A Grid-Enabled E-Business Resource Sharing With Cooperative Agent

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Abstract:

In this paper we present a new intermediary agent, called Cooperative Agent, for mediating negotiation interaction between providers of resources and consumers of resources. In this model, the providers of resources form a cooperative group for the purpose of trading grid resources. In other words, the resource providers sell their resources through the cooperative group. The clients express their need for resources to the cooperative center through their agent. Clients are usually charge per unit of the resources they consume. By pooling their resources together, this model enables providers of resources to combine sales returns, and operating expenses, and distributing sales among members in proportion to volume each provides through the cooperative over a specified time.

The model enables multiple users to access a virtualized pool of resources in order to obtain the best possible response time overall by maximizing utilization of the computing resources. It promotes collaboration between grid resource providers so that grid resources can be shared and utilized collectively and efficiently. It guarantees improved business agility by aggregating the resources of the providers in the grid into a pool where clients can easily access, negotiate and buy.

Introduction

Utility Computing is emerging as a new paradigm for aggregation and sharing of resources that are geographically distributed across organizations and administrative domains. This essentially leads to complex control and coordination problem, which is frequently solved with economic model based on real or virtual currency.

The nature of economic models, which imply self-interested participants with some level of autonomy makes an agent based approach the preferred choice for this study. Approaches based on direct negotiation between providers of resources and consumers of resources are suitable only for small numbers of agents. As the size of the agent society grows, it becomes imperative to introduce intermediary agents. The notion of intermediary agent refers to those economic agents who coordinate and arbitrate transactions in between a group of providers and consumers. The most important type of intermediary agents discussed in the literature of economic models in distributed systems are the matchmaker, broker agents [1, 2] and market maker agent. Distinction has often been made between (i) a matchmaker, (ii) a broker agent and (iii) a marketmaker agent: (i) a matchmaker matches the request of the user with the available resources. (ii) a broker agent provides services without owing the goods being transacted. A broker agent distinguishes the services that benefit the customers and those that benefit the suppliers. (iii) A marketmaker agent buys, sells and holds inventory. A marketmaker agent searches for investment opportunity which it negotiates, and buys from the resource providers and re-sell to the consumers, thus a market-maker acts as a “Superproviders” that aggregates resource reservations. These intermediary agents considered in the literature of economy for coordinating resource sharing suffered a number of shortcomings. (i) In using matchmaker model for resource sharing coordination, the consumer has extensive responsibilities, including directly contacting and negotiating with the resource providers. (ii) the shortcoming of the broker agent results from poor bandwidth utilization due to brokers messaging overhead.(iii) the marketmaker model suffers from scalability problem. Not only that, a market-maker’s offer of resources is decoupled from the price at which it acquired the resource, hence allocation of resources using marketmaker model distorts the trade off in the grid economy and moves it away from pareto efficiency.

To overcome all these shortcomings, a new intermediary agent called Cooperative Model is being proposed for coordinating grid resource sharing. In this model, the producers of resources form a cooperative group for the purpose of selling their resources. The cooperative agent sells these resources on behalf of the resource producers.

A cooperative is an autonomous association of agents united voluntarily to meet their common economic, social, and cultural needs and aspirations through a joint owned and democratically controlled enterprise. Cooperative business therefore is a business owned and controlled by the people who use its services. By pooling their resources together, providers of resources combine sales returns, and operating expenses, and distributing sales among members in proportion to volume each provides through the cooperative over a specified time. Pooling means assembling resources from many producers, combining sales returns and operating expenses, and prorating or distributing net returns among members in proportion to the volume each provides through the cooperative over a specified time. A cooperative may operate a single resource pool or a multiple resource pool. In a pool operation, members bear the risk and gains of changes in market prices. So, the advantages of pooling are that, it spreads market risks; it permits management to merchandise resources according to a program it deems most desirable and to one that can be planned with considerable precision in advance; it also permits management to use caution in placing and timing shipments to market demands and in developing new markets i.e., orderly marketing; and it helps finance the cooperative.

The rest of the paper is organized as follows: In section 2, we discuss the related work to this study. Section 3 presents the architecture of the proposed cooperative model while in section 4 we present the negotiation model for sharing resources. Section 5 presents the flow chart for implementing the negotiation model. In section 6, simulation result of an experiment carried out on bilateral negotiation between the presented cooperative agent and the agents of the resource consumer is presented. We conclude the paper in section 7.

2. Related work

In order to mediate negotiation interaction between producers and consumers of resources, Xin Bai et.al, 2006 proposed a Grid Coordination with Marketmaker Agents, [2]., In their paper, three scenarios of agent mediating negotiations were presented:

2.1 *Scenario1: Customers + Matchmaker + Providers*

This scenario consists of: (i) a set of clients having an infinite supply of tasks of various length and resource requirements, which they execute sequentially, (ii) a matchmaker and (iii) a set of resource providers. The clients contact the matchmaker agent (who maintains a knowledge base of the resources) using the Query protocol for a collection of providers, which are a good match for the task. The clients then start negotiations with all the returned matches using allocation sub protocol. From all the returned offers, the client selects the one, which provides the highest satisfaction (considering its utility and price), and pays for the allocation of resources.

The shortcoming of the matchmaker model is that, the consumer has extensive responsibilities, including directly contacting and negotiating with the resource providers

2.2 Scenario *2: Customers + Broker + Matchmaker + Providers*

In this scenario, the clients first contact a broker agent, who in turn contacts the matchmaker agent for matches, and starts a set of negotiations with the returned providers. The resulting offers are first pre-processed by the broker, by discarding the dominated offers (with the same or lower resource offering and the same or higher price) and randomly selecting one from the equivalent offers. The resulting set of offers is forwarded to the client, while the negotiations with the discarded providers are terminated without further contacting the client. The client selects the best offer according to its satisfaction function. The resources are allocated at the request of the broker, the provider and the broker are paid, and the reservation id is forwarded to the client. At this, the role of the broker ends. The clients are directly contacting the providers for the execution of the tasks.

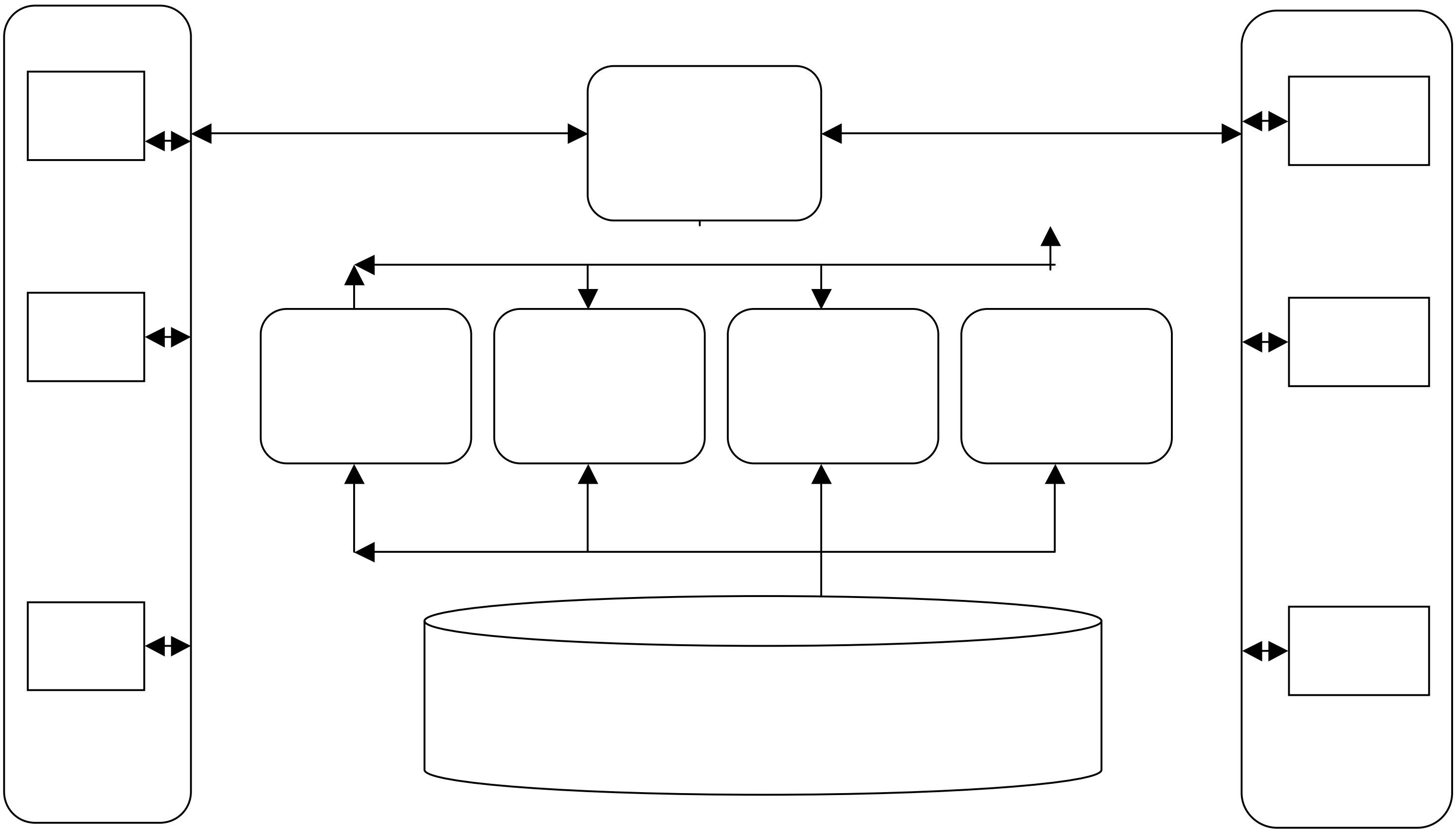
The shortcoming of the broker agent results from poor bandwidth utilization due to brokers messaging overhead.

2.3 *Scenario 3: Customers + Marketmaker + Matchmaker + Providers*

The third scenario presents a situation where the clients are contacting the marketmaker agent for the execution of tasks. The marketmaker negotiates and buys resources from the providers and re-sell it to the clients , thus a marketmaker acts as a “Superproviders” which aggregates resource reservations. When the client consults the marketmaker using the allocation subprotocol, the marketmaker checks if it can satisfy the request, and generates an offer for the resource allocation. While the broker only passes a filtered set of offers to the client, the marketmaker’s offer is decoupled from the price at which the marketmaker acquired the resource. Once the offer is accepted by the client, it receives a special reservation id, which is locally generated by the marketmaker. Then the client sends the task for execution to the marketmaker using execution subprotocol and this reservation id. The marketmaker forward the tasks to a provider using a subset of one of its own previous allocation. In this scenario, the client is never directly communicating with the providers. The marketmaker has a smaller number of messages than the broker and the matchmaker models.

The shortcomings of the marketmaker model include: (i) the market-maker model suffers from scalability problem. (ii) the marketmaker’s offer of resources is decoupled from the price at which it acquired the resource, hence allocation of resources using this model distorts the trade off in the grid economy and moves it away from pareto efficiency.

3. COOPERATIVE MODEL ARCHITECTURE



Building architecture for the proposed Cooperative starts with classification of the resources that are meant to be sold at the cooperative center. The grid resources we considered can be classified as CPU cycles, disk space, memory space, network bandwidth and a specialized processing power.

Our architecture is made of three layers: (i) the client layer, (ii) the cooperative center layer and (iii) the Resource Provider layers. (i) The client layer consists of clients having an infinite supply of tasks of various length and resource requirements, which they execute sequentially. The clients express their needs for resources in form of task to the cooperative center. Clients are usually charge per unit of the resources they consume. (ii) The Cooperative Centre is the layer that holds resource reservation. The cooperative center sells these resources on behalf of the resource providers. The Cooperative center is the intermediary that mediates resource negotiation interaction between the providers of resources and consumers of resources. (iii) The third layer is made up of a set of Providers of resources with distributed, heterogeneous resources. The resource providers form a cooperative group for the purpose of trading their resources. In other words, the resource providers sell their resources through the cooperative.

4 NEGOTIATION MODEL FOR SHARING RESOURCES

In what follows we illustrate the bilateral negotiation interactions between providers of resources, the cooperative, and the consumers (clients i.e. buyers) of resources:

To the Cooperative, the agent of the client (buyer) reveals her valuation v (that is the maximum price she is willing to pay for a unit of a resource), the resource providers also reveal her valuation s (that is the minimum price she is willing to sell a unit of a resource), to the Cooperative. Based on the players' reports, the cooperative agent specifies a mechanism $\Gamma(\beta, p, w)$ as follows:

i. The Cooperative agent determines $\beta(s,v)$ which specifies if the current trade is to take place:

$$\beta(s,v) = \begin{cases} 1 & \text{if} \quad v \geq p \quad \text{and} \quad w \geq s \\ 0 & \text{otherwise} \end{cases}$$

ii. If the trade is to take place $\beta(s,v) = 1$, the Cooperative agent collects ask price p from the buyer and pay the bid price w to the resource provider. The cooperative agent determines the bid – ask spread (p, w) to maximize its utility function.

If the trade is not to take place $\beta(s,v) = 0$, the players take their outside options.

5. Flowchart for Implementing the above Negotiation Model

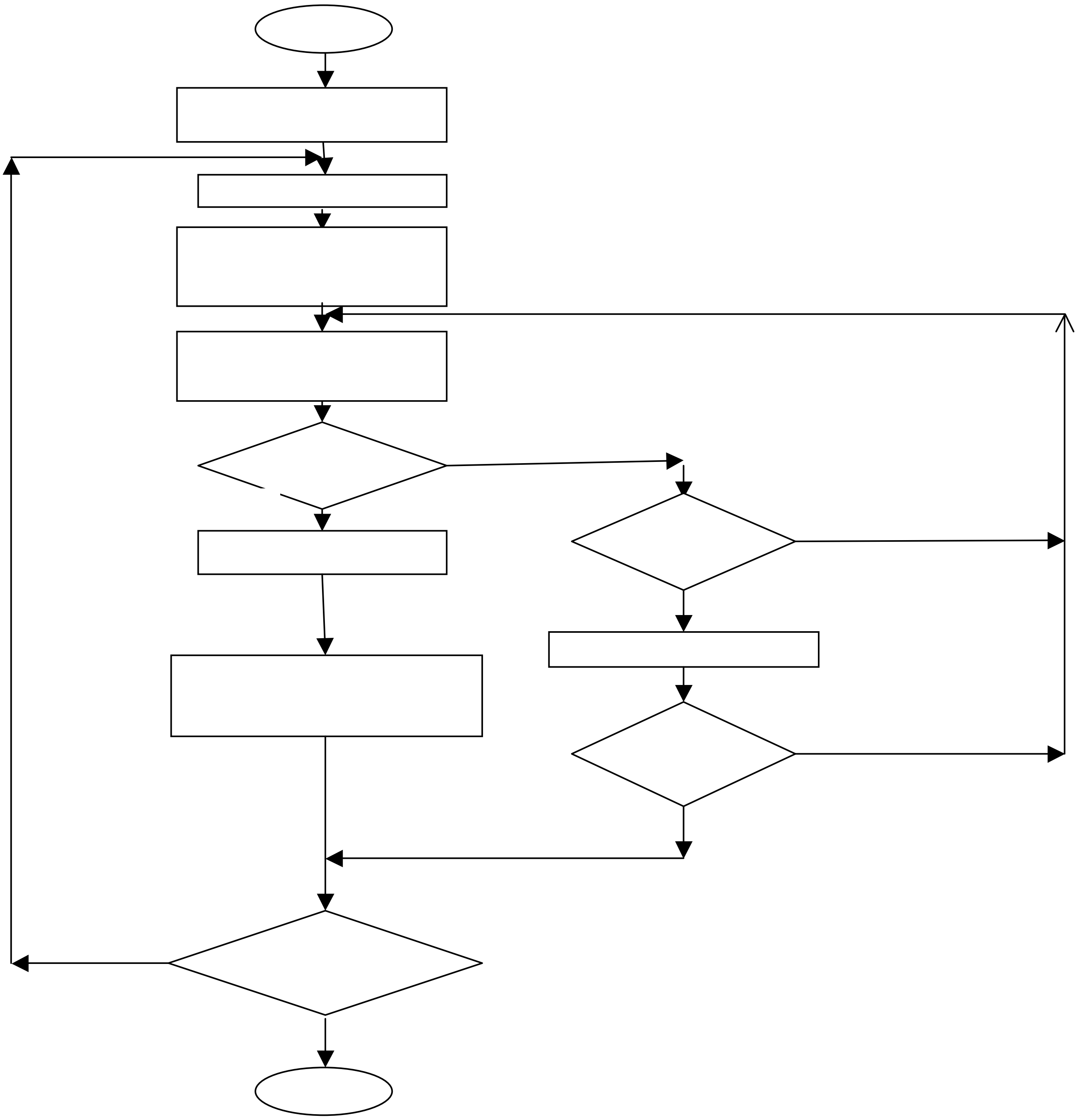
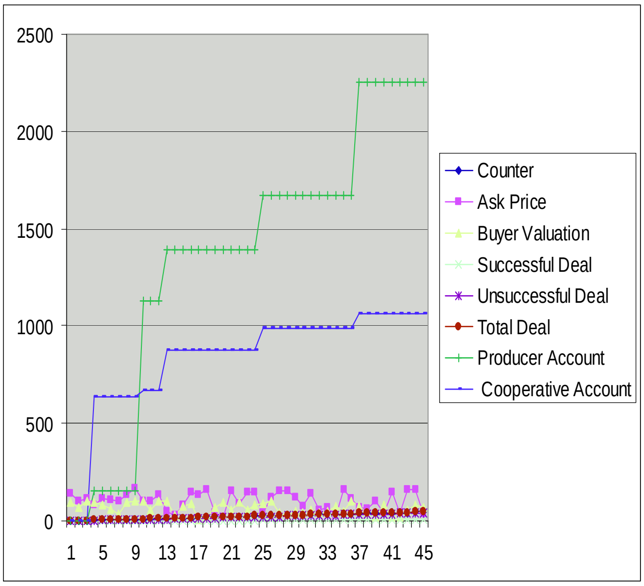


Figure 2: Negotiation Model Implementation

6. Simulation Result

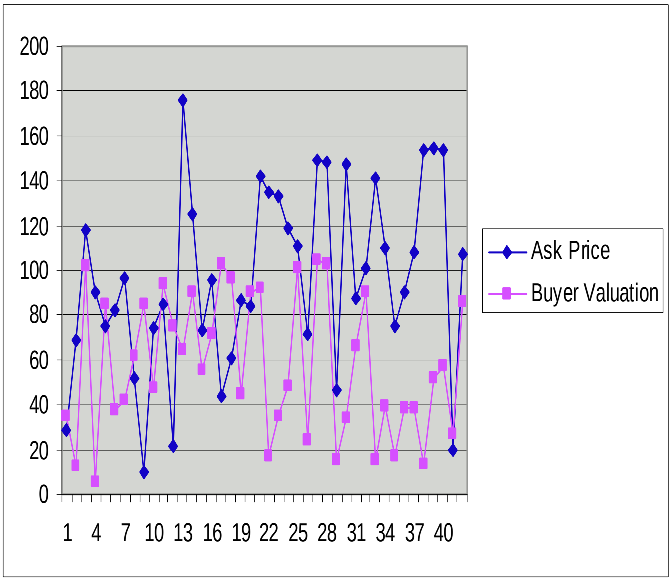
The simulation experiment was carried out using JBuilder 2005 Application Programming. The variables used: the cost-price (s), the bid-price (w), the ask-price (p), and the buyer valuation (v) were randomly generated and simulated using the procedure as shown in the flow chart in figure 2 above. The graph of the simulation result, using Microsoft Excel, is reported as follows:



Graph 1 Simulation Result of Negotiation over the price of a resource.

Simulation Result in graph 1 above relates: (i) the unit price of a resource, (ii) the buyer valuation for that resource (that is the maximum unit price the buyer is willing to pay for the resource), (iii) instances of successful or unsuccessful deals (that is to say whether or not a zone of agreement exist between the buyer and seller over the price of a resource), (iv) producer and cooperative account records. If there is agreement between the seller and the buyer over the deal, the buyer pays for the resource, the producers' account record is updated by the product of the number of units of the resource sold and the agreed negotiated unit price. The cooperative account record is also updated by the product of the number of units of the resource sold, and the difference between the unit price that the resource was sold and the unit cost price of the resource to the producer.

The points at which the producer account and the cooperative account remain constant indicate that there is no deal (that is the buyer and the seller are not in agreement over the deal) at those points.



Graph 2. Simulation Result relating the unit price charged for buying a resource and the consumer's valuation (that is the maximum unit price the consumer is willing to pay) for that resource.

The above result indicates that a consumer's valuation for a resource seems to be higher at the beginning of a negotiation deal, but as negotiation progresses, increasing the price of a resource lower the consumer valuation for that resource. That is as negotiation progresses, the higher the price place on a resource, the lower the consumer valuation for that resource.

7 Conclusion

In this paper, we have presented a new intermediary agent called Cooperative Model, for mediating resource negotiation between providers of resources and consumers of resources. Our model enabled resource negotiation interaction between producers and consumers of resources. By pooling their resources together, the model enables providers of resources to combine sales returns, and operating expenses, and distributing sales among members in proportion to volume each provides through the cooperative over a specified time.

Unlike the previous intermediary model considered in the literature of economic in distributed systems, the presented model is scalable and efficient for resource allocation.

It enables multiple users to access a virtualized pool of resources in order to obtain the best possible response time overall by maximizing utilization of the computing resources. It promotes collaboration between grid resource providers so that grid resources can be shared and utilized collectively and efficiently. It guarantees improved business agility by aggregating the resources of the providers in the grid into a pool where clients can easily access, negotiate and buy. The presented model enables providers of resources to combine sales returns, operating expenses, and distributing sales among members in proportion to volume each provides through the cooperative over a specified time. Not only that, the model enables the spread of market risks and gains across members of the cooperative.

References

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Biography of the author

1. Mr Aremu Dayo Reuben’s educational background is as listed : (i) B. Sc. (Honors) degree in Mathematics, University of Ilorin, Ilorin, Nigeria, (1989) (ii) M. Sc degree in Mathematics(Option in Computer Science), University of Ilorin, Ilorin, Nigeria, (1998)

2. He started his working career as a Mathematics teacher in one of Nigerian High Schools in November, 1989 shortly after completion of his B. Sc. (Honors) degree in Mathematics. He also worked as a programmer at Essential Drug Project, Ministry of Health Ilorin, Nigeria – (October, 1991 – September, 1995). He was employed by the University of Ilorin, Ilorin, Nigeria as: (i.) Programmer, Department of Mathematics, University of Ilorin – (October 1995 – March 2000). (ii) Lecturer, Computer Science Department, - (Mach 2000 to date).

3. Mr Aremu is currently a Ph.D. Student at the University of Zululand, South Africa.