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Agent based User Interface Design for Mobile Cloud Computing Environment (AUID)

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Abstract **- Mobility is the need of the hour and the Mobile Clouds are becoming popular and are able to meet the needs of the current day customers. Cloud computing being the state of art technology enables the individuals, entrepreneurs, small and medium companies to carry on their personal and business activities at all levels, without any interruption. Provisioning and offering an exactly matching service to the highly demanding customer has been a night mare and will continue to be the same in the mobile environment. In this paper, we propose an Interactive Multi Agent based User Interface that interacts with the end user on one side and with the mobile network cloud on the other side and offers an optimal solution so as to balance the interests of both the parties. Here the Mobile Agent Manager with its simple architecture and interactive capability, understands, analyzes and organizes the services being offered by the cloud to achieve customer satisfaction always and every time and on demand to meet explicit needs.**

Keywords **- Mobility, Mobile Cloud, Interactive Multi Agent, User Interface, Mobile Agent Manager and Customer Satisfaction.**

I. INTRODUCTION

Cloud Computing, which characterizes computing as a utility - is at the helm of "industrializing" the IT Industry by providing software and/or hardware in a "ready to use"/"on demand" state. The infrastructure setup expenses, complexity as well as the administrative efforts are all taken care by the cloud service provider. Cost is kept under check as the developers pay only for what they use; thereby reducing the unnecessary expenditure. Scalability is another huge advantage of the Cloud infrastructure. Suppose a small company grows "big", the first obstacle is the infrastructure explosion and the related costs. Whereas a small company already using Cloud infrastructure, can demand for hundred times as many hardware instances, as required by the user for almost instantaneously. Such an expansion in a conventional physical hardware setup is not only a nightmare but also unimaginable in a short time frame. Thus the Cloud allows the consumer to scale up and scale down, the hardware resources significantly, based on the business requirements. This is a phenomenon that the IT Industry has never experienced before.

Cloud computing in the simplest terms can be explained as the consumption of computing resources via the Cloud [9]. Here the computing resources could be either software or hardware. Software could be an application software (e.g. Sales force automation package) or systems software. Hardware computing resources take the form of full-fledged servers, for usage by the consumer. And all these offerings are made over the Cloud and the user can consume the computing capabilities like CPU power &storage space, over the Cloud (Internet); without knowing the location of the computing resources. Cloud computing thus offers fast, simple, on-demand resources accessible from anywhere, on the globe almost instantaneously. Currently there are three types of Clouds exist – Public, Private and Hybrid. Public Cloud, as the name suggests, is accessible to general public – wherein services are sold as a utility. Here the consumer pays only when the Computing resources are being utilized. Amazon AWS and Microsoft Azure currently offer Public Cloud on a large scale. Private Clouds are generally restricted cloud networks, created and maintained by companies internally. Such an environment is advantageous to both the Cloud service provider and consumer. For the service Provider, there exists a central control from where the installation and administration of instances can be provided and monitored constantly. Moreover, none of the resources procured, ever stay idle due to the inbuilt virtualization concept of Cloud computing.

If one end user is not actively using the assigned Computing resources, virtualization takes care that the unused sharable resources like CPU, RAM etc are allocated to another active user. Of course, care is taken that non-sharable resources like the hard disk are not available to multiple users. Hence, the service provider gets a very high hardware utilization value. On the other end, benefits to the service consumer are already well known – simple easy access, on-demand availability and cost effectiveness. Hybrid cloud is a combination of Public and private networks, where the service providers are different, but with clear cut technical and business understanding to provide optimal services to the consumers. Thus, the Cloud computing environment is a win-win situation for the provider as well as the consumer.

II. MOBILE AGENTS IN CLOUD COMPUTING ENVIRONMENT

Mobile agent technology has been perceived as an emerging technology that makes it much easier to design, implement, and maintain distributed systems, including cloud computing and sensor networks. It does not provide an infrastructure, just for executing autonomous Agents but for migrating them between various computing systems. It describes technologies for executing, mobilizing, and implementing mobile agents. It presents several practical and potential applications of mobile

agents in smart environments in addition to distributed systems.

Although cloud computing is generally recognized as a technology which has a significant impact on IT in the future, but it still is in its infancy, lacking standardization, availability, portability and interoperability features. Hence it is impossible for different Cloud computing Service Providers to implement wide deployment and service provisioning across various infrastructures to the best of the satisfaction of their customers.

Cloud computing provides dynamically scalable infrastructure or virtualized resources in the form of services over the Internet. It is a model for enabling scalable, on demand network access to a shared pool of configurable computing resources that can be provisioned ubiquitously and released with minimal management effort and cloud service provider interaction [1]. Cloud infrastructure is implemented on VM's which are remotely located. Any user who wants to access data or any application has to send request to cloud service provider who in turn replies with an address or a pointer to the services. Existing cloud infrastructures use virtualization techniques with hypervisors to transparently allocate resources of physical hosts for a service provider's virtual machines (VMs). A key benefit of virtualization is that it allows running multiple operating systems on a single physical system where underlying hardware resources are shared. Fig: 1 gives the over view of the Cloud architecture at any generic Cloud Service providers end, which is depicted below for ease of understanding and clear visualization. Ideal cloud computing infrastructure has provided the basis for building the required hardware and software platforms, with the virtualization architectures, so as to support the planned cloud services for the consumer community. Generic enterprise solutions have been placed at the top most layer, in line with that of the application layer, over and above the abstraction layer of the operating system, to meet the customer needs. Many of the service providers have built their own platforms and added value to enhance the infrastructure facilities and the user comfort levels, in order to push their businesses and to show their competitive skills to attract the consumers.

Dynamic Operations layer plays an important role to provide the flexible on demand services to the users. Quick reconfiguration and reallocation of computing power, RAM and hard disk space, functions are the primary jobs of this layer. Thus the dynamic requirements of the customers are managed by this layer. Hence it acts as vertical to the entire cloud infrastructure. It is here in this layer the requisite number of cloud instances are created and deleted as on required basis. Further the dynamic layer facilitates the creation of images of the instances, containing the installed and configured applications. These images will be used for spawning the instances for future applications, by avoiding the over heads of installation and configuration, which in turn enhances the performance, specially the response time to the customers [6].

Basic agent architecture, its mobility, availability and autonomous nature and in general the over all behavior, effectively utilizes this Cloud architecture and adds value in providing dynamic services to the user community. Thus the agent technology integration to that of the Cloud infrastructure is the need of the hour for seamless service provisioning.

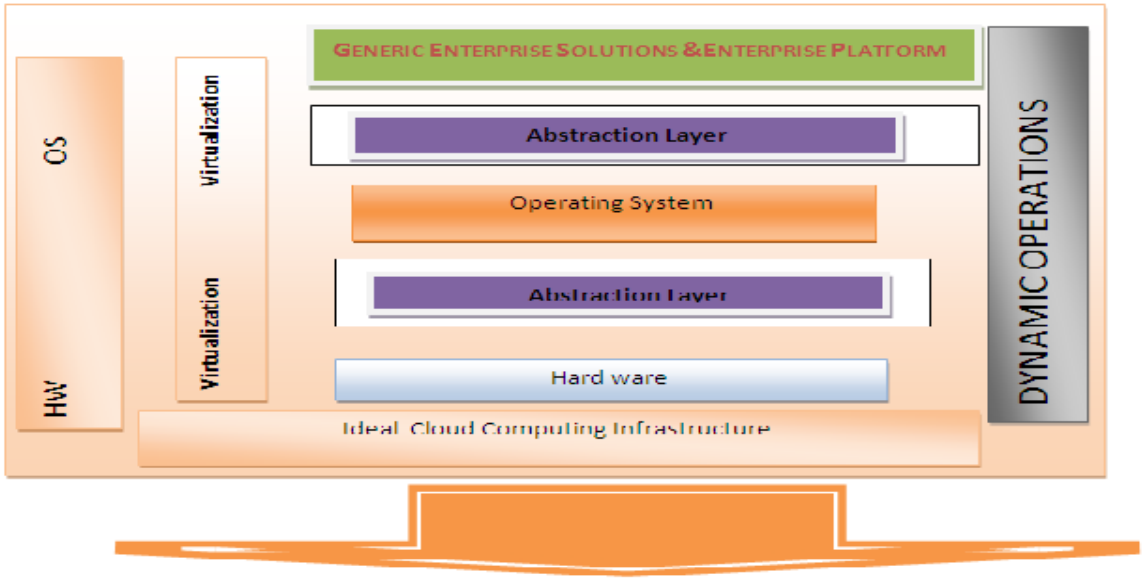

Fig.1. Generic Service providers' Cloud Architecture

A. *Interactive Mobile Agents, Agent Platforms and their implications*

Mobile agents have been the focus of much speculation and hype in recent years. The appeal of mobile agents is quite alluring – mobile agents roaming the Internet could search for information, find us great deals on goods and services, and interact with other agents that also roam across the networks(meet and interact in a gathering place) or remain bound to a particular system.

A Mobile Agent, namely, is a type of software agent, with the features of autonomy, social ability, learning, and most importantly, mobility. More specifically, a mobile agent is a process that can transport its state from one environment to another, with its data intact, and be capable of performing appropriately in the new environment. Mobile agents decide when and where to move. Movement is often evolved from RPC methods. Just as a user directs an Internet browser to "visit" a website (the browser merely downloads a copy of the site or one version of it in the case of dynamic web sites), similarly, a mobile agent accomplishes a move through data duplication. When a mobile agent decides to move, it saves its own state, transports this saved state to the new host, and resumes execution from the saved state.

A mobile agent is a specific form of mobile code. However, in contrast to the Remote evaluation and Code on demand programming paradigms, mobile agents are active in that they can choose to migrate between computers at any time during their execution. This makes them a powerful tool for implementing distributed applications in a computer network.

Mobile Agents are agents that can physically move across a Network, and perform tasks on machines that provide agent hosting capability. This allows process to migrate from computer to computer, for processes to split into multiple instances that execute on different machines. And after completion of task immediately another task will be assigned to the Mobile agent by agent manager.

If mobile agents were to gain widespread commercial adoption (to the degree that say, web browsing or email has), then what type of network would we have? The following list of implications is by no means exhaustive, but does provide an interesting set of observations.

III. Relevant Work and State of the Art

Basic ability of the agents, to move around, communicate and cooperate with their peeers and also respond to the environmental conditions makes them very effective and attractive to tackle the dynamically varying mobile customer needs in mobile cloud environment. Task specific agents , which can communicate with users through e-mail and graphical interface were designed and implemented to handle real world problem of scheduling visitors the laboratories by Henry A Kautz etal in [2].Here the efficiency and optimization aspects of the agents was given low priority with the focus on functional issues. In [3], the authors elaborated the concerns regarding task/ requirements delegation and also the merits and demerits of assigning the jobs to agents. However the allocation methodologies and the corresponding architectural support to facilitate, speedy execution of various activities could draw very less attention. Multi agent architecture for secure services has been proposed with the concept of layered architecture in the review paper [4].Distribution of interfacing, authentication, authorization and also the service provider's activities as an association of knowledge base has been highlighted. The overheads of communication between the agents and the communication network sub system entities

IV. Mobile Agent Interaction

In some of the systems, agents are implemented as active objects (objects which represent parallel threads or processes). The natural way for an agent in such an environment to interact with another agent is by simply calling that agent's methods. References are used to call one another. By carefully controlling which agent obtains what references of other agents, the privacy of agents can be assured. As an example of a system with very tightly coupled object-oriented agent interaction, Tele script platform can be considered the best one. But Java based mobile agent platforms also use a similar way for agents to communicate, because the basic language concepts of Java and Tele script are very similar.

Java Remote Method Invocation (Java RMI) enables the programmer to create distributed Java technology-based to Java technology-based applications, in which the methods of remote Java objects can be invoked from other Java virtual machines, possibly on different hosts. RMI uses object serialization to invoke/create and dispose marshal and unmarshal parameters and does not truncate types, supporting true object-oriented framework.

V. Proposed Agent Based User Interface for Mobile Clouds

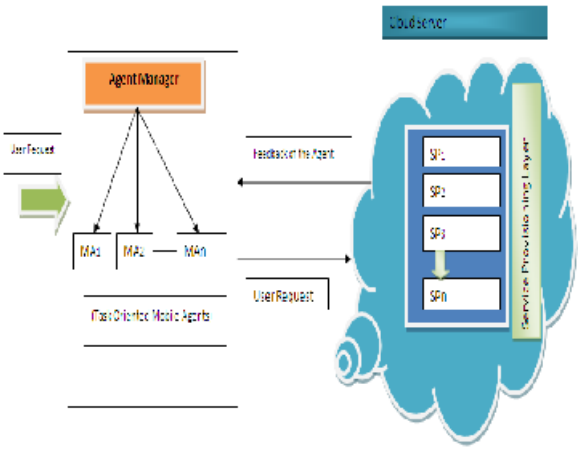

Fig.2. Agent based User interaction Architecture

User initially selects the type of service that he thinks looks good for his application. Then Agent manager, analyses the request, understands complexities if any and allocates Mobile Agents for that specific service. Here the complex service request may demand the allocation of more than one agent, so as to provide an optimal service to the request. Thus the Agent Manager uses its discretionary powers and takes a decision and activates the corresponding agents' for action. Further the respective agents will interact with the cloud server to get the information of that service. The search process in the cloud server will start and the services offered by the server will be sent in the feedback form as response. The following are the examples of such Services: SP1 (Security Service), SP2 (Response Time), SP3 (Data Transfer rate), SP4 (Storage Space)…… SPn (Transaction time) etc. corresponding to the specific parameters, that generally satisfy the user requirements, in accordance with the Enterprise Policies.

A. *Agent Manager*

The main role of agent manager is creation, registration, of events and deletion of each agent. In addition, agent manager offers knowledge –base to each agent, monitoring the whole agents according to types of usage of service resources. It includes the ability to control activity of each agent.

Agent manager obtains only relational information from user log information and context information from mobile agent. This information decides the event of creation of distributed mobile agent and service items to be provided to users.

The event of creation, activity and deletion of distributed agent are regularly generated by agent manager to the system time line. The structure of control signal consists of agent's ID, control information, MAC, TAG, Trap etc.

Control signal of distributed agent is composed of MA (Mobile Agent) index, Request and TRAP; Request ID is offered by user agent. Finally, Trap contains the action state value of distributed agent as well as state value regarding the information event received by the system.

B. *Optimal Service provisioning and management in Cloud Environment*

Virtualization is the essential catalyst for cloud computing. As the virtualization leader, VMware builds on this solid foundation with platforms and solutions to power cloud infrastructure, build and run, robust cloud applications, and supply end-user computing as a cloud-based service.

To deliver competitive advantage, cloud computing must be flexibly tailored and aligned to individual needs. For an enterprise, this could mean a cloud that's internal and private – one that leverages external services, or a hybrid cloud that combines both and that is the business life line.

VI. IMPLEMENTATION METHODOLOGY

Agent based User interface has been developed using the basic Client Server Architecture through Java Remote Method Invocation (Java RMI). As per the user request the Runtime system corresponding to the Agent manager alerts and holds the agent. As an initiation process it activates the agent into a bit chunk that can be transmitted over the mobile network by segregating the specific task to be executed as extracted from the user request, then the bit chunk is transmitted to the service provider's server for accessing the required service, strictly in accordance with the supported network protocols. The runtime system at the service provider's end responds to the request through the mobile network connection. The interaction amongst various components of the proposed architecture is depicted in fig3.below. It is this interaction that facilitates the over all process to reduce various over heads of the regular and standard activities of the networks and the interfaces. One Agent manger can handle handful of agents within its jurisdiction and control them with requisite degree of freedom of operation for the agents, to enable them to perform the executable actions individually assigned. Thus the user request has been parsed and redistributed to the agents for simultaneous initiation of actions, for proper and faster response to the customer. Each service agent interacts with its corresponding server side counterpart and confirms the availability and the nature of the service, from the server pint of view. These agents, with their inbuilt intelligence, are capable of assessing the service and will match the user requirement. Having got the inputs from the activated service agents, the agent manager will finally, makes a perfect match of the offered service to that of the customer request and extends service with the customer's acceptance. Thus this phenomenon of multi agent activation and their integrated effort in providing the best possible offer is the unique feature of our work. Here we are providing the value addition to the end user and also to the cloud service provider by making the right mix and match of the request on one side and the offered service on the other side.

Most existing mobile agent systems use TCP channels, SMTP, or HTTP as their underlying communication protocols. Mobile agents themselves are separated from these underlying communication protocols. Emerging virtualization technologies are making ubiquitous access to on-demand computing, network and storage resources to deliver various applications over public Internet.

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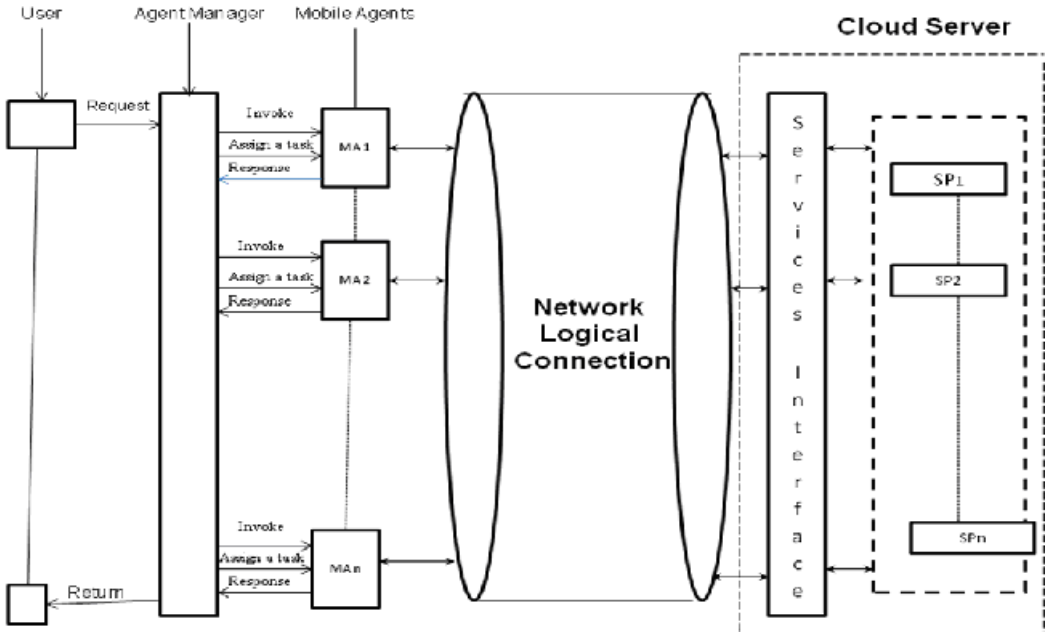

Fig.3. Interactive Agents Architecture

A. *Next Generation Network Services and their impact on cloud computing environment*

Service Management On Demand is the first and only global, Web-based service management solution in the market that is field centric— built to mirror and optimizes the work flow of a field service engineer on a service call. This unique perspective allows Service Management OnDemand to manage the traditional challenges that bog down service operations which adversely impact customer satisfaction, service revenue, and business growth.

Service Management On Demand strategically automates, standardizes and streamlines manual processes, and centralizes disparate systems associated with customer service lifecycle management. Agent interaction capability has been effectively utilized, to mange the complexities of
dynamic requirements and real time needs of the customers.

VII. Experimental Setup and Performance Analysis

For our experimentation and performance check, we used a customized AMI Cloud instance – with the details given below:

- **Operating System**: Linux Enterprise Server 10 SP01
- **Database**: Oracle 10g, Server-Client.
- **CPU**: 4x1.2GHz AMD 2007 Opteron Amazon Computing Unit (ACU) 32-bit
- **6 GB RAM**
- **450GB HDD** with prepared File System
- **Java 1.5.0**_14 installed
- **Open VPN** Ready

Measuring performance for applications hosted in the Public Cloud is a major challenge because of its unpredictability. As application is access over the internet bandwidth is dependent on many factors. Hence zeroing on the performance bottleneck is a night mare.

During our study the ERP performance of A Company was quite satisfactory.As for as the functional aspects are concened specific modules like Administrative, Financial and Human Resource were check and the results are tabulated below:

Parameter	Admin	Finance	HR
Response Time	1389 ms	1112 ms	1088 ms
Avg. Roundtrips	1	1.5	1.25
Data Traffic	15 KB	12 KB	18 KB
Data Retrieval Time (100 KB File)	2.0 sec	1.75 sec	1.5 sec
Avg. Transaction Time (simple query)	2.5 sec	2.2 sec	2.0 sec

Table1.Parameters and performance measures

VIII. Conclusion and Future Work

The various benefits offered by Cloud, suit perfectly to the current on-demand business models, and are applicable to the Educational Institutions also with their varied requirements. Cloud environment offers a win-win situation for both the Cloud service provider as well as the consumer. The applicability of the Cloud model is even more impressive as both startups as well as huge corporates can adopt the cloud and benefit from it. However the security aspect could not be studied in detail due to the limitations. With the customer data being placed

completely in the hands of the service provider, the data vulnerability is always a serious concern. Data lock-in is another aspect which scares the users away from cloud environments. In our proposal, end to end security provision is made so that the user can select the desired degree of secure algorithms based on the information content. Developing new cryptographic algorithms and key exchange mechanisms for regular information exchange in the cloud environment is our next area of interest. Further research focus will be to handle the dynamically changing mobile network environment and provisioning of high degree of security for the user data at all levels. Our contribution is the development of agent based user interface that enhances the user satisfaction and comfort levels by matching the offered services to specific needs of the user community.

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