



# A Mobile Agent Design for Fleet Management.

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**Abstract:** Agents can be viewed as an extension of the remote procedure call and remote programming paradigms, this coupled with the bane of fleet management such as the inability to monitor the respective vehicles in their fleet, which has negative consequence on the business. To solve this problem, the design of a mobile agent system for fleet management that will ensure its profitability comes to fore. The objective of this study is to design a Mobile Agent System for Fleet Management. To achieve the objective of the system, C# programming language has been adopted because it is a general-purpose language and it is also a component-oriented programming. The migration technique of the Agent is also presented.

**Keywords:** Design, Fleet, Management, Migration, Mobile Agent

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## 1. Introduction

A mobile agent is a software abstraction that can migrate across the network (hence mobile) representing users in various tasks (hence agents). It communicates in an agent communication language; it is also a computer system in a complex environment that realizes a set of tasks and goals it was designed for (Hanjuan, 2002; Hameed, Ramoni, Fabiyi and Amosa, 2020). It can be installed in many complex applications such as the Internet, Mobile Data Computing, Electronic Commerce, Networking, Manufacturing, and scientific computing. There are three application domains do need a mobile agent: One is data-intensive applications where the data is in a remote location, is owned by the remote service provider, and the user had specialized needs. In this case, the user sends an agent to the server storing data. The second domain is where agents are launched by an appliance - for example, shipping an agent from a cellular phone to a remote server, the third is for the expandable server, where a user can ship and install an agent representing him more permanently on a remote server. An Agent can

be described as a software element that is autonomous with intelligence, mobility while having the ability to collaborate well by other users, Intelligent Agents, and Systems. They hold responsibilities without constantly consulting the user with a dedication, on their behalf. They can effectively co-ordinate among agents, users, and software hosts. A searching agent that is competent to retrieve preferred information on behalf of the users. The agent is sent away to carry out the look for off-line as well, after being told what to search for. Eventually, the agent can move back with the needed output.

Mobile Agents can learn, search with a domain knowledge that is the reason they are called as an intelligent agent to possess a degree of domain knowledge. The ability of understanding determines the learning and adapting to the required behavior of the agent in the logic to handle a new situation very effectively. Also, it can interact effectively with other agents, users and systems are a capability of Intelligent Agent. An Agent Communication Language (ACL) (for example KQML) helps carry out inter-agent communication. The KQML (Knowledge

Query Manipulation Language) language assumes the specific anthologies for specific agent systems.

Fleet (vehicle) management can include a range of functions, such as vehicle financing, vehicle maintenance, vehicle telematics (tracking and diagnostics), driver management, speed management, fuel management, and health and safety management. Fleet Management is a function that allows companies that rely on transportation in business to remove or minimize the risks associated with vehicle investment, improving efficiency, productivity, and reducing their overall transportation and staff costs, providing 100% compliance with government legislation (duty of care) and many more. The problems of the fleet management are:

- a. Minimizing the risk involving in-vehicle investment by accessing each vehicle data from remote location
- b. Problems faced in having the full data of the vehicle being managed by the Transportation Company.
- c. Inconveniences faced in knowing the vehicle condition of all the fleets being managed.

The objective of this study is to design a Mobile Agent System for Fleet Management. The design approach to this mobile agent system ensures a solution that will enhance vehicle management and increase their profit. Thus, as a result, have the main importance as follows:

- i. It will help use limited resources more effectively
- ii. Make the vehicle management process more reliable and transparent
- iii. It can be useful in reducing the risk involved in vehicle management effectively.

## **2. Literature Review**

Mobile Agent is a software element that is autonomous with intelligence, mobility while having the ability to collaborate well by other users, Intelligent Agents, and Systems. They hold responsibilities without constantly consulting the user with a dedication, on their behalf. They can effectively co-ordinate

among agents, users, and software hosts. A searching agent that is competent to retrieve preferred information on behalf of the users. The agent is sent away to carry out the look for off-line as well, after being told what to search for (Andrea, Borr and Franco, 2008; Amosa, Hameed, Ramoni and Olorunlome, 2020). In detail, it captures meanings of mobile agents, applications of mobile agents, techniques use in mobile agents, models of agents, major characteristics of agents, agents and objects, fleet Management, advantages of fleet management systems, fleet management systems in the transport industry, fleet management tracking, essential operational stages in fleet management, operational efficiency, maintenance, repair and operations, vehicle maintenance, vehicle operations, characteristics of vehicle operations, full management, developing full management, assigning a fuel champion, full selection, driver training, and conceptual framework are discussed. Mobile Agents can be viewed as an extension of the remote procedure call and remote programming paradigms. Remote procedure call (RPC) allows a client to invoke a server operation using the standard procedure call mechanism. Remote programming allows a client to send a subprogram to a server. The subprogram executes on the server and sends its result back to the client. Agents generalize remote programming to allow arbitrary code movement (Birrel and Nelson, 2007).

The best-known mobile-agent system is Tele-script from General Magic. Tele-script supports mobile computers and is used primarily on Personal Digital Assistants (PDA) such as the Sony Magic Link. The details of how Tele-script agents jump between mobile hosts and handle disconnected operations are unclear. The Mobile Service Agent (MSA) system from ECRC also supports mobile computers, but it uses a less general mechanism than described in this paper. Others have specifically suggested using mobile agents in mobile-computing environments. They propose a framework for agents to interact with heterogeneous mobile databases, but they focus on database consistency issues more

than communication and transport issues (Evaggelia and Bharat, 2005). In these systems, applications on the laptop access the local file cache while the laptop is disconnected. On reconnection, the file system reconciles any differences with the appropriate file servers. The Bayou file system internally uses a form of mobile code (but not agents) to handle reconciliation (Douglas, Marvin, Karin, Alan, Mike and Carl, 2009). The Rover system supports disconnected operation through queued RPC and reloadable dynamic objects (RDO). Queued RPC allows asynchronous RPC requests to be queued and then sent when the laptop connects; an asynchronous reply is delivered later. Reloadable dynamic objects (RDO) allow objects (code and data) to be downloaded from the server into the client, where they can execute closer to the user and, potentially, while disconnected. These RDOs are not truly mobile agents because they do not move after they have begun execution (Anthony, Alan, Joshua, David and FransKaashoek, 1995).

In Brian, Illorgan and Satyanarayanan (2015) and Amosa, Ekuewa, Hameed, Onyeka and Ugwu (2020), Mobile Agents is described as the system in which applications on mobile computers can request up-calls whenever a change in resource states, such as network bandwidth or battery power, exceeds some threshold. This feature enables applications on mobile computers to change their behavior according to their environment and would be a helpful substrate for an agent system. There are of course many papers on mobile agents online but the idea is generally to allow a mobile computer to retain the same IP address regardless of location, so that applications on the laptop may continue to communicate with applications elsewhere. While such a system would simplify our laptop-docking scheme, since the laptop would never change address, it would not solve the primary problem of disconnection. They go further in routing all of a laptop's communication through an "agent" that can filter data according to current network conditions, or store messages for delayed delivery (Andrew, Duchamp, 2009).

Mobile agents provide an innovative concept for creating distributed systems Amosa, Ekuewa, Onyeka, Olatunji and Adeyanju (2019); Baker, Xinhua, Stuart and Stone (2006). Being mobile means the ability of a computational entity to move from one system to another in the same network. Acting and interacting with compatible objects in the temporary host system expresses the core idea behind mobile agents, that is, bringing the computation to the data rather than the data to the computation. The "Seven Good Reasons for Mobile Agents" appear to be far-reaching. Mobile agents reduce network load, overcome network latency, encapsulate protocols, work autonomously and asynchronously, and adapt dynamically. They are also robust and fault-tolerant to changing environments. Some of these benefits, however, are becoming less significant as the performance of hardware technology is increasingly improved and better able to cope with such problems as the bottleneck of bandwidth and network latency. The question is whether the technical promises of such a software concept are strong enough to provide sufficient momentum for building unknown application types? Where the real challenges and what are is for mobile agents? Mobile agents are much more powerful since they migrate at will (Hanjuan, 2002).

Fleet Management is a function that allows companies that rely on transportation in business to remove or minimize the risks associated with vehicle investment, improving efficiency, productivity, and reducing their overall transportation and staff costs, providing 100% compliance with government legislation (duty of care) and many more. These functions can be dealt with by either an in-house fleet-management department or an outsourced fleet management provider (Besiou, Martinez, Van Wassenhove, 2012).

Vehicle fleet management is the proactive management of an Organization's vehicle assets, which may include light vehicles, heavy vehicles, specialist vehicles, and motorcycles. Fleet management covers a range of functions, including vehicle procurement and financing, vehicle

maintenance, vehicle telemetric (tracking and diagnostics), driver and personnel management, speed management, fuel management, and health and safety management. In recent times, to address problems in fleet management and the ever-expanding need to monitor the usage of vehicles, also commercial organizations have designed automated control systems. Transport and logistics are both key components of a successful economy. Governments worldwide seek to increase their competitiveness through new or replacement of infrastructure. The transport and logistics sector plays a major role in the world economy and is a significant contributor at both the national and local level in any country. This sector underpins the economy, enabling the efficient movement of goods, services, and people. Transportation is at the center of logistics as it represents the physical movement of materials between points in a supply chain. High customer expectations and little tolerance for inadequate performance create a competitive environment for operating a fleet, which forces fleet managers to achieve high levels of reliability and cost-efficiency (Waiyaki, and Anton, 2013).

Nowadays, for governmental and non-governmental organization, it is favorable to have a huge fleet of vehicles, since it improves the efficiency and equal opportunity to support activities. Nevertheless, the activities and management of large fleets cannot be easy for logisticicians in the field (Huang, Smilowitz and Balcik, 2012; Huang et al, 2012)

A sustainable fleet management strategy is one that aims to reduce environmental impacts through a combination of cleaner vehicles and fuels, fuel-efficient operation, and driving; and by reducing the amount of road traffic it generates (Besiou, Martinez, Van Wassenhove, 2012).. In doing so the fleet minimizes fuel and vehicle costs and improves the safety and the welfare of employees especially in developing countries while reducing its exposure to the problems of overcrowding.

In today's competitive marketplace, it is imperative that businesses operate at peak

efficiency, provide timely customer service, and still make a profit. Thus, given these realities, it is often crucial for business owners to discover those areas in terms of which cost-effectiveness may be improved.

The idea that ICT systems affect competition in the logistics sector in three distinct ways was presented in (Azevedo, and Leitaco, 2007). Firstly, ICT systems may change the structure of the logistics industry, and even modify the rules of competition. This is because ICT systems offer new value-added services that previous paper-based administration could not. Moreover, ICT systems lead to higher efficiency and effectiveness, which affect their competitiveness. Secondly, ICT may be used to create sustainable competitive advantage and provide firms with new competitive instruments. Thirdly, ICT systems do not necessarily need to change existing processes, but rather facilitate their execution within the current business model.

Technology is usually the driving force behind such discoveries. Organizations that manage fleets or a mobile sales force as well as field service organizations are facing many challenges. These challenges include improving compliance and organizational communications, reducing costs, and improving customer satisfaction. As a result, fleet management systems are perceived in terms of how they can benefit companies by realizing efficiency and profitability.

In the knowledge-based economy of today, the rapidly changing and uncertain environment means that transport firms are facing their biggest challenge on how to address the current situation and capture a competitive advantage. The increasing competence in the market is an important factor that drives the adoption of new technologies and innovation, as companies search for new opportunities to cut costs by improving process efficiency or by developing new products (Hidalgo and Lopez, 2009).

### **3. Design of Mobile Agent for Fleet Management**

#### *3.1. Features of Mobile Agent*

### Environment

Mobile agent environment is a model that comprises a server and several workstations (Amosa, Ekuewa, Oyetunji, Nwaekpe and Ogunleye, 2017). The server connects directly to several workstations. The server is a typical computer that is composed of some hardware devices such as CPU, main and secondary memory, printer, scanner, switches, modems, network ports, and so on, and in which a network operating system is running. Other categories of

software can be running on the server. This includes: frontend software, backend software, and utility software. The workstation environment on the other hand comprised of basic hardware devices, an operating system, and other software systems. Though the configuration of the workstation can be lower than the server, this is not a mandatory requirement. The mobile agent environment for fleet management is presented in Figure 1

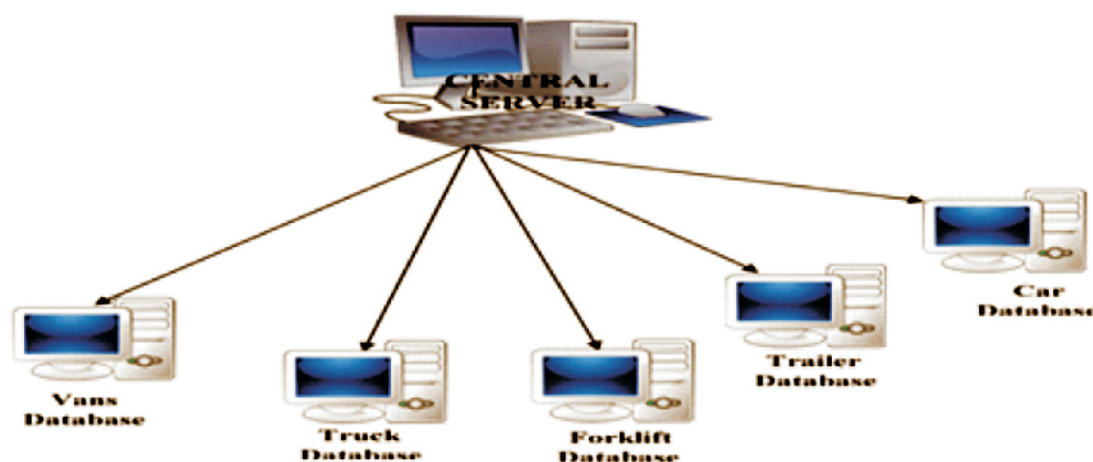


Fig. 1. Block Diagram of Mobile Agent Environment

A mobile agent is a multi-dimensional system that can be launched from a server to monitor the basic software tools on any other workstation or a server in a computer network environment. Thus, there is a source host and one or more target hosts or destinations of a mobile agent (Amosa, Adekunle, Abasiene, Johnson, 2018).

### 3.2. Architecture of the Mobile Agent System

The architecture of a mobile system adopted in this research consists of two types of agents namely: the static agents, otherwise referred to as Server agents, and the mobile agent referred to as Agent Monitor, together with their underlying software and hardware infrastructure. On the other hand, the architecture of the mobile agent system can also be categorized as comprising of backend and frontend engines. The backend engine is made up of the server machine and workstations which are considered to be static. The frontend is the software-based interface, which creates the environment for creating and launching the mobile agent and is dynamic Amosa, Adejuwon, Longe, Onyeka, and Abasiene (2018)

The architecture of the proposed mobile agents indicates that when the sender search for a vehicle from fleet 1 Data Base and that particular vehicle cannot be

found on the fleet 1 database, it will autonomously move to fleet 2 database and if not found, it will move to the next database until the agent reaches the database n. When the file has been found, it will now report back to the server indicating the name of the system, location, fuel capacity, and vehicle condition else the agent will return file not found.

The architecture of the proposed mobile agent is conceptualized in Figure 2. The platform for the take-off of the Agent Monitor at the server host and the platform for its landing at the target workstations are their respective operating systems. At the server host, the Agent Monitor is created and equipped with the code, data, and other necessary parameters and dispatched to the target workstations in the network. The Agent Monitor then navigate autonomously through the network from the server end and interact with the host operating system of the target workstations and its utility programs as it processes the desired information. The Agent Monitor moves from one workstation to another while carrying along with intermediate results. The results obtained by the mobile agent after successful visits to a set of target workstations are transferred to the server, which is displayed on its screen or printed out for external

analysis, interpretation, policy formulation, and decision making by the Network System Administrator. The design of the Agent Monitor has three major components namely:

- a. Inputs: the input to the Agent monitor is the

- target machine identity,
- b. Agent Monitor, and
- c. Output report.

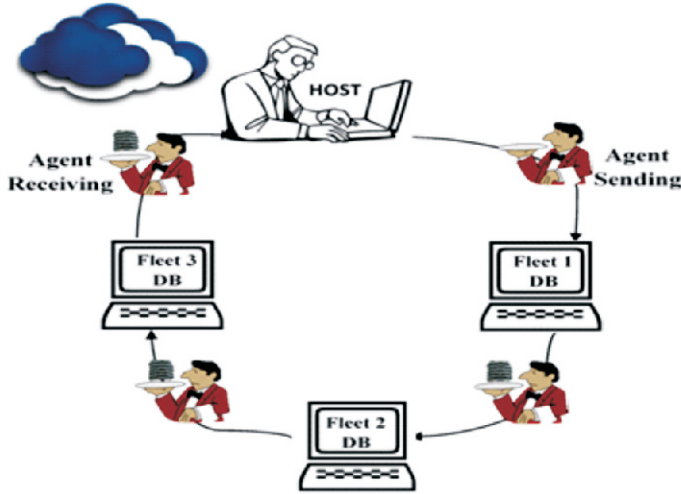


Fig. 2. Architecture of the Mobile Agent.

**3.3. Mobile Agent Development** In the monitoring of software tools, there are two main issues to resolve. One, a system that has to monitor the software tools on workstations in the network, and two, a system that has to report back to wherever the request is made

(Amosa, Adejuwon, Longe, Onyeka and Abasiene, 2018). Hence, we have static agents (server agents) and the mobile agent (agent monitor). The two agents are integrated to design the system. The migration of the agent is as presented in Figure 3

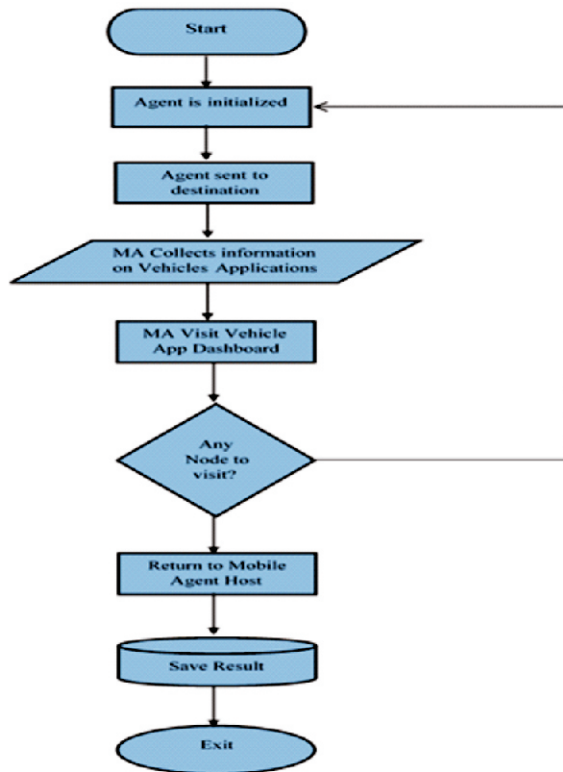


Fig. 3. Migration of the Mobile Agent

### **3.4. Migration Techniques of the Agent**

The mobile agent has been coded with C# providing mobility in an environment characterized by Windows NT operating system as the platform software, Microsoft Access as backend engine, and C# application language as the frontend engine.

All agents' activities start from the server interface where the server is configured to include all other workstations. The following are the steps involved in running Agent Monitor:

- a. Bring up all the computers involved in the network.
- b. Configure the computers by assigning IP addresses.
- c. Start the server agents in all the workstations.
- d. Start the login page on the server. If login fails at the first attempt, try to reenter the correct password. If the login succeeds, the welcome screen is presented.
- e. When the "Launch Server Agent" button is clicked, the server agent is loaded.
- f. Launch the Agent Monitor through the server to visit the configure target computers.
- g. The Agent Monitor visits a target node or all the target nodes depending on the instruction of the administrator.
- h. Agent Monitor reports back with the information about file string on target nodes to the system administrator in Microsoft excel format.

### **4. Conclusion**

The design of a mobile agent for fleet management has been presented in this study. The right usage and implementation of this project will enhance the accuracy of information retrieval in fleet management. An architecture comprising of backend engine (server and workstations) considered to be static and frontend engine (mobile agent) which serves as the software-based interface considered to be dynamics was used for implementation. The platforms for the takeoff of the mobile agent at the source and its landing at target destinations are the respective operating system.

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