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A Java Simulation-Based Performance Evaluation of Mobile Agent Platforms.

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A Java Simulation-Based Performance Evaluation of Mobile Agent Platforms.

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ABSTRACT

Mobile agents are emerging as a promising paradigm for the design and implementations of distributed applications .Many of these Mobile Agent platforms have been developed, new one, and new versions of old agents, kept on appearing every year, so choosing the right or most suitable platform for a particular application area; based on their performance is a challenge for both the developers and the users. This paper carried out a qualitative comparison across three selected, Java based Mobile Agent System, Aglet Tracy, and JADE. Two of them (Aglets and JADE) were selected for quantitative evaluation on their time of transfer/retrieval of compressed data files. In our implementation, Aglet version 2.02 and JADE 3.4.1 were used. A java simulation program was developed and used in measuring the performance of the two mobile agents, using transmission time and compressed time as performance metrics. In this paper work, a unique port number(2080) was chosen for the loading of classes and mobility of agents. Ten dummy data files (also refer to as Load or Message) were created with sizes ranges from 100Kb to 1 Mb. A gzip compression tool was used to compress each of these files and sent through the Aglet and JADE enabled network. The transmission time (in milliseconds) for each corresponding files size (in Bytes) in the two Mobile agents were recorded. We deduced from our qualitative results that, Tracy plug-in features give users room for reusability and extension. Aglets provide weak security and poorly scalable. JADE has a strong security, scalable and its multi agent feature will enrich its usage on the internet. Our quantitative results show that transferring/retrieving of compressed data file is faster in JADE than in Aglets. The integrity of the files are also kept safe, in both mobile agents, that is after decompressions they can still be reused.

Keywords: Aglet, Gzip, JADE, Compression ratio, Mobile Agent Network

1. INTRODUCTION

Rapidly evolving network and computer technology, coupled with the exponential growth of the services and information available on the internet, will soon bring us to the point where hundreds of millions of people will have fast, pervasive access to a phenomenal amount of information, through Desktop machine/Mobile devices, at work, School and Home; through Televisions, Phones, pagers and Car dashboards, from anywhere and everywhere. Mobile Code and in particular mobile agents will be an essential tool for allowing such access. (David & Gray, 2004, and Aiello et al., 2010).

Mobile Agents are programs that can migrate from host to host in a network, at times and to places of their own choice. Along, with the wide spread of Java based applications, mobile agents became extensively popular not in research but also in industrial projects. Mobile agents are useful in distributed/Information retrieval applications, since they move the location of execution closer to the data to be processed. Software mobile agents help people with tedious repetitive job and time consuming activities. Some of the benefits provided by mobile agents for creating distributed application include autonomy, flexibility, effective usage of network bandwidth, and reduction in network load, overcoming network latency, faster interaction and disconnected operation. (Lange & Oshima, 1999 and Silva, et al., 1999).

However, Mobile agent toolkits are many and their performances, also defer. Some of the mobile agent systems (MAS) developed in the last years is: Aglets, JADE, Voyager, Concordia, Mole, Discovery, Ara, TACOMA, Grasshopper, Springs, Map, Tracy etc.

In fact, it is impossible to provide an almost –complete list of available ones. Indeed despite the high number of mobile agent platforms developed a long time, new platform have still been developed in the last few years. (Braun & Rossak, 2005). So choosing the right or most suitable platform for a particular application area; based on their performance is a challenge for both the developer and the users. Braun *et al,* (2001) identified several points during the migration process where performance can be improved and divided them into two classes: transmission aspects and runtime aspects. All techniques that influence Network load and transmission time during agent migration are grouped under transmission aspects. Runtime aspects involve the techniques by which an agent's execution time can be improved. The quantitative aspect of this paper work is on transmission aspects, we targeted at determining the influence of transferring compressed data files in two mobile agents. We perform an extensive experimental evaluation in order to analyse the performance of the two mobile agents.

The rest of this paper is structured in this way. In section 2 works related to our area of research were reviewed, in section 3, qualitative and quantitative evaluations were carried out. Results and discussion are presented in section 4 and conclusion in section 5.

2. REVIEW OF RELATED PAST WORK

A lot of qualitative researches has been has been presented on mobile agents but they have not translated into a significant number of real-world applications. (Rahul & Sridhar, 2000). One of the major reasons for this is the lack of research work that quantitatively evaluates (i) the effectiveness of one mobile agent framework over another. In literature we found that, Silva et al (2000) compared eight mobile agent toolkits using twelve experiments. Their results showed the influence of several factors (e.g. the number of agent servers to visit on one tour, the influence of the agent's size, and the influence of class caching) on the performance of mobile agents. Unfortunately, Silva et al did not consider the different security strategies, different migration and transmission time with regard to data compression.

Braun et al., (2001) presented Performance evaluation of various migration strategies for mobile agents. The researchers presented an overview of the state-of-the art migration strategies for mobile agents and compare them with regard to network load and transmission time. They propose a simple mathematical model to show the influence of various network parameters, and present results of first measurements to point out that there is no strategy (push-all-to-next, push-all-to-all, pull-all-to-unit) that is in all cases leads to a minimum transmission time (i.e. no migration strategy is best in every situation). They also concluded that the various migration strategies we have lead to almost the same executions time.

Likewise, reduction in the mobile agent code size on transit will also have significant effect on the transmission time (Braun & Rossak, 2005). This they achieved by compressing the code size during migration. The experiment considered only the code size aspect and was silenced about the size of data collected during migration.Osunade & Atanda(2008), reported a lower transmission time when agent migrate with the data, especially at the second stage of the migration process. Osunade & Oyewole(2011), gave account on the effect of Network load on the transmission time in Aglet. It was reported that Aglets mobile agent performed actively well, (transmission time) with reduced Network load. Gupta & Kansal(2011), qualitatively analysed six mobile agents; Voyager, TACOMA, Aglets, Grasshopper, JADE and Spring, using security, communication technology, mobility, support for graphic based tools and languages, features. According to the researchers "JADE mobile Agent seems most appealing".

This paper contributes towards such an evaluation. We carried-out qualitative analysis on three mobile agent frameworks, and two of them were selected for quantitative performance evaluation, when network load is reduced by compression tool.

3. METHODOLOGY/FRAMEWORK

3.1 Qualitative Comparison

All Mobile agents features mentioned in this section, are based on the past work of the inventors of the three Mobile agent platforms, what we did, is collation and comparison of the three platform qualitatively. The selected mobile agents are compared on six major features, namely: The background of the mobile agents, programming compatibility, mobility nature, communication and security provided.

- **Background**: Aglet is a general purpose mobile agent platform developed by IBM' Tokyo research laboratory in 1995. JADE (Java Agent Development Framework), is Java-based Mobile agent developed by TILAD (Telecom Italia Lab) in July 1998. Tracy was developed at the University of Jena in Germany 2005 by Peter Braun and Wilhelm Rossak.
- **Programming:** In Java, an instance of Aglet is derived from an abstract Class called Aglet. JADE is implemented in Java, and it can only run in Java Virtual Machine (JVM). JADE is also agent based just like Aglet but it provide index facilitator, agent communication channel which make the development of agent easier, Gupta & Kansal(2011). It is flexible and highly scalable. In Tracy, an agent is an object of a specific class, named Agent (i.e. ClassAgent). ClassAgent has three classes (SystemAgent, GatewayAgent, and MobileAgent) which are all member of a package. ClassAgent is the main class within the TracyAPI. It is an abstract class that serves as base for all agents and must not be instantiated by the programmer. ClassAgent defines methods and variables to control an agent's life-cycle, get and set internal data structures, and receive messages.
- **Mobility:** Aglets are objects, that can move/migrate from one sever to another. It can intermittently exhibit each of its states (dispatching, retracting, cloning, creation, disposal, messaging etc) as it moves around from one host to another. JADE is also an object, but before the JADE object can move it need to be changed to the format that can be transfer on the network (serialization). Unlike in Aglet, it has an inbuilt agent mobility service that support mobility among containers. Tracy uses its own migration protocol, called Simple Agent Transport Protocol(SATP), which is an asynchronous network protocol, that is, bases on the TCP/IP protocol, to transfer agent information to a single destination agency. The two main techniques used are; the go-command, to initiate migration with default migration behaviour to a single remote agency, and the use of migration properties to configure the migration process in detail.
- **Communication:** Aglets are passed using single thread model communication. An agent message-passing scheme in Aglets supports loosely coupled asynchronous as well as synchronous Peer-to-peer communication between agents. In JADE, messages are dispatched within agents in the same container of the same platform using Java Local Calls and its uses FIPA delivery when it is between platforms. It is asynchronous. Tracy has two main parts, the rest are inform of Plug-in(is a software component that provides/implement a service) e.g. its uses AgencyShell Plug-in to communicate to an agency via a textual user interface.
- **Security:** Aglets framework supports MASIF standard, recorded to be a very preliminary form of security. JADE comply with the FIPA (Foundation for Intelligent Physical Agents) specifications, very strong security. Tracy uses AgencyPolicy Plug-in, to assign permission to agents dynamically, and Tracy Authentication and Authorization Service (**TAAS**) plug-in to provide user management, which includes granting permissions to users dynamically.

3.2. Quantitative Evaluation
A Java simulation program was developed and used in noting the transmission time for both the compressed and decompressed data file. The application was developed on Pentium IV 1.83 GHZ (Duo processor) that runs on Windows Vista, 1GB RAMs Size. Net-Bean 5.5.1, a robust IDE, developed by Sun Micro-System adopted for implementation. A unique port number (2080) was chosen for the loading of classes and mobility of agents. The preferred range is from 1024-65535 as numbers below 1024 might already be running system programs. The data compression technique used is Gzip, because it can be used to compress variety of file formats, apart from text file.

Ten dummy files were created with sizes ranging from 100KB -1Mb, the essence of this is to have a long range/trend to compare the performance of size against time for both compressed and decompressed data file.

3.2.1 Program Design
The program design followed the default data migration used by java-based Mobile agent systems, where the mobile agent migrates from host to host on its itinerary with the data, until it returns to the home host. The program is made up of two major classes, the File selector and the mobile agent system class, that housed the JADE/Aglets mobile agent system.(Fig 1.)

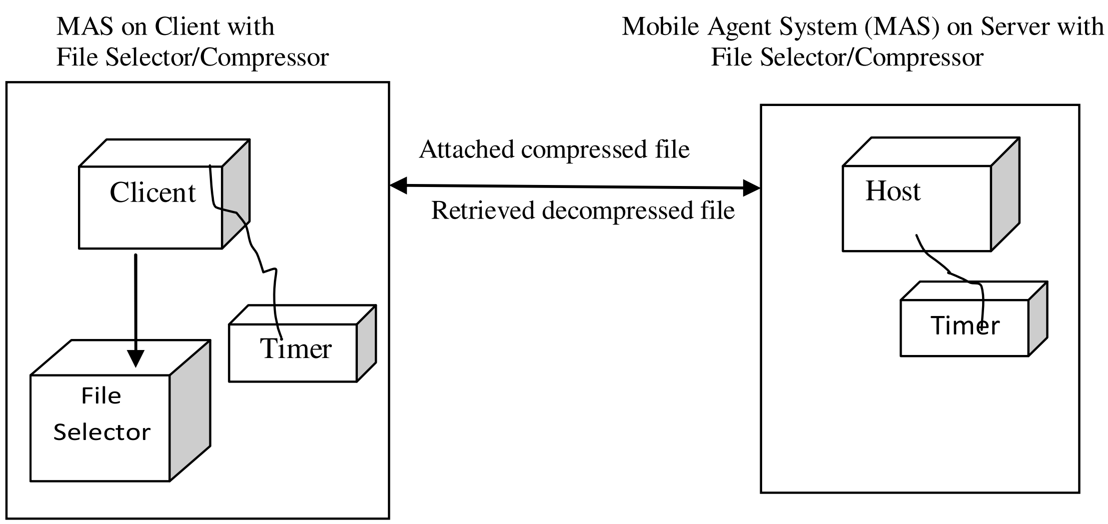

Fig 1: Proposed Design of a Mobile Agent Based Data-File Retrieval System

The File selector class handles searching for the selected file to be compressed, attached this file and exports it via the agent. The below methods perform all these operations:

Public file getDirectory
Public file LocateFile
Public void compressedAndProcessStream

The method **LocateFile** written in JAVA (see below) performed the search operation, and returns a file name as the selected file.

```
/** creates a new instance of SelectFile */
    Public File locatefile (File searchFile, File
searchDirectory)
   {
      File probableFile[]=searchDirectory.listFiles();
       for (File y:probableFile)
        {
          if(y.getName().equals(searchFile.getName()))
           {
             return  y;
           }
        }
         return null;    }
```

The selected file is compressed/decompressed with Gzip, and later attached to JADE/Aglets mobile agent, before the agent migrates with it, through the client JADE and back to its destination host (*Fig 1*). At the destination both the SendTermination and GetStopTimeFromClient methods (see above) will be invoked to determine the transmission time (which is the different between current time and recievedTransportTime) for both the compressed and decompressed data files. The time interval between when a compressed data file/decompressed is sent from the source (host) and when it is received back at the host (i.e the transmission time) they were both documented and compared.

```
void sendTermination()
 {
    acceptConn = false;
     try {
          if (oos != null)
            {
              oos.writeObject("disconn");
              oos.flush();
              input.close();
              oos.close();
            }
         }
       catch (IOException ex)
          {
```

```
          ex.printStackTrace();
         }
   }
private void getStopTimefromClient()
{
 try {
     oos.writeObject("getEndTime");
     oos.flush();
     }
  catch (IOException ex)
     {

Logger.getLogger(ServerPlatform.class.getName()).log(Le
vel.SEVERE,   null, ex);
     }
 }
```

The integrity of the data file (text file only) on transit is also checked after reaching its destination. This is done by decompressing it; and its contents compared with the original, to see if there is any different or distortion in the file.

3.2.3 Materials

For this research work we have chosen to work with Aglets version 2.0.2, and JADE version 3.4.1. Platforms. Some of the important factors that support our choice are:

- Aglet is one of the most popular Java based mobile agent Platform
- JADE is very popular for the development of agent-based system.
- JADE is compatible with the J2ME CLDC/MIDP1.0 environment. This means that it works well with the GPRS network and hence can be used both on the internet and wireless network (Bellifemine et al, 2007).
- Also JADE can be integrated with different software eg Jesse (A rule engine which allows JADE agent to ''reason'' using knowledge provided in the form of declarative rules) Jha, & Lyer(2001).

Since JADE provides a homogeneous set of Applications programming interface (API) that are independent from the underlying network and Java version, hence the JADE aspect of this program run in JVM, J2EE, and J2ME environment.

4. RESULTS AND DISCUSSION

Before any operation (compression/decompression or any file transfer) can be performed, the two mobile agents must have been running in the entire Network nodes. This is done through the above screen. The Select-Button allows user to pick file name to be compressed and the Transfer-Button sends it through the selected platform. Proper connection need to be done between the hosts, (JADE-Client to JADE-Server or Aglet-Client to Aglet-Server) otherwise the Test-Results will read zeros all-through and the connection status will read "Unavailable". The starting interface connection for JADE and Aglets are shown in Fig 1a and 1b

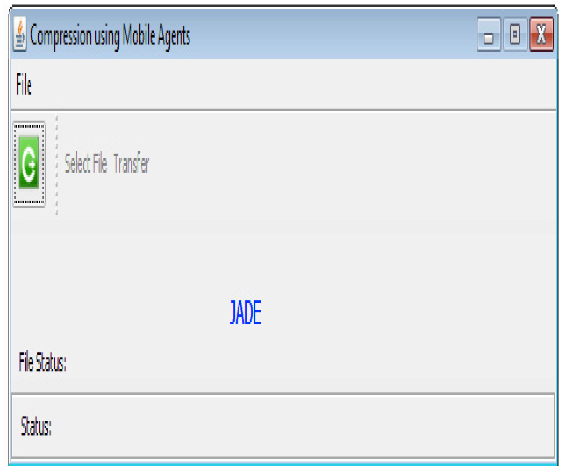

Fig 2 : Select Attached Form (a)

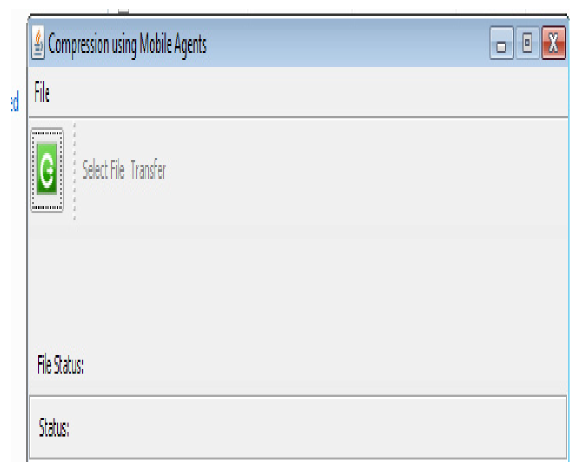

Fig 2 : Select Attached Form (b)

In Figure 3 & 4, a file of size 103327(100 kb for short) sent from an IP address 127.0.0.1 takes 34 ms to reach its destination in JADE and 36ms in Aglet. In fig 5 and 6 the same files of size takes 130 milliseconds (0.13 seconds) to compressed to 92367 kb on JADE mobile agent, and 112ms(0.112 seconds) in Aglet Mobile Agent. From the above, it is evidence that the two platforms and the compressor utility have perfectly been linked together

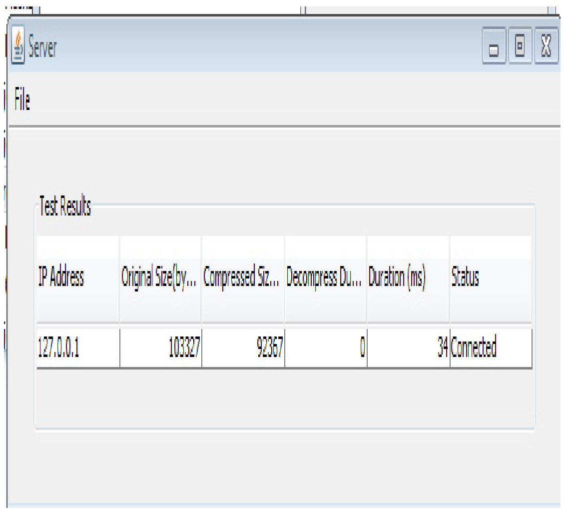

Fig 3: Total time taken to transfer 100kb on JADE Platform

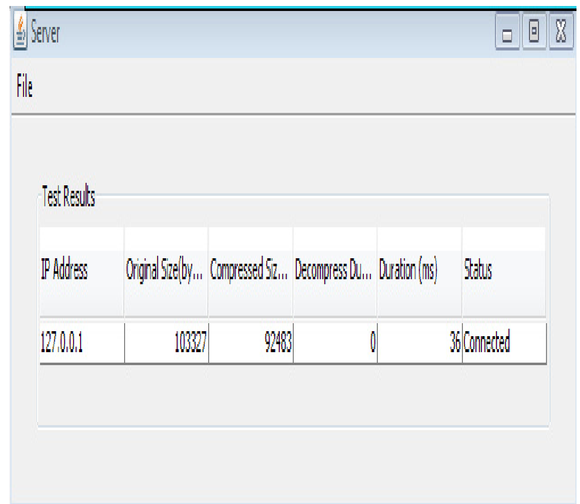

Fig 4: Total time taken to transfer 100kb on Aglets Platform

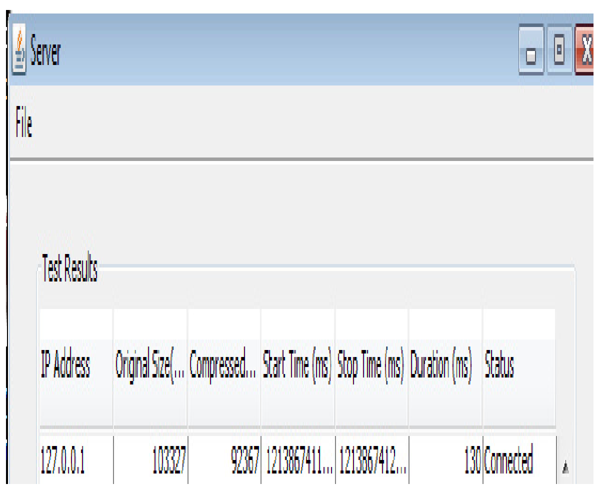

Fig 5: Compression time for (100 Kb) on JADE

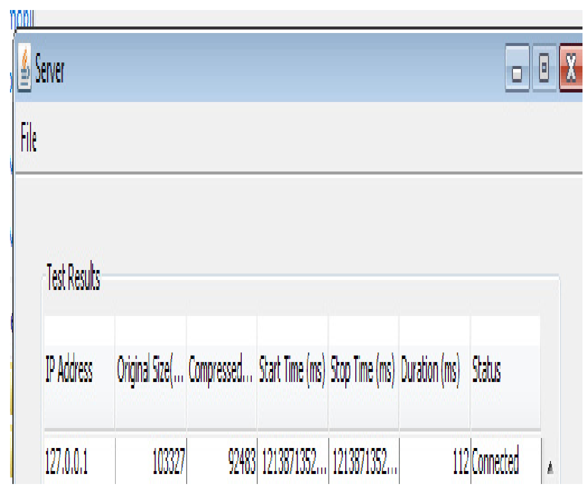

Fig 6: Compression time for (100 Kb) on Aglets

Table 2: Transmission Time of Compressed Data File on Both Jade and Aglets(in s)

File Type	Adobe Doc	Adobe Doc	HTML Doc	Adobe Doc	Word Doc	Word Doc	Word Doc	Word Doc	Word Doc	Word Doc
Actual File Size used (KB)	100	200	300	400	500	600	700	800	900	1,000
Transmission Time in Aglets	0.036	0.061	0.078	0.108	0.143	0.173	0.180	0.224	0.256	0.272
Transmission Time in JADE	0.034	0.058	0.076	0.104	0.138	0.163	0.173	0.219	0.254	0.271

The transfer time in both are less than the time taken to commpressed the file. This tell us that the total time realised in figures 3, and 4 depend on numbers of nodes that the agent is visiting before its final destination. Also from figures 5, 6, and Table 2 it is clearly shown that, the time duration taken to compressed agiven file, relatively depend on the size. The amount of compression ratio achieved, in JADE is lower than that of Aglets. Meaning compression has positive effect on JADE than on Aglet Platform. In this research we claimed it will be better to use JADE platform in transferring compressed file on the net. Also its compatibility with J2ME and J2EE is an added advantage for effective performance on mobile devices.

5. CONCLUSION

In this paper, we have presented comparison among three mobile agents (Tracy, Aglets and JADE) and quantitative analysis on Aglets and JADE. From qualitative analysis we deduced that, Tracy plug-in features give users room for reusability and extension. Aglets are not scalable and it provides weak security measures. JADE has a strong security measure, scalable and its multi agent feature will enrich its usage on the internet. From our quantitative analysis we realised that file transfer/retrieval is faster in JADE, than, in Aglet. This shows that it will be better to use JADE mobile Agent for file transfer and retrieval. We also discovered that data compression has a positive effect, on a moderately size data file/agent by reducing the transmission time. The results showed that the amount of compression ratio achieved, greatly depended on the file format and the amount of space redundancy found in the file, hence, compressing small amount of data, some times increased the size of the data. Finally, we realised that the integrity of all the files are intact (guaranteed) and it can still be used again, at the receiver side.

6. FUTURE WORKS

This paper focused more on the performance of JADE and Aglet mobile agent, when a compressed data file is transfer within the two platforms. The research work can be further extended to other mobile agents. The Paper has considered the process of compressing data before the agent migration. The process of compressing data during migration can be investigated. Compressing both the data and the agent code would speed-up data transmission and on the long-run enhance performance. This also needs to be investigated.

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