and services. These agents, also known as 'shopping bots', work very efficiently for commodity products such as CDs, books, electronic components, and other one-size-fits-all products. **For example**, *Amazon.com* is a good example of a shopping bot. The website will offer you a list of books that you might like to buy on the basis of what you're buying now and what you have bought in the past.

#### b. User agents(Personal agents):

User agents are intelligent agents that take action on your behalf. In this category belong those intelligent agents that already perform, or will shortly perform, the following tasks:

1. Check your e-mail, sort it according to the user's order of preference, and alert you when important emails arrive.
2. Play computer games as your opponent or patrol game areas for you.
3. Assemble customized news reports for you. There are several versions of these, including News hub and CNN.
4. Find information for you on the subject of your choice.
5. Fill out forms on the Web automatically for you, storing your information for future reference.
6. Scan Web pages looking for and highlighting text that constitutes the "important" part of the information there.
7. Discuss topics with you ranging from your deepest fears to sports.
8. Facilitate with online job search duties by scanning known job boards and sending the resume to opportunities who meet the desired criteria.
9. Profile synchronization across heterogeneous social networks.

#### c. Monitoring-and-surveillance agents(Predictive Agents):

They are used to observe and report on equipment, usually computer systems. The agents may keep track of company inventory levels, observe competitors' prices and relay them back to the company, watch stock manipulation by insider trading and rumors etc. **For example**, NASA's Jet Propulsion Laboratory has an agent that monitors inventory, planning, and scheduling equipment ordering to keep costs down, as well as food storage facilities. These agents usually monitor complex computer networks that can keep track of the configuration of each computer connected to the network.

#### d. Data mining agents:

Data mining agent uses information technology to find trends and patterns in an abundance of information from many different sources. The user can sort through this information in order to find whatever information they are seeking .A data mining agent operates in data warehouse discovering information. A 'data warehouse' brings together information from lots of different sources. "Data mining" is the process of looking through the data warehouse to find information that you can use to take action, such as ways to increase sales or keep customers who are considering defecting.

### 1. 3 Working of Mobile Agents:

A mobile agent consists of the program code and the program execution state (the current values of variables, next instruction to be executed, etc.). Initially a mobile agent resides on a computer called the home machine. The agent is then dispatched to execute on a remote computer called a mobile agent host (a mobile agent host is also called mobile agent platform or mobile agent server). When a mobile agent is dispatched the entire code of the mobile agent and the execution state of the mobile agent is transferred to the host.

The host provides a suitable execution environment for the mobile agent to execute. The mobile agent uses resources (CPU, memory, etc.) of the host to perform its task. After completing its task on the host, the mobile agent migrates to another computer. Since the state information is also transferred to the host, mobile agents can resume the execution of the code from where they left off in the previous host instead of having to restart execution from the beginning. This continues until the mobile agent returns to its home machine after completing execution on the last machine in its itinerary.

#### 1.3.1 The life cycle of a mobile agent:

1. The mobile agent is created in the Home Machine.
2. The mobile agent is dispatched to the Host Machine A for execution.
3. The agent executes on Host Machine A.
4. After execution the agent is cloned to create two copies. One copy is dispatched to Host Machine B and the other is dispatched to Host Machine C.
5. The cloned copies execute on their respective hosts.

6. After execution, Host Machine B and C send the mobile agent received by them back to the Home Machine.
7. The Home Machine retracts the agents and the data brought by the agents is analysed. The agents are then disposed.

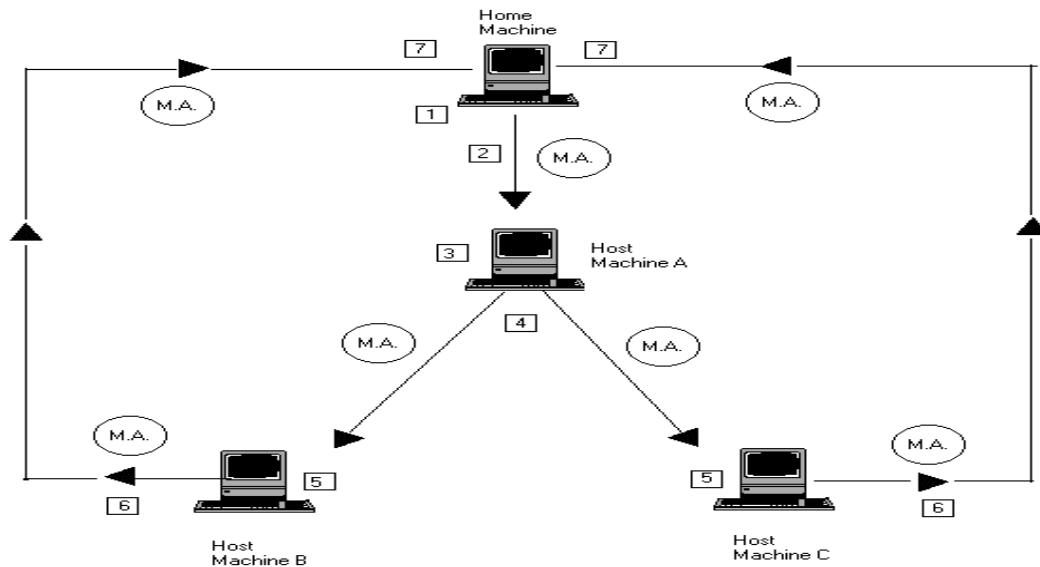


Figure 1 working of Mobile Agent

**1.3.2 Events:** From this we observe that a mobile agent experiences the following events in its life cycle:

- a. **Creation:** a brand new agent is born and its state is initialized.
- b. **Dispatch:** an agent travels to a new host.
- c. **Cloning:** a twin agent is born and the current state of the original is duplicated in the clone.
- d. **Deactivation:** an agent is put to sleep and its state is stored on a disk of the host.
- e. **Activation:** a deactivated agent is brought back to life and its state is restored from disk.
- f. **Retraction:** an agent is brought back from a remote host along with its state to the home machine.
- g. **Disposal:** an agent is terminated and its state is lost forever.

#### 1.4 Advantages of Mobile Agents:

##### 1.4.1 Reduction in Network Load:

The interactions in a distributed system are often achieved using communication protocols. An alternative to using communication protocols is the use of mobile agents. Mobile agents are dispatched to the remote hosts containing the data. The agents perform the computations at the remote hosts and return back with the results. Since computations are moved to the data storage location instead of moving data to the computing location, network load is reduced.

##### 1.4.2 Overcome Network Latency:

Controlling many systems through a network involves significant delays, which are not acceptable for critical real time systems. To overcome this problem, mobile agents can be directly dispatched from the central controller in the manufacturing plant to the real time systems.

##### 1.4.3 Protocol Encapsulation:

However, protocols evolve over a period of time and new features such as better security may be introduced in the protocol. It is a cumbersome task to upgrade the protocol code at all locations in the distributed system. The mobile agent code can encapsulate the protocol. When a protocol is upgraded, only the mobile agent has to be altered.

##### 1.4.4 Asynchronous and Autonomous Execution:

Mobile agents operate asynchronously. Once a mobile agent is dispatched from the home machine, the home machine can disconnect from the network. The mobile agent executes autonomously without the intervention of the home machine.

##### 1.4.5 Fault Tolerance:

Mobile agents react dynamically and autonomously to the changes in their environment, which makes them robust, and fault tolerant.

1.5 Related Work

Various proposals have been defined for avoiding the writing delay due to call back algorithm. Ichiro Satoh [2] described that when a task is assigned to mobile agents, those suitable to perform the task need to be selected according to, not only their application-specific behaviours, but also their mobilities. The focus is on the development of execution platforms and applications for mobile agents and not on methodologies for selection of mobile agents. Seungsang Sun [6] various migration schemes for mobile agents. The agents play a key role to manage a huge amount of tasks instead of human being in ubiquitous computing environments. Jinghua Wang [9] presented an improved cache invalidation schema based on mobile Agents. An asynchronous invalidation broadcast technology and the control messages which are broadcast by MSS periodically is introduced. MSS maintains for each MC a data structure that stores the latest time stamp for each data item cached by MC. The improved schema can maintain client cache consistency better and improve the speed of execution of transaction. Chu Yan [10] observed that in mobile computing environments, the limited bandwidth of wireless communications, the weak capability of mobile computing equipment and the valuable power make it difficult for mobile devices to be maintained with the network all the time. Cache technique caches part of data in the clients to reduce the query of database server, so it solves the problem to some extent.

2. Methodology

2.1 Agent-based cache strong consistent validate strategy

The key issue in cache algorithm is how to maintain consistency of cached data. We studied the caching consistent checking problems which aroused by data query operations from clients and write operations on server. Utilizing *predicate-based* method to represent cache data structure, which described a data record as a string (called predicate) including '0', '1' and '\*'. Predicate-based scheme could reduce networks communications cost and execute subtraction sign '-' operation and intersection sign '^' operation to compute 'remainder predicate' in practically reasonable complexity. Here, remainder predicate is the cache data record which should be updated. Figure 2 shows the architecture of proposed agent-based cache validation scheme.

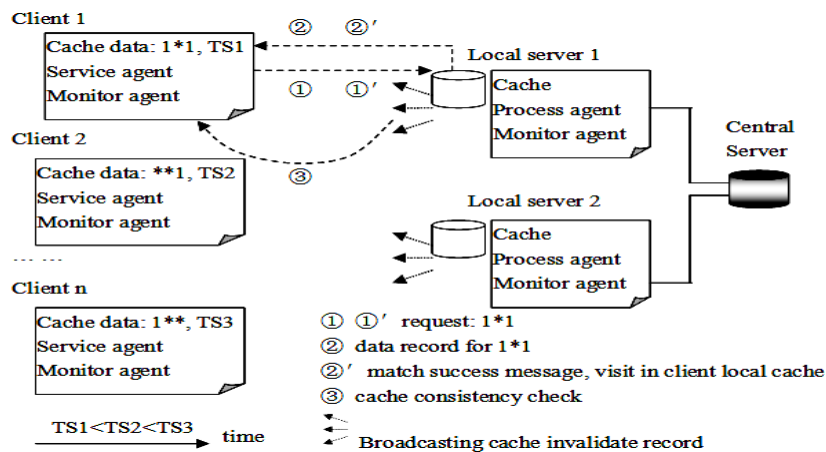


Figure 2: The architecture of our agent-based cache Validation scheme

Figure 3 shows the proposed architecture of 'Client/Agent/Server' for mobile computing. Local server encapsulates MSS's functions.

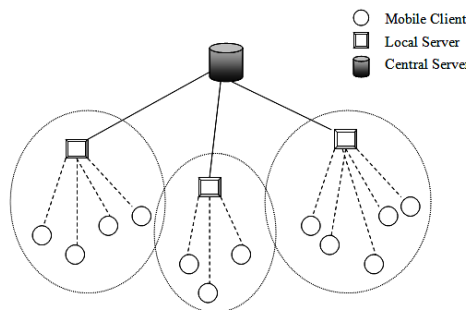


Figure 3: our proposed client/agent/server architecture

To remove writing delay and to improve the performance we propose methodology/research has been Come out which removed the drawbacks of existing call back method, introduces an agent technology, and extends conventional Client/Agent into Client/Agent/Server.

Main objective of the agent cache system is:

- 1) We will implement the previous model of the agent cache in the NS2  
Then we will Implement the new agent cache system and compare the following parameters

- 1) Throughput
- 2) End to end delay
- 3) Round Trip time

Purposed scheme that extend the Existing system are as under:

- 1) We will introduce replication agent system into previous work , to make it much sophisticated
- 2) With addition of replication agent , we need to prepare a system that will handle the data replication cost and data accessing cost in the Mobile computing
- 3) In addition to this we will discard the Malicious attack in this system which will lead to provide the quality of service in the mobile computing

## 2.2 Performance Metrics:

The estimation of performance of mobile computing system by replicating the agents can be estimated by following metrics:

### a. Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. This performance metric gives us an idea of how well the agent is performing in terms of packet delivery at different speeds using different traffic models.

**b. End to End Delay:** end-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.

$$d_{\text{end-end}} = N [ d_{\text{trans}} + d_{\text{prop}} + d_{\text{proc}} ]$$

Where

$d_{\text{end-end}}$  = end-to-end delay

$d_{\text{trans}}$  = transmission delay

$d_{\text{prop}}$  = propagation delay

$d_{\text{proc}}$  = processing delay

N = number of links (Number of routers + 1)

Note: we have neglected queuing delays.

**c. Throughput:** The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network. The throughput can be analysed mathematically by means of queuing theory, where the load in packets per time unit is denoted arrival rate  $\lambda$ , and the throughput in packets per time unit is denoted departure rate  $\mu$ .

## 3. Result and Discussion

**3.1 Throughput:** Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network.



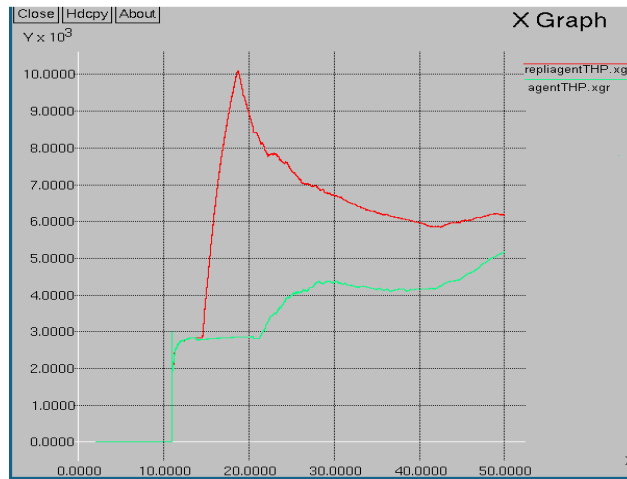


Figure 4: Throughput graph between Pause time and KPBS

As it is clear from the graph that the throughput data packets are higher in Replicated agent as compared to simple agent cache system.

3.2 **Average end-to-end delay of data packets** — This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. The average end-to-end delay of packet delivery is higher in Agent Cache as compared to replicated agent system.

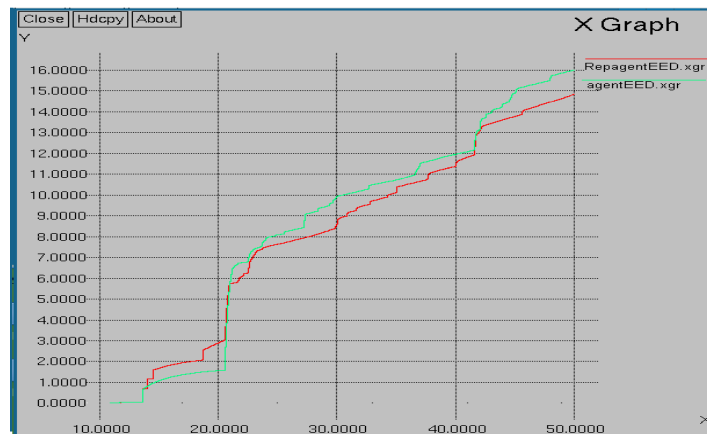


Figure 5: end to end Delay graph between Pause time and Delay time in milli sec

3.3 **Packet delivery fraction** — the ratio of the data packets delivered to the destinations to those generated by the CBR sources. The delivery fraction is higher in Replicated agent as compared to agent cache.

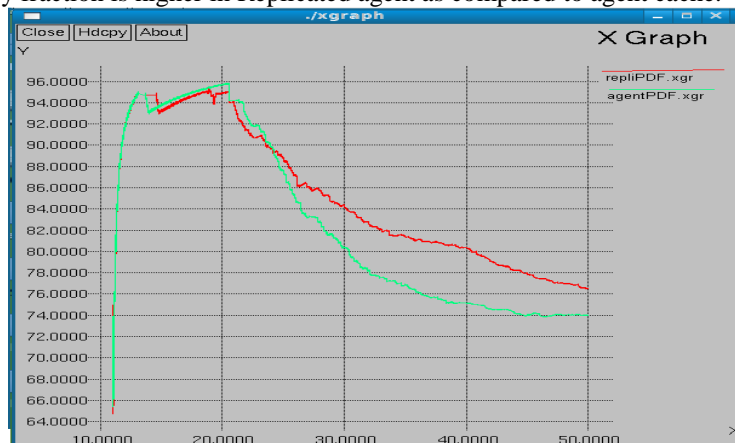


Figure 6: Packet Delivery fraction graph between pause time and packet fraction

#### **4 Conclusion:**

In mobile computing existing call-back arithmetic has the drawback of 'writing delay' due to which server must wait for invalidation confirmed messages from every client. And client's caching data need be revalidated again when any one appears. In this paper, based on wireless access network, I propose a technology of agent-cache which is fit for a mobile computing environment with the architecture of Client/Agent/Server'. I use the artifice of agent-cache to reduce traffic and take some proper control to avoid dirty data been read by one. It also includes that user data can be updated in time by virtue of validating the consistency of data among the client, agent and server. A new Callback Validating Policy is presented by me for mobile environment because the current arithmetic for this is believed with the problem of writing delay, in which the cache data need be revalidated again when any client appears.

#### **5 Acknowledgement**

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Reena

#### **References**

- [1] Parineeth M Reddy, "Mobile Agents", General Article, Year 2002, pp. 35-43.
- [2] Ichiro Satoh, "Building Reusable Mobile Agents for Network Management", IEEE, Year August 2003, vol. 33, no. 3, pp. 350-357.
- [3] Stefan Pleisch, Andre Schiper, "Fault-Tolerant Mobile Agent Execution", IEEE Transactions on Computers, vol. 52, no. 2, Year 2003, pp. 209-222.
- [4] Wenyu Qu, Hong Shen, "Some Analysis on Mobile-Agent Based Network Routing", IEEE International Symposium on Parallel Architectures, Algorithms and Networks, Year 2004, pp. 1-6.
- [5] Gabor Vilmos Szabó, Diploma. Eng. in Comp. Sc., Swiss Federal Institute of Technology, ETH Zurich {DISS. ETH No. 16207, 2005 © IEEE}
- [6] Seungsang Sun, Hyun-Su Jang, Youn-Woo Kim, and Young Ik Eom, "An Efficient Migration Scheme for Mobile Agents in Ubiquitous Environments", IEEE International Symposium on Information Technology Convergence, Year 2007, pp. 110-114.
- [7] Amanpreet Kaur, Sukhdeep Kaur, "Role of Mobile Agents In Mobile Computing", National Conference on Challenges & Opportunities in Information Technology, March 23, 2007, pp.68-71.
- [8] Khaleel Ur Rahman Khan, Rafi U Zaman, A Venugopal Reddy, "A Three-Tier Architecture for Integrating Mobile Ad Hoc Network and the Internet using a Hierarchical Integrated Routing Protocol", IEEE International Conference on Advanced Computer Theory and Engineering, Year 2008, pp. 518-522 Rubing Liang, Qiong Liu., "A Technology of Agent-Cache Used in Mobile Computing Environment", World Congress on Computer Science and Information Engineering, Year 2009, pp.120-124
- [9] Jinghua Wang, Zhiyun Zhou, Minhra Liu, "An improved cache invalidation schema based on mobile Agents", IEEE, Year 2010, vol. 1, pp. 7-9.
- [10] Chu Yan, Zhang Jianpei and Zhao Chunhui, "Data Cache Strategy Based on Colony Algorithm in Mobile Computing Environment", IEEE Fourth International Conference on Internet Computing for Science and Engineering, Year 2010, pp. 235-238.