# Toward Development of Mobile Agent Based Architecture for Wireless Sensor Network

**Sonia Rani, S. Niranjan**

***Abstract:*** ***There is huge amount of information gathered from the sensor nodes in wireless sensor network that must be explored, analyzed and stored for future use. Energy and storage requirement remain a major challenge for these types of network. From last few years, the Cloud technology is more popular, especially in e-commerce business sector. Google, Amazon, IBM, and Microsoft are the examples of cloud computing platforms. In cloud computing ,instead of storing data in personal computers it is stored on cloud servers and sufficient bandwidth is also available for fast access .Combination of WSN and cloud computing provide the facility of sharing various resources such as storage, computation and analyzing data. In this paper, we have designed a new four-tier Mobile Agent based Architecture for Wireless Sensor Network (MAAWSN) which includes Mobile Agent technology and cloud computing technology. Mobile agent is a software code which migrates from one cloud to another cloud to trans-receive data to base station. Then performance is evaluated by comparing it with three tier architecture in term of throughput, time delay and packet loss.***

***Keywords: Cloud Computing (CC), Mobile Agent (MA), Co-ordinator Head (CH), MAAWSN***

## I. INTRODUCTION

Wireless Sensor Networks (WSNs) having small sensing devices which have capability of sensing, processing, and storage. These sensing devices are connected via wireless links called sensor nodes [1]. Sensor nodes have limited computing resources, and powered by small batteries. So energy saving is a main issue for networks [2]. Many researchers work on these issues and provide a better life time for sensor deployed infrastructure. The combination of these two technologies: WSNs and cloud computing provide us robust and scalable infrastructure for various applications. This is a better approach for the efficient management of data from millions of sensors and other energy management systems [10]. This cloud infrastructure provides necessary tools for collecting and storing sensor data from geographically distributed sensors. The objective of the integration of WSN with Cloud Computing is to providing the facilitate of shifting data from WSN to the Cloud Computing for historical, future research, and re-analysis in future. Scientifically and economically valuable data may be fully utilized.

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### A MOBILE AGENT TECHNOLOGY

In coming era, wireless and portable devices users will increase exponentially so it becomes a challenge, how to collect data efficiently from widely distributed areas. Now a day's mobile agent technology is used to collect data efficiently, rather than client server model. Client server model can lead the problem of high bandwidth and energy consumption but mobile agent technology solve the problem of bandwidth. Mobile agent is a software code moving in wireless network periodically according to the requirement of application to gather data and perform network maintenance [4] After completing their task, the mobile agents may return to their home location in order to report their results to the sink. Mobile agent based WSN architecture have following features [5].

- **Scalability**: when sensor nodes increase in network, it does not affect the performance of network.
- **Reliability:** when the network is connected mobile agents can be sent and it will send results when connection is re-established. Therefore we can say that MA based network model is much reliable.
- **Extensibility and task adaptively**. Mobile agents can extend the functionality of the network by programmed it according to application specific tasks.
- **Energy awareness**. Mobile agent can find their root dynamically according to the requirement of application. So MA model save the energy.

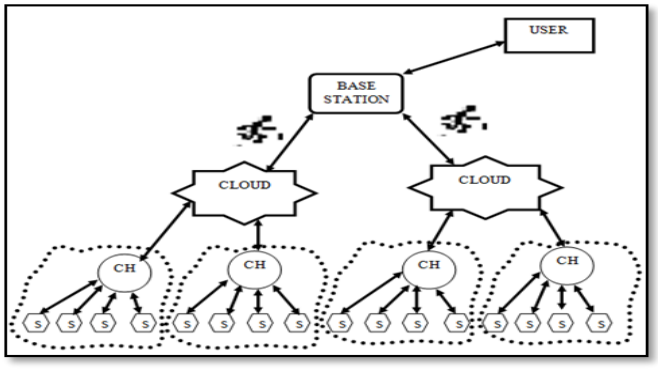

**Fig.1.** Mobile Agent based Architecture for Wireless Sensor Network (MAAWSN)

Above Figure 2 shows our four tier Mobile agent based hierarchal architecture for Wireless Sensor Network. There are four levels in this model. At the highest (First) level, Base station receives data from clouds and sends it to users as per their requirement. At second level, there are various clouds communicate with co-ordinator heads to receive data and transmit it to BS. Clouds provide the facility to co-ordinator heads to store large amount of data. At third level, CHs will collect sensed data from various sensor nodes and store it in the clouds. Data stored in cloud is analyzed and refined by cloud for future use. At fourth level or lowest level, we find the sensor nodes which are responsible for monitoring the surrounding environment, collecting sensed data and then the transfer of their data to the next level which is the co-ordinator heads.

## II. RELATED WORKS

In Zhao, Huan [3] Energy-saving Topology Control Algorithm is proposed to increase the lifespan of the network with concept of mobile sink. A heuristic topography control rule with time complexness O (n(m+n)log n) is proposed by making use of greedy policy. Pengfei, Huiba Li et al.[6] propose a framework to combine cloud technology with WSN, in which sensed data is transmitted, processed, stored in cloud, then sensor data from multiple types of WSN is refined and analyzed by cloud and send to the clients. Wen-Yaw Chung [7] presents an integrated wireless sensor network (WSN) that is used in continuous checking the information in the field of agriculture systems such as temperature, humidity, hydrogenii etc. It also introduce about database design by SQL, cloud computing system ,web services, virtualization and C# interfaces, user control centre. Khandakar Ahmed et al. [8] present a framework to integrate the Cloud Computing model with Wireless Sensor Network in which requests from each user will be served via its three service models (IaaS, PaaS, SaaS). It creates archive by collecting data periodically from WSN to Data Centres, or by direct generating query to particular sensor network. Nafaa Jabeur et al. [9] explain the ecosystem metaphor and communication mechanisms for WSNs for living organisms. They propose an agent-based architecture for Ecosystems onto Wireless Sensor Networks. Software agents remove the gap between WSNs and natural ecosystems and provide optimal mapping between both systems.

## III. PROBLEM FORMULATION

Our main focus in new architecture is to increase the lifetime of network, capacity of storage and fast data aggregation with security. Clouds are used to provide data security, high availability of data and to store data for future use. In our architecture, we use two private clouds. Number of clouds can varied according to the nature of the application and number of node deployed. In real world, base station situated at remote area which can far from wireless sensor network and it is a big challenge to collect information from target field. That can also create a problem such as require high energy, lot of high cost to route data to the final destination, data may be lost during communication. To solve these issues, we introduce Mobile Agent technology in already implemented cloud based wireless sensor network.

## IV. IMPLEMENTED MOBILE AGENT BASED ARCHITECTURE FOR WIRELESS SENSOR NETWORK

Here we create a new architecture that can work for different type of applications. In our Implemented Four tier Hierarchical architecture, we combine two different technologies one is cloud computing and other is Mobile Agent Technology for Wireless Sensor Network. Both technologies have their own advantages such as cloud computing provide on demand service, more storage ,high processing devices, better durability, security by encryption and decryption of data whereas Mobile Agent technology provide bandwidth utilization, remove redundant data, increase network lifetime, efficient data gathering etc .

Here below flowchart shows the different modules of our implemented work:

Step.1 Random deployment of sensor nodes
Step 2. Two tier hierarchical WSN architecture in which a coordinator node (CH) is selected over a group of sensors.
Step 3: Three tier hierarchical WSN architecture, in which clouds works as intermediate between coordinator nodes and data collecting node i.e Base Station (BS).
Step 4: Four tier Mobile agent based hierarchical WSN architecture.
Step 5: Implementing Mobile Agent Communication modules.
Step 6: Result and discussion

### A. Random Deployment of sensor nodes

There are many node deployment schemes have been proposed for wireless sensor networks .Some of them are random, grid, cluster and grid-cluster to increase network connectivity, without increasing storage requirements .Here we use the strategy for placement of SNs is random scattering from the air which is a most common deployment strategy used for large-scale open regions.

### B. Two-tier Hierarchical Architecture for WSN

In two tier hierarchical architecture of Wireless Sensor Network, firstly the sensor nodes are divided into different groups and coordinator nodes selected for each groups. All coordinator nodes are high powered

nodes which communicate with their group members to collect sensed data and then transmit it to base station .Drawback of this architecture is that it send huge amount of redundant data to BS ,consume high transmission energy, require large storage space and also require high bandwidth speed etc.

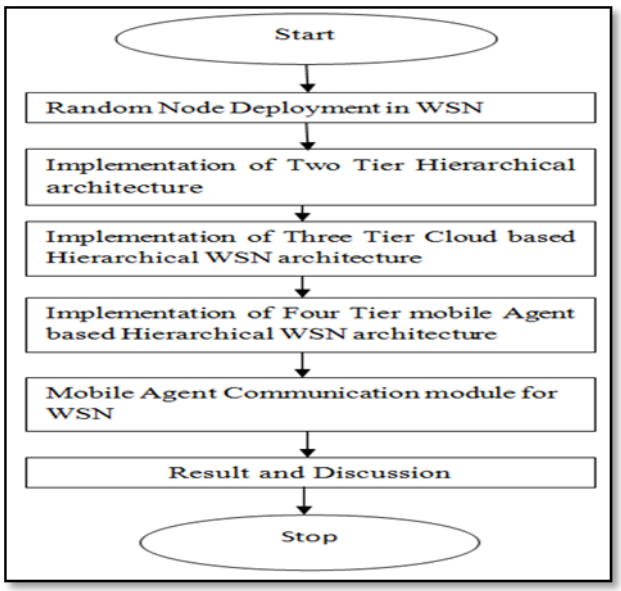


**Fig.2.** Flow chart of Implemented work

### C. Three-tier Hierarchical Architecture for WSN

Cloud computing technology is introduced in three tier hierarchical architecture to overcome the drawback of previous architecture. In this, coordinator nodes (CHs) collect data from group member nodes and store it to the clouds. Two or more groups of sensor nodes connected to a cloud with wireless channel. Cloud technology increases reliability, high availability and security of data in wireless sensor network .Whenever user request for data to the BS, BS collect data from cloud rather than CHs. There are two type of communication one is inter-network (sensor node send data to CH) and second is intra-network (CH send aggregated data to clouds) communication.

### D. Mobile Agent Based Four-tier Hierarchical Architecture for WSN

In three-tier architecture Base station receives data from their respective clouds with wireless channel. To increase the efficiency of network, Mobile Agent technology is used in four-tier hierarchical architecture for WSN. When Base station requires data it sends multiple mobile agents to the clouds for collecting data.

### E. JADE Mobile Agent communication module

JADE is java based mobile agent system which provides mobile agents execution environment and it is distributed agent platform in which various mobile agent applications can be developed and managed[2]. JADE include Agent Management System (AMS), Directory Facilitator (DF) and Agent Communication Channel (ACC) and all automatically activated at the platform start-up. JADE execution environment is called Container which contains several agents. Agent can communicate using Message Transport Protocol (MTP), it provide interface to send and receive messages to and from agents. There is another Dummy tool in JADE to send and display custom messages.

- **Jade GUI platform**

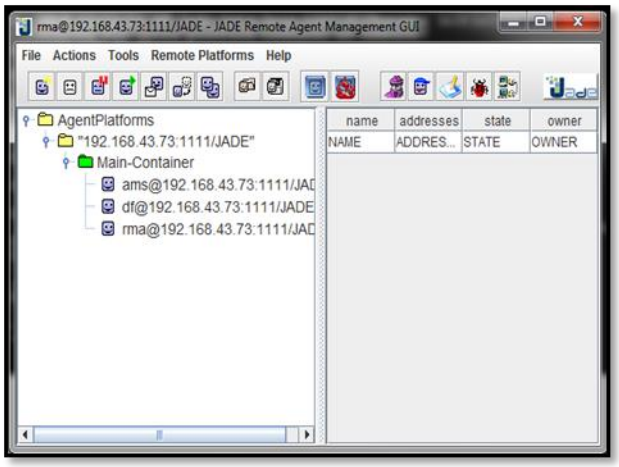


**Fig.3.** Jade GUI platform

- **Creating Mobile agent in main container and set the class for agent**

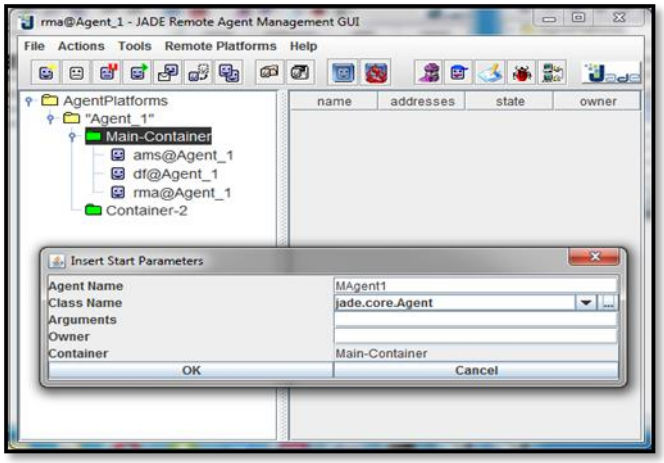


**Fig.4**. Creating Mobile agent in main container

Main container always have three agents AMS,DF and RMA. We can also create more containers using following command: Java –cp lib\jade.jar jade. Boot –container through command line argument.

- **Migration of agent from one container to another container**

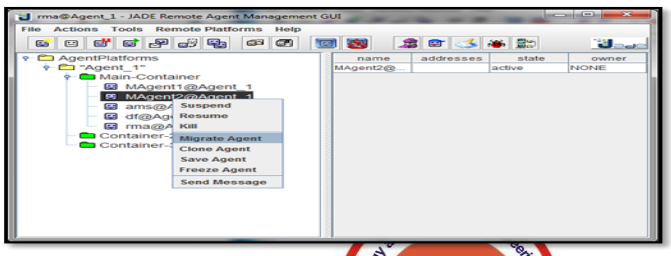



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**Fig.5**. Migration of agent from one container to another container

Mobile agent can migrate from one container to another container. Agent can migrate from one location to another location, cloned, disposed, freeze and can save.

**Communication between two agents in local platform**

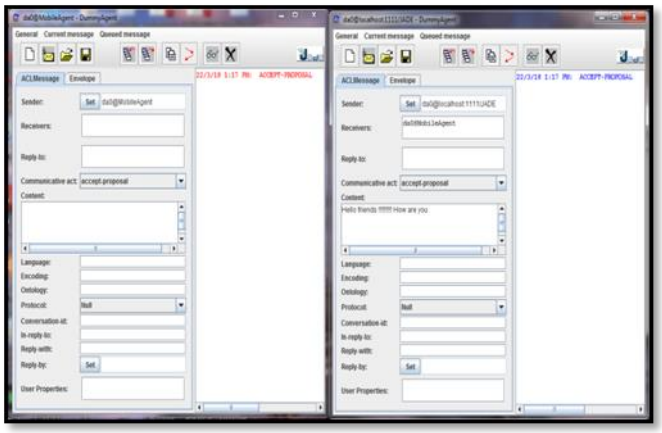

**Fig.6.** Communication between two agents in local platform

Now a message is sent from one agent to another agent in two different platforms. A message is transferred from MAgent2 of first platform to another agent in second platform using dummy agent of JADE. To send message first we have to set AID and address of agent. Here **Local host** is sender and **Mobile Agent** dummy Agent is receiver of messages. After sending message it shows a notification of accept-proposal. Here a message is received by Mobile Agent "**Hello Friends!!!!!!!!!!! How are you"**

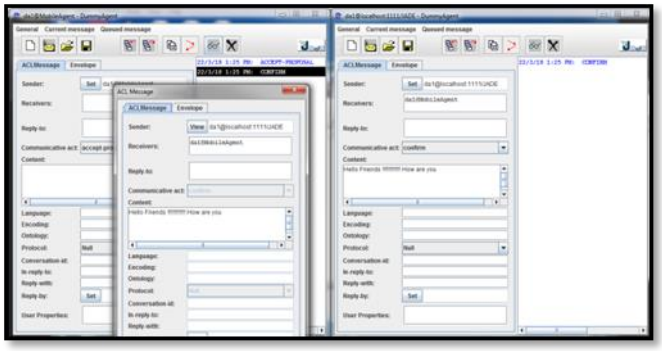

**Fig.7.** Received by Mobile Agent

Then Mobile Agent of first platform send a response to second Agent in local host as shown below:

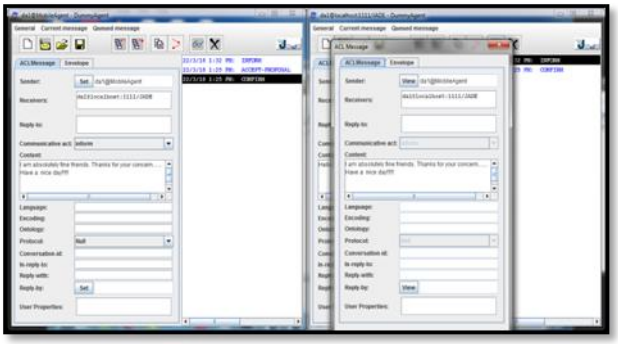

**Fig 8.** Mobile Agent of first platform sends a response to second Agent

## V. IMPLEMENTATION AND RESULT DISCUSSION

### A. Simulation Environment

The proposed work is simulated in NS 2.35 simulator by extending with mobile agent model and show agent communication using java based JADE agent platform. We simulate our proposed work in a 1000*1000 $m^2$ areas, with 25 nodes. The node parameters and physical layer parameters are in shown in Table1 and Table 2.

**Node parameter**

**Table .1.** Node parameters

| Parameters | Values |
|---|---|
| Area | 1000*1000 |
| Nodes | 25 |
| Base Station | (550,140) |
| Initial Energy (normal node) | 50J |
| Receiving energy | 10.18e-3 |
| Transmission energy | 8.12e-3 |
| Data rate | 600kb |
| Time Interval | 0.05 |
| Packet Size | 500 bit |
| max packet in queue | 50 |

**Physical Layer Parameters**

**Table 2.** Physical parameters

| Parameters | Values |
|---|---|
| Channel | Channel/Wireless Channel |
| radio-propagation model | Propagation/Two Ray Ground |
| Antenna | Antenna/Omni Antenna |
| Link layer type | LL |
| Interface queue type | Queue/Drop Tail/Pri Queue |
| network interface type | Phy/ Wireless Phy |
| MAC type | Mac/802_11 |
| Routing protocol | DSDV |

## VI. IMPLEMENTATION OF FOUR-TIER ARCHITECTURE

Here mobile agents receive query form base station and move towards clouds to collect data. After collecting required data mobile agent send to base station .We take multi mobile agent in our four-tier architecture that move to cloud according

their itinerary planning decided by base station.

### A. Throughput comparison between three tier and MA based four tier architcture of wsn

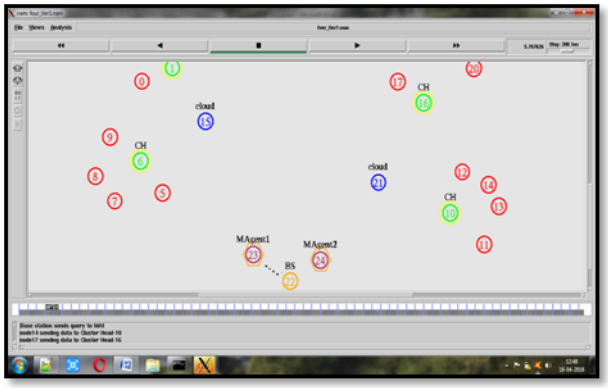


**Fig.9**. Mobile agent communicate with cloud and Base Station

Throughput= the total number of bits received/1000.

Where the bits received can be calculated as: packet_size * recv * 8.0.

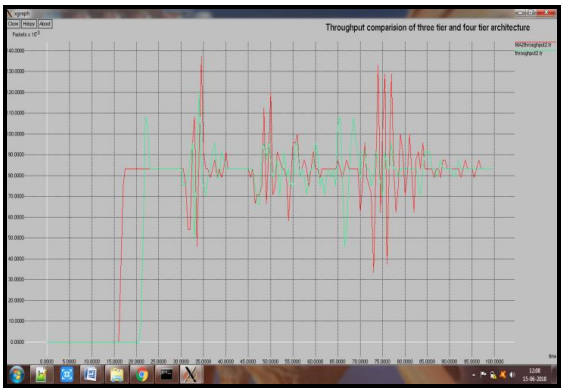


**Fig.10**.Three-tier and Four-tier throughput comparison

In above graph, red line shows throughput of mobile agent based architecture and green line show throughput of CHs in three-tier architecture. Mobile Agent starts data transmission after 16 sec but CH starts after 21 second. Throughput of four tier architecture is high than three tier architecture in the period of 35 second to 65 second. Therefore MA based architecture is better than three-tier.

### B. Time delay comparison between three tier and MA based four tier architcture of wsn.

Here the time delay is recorded into a file using formula: puts $f2 "$now [expr ($bw6 - $holdtime0)/($bw9 - $holdseq0). Here bw6 hold receiving time, holdtime0 represent sending time and bw9 represent total number of packets.

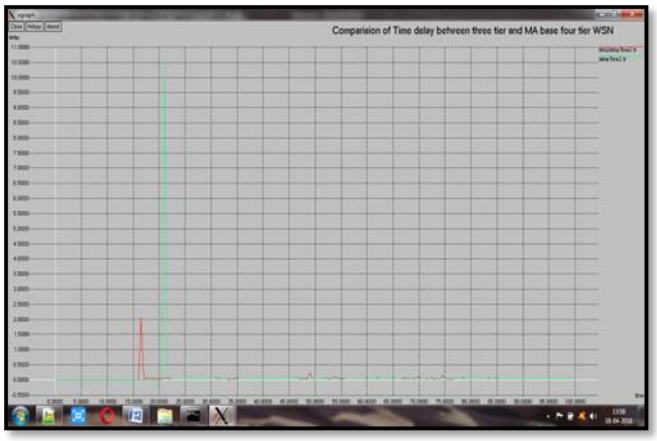


**Fig.11.**Three-tier and Four-tier time delay comparison

In above graph, red line show delay time of mobile agent based architecture and green line show delay time of three-tier architecture. Here we can see that in three tier architecture has maximum time delay

### C. Packet Loss comparison between three tier and MA based four tier architcture of wsn

In figure 12, red line show Packet loss of mobile agent based architecture and green line show Packet loss of three-tier architecture. Here we can see that using mobile agent technology packet loss reduced as compare to direct communication.

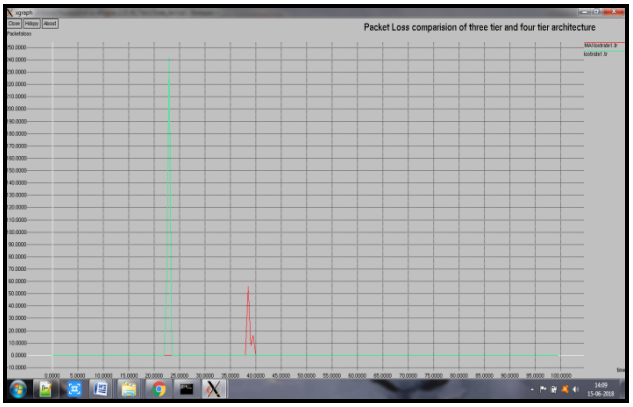


**Fig.12.** Packet Loss comparison between three tier and MA based four tier architcture

## VII. CONCLUSION AND FUTURE WORK

In this paper, we presented a new Architecture for mobile agent in WSNs. We have designed a new four-tier hierarchical architecture for wireless sensor network which includes Mobile Agent technology and cloud computing technology. The main purpose of mobile agent with cloud technology in our architecture is to reduce information redundancy, traffic load, query latency and communication overhead in order to increase network lifetime. It also ensures a good durability of the network, minimize the packet loss rate, improve packet transmission rate as compare to three tier architecture. If in any case CH loss there connectivity in network in that case base station can found data from cloud. Cloud technology provides data security, high data storage and computing capability. Mobile agent

technology in four tier architecture improve the efficiency of network as compare to three tier architecture in term of throughput, packet loss and delay time.

In this work, route for mobile agent is predefined by Base station which is static itinerary planning. In future, we can implement dynamic rout planning for mobile agent in which route is dynamically decided by mobile agent itself to reduce route cost.

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