# Simulation of Wireless Grid Computing

By

Abdul Rahman bin Romli

**Dissertation submitted in partial fulfillment of the requirement for the Bachelor Of Technology (Hons) (Business Information System)**

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# CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information System Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(BUSINESS INFORMATION SYSTEM)

Approved by,

______________________

(Ms. Nazleeni Samiha Haron)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
January 2006

# CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

ABDUL RAHMAN ROMLI

# ABSTRACT

For the last decade we have seen that there is an extensive increase in the computer and network area. There is faster hardware and sophisticated software that are been release time to time. Even so there are still problems in the field of science, engineering, and business which cannot dealt effectively with the new era of supercomputers. The objective of this paper is to design and implement the wireless simulation for grid computing architecture. The problem that has been state here is whether it is possible or not to design and implement the wireless grid computing in order to enhance the grid computing utilization. This paper is focus on the designing and implementing the wireless grid computing architecture that will enhance the performance. This project will have 3 phases which is phase 1 consist of system identification and requirement analysis, phase 2 consist of project design and project development and lastly code and unit testing for phase 3. For this project, it will focus on how the wireless architecture can enhance the grid computing usage in the network management.

# ACKNOWLEDGEMENT

In the name of Allah SWT, I had completed this Final Year Project successfully. Every phase in doing this project brought valuable experience and exploration to the real technology world and how to handle it. A lot of opportunity had been given to me to enhance all skills in many kind of knowledge in solving problems.

In this opportunity, I would like to thank to every person who had helped me to do this project. Mostly to my gratitude supervisor, Ms. Nazleeni Samiha Haron for her guidance and helping me by supply some information to complete this project. This gratitude also goes to Mr. Nordin Zakaria, FYP Coordinator for approving this project and gives some opinion in developing the system.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

Based on the popularity of using the powerful computers and high speed network technologies is changing the way we use computers today. These technology opportunities have led us to the possibility to use the distributed computer that is known as Grid computing. Grid computing is a form of distributed computing that involves coordinating and sharing computing, application, data, storage, or network resources across dynamic and geographically dispersed organizations. "Grid computing enables virtual organizations to share geographically distributed resources as they pursue common goals, assuming the absence of central location, central control and an existing trust relationship" (Ahmar Abbas, 2003, *Grid Computing: A Practical Guide to Technology and Applications).*

The distributed computing is a part of network management that the author must know before proceed with the detail how to manage the wireless network for the Grid Computing. In general, network management is a service that employs a variety of tools, applications, and devices to assist human network managers in monitoring and maintaining networks. The study of network management configuration is important for the author besides design the suitable architecture of Grid Computing. This project focuses on how the distributed computing is applied in the wireless network. The network management configuration is to simplify the devices or medium that will be used for this project. This will help in reducing the time using and errors occurs due to on misconfiguration of network devices. This is because the wireless technology is different from the wired technology. There is many things that need to be covered such as the network congestion control and security controls. Therefore, a study of wireless technology needs to be done before implementing this project for better performance.

Wireless technology established their connection without a connection cable. Wireless network utilize radio waves and/or microwaves to maintain communication channels between computers. The wireless technology rapidly has been increasing and gains the popularity in the business environment. Their technology has been improved and their high cost technology is decreased.

With the capability to solve various type of networking problem, grid computing can be considered as a solution for the networking problems. Since the technology is rapidly increase the wireless grid computing may become one of the greatest technologies in these computer and network era.

## 1.2 Problem Statement

Grid architecture providing the protocols, services and software development kits needed to enable flexible, controlled resource sharing on a large scale. The grid architecture will be used for this project. There are several processors that will be integrated and connected to each other for the distributing the tasks. This grid architecture required network manageable skills in order to distribute the task and also the wireless technology needs to be applied for this project. The main problem for the grid computing is their fixed location computers and static ways of distributed computing. Therefore, to solve this problem the wireless grid computing need to be implementing. The wireless grid computing can create the mobility and ad hoc resource sharing. The wireless technology also has their limitation. This is because the wireless network speed is low compared to the Ethernet and also the signal may be blocked by the wall or furniture in the building. The possibility in designing and implementing the wireless grid computing might be the problem for this project. Quoted from website at http://www.alzinfo.org/ "I've been involved in the business over ten years now and we still have not cracked this network management issue in grid architecture," Dowler Concedes. From the situation and based on the statement above, these network management project is focus on how to configure the network and to apply the wireless technology into the grid computing technology. The wireless grid computing will bring new challenges to the wired grid computing. The wireless grid computing will enhance the utilization of the grid computing itself with emergence of the wireless devices.

## 1.3 Objective and Scope of Study

In order to complete this project within the time limit and the scope given, several objectives has been identified. The main objective is to design and implement of wireless for grid computing architecture. There are some classification that might be used to understand more about the shareable resources, the places of use, and ownership and control patterns within which wireless grids will operate. The grid computing is a static way of distributed computing while the wireless grid put some advance in mobile utility and ad hoc resource sharing for the user. Before the design and implementation takes part, a research of grid computing and the possibilities of implement it in the wireless technology need to be done. Therefore, this project have to design and implement the suitable grid architecture that may help to manage the network and to control changes to the configuration of the wireless network devices which automatically enable the network distribute the task to others processors.

The scope of this study is to design and implement the wireless grid computing for distributing the task to each computer that will enhance the performance of each computer. The network management will help in design and analyze wireless networks that can provide QoS guarantees and high communication performance. This project will focus on the network management in wireless grid computing.The network configuration management is to configure the network in grid architecture which automatically enables the network to distribute the task to others processors if there is a fault and failure (up/down) occurred.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Grid Computing

Grid computing (or the use of a computational grid) is applying the resources of many computers in a network to a single problem at the same time - usually to a scientific or technical problem that requires a great number of computer processing cycles or access to large amounts of data [12]. A well-known example of grid computing in the public domain is the ongoing SETI (Search for Extraterrestrial Intelligence) Home project in which thousands of people are sharing the unused processor cycles of their PCs in the vast search for signs of "rational" signals from outer space. According to John Patrick, IBM's vice-president for Internet strategies, "the next big thing will be grid computing."

The definition of Grid Computing resource sharing has since changed based upon experiences, with more focus now being applied to a sophisticated form of coordinated resource sharing distributed throughout the participants in a virtual organization. This application concept of coordinated resource sharing includes any resources available within a virtual organization, including computing power, data, hardware, software and applications, networking services, and any other forms of computing resource attainment. Long discussed, grid computing is alive and kicking and coming to a data center near you.

Why grid now? The time is right. By many accounts, average system utilization across organizations is 15% to 20%, while obviously the ideal would be about 80%.

And some 20% of IS budgets goes to operations today, marginally less than the 25% that goes to capital investments. (By John Dix, Network World, 02/14/05)

Until now, the problem with grid computing has been a lack of common software for developers to work with. One good way to gauge a new technology's degree of acceptance is to observe whether it has moved out of the laboratory and onto store shelves -- from science to commerce. According to that measure, grid computing is just coming of age. Often called the next big thing in global Internet technology, grid computing employs clusters of locally or remotely networked machines to work on specific computational projects. (Tim McDonald July 24, 2002 4:22PM)

The Grid refers to an infrastructure that enables the integrated, collaborative, and coordinated use of distributed heterogeneous computing resources, such as computers, networks, databases, and scientific instruments owned and managed by multiple organizations (Foster and Kesselman, 1999). Since the very early stages of the evolution of the Grid, middleware has been a primary focus of software development and research effort (Foster *etal.* 2001). When the network is as fast as the computer's internal links, the machine disintegrates across the net into a set of special purpose appliances. – (Gilder Technology Report, June 2000). (Ian Foster)

Through implementing this type of Grid Computing environment, these resources are immediately available to the authenticated users for resolving specific problems. These problems may be a software capability problem (e.g., modeling, simulation, word processing, etc.) or hardware availability and/or computing capacity shortage problems (e.g., processor computing resources, data storage/access needs, etc.)[4]. While on another level, these problems may be related to a networking bandwidth availability problem, the need for immediate

circuit provisioning of a network, a security event or other event correlation issue, and many more types of critical environmental needs.
Based upon the specific problem dimension, any given problem may have one or more resolution issues to address. For example, in the above case there are two sets of users, each with a need to solve two different types of problems.

Today, Grid Computing offers many solutions that already address and resolve the above problems. Grid Computing solutions are constructed using a variety of technologies and open standards. Grid Computing, in turn, provides highly scalable, highly secure, and extremely high-performance mechanisms for discovering and negotiating access to remote computing resources in a seamless manner [13]. This makes it possible for the sharing of computing resources, on an unprecedented scale, among an infinite number of geographically distributed groups.

## 2.2 Wireless Network

Wireless data communication systems can provide remote or mobile users with different forms of wireless data service in a cost-effective and timely manner. In general, wireless data communications can be categorized into mobile data networks, and wireless local area networks (LAN)[5].Mobile data networks support a large number of users in a relatively wide area at a low data rate. Mobile data networks are widely used in short message applications, such as paging and electronic mail [5].

A wireless LAN typically supports a small number of users at a high data rate in a well-defined indoor area. A wireless LAN is commonly used in high-speed local data communications such as file transfer, data terminal, and remote login in distributed file systems [5]. Most of people know choose the wireless technology because it can eliminate expensive wireline installations and can support fast changing work environments by providing virtual data connections for temporary events. As high-performance portable computers continue to become more widely used and more dependent on networking, wireless local area networks present a promising solution.

Innovation in wireless technology continually introduces new devices, with new challenges to the grid [Lehr and McKnight, 2003, Anius and McKnight 2002)]. Wireless devices are increasing in numbers, and their power is growing. Wireless laptops rival the power of mainframes just a few generations ago. Cellular and 802.11 networks are increasing the connectivity of these devices. These new devices bring challenges to the grid paradigm because their mobility will create additional constraints on grid protocols [McKnight 2003]. Policy as well as technical and business challenges arise from the confluence of grid computing and mobile and nomadic devices, services, applications, and users [McKnight 2002].

## 2.3 Wireless grid computing

Grid computing uses the power of many computers that is connected via network in order to accomplish one computer could not accomplish alone. Grid computing takes advantage of several networked computers to create a virtual computer architecture that can distribute data across a parallel infrastructure. Grid computing uses the power of several computers to solve one large-scale problem, something that would be impossible using only one computer at a time. Devices on the wireless grid will be not only mobile but nomadic which is shifting across institutional boundaries. The wireless grid extends this potential to mobile, nomadic, or fixed-location devices temporarily connected via and ad hoc wireless networks [McKnight 2003, Gaynor 2003]. The wireless grid makes it easier to extend grid computing to large numbers of devices that would otherwise be unable to participate and share resources. Wireless grids resemble networks already found in connection with agricultural, transportation, air-quality, environmental, health, emergency, and security systems [McKnight 2004, Bradner 2004].

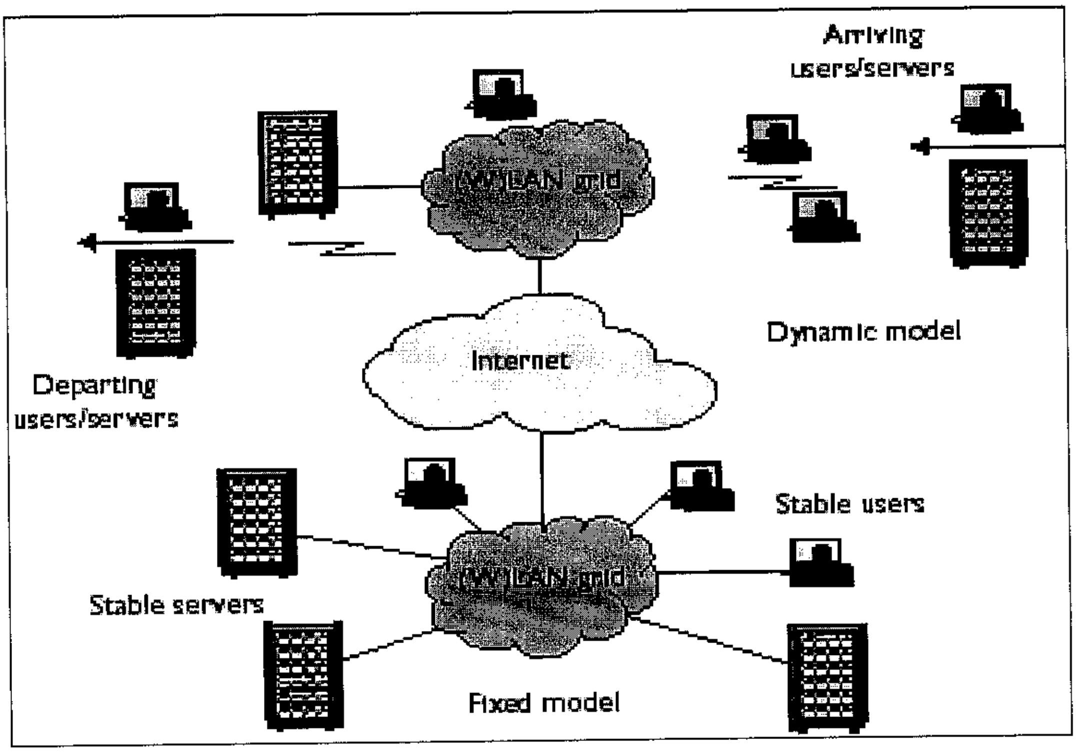



**Figure 1:** *Dynamic and fixed wireless grids.*

Here we se two types of wireless grids: those composed of unknown mobile users and devices engaged in ad hoc resource sharing and service creation in a particular location, and those composed of components with known identities managed within a stable institutional structure. [McKnight 2004, Bradner 2004].

Wireless grids offer a wide variety of possible applications. They can reach both geographic locations and social settings that computers have not traditionally penetrated. Wireless grids present three novel elements [McKnight 2004, Bradner 2004]:

- New resources
- New places of use, and
- New institutional ownership and control patterns

Wireless devices bring new resources to distributed computing. In addition to typical computational resources such as processor power, disk space, and applications, wireless devices increasingly employ cameras, microphones, GPS receivers, and accelerometers, as well as an assortment of network interfaces (cell, radio, Wi-Fi, and Bluetooth) [McKnight 2004, Bradner 2004]. The wireles devices are loaded with this new hardware and software technology features. It is likely that as they become more pervasive, more features will be added. It has been observed that actually very few of the features are actually used in any such feature-rich system [9]. Wiereless devices are limited in resources: bandwidth, power, memory, storage, etc [9].

Wireless grid networks inherit the three main characteristics of the general grid in a wired networking environment (Foster 2002) that include:

- Geographically distributed and decentralized resource coordination
- Standard and open services and protocols
- Nontrivial QoS support for computing and networked applications

Wireless grids present an opportunity to leverage available resources by enabling sharing between wireless and non wireless resources [8].

People increasingly take wireless devices with them to new places, in both their personal and professional lives. The numbers of those devices that include sensors are growing. In fact, the pervasive mobile is developing into a super-sensor. From shopping malls to medical disaster areas, sporting events, and warehouse floors, wireless devices are on the verge of becoming ubiquitous. Wireless grids present an opportunity to levberage available resources by enabling sharing between wireless and non-wireless resources [McKnight 2004, Bradner 2004].

## 2.4 Coordinating Behavior in Wireless Grids

Grid computing focuses on the large-scale sharing of computing resources such as software, hardware, databases and data sources [Foster 2001,2002]. Wireless grids organized as ad hoc networks represent the epitome of this evolution [McKnight 2003, Gaynor 2003, McKnight and Howison 2003].

There are four prototypical ways in which coordinate and allocate resources in distributed networks. These four principal mechanisms are relevant for coordinating behavior in wireless grids and other distributed computing networks. The four principal mechanisms are[McKnight 2003, Lehr 2003, Howison 2003]:

- Technical
- Social
- Legal
- Economic

The growth of wireless accelerates these trends because it increases opportunities for computing to become ubiquitous, the heterogeneity of networking resources that need to be managed, and the share number of end nodes that need to be managed. In a wireless grid the edges nodes are the network. Designers and network managers of an ad hoc wireless grid will need to anticipate the strategic behavior of the end-nodes that will comprise the network. Wireless grids are emerging from the coalescene of a number of independent research efforts and industry. Wirelss grids will not be computing network separate from the social/economic framework in which they operate [McKnight 2003, Lehr 2003, Howison 2003].

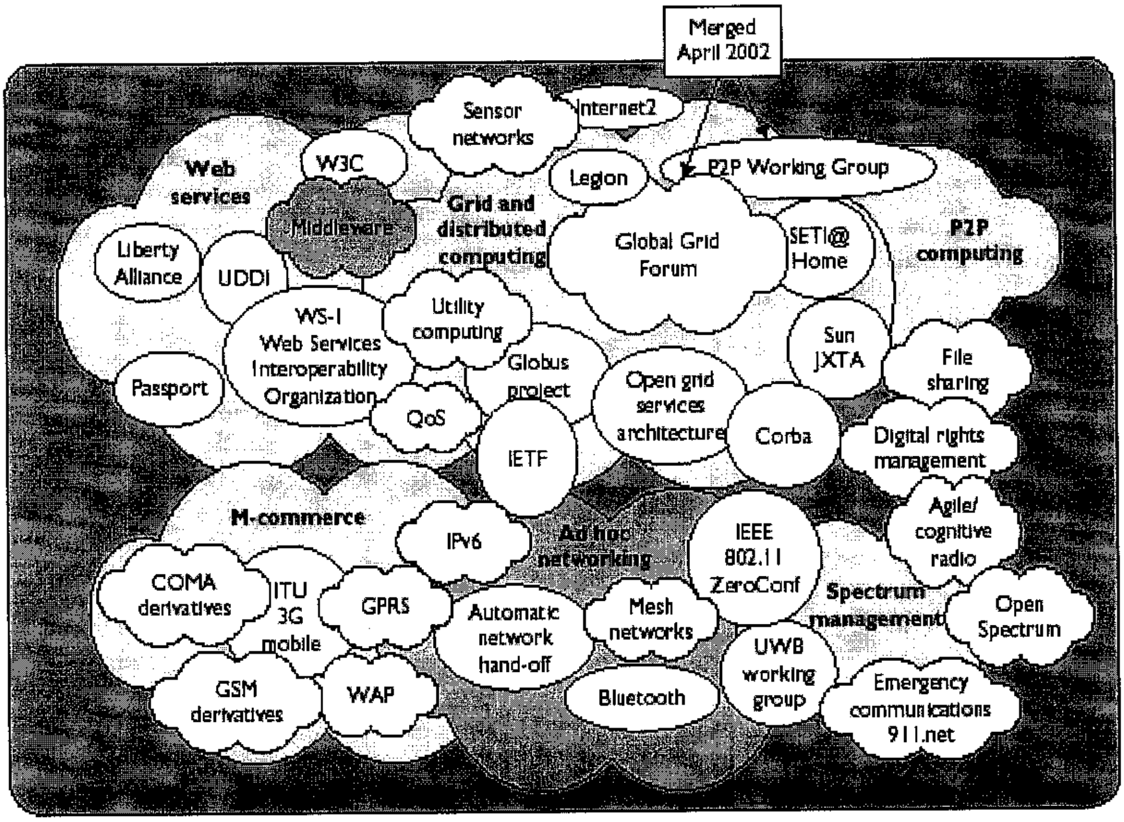



**Figure 2:** *A wireless grid issues and standards map. The variety of issues and technologies illustrates how complex the needs of wireless grids are [McKnight 2004, Bradner 2004].*

## 2.5 Characteristics of Wireless Grids

Wireless grid application requirements may have significant effects on advanced network architectures. Research on wireless power constrained device and grid application requirements may also help clarify some of the remaining critical research challenges to be overcome [Park 2003]. Ian Foster [Foster 2001] discusses the virtual nature of organizations built around distributed computing because the boundaries of the physical organization are ephemeral when working in a distributed computing environment.

The mobility of small, wireless devices creates tremendous opportunities to grow the diversity of devices and users that utilize the grid, and enhance the services available on the grid. These mobile devices have very different constraints than typical grid servers and clients. Their communication and computation abilities are limited because of power constraints, small screen real estate, and the transitive nature of their connection to network infrastructures. This new devices of wireless technology are expect to enhance the benefits of belonging to a virtual organization when they are integrated into the grid [18].

Wireless grid networks inherit the three main characteristics of the general grid in a wireless networking environment: 1) decentralized resource coordination 2) standard and open service and protocols 3) nontrivial QoS support [Foster 2002a]. The ad hoc dynamic nature of small mobile devices differ form traditional grid servers and clients. The decentralized resource coordination is proposed for the markets and their enabling mechanisms because the markets will consist of heterogeneous and dynamic resources that need to be coordinated (not centrally) in wireless grid networks [18].

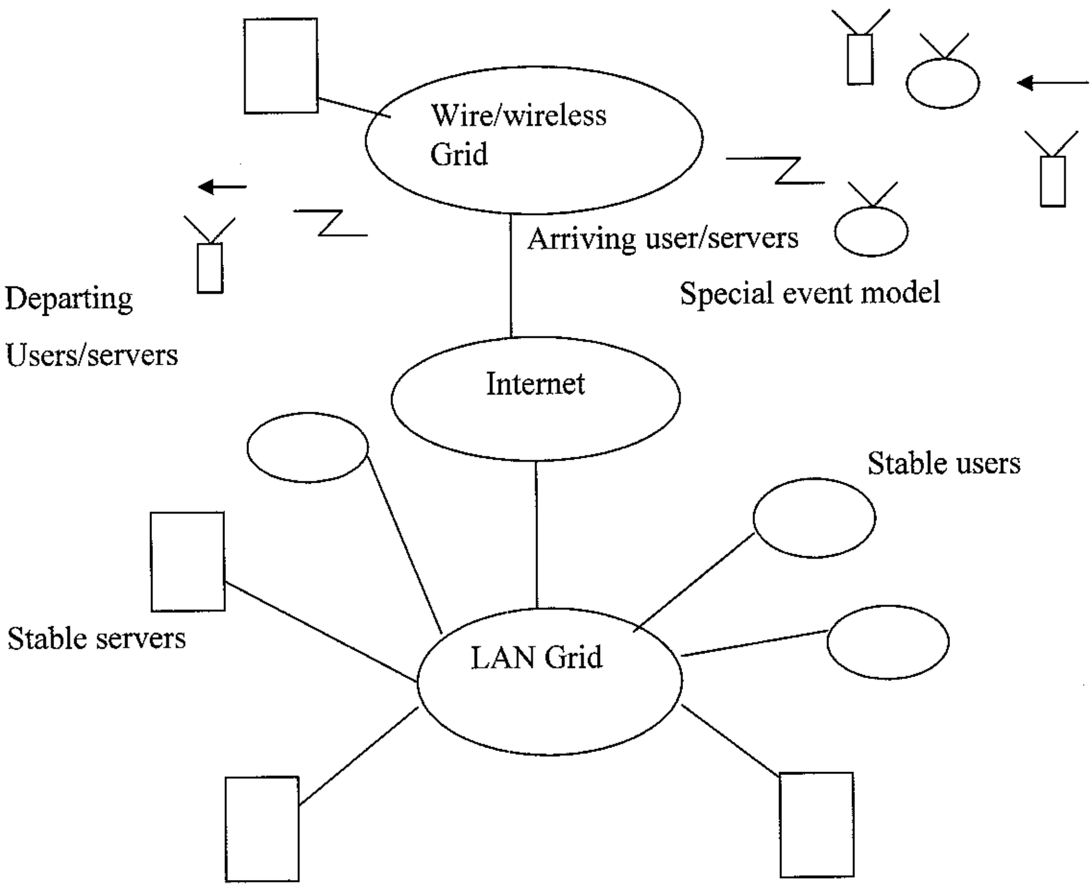



**Figure 3:** *Residential community model for wireless grid computing architecture.*

## 2.6 The New Requirements for Wireless Grid Computing

There are many technical concerns with integrating wireless devices into the grid paradigm including [Gaynor, McKnight, Hwang, and Freedman]:

- *Service discovery and service advertisement* – perhaps most important in a dynamic ad hoc wireless network is detecting what services exist, how much they cost, and how these services will be used. This approach is to determine the optimum usage of the wireless grid itself.
- *Network structure and management* – a dynamic ad hoc environment demands a combination of distributed and centralized architecture. A wireless grid with island-like attributes demands a distributed structure because connection to a centralized control cannot be guaranteed. A wireless grid also needs centralized

management to be scalable, and allow efficient provision of services. It is equally important to allow successful services to be provided in a scalable architecture so that many users can benefit from it.

- *Security* – in this section the concern is how the wireless security is different from the wired technology. In any wireless environment security is critical to successful adoption. Many wireless devices have security models and ongoing research for example 802.11 wireless LAN.

# CHAPTER 3

# METHODOLOGY

## 3.1 Methodology

The methodology of this project can be divided into 3 phases. The first phase involves System Identification and Requirement Analysis. The second phases are Project Design and Project Development. The last phase is Code and Unit Testing. However, due to the limited time given, the details of this methodology are not able to be identified yet. Thus it will be explained in the next report. Below are the methodology used during the development of the project.

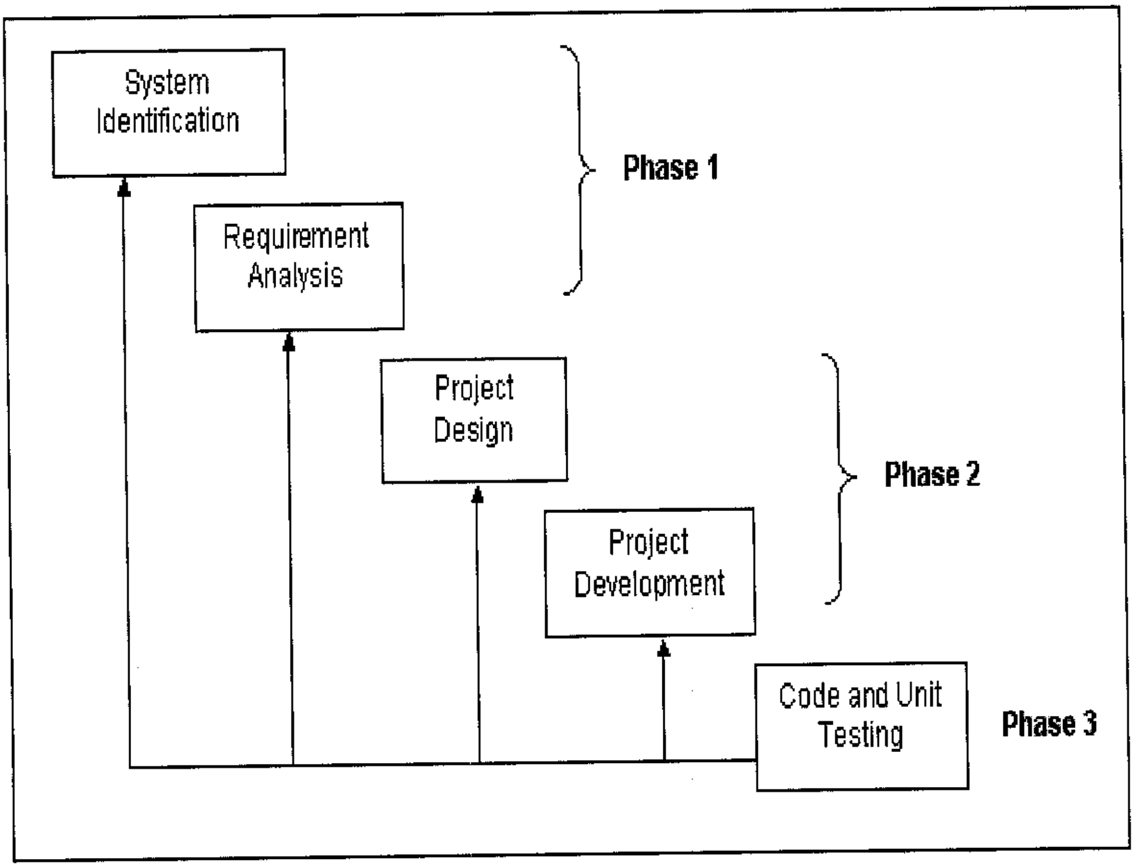



**Figure 4:** *Project Methodology*

### 3.1.1 Phase 1

The main focus on this phase is making research on the project identification. It deals with the understanding requirements of the system, and how these requirements will accomplish. Project identification is studied thoroughly to define the problems, objectives and opportunities.

- System Identification

  In this stage, the author involves with identifying problems, opportunities and objectives of the project. These three important components were recognized from the research and investigation that had been done. The problem rose when all of the processors are able to be integrated using the wireless and automatically distribute the task to others processors if there is a fault or failure (up/down).

- Requirement Analysis

  The requirement document consist the identification of software, hardware and system requirement. Basically, this phase is trying to resolve 'what' issues in a project. Among the tools used to define information requirements in this project are investigating data and information from Internet, observing and gathering information by doing research on the existing system and research. The requirements identified are the system needs to use suitable architecture with network management software as a server.

### 3.1.2 Phase 2

In the second phase the architecture of the system will be established. The architecture defines the components, their interfaces and behaviors. The deliverable for this phase is the design architecture and project development. Given the architecture from the design phase and requirement, the author will develop the system by following the requirement. The implementation deals with issues of quality, performance, baseline and debugging.

- Project Design

  Details on computer programming and environments, client server system, packages, application architecture, distributed architecture layering, memory size, platform, data structure and other system details are established in this phase. Information that collects during phase 1 will be used to accomplish the logical design of architecture.

- Project Development

  This process resembles software development because it involves using a specific syntax for encoding the network configuration management or programming languages for the system in performing specific functions.

### 3.1.3 Phase 3

In many methodologies, the testing phase is a separate phase in which is performed after the implementation is accomplished. When doing testing on a system, the author should consider the quality, stability, performances, and efficiency of the system.

- Code and Unit Testing

  The purpose of this testing is to catch the problem before the system is signed over the users. Any errors that encountered will be debugged in this phase. The application is tested in several computer and user to recognize the problems.

## 3.2 Tools and Equipments Required

The tools that are used throughout this project also must be identified. Basically, the tools used are divided into three parts which software, hardware and documents. The lists of the tools used are described as below:-

### 3.2.1 Software

- Windows XP professional or Home Edition
- Acrobat Reader 5.0
- Windows 2000 server
- Visual Studio.NET

  This tools used for implementing the programming in collaboration with Alchemi software
- Alchemi
- A .NET API and tools to develop .NET grid applications and grid-enable legacy applications.

### 3.2.2 Hardware

- 3-5 computer or pc
- Wireless adapter
- Wireless Router

# CHAPTER 4

# RESULT AND DISCUSSION

## 4.1 Findings

This section will discuss the result from this project. The result can be achieved from the research that have been made earlier by the author. In this section also there are some discussions about the related issues for this project. Basically, the result will be the evaluation of the end product, which is the network management in the wireless grid computing.

The research and finding must meet the requirement to fulfill the objectives of the project. The expected end result of this project is to enable the network to process the distributed jobs as a solution for network management as well as configure the network which can automatically distribute the tasks if one or more processor has a problem or fault has occurred (up/down) using the wireless technology. The application is expected to be used in the future in managing the network in the wireless grid computing.

From the earlier research, the author found that until now, the problem with grid computing has been a lack of common software for developers to work with, largely because grids rely on Internet-based software. Therefore the suitable and successful network management in inquired to manage the network in grid architecture or High Performance Computer. It is also difficult in enhancing the grid computing technology to the wireless grid computing which means that the nomadic devices can come in to share the resources and after the device finish it task then it will be replaced by another devices.

Grid computing appears to be a promising trend for three reasons, its ability to make more cost-effective use of a given amount of computer resources, as a way to solve problems that can not be approached without an enormous amount of computing power, and because it suggests that the resources of many computers can be cooperatively and perhaps synergistically harnessed and managed as a collaboration toward a common objective. In some grid computing systems, the computers may collaborate rather than being directed by one managing computer. With the wireless grid computing, it will enhance the utilization of the grid computing by providing such nomadic devices that is put with the new technology like the infrared technology, Bluetooth technology and WiFi technology.

From the research also the author found that the grid computing distributed its resources to offer a various collection of services over a network of connected wireless devices. The continuing growth of wireless services brings many new devices, new applications, as well as many new technical, economic and policy challenges, to wireless Internet access to virtual markets on the grid [Lehr 2003, McKnight 2002a, Anius 2003]. These challenges include resource discovery and sharing in dynamic ad-hoc network environments, power and bandwidth management including for power constrained devices, user interface design for mobile devices, business models, and policy infrastructure [Gaynor 2003, Hwang 2003, McKnight 2002b].

### 4.2 Grid Components

Essentially, grids are built from clusters of computer servers joined together over a local area network (LAN) or over the Internet. There are several development tools that can facilitate the growth and adoption of grid computing.

One of those tools is Globus, a research and development project focused on helping software developers apply the grid concept. The Globus toolkit, the group's primary offering, is a set of components that can be used to develop grid applications. For each component in the toolkit, Globus provides an API (application programmer interface) for use by software developers.

The other tool than Globus is MPI which stands for Message Parsing Interface. One of the tools is MPICH. MPICH is a freely available, portable implementation of MPI, the Standard for message-passing libraries. MPICH is an all-new implementation of MPI, designed to support research into high-performance implementations of MPI functionality. In addition to the features in MPICH, it includes support for one-side communication, dynamic processes, intercommunicate collective operations, and expanded MPI-IO functionality. Clusters consisting of both single-processor and SMP nodes are supported.

MPICH is a unified source distribution, supporting most flavors of UNIX and recent versions of Windows. In additional, binary distributions are available for Windows platforms.

Alchemi is an open source software framework that allows you to painlessly aggregate the computing power of networked machines into a virtual supercomputer (computational grid) and to develop applications to run on the grid.

It has been designed with the primary goal of being easy to use without sacrificing power and flexibility.
Alchemi includes:

- The runtime machinery (Windows executables) to construct computational grids.
- A .NET API and tools to develop .NET grid applications and grid-enable legacy applications.

### 4.3 Power to the People

Research scientists historically have been attracted to manage the network in grid computing because it uses the power of idle computers to work on difficult computational problems.

The technology will enable universities and research institutions to share their supercomputers, servers and storage capacity, allowing them to perform massive calculations quickly and relatively cheaply.

### 4.4 Sharing Data

Until now, the problem with grid computing has been a lack of common software for developers to work with, largely because grids rely on Internet-based software. Therefore the suitable and successful network management in inquired to manage the network in grid architecture or High Performance Computer.
"Scientists are now sharing data and instrumentation on an unprecedented scale, and other geographically distributed groups are beginning to work together in ways that were previously impossible," according to the Grid Research Integration Deployment and Support Center.

### 4.5 Functions and Services

Grid computing appears to be a promising trend for three reasons, its ability to make more cost-effective use of a given amount of computer resources, as a way to solve problems that can't be approached without an enormous amount of computing power, and because it suggests that the resources of many computers can be cooperatively and perhaps synergistically harnessed and managed as a collaboration toward a common objective. In some grid computing systems, the computers may collaborate rather than being directed by one managing computer. Grid implementations differ in the way they implement this abstraction. One of the key differentiating features of Alchemi is the way it abstracts the grid, with the aim to make the process of developing grid software as easy as possible [21]. The next section expands on this. Alchemi on the other hand, primarily offers a more low-level (and hence more powerful) abstraction of the underlying grid by providing a programming model that is object-oriented and that imitates traditional multi-threaded programming. Alchemi is written for the .NET CLR [22]. Hence all machines running any Alchemi software component must have the .NET Framework installed. Additionally, the Alchemi API is closely tied in with the .NET CLR and thus can only be used by .NET applications [23].

### 4.6 How the Alchemi works

There are four types of distributed components (nodes) involved in the construction of Alchemi grids and execution of grid applications: Manager, Executor, User, and Cross-Platform Manager.

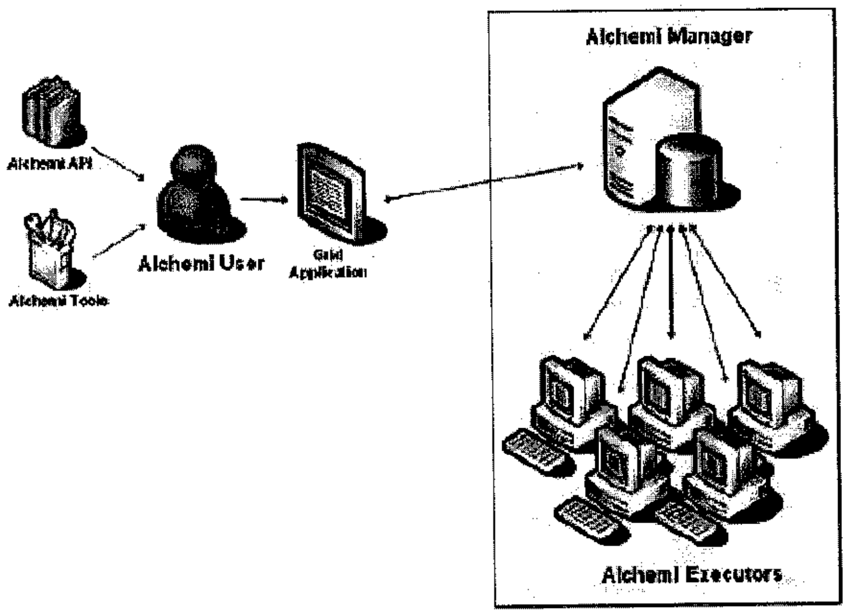



**Figure 5:** *An Alchemi Grid*

The grid architecture that is shown in Figure 5 will be used in this project. The author needs to setup the Alchemi grid architecture and then transform it to the wireless technology.

A grid is created by installing Executors on each machine that is to be part of the grid and linking them to a central Manager component. The Windows installer setup that comes with the Alchemi distribution and minimal configuration makes it very easy to set up a grid.

An Executor can be configuring to be dedicated (meaning the Manager initiates thread execution directly) or non-dedicated (meaning that thread execution is initiated by the Executor.) Non-dedicated Executors can work through firewalls and NAT servers since there is only one-way communication between the Executor and Manager. Dedicated Executors are more suited to an intranet environment and non-dedicated Executors are more suited to the Internet environment.

Users can develop, execute and monitor grid applications using the .NET API and tools which are part of the Alchemi SDK. Alchemi offers a powerful grid thread programming model which makes it very easy to develop grid applications and a grid job model for grid-enabling legacy or non-.NET applications.
An optional component (not shown) is the Cross Platform Manager web service which offers interoperability with custom non-.NET grid middleware.

### 4.7 Grid Architecture

Grid architecture is important aspect of this project. The design of the architecture is vital in order to ensure that the grid computing facility will be able to be build thus ensure that the network is able to distribute the jobs and task to others processors if fault and failure (up/down) occurred in grid architecture. Grid architecture that has been identified and used in the project is from author's research in literature review section. The grid architecture used in the project is as follow:-

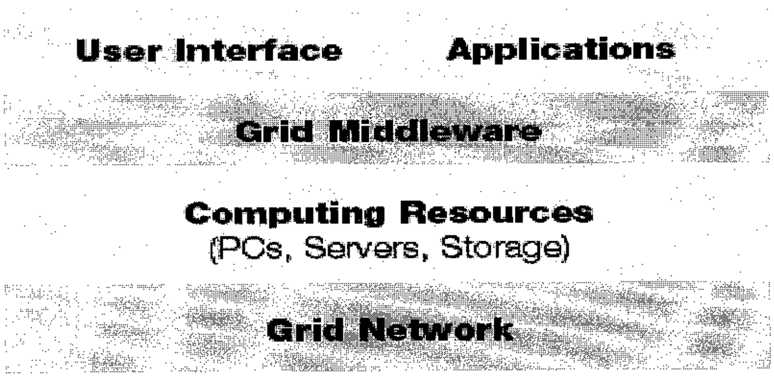



**Figure 6:** *Grid Architecture*

Based on the architecture, the author assembles computing resource (in this project, the workstation) and connects it through grid network. Grid network that have been set up was using existing Ethernet connection and workstation are connect using a hub. Then after the entire grid is setup using the wired Ethernet, the transformation from wired to wireless technology need to be apply.

### 4.8 Alchemi Installation

In development process, the author is using an Open Source tool known as Alchemi. Alchemi is a unified source distribution, supporting most flavors of UNIX and recent versions of Windows. In additional, binary distributions are available for Windows platforms. The main requirement for Alchemi is Microsoft .NET Framework 1.1. Then the Alchemi manager installation needs to be done. For this project the author used the Alchemi version 1.0 beta. Installing an Alchemi application need to apply after the author install the Microsoft .NET Framework 1.1.

#### 4.8.1 Alchemi Manager

To install Alchemi manager SQL Server 2000 or MSDE 2000 is needed. The Alchemi manager can be installed as a normal Windows desktop application or as a windows service. To install the manager as a windows application, use the Manager Setup installer. For service-mode installation uses the Manager Service Setup. Before install the Alchemi manager, the author need to install the SQL

Server 2000 or MSDE 2000 first. The system administrator (sa) password need to be consider in either case. The system administrator (sa) account is created during the installation process and the system administrator (sa) account has full rights in the SQL Server environment. By default, the system administrator (sa) password is blank, unless you change the password when you run the MSDE Setup program.

### 4.8.2 Alchemi Executor

The Alchemi executor can be installed as a normal Windows desktop application or as a windows service. Install the Executor via the Executor installer and follow the on-screen instructions. The Executor is configured from the application itself. You need to configure 2 aspects of the Executor:

- The host and port of the Manager to connect to.
- Dedicated / non-dedicated execution. A non-dedicated Executor executes grid threads on a voluntary basis (it requests threads to execute from the Manager), while a dedicated Executor is always executing grid threads (it is directly provided grid threads to execute by the Manager). A non-dedicated Executor works behind firewalls.

The Executor only utilises idle CPU cycles on the machine and does not impact on the CPU usage of running programs.

### 4.8.3 Software Development Kit

The Alchemi also has come out with it SDK tools. The SDK can be unzipped at any location. The SDK file contains two folders that are bin and examples. These include the following:

- Alchemi Console
- Alchemi.Core.dll
- Examples

The Console (Alchemi.Console.exe) is a grid administration and monitoring tool. It is located in the bin directory. Alchemi.Core.dll is a class library for creating grid applications to run on Alchemi grids. It is located in the bin directory. It must be referenced from by all your grid applications. The examples directory contains several example grid applications that let you test grid creation and demonstrate grid programming. You can verify successful setup of a grid by running a sample application on it. The examples directory in the SDK contains a number of sample applications.

### 4.8.4 Cross Platform Manager

To install the Cross Platform Manager it will requires the Internet Information Services (IIS) and ASP.NET. Install the XPManager web service via the Cross Platform Manager installer. The web service interfaces with the Manager. The Manager must therefore be running and started for the web service to work.

## 4.9 Results and Analysis

### 4.9.1 Results of Comparison between using 3 executors and 4 executors

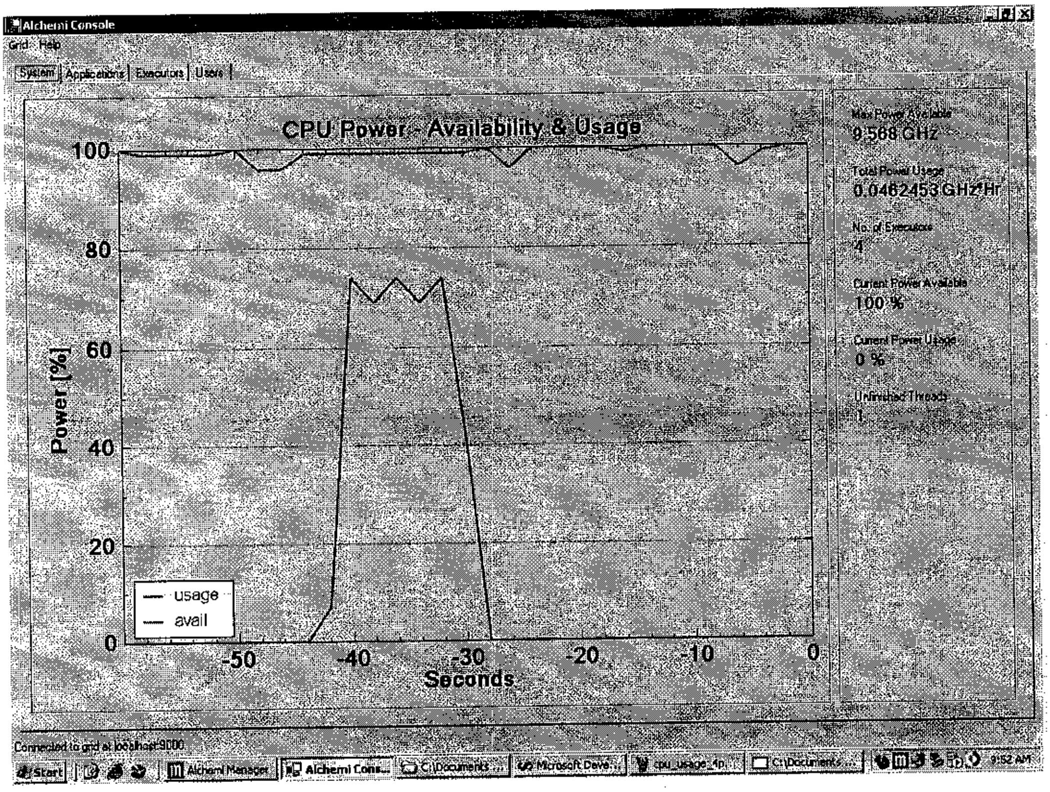


**Figure 7:** *CPU Power – Availability & Usage for 4 executors*

All of 4 executors are turn on and connected to the manager. The figure above shows the system statistics and a real time graph of power availability and usage. The Executor only utilises idle CPU cycles on the machine and does not impact on the CPU usage of running programs.

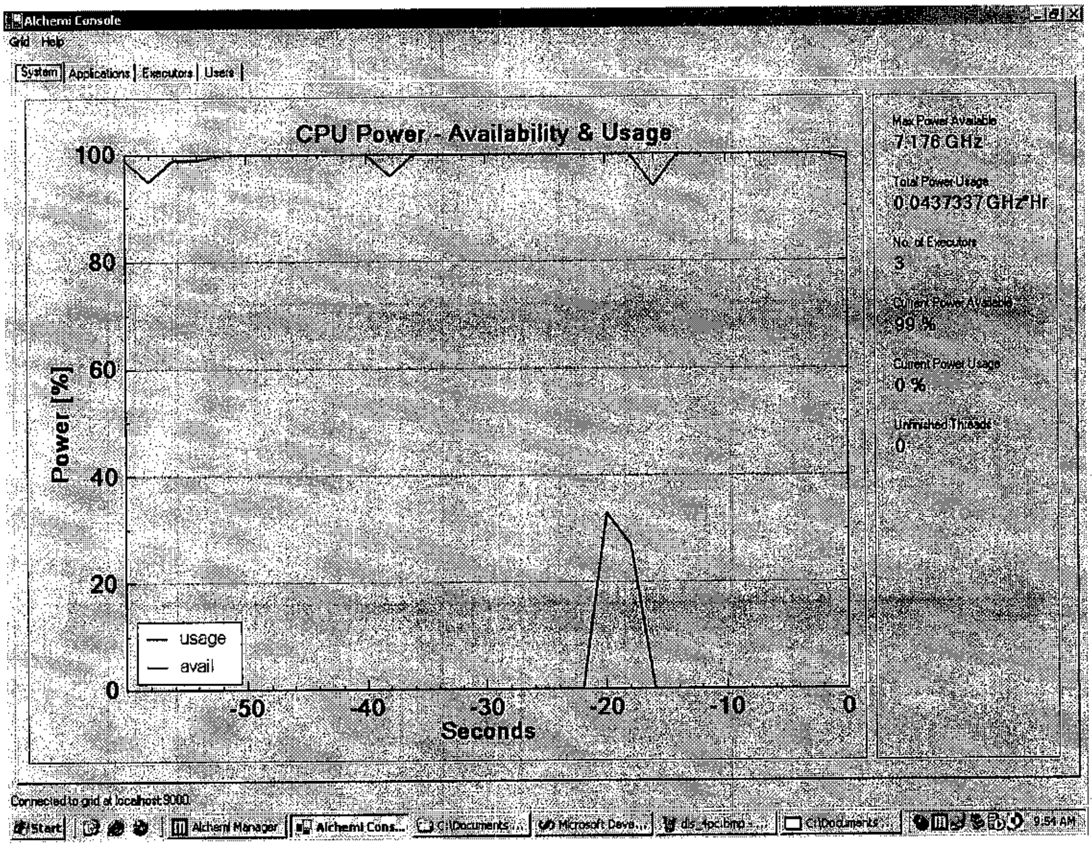



**Figure 8:** *CPU Power – Availability & Usage for 3 executors*

The figure 8 above shows the system statistics and a real time graph of power availability and usage for 3 executors. It shows how the availability and usage when the executors process the distributed jobs.

### 4.9.2 Comparison the availability and usage of CPU power between wired and wireless grids

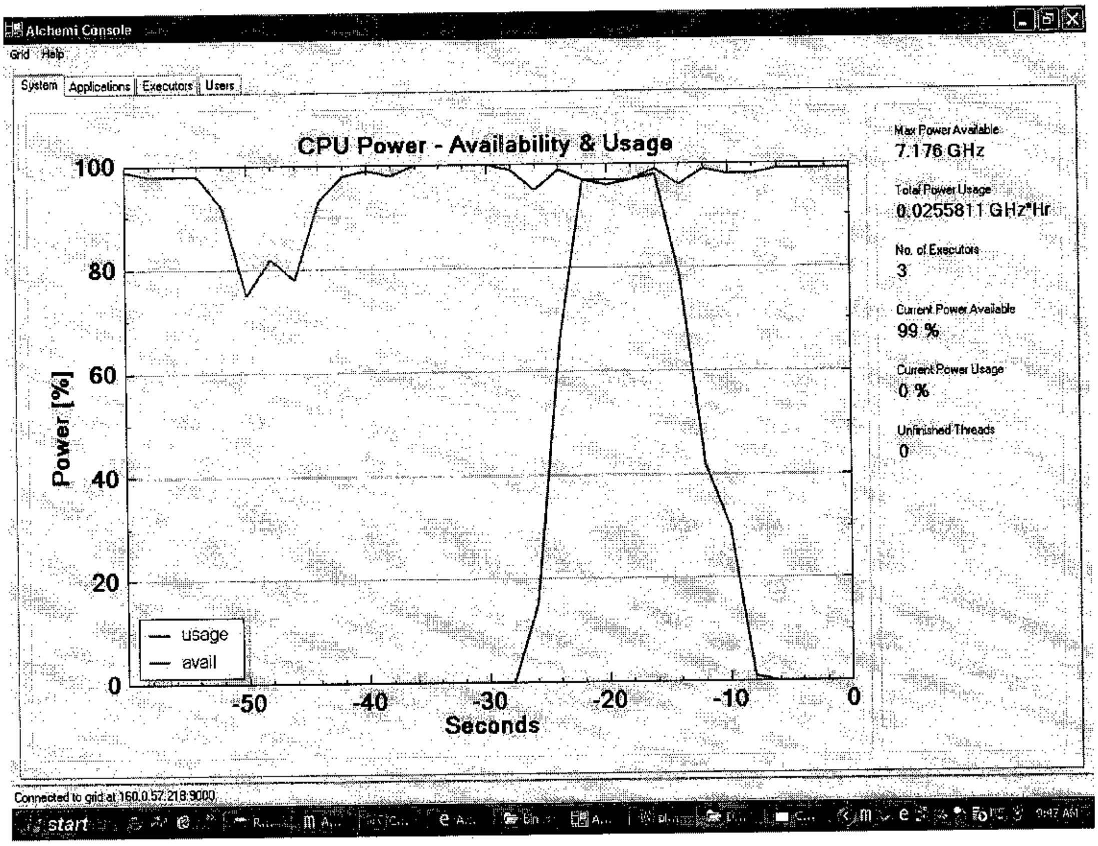



**Figure 9:** *CPU Power – Availability and usage for wireless grid*

The figure 9 above shows the system statistics and a real time graph of power availability and usage for 3 executors. It shows how the availability and usage when the executors process the distributed jobs. This figure shows the process of jobs distributing in wireless grid computing.

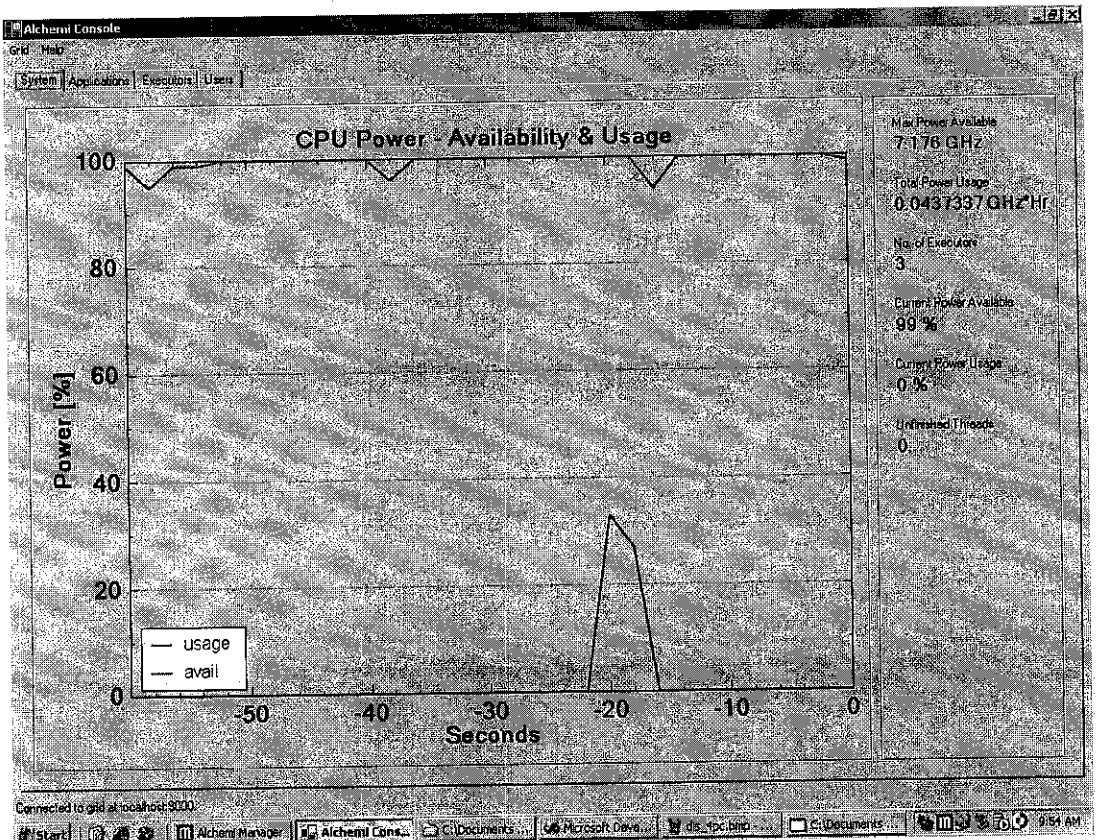
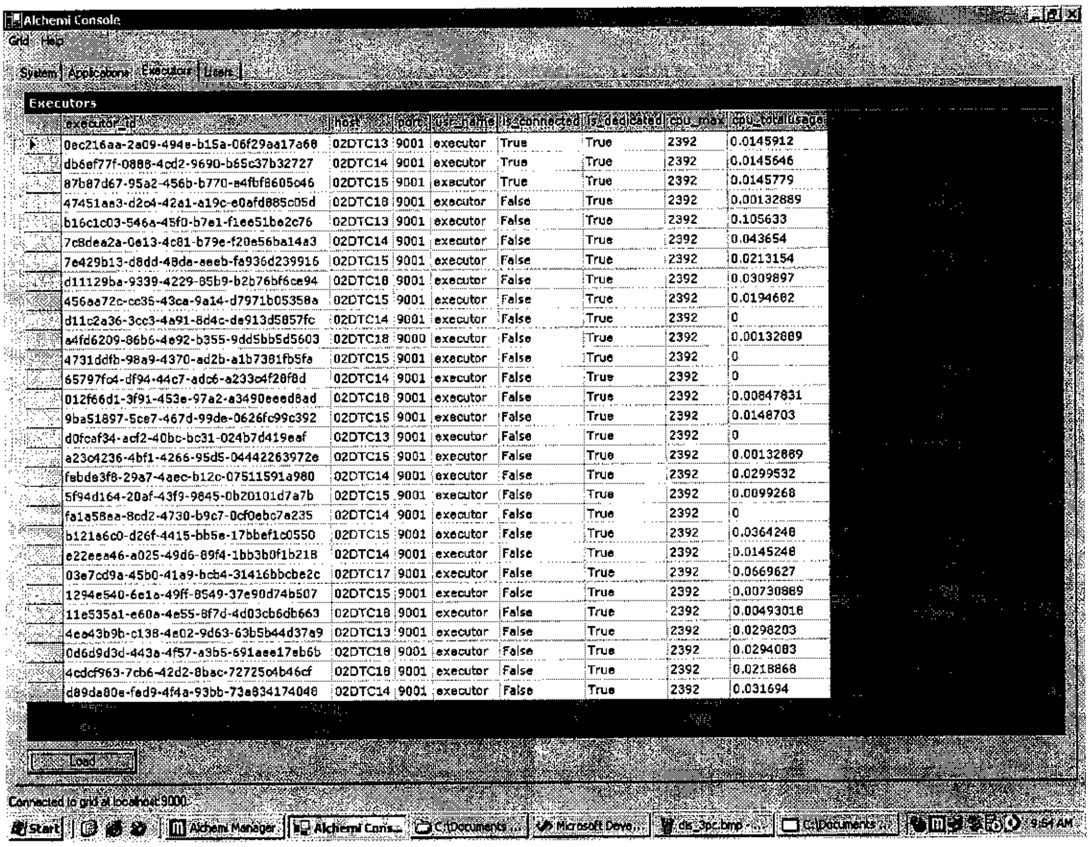



**Figure 10:** *CPU Power - Availability and usage for wired grid*

Figure 9 and 10 show the comparison in availability and usage for CPU power in wired and wireless grid. As we can see, the wireless grid will use more CPU power in executing and distributing the task/jobs. The availability for the CPU power in wireless grid also decreased compare to wired grid.

### 4.9.3 Result for CPU usage of the executors




| executor_id | host | port | usr_name | is_connected | is_dedicated | cpu_max | cpu_totalusage |
|---|---|---|---|---|---|---|---|
| 0ec216aa-2a09-494e-b15a-06f29aa17a68 | 02DTC13 | 9001 | executor | True | True | 2392 | 0.0145912 |
| db6ef77f-0888-4cd2-9690-b65c37b32727 | 02DTC14 | 9001 | executor | True | True | 2392 | 0.0145646 |
| 87b87d67-95a2-456b-b770-e4fbf8605c46 | 02DTC15 | 9001 | executor | True | True | 2392 | 0.0145779 |
| 47451ae3-d2c4-42a1-a19c-e0afd885c05d | 02DTC18 | 9001 | executor | False | True | 2392 | 0.00132889 |
| b16c1c03-546a-45f0-b7e1-f1ee51ba2c76 | 02DTC13 | 9001 | executor | False | True | 2392 | 0.105633 |
| 7c8dea2a-0e13-4c81-b79e-f20e56ba14a3 | 02DTC14 | 9001 | executor | False | True | 2392 | 0.043654 |
| 7e429b13-d8dd-48da-aeeb-fa936d239916 | 02DTC15 | 9001 | executor | False | True | 2392 | 0.0213154 |
| d11129ba-9339-4229-85b9-b2b76bf6ce94 | 02DTC18 | 9001 | executor | False | True | 2392 | 0.0309897 |
| 456aa72c-cc35-43ca-9a14-d7971b05358a | 02DTC15 | 9001 | executor | False | True | 2392 | 0.0194682 |
| d11c2a36-3cc3-4a91-8d4c-de913d5857fc | 02DTC14 | 9001 | executor | False | True | 2392 | 0 |
| a4fd6209-86b6-4e92-b355-9dd5bb5d5603 | 02DTC18 | 9000 | executor | False | True | 2392 | 0.00132889 |
| 4731ddfb-98a9-4370-ad2b-a1b7381fb5fa | 02DTC15 | 9001 | executor | False | True | 2392 | 0 |
| 65797fc4-df94-44c7-adc6-a233c4f28f8d | 02DTC14 | 9001 | executor | False | True | 2392 | 0 |
| 012f66d1-3f91-453e-97a2-a3490eeed8ad | 02DTC18 | 9001 | executor | False | True | 2392 | 0.00847831 |
| 9ba51897-5ce7-467d-99de-0626fc99c392 | 02DTC15 | 9001 | executor | False | True | 2392 | 0.0148703 |
| d0fcaf34-acf2-40bc-bc31-024b7d419eaf | 02DTC13 | 9001 | executor | False | True | 2392 | 0 |
| a23c4236-4bf1-4266-95d5-04442263972e | 02DTC15 | 9001 | executor | False | True | 2392 | 0.00132889 |
| febde3f8-29a7-4aec-b12c-07511591a980 | 02DTC14 | 9001 | executor | False | True | 2392 | 0.0299532 |
| 5f94d164-20af-43f9-9845-0b20101d7a7b | 02DTC15 | 9001 | executor | False | True | 2392 | 0.0099268 |
| fa1a58ea-8cd2-4730-b9c7-0cf0ebc7a235 | 02DTC14 | 9001 | executor | False | True | 2392 | 0 |
| b121e6c0-d26f-4415-bb5e-17bbef1c0550 | 02DTC15 | 9001 | executor | False | True | 2392 | 0.0364248 |
| e22eea46-a025-49d6-89f4-1bb3b0f1b218 | 02DTC14 | 9001 | executor | False | True | 2392 | 0.0145248 |
| 03e7cd9a-45b0-41a9-bcb4-31416bbcbe2c | 02DTC17 | 9001 | executor | False | True | 2392 | 0.0669627 |
| 1294e540-6e1a-49ff-8549-37e90d74b507 | 02DTC15 | 9001 | executor | False | True | 2392 | 0.00730889 |
| 11e535a1-e60a-4e55-8f7d-4d03cb6db663 | 02DTC18 | 9001 | executor | False | True | 2392 | 0.00493018 |
| 4ea43b9b-c138-4e02-9d63-63b5b44d37a9 | 02DTC13 | 9001 | executor | False | True | 2392 | 0.0298203 |
| 0d6d9d3d-443a-4f57-a3b5-691aee17eb6b | 02DTC18 | 9001 | executor | False | True | 2392 | 0.0294083 |
| 4cdcf963-7cb6-42d2-8bac-72725c4b46cf | 02DTC18 | 9001 | executor | False | True | 2392 | 0.0218868 |
| d89da80e-fed9-4f4a-93bb-73a834174048 | 02DTC14 | 9001 | executor | False | True | 2392 | 0.031694 |

**Figure 11:** *CPU usages of 3 executors after process the distributed jobs*

Figure 11 above illustrate the CPU usage result of 3 executors while fault occurred to one of the executors available. The total CPU usage will increase because of the CPU power available decrease. The availability of remaining processors will process the distributed jobs and distribute the jobs to remaining executors.

### 4.9.4 Results of time taken for distributed jobs

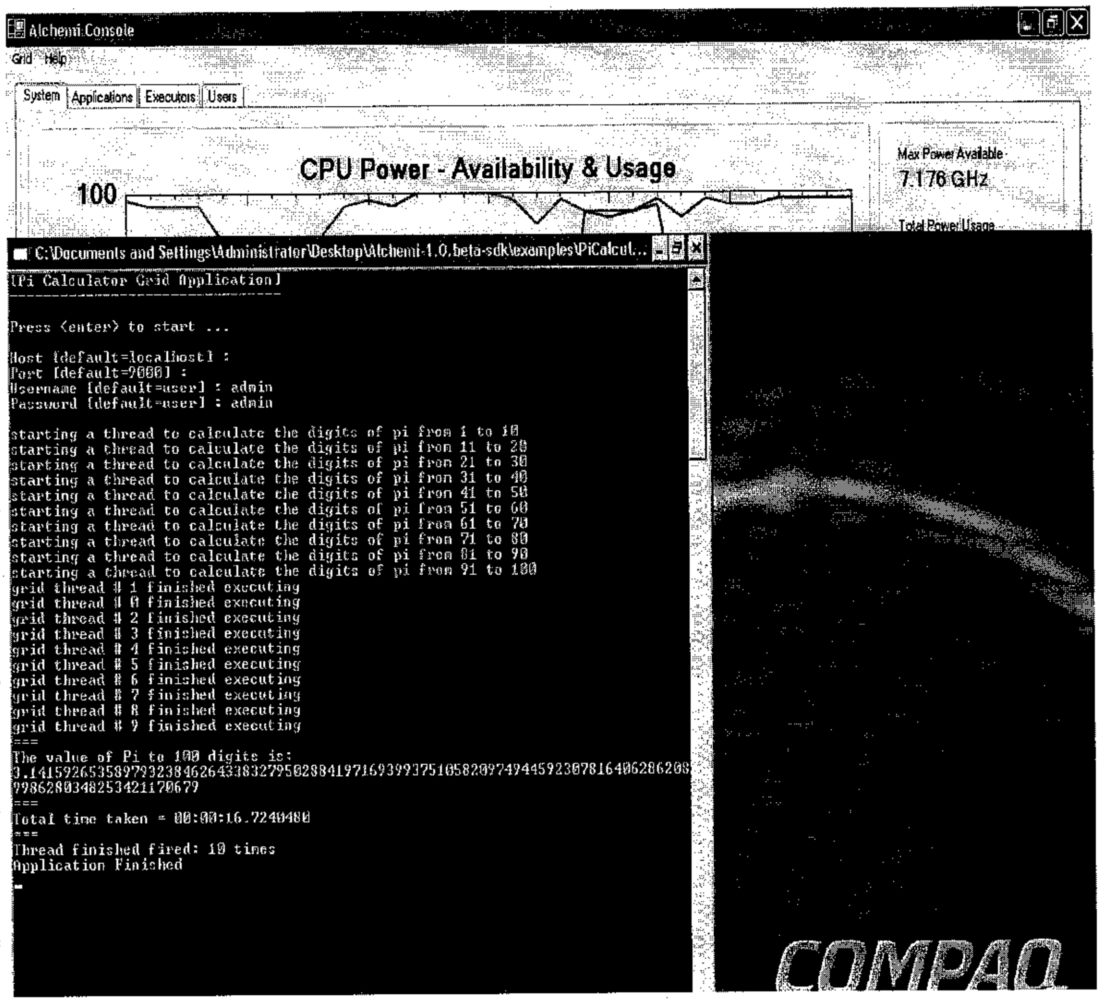



**Figure 12:** *Result of 3 executors process the distributed jobs*

Figure 12 above illustrate the result of time taken for 3 executors to process the distributed jobs when fault occurred.

The result above was tested using the wired grid computing and wireless grid computing. The availability in CPU power for wireless grid computing always fluctuate compare to the wired grid computing. The wireless technology had a limitation. The limitations of wireless technology are:

- Wireless systems are slower 10Mbps – 70Mbps
- Wireless signal may be affected by building constructions and electrical devices.
- Security measures need to be put into place to protect the network.

### 4.9.5 Analysis of wireless technology

## The Chart

| Technology | Speed | Wireless | Range | Support | Cost |
|---|---|---|---|---|---|
| Ethernet 10/100 | 100Mbs | N | A | A | A |
| 802.11b | 11Mbps | Y | B | A | B |
| 802.11a | 52/72 Mbps | Y | C | B | C |
| PhoneLine 2.0 | 10Mbps | N | A | B | B |
| Gigabit Ethernet | 1000Mbps | N | A | D | D |
| 802.11g | 22/54Mbps | Y | C | NA | NA |
| Firewire | 400Mbps | N | D | C | A |
| Bluetooth | 1.5Mbps | Y | D | C | C |
| HomeRF 2.0 | 10Mbps | Y | B | C | C |
| PowerLine | 14Mbps | N | A | C | C |

**Figure 13:** *The statistics and analysis of wireless technology*

Figure 13 shows the analysis that has been made for the wireless technology. This analysis shows which technologies that have a wireless technology. It also analyst the speed, range, support and cost for that technology. For the figure above 'A' is for the best and 'D' is for poor and inappropriate.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

Unlike conventional networks that focus on communication among devices, grid computing harnesses idle processing cycles of all computers in a network for solving problems too intensive for any stand-alone machine. Grid is an infrastructure that involves the integrated and collaborative use of computers, networks, databases and scientific instruments owned and managed by multiple organizations. Grids enable the sharing, exchange, discovery, selection, and aggregation of geographically/Internet-wide distributed heterogeneous resources—such as computers, databases, visualization devices, and scientific instruments. Accordingly, they have been proposed as the next-generation computing platform and global cyber infrastructure for solving large-scale problems in science, engineering, and business. Unlike traditional parallel and distributed systems, Grids address issues such as security, consistent access, dynamic discovery, dynamic aggregation, and quality-of-services. The Grid infrastructure can benefit many applications, including collaborative engineering, data exploration, high-throughput computing, and distributed supercomputing. Utilizing the grid network for dynamic job submission and completion provides an effective path and resource communication in a distributed wireless environment. Adapting the wireless devices to the grid computing can enables an extensive utilization of the network devices in the grid computing. The wireless grid computing has to focus on the mechanism such as the legal, social, economy and technical.

## 5.2 Recommendation

For the recommendation and for future upgrade, the grid computing can be integrated with mobile phone in order to improve the usage of grid computing technology. For the wireless technology, it need to be improve in order to make sure the wireless grid computing can create effective path and resource communication in a distributed wireless environment. The speed of this technology need to improve for the purpose to have good and smooth processing jobs in distributed computing. The security in the wireless technology must be enhancing to secure the information that is transferred using the wireless devices.

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**APPENDICES**

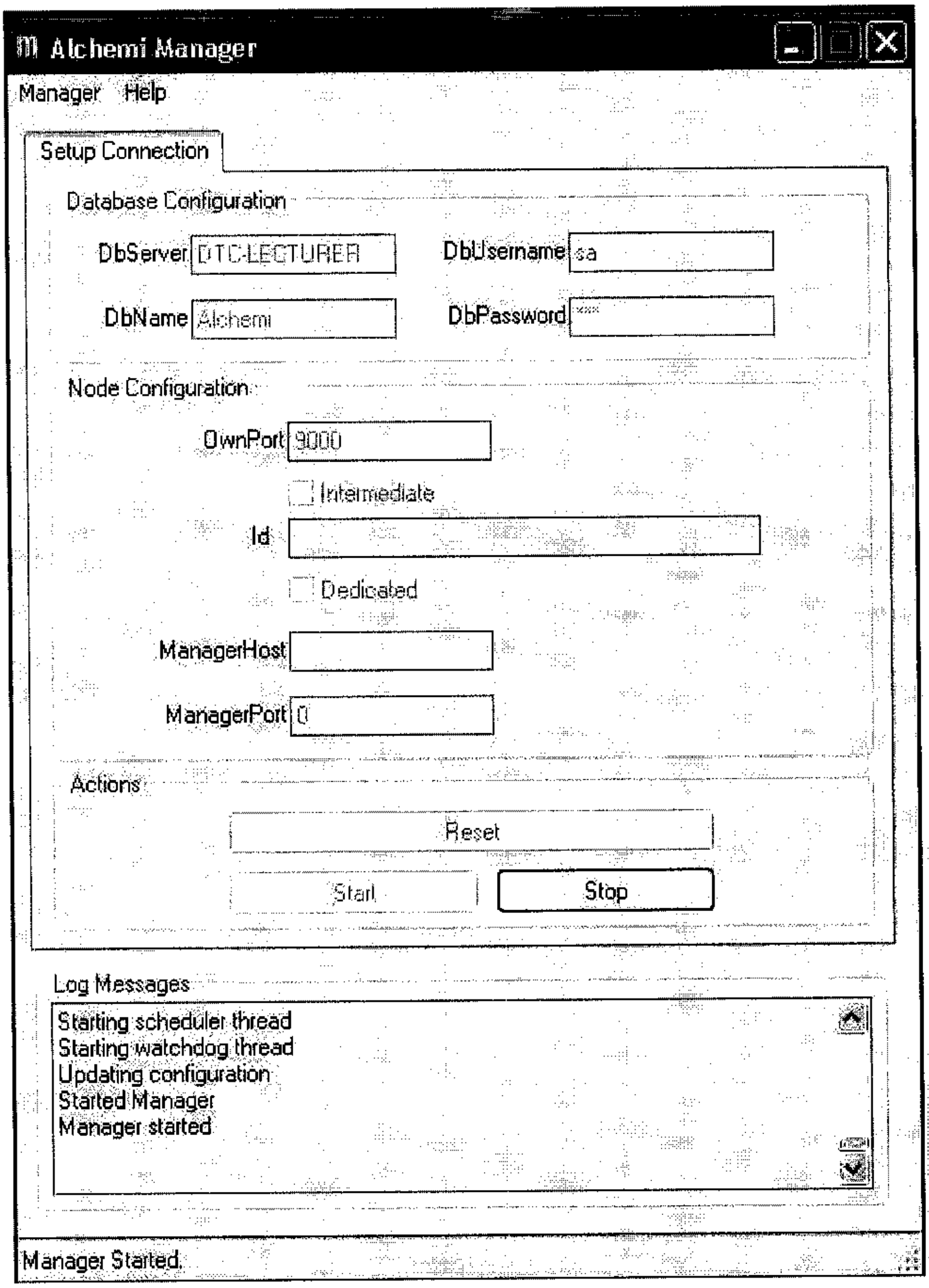


**Figure 14:** *The Alchemi Manager*

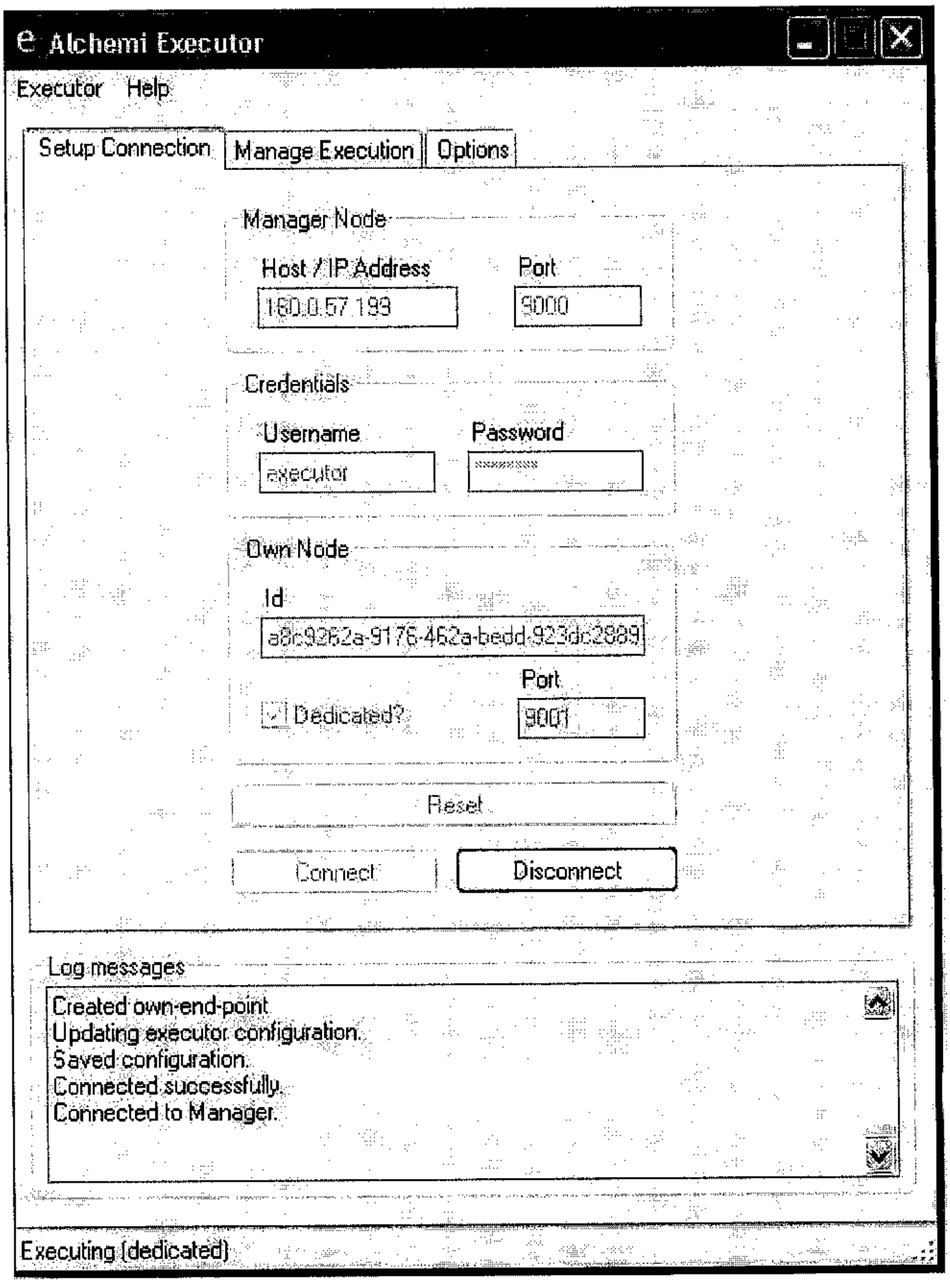


**Figure 15:** *The Executor*

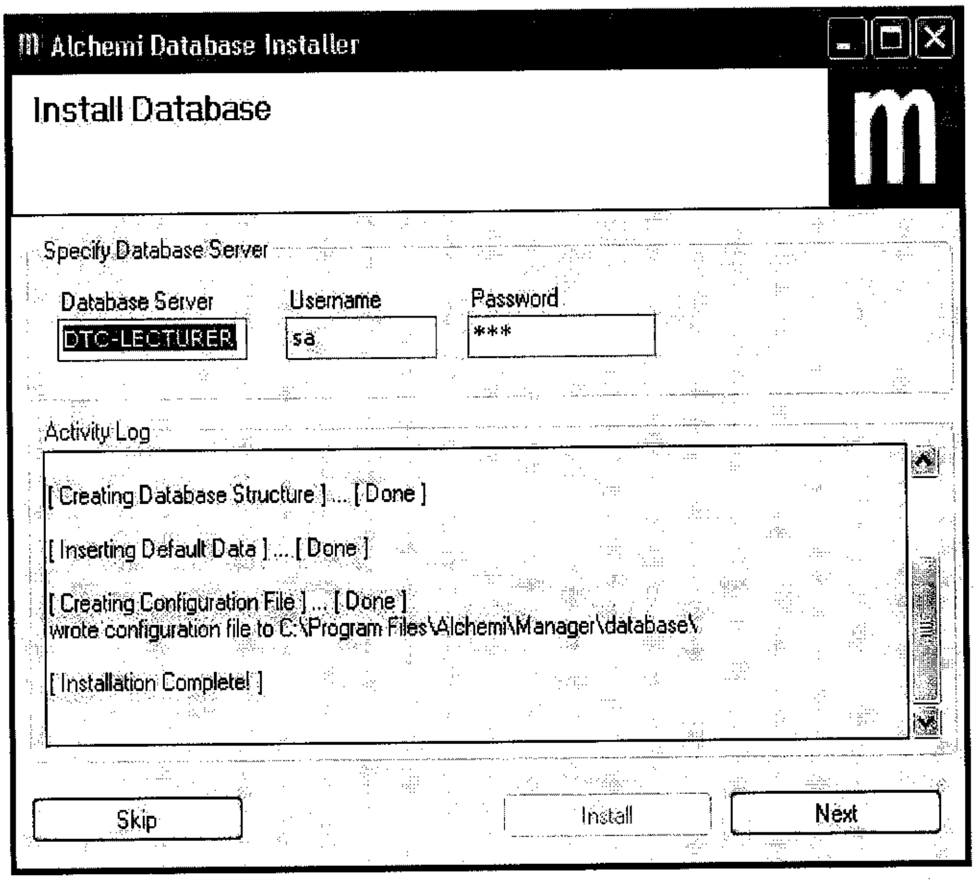


**Figure 16:** *The Alchemi Database*

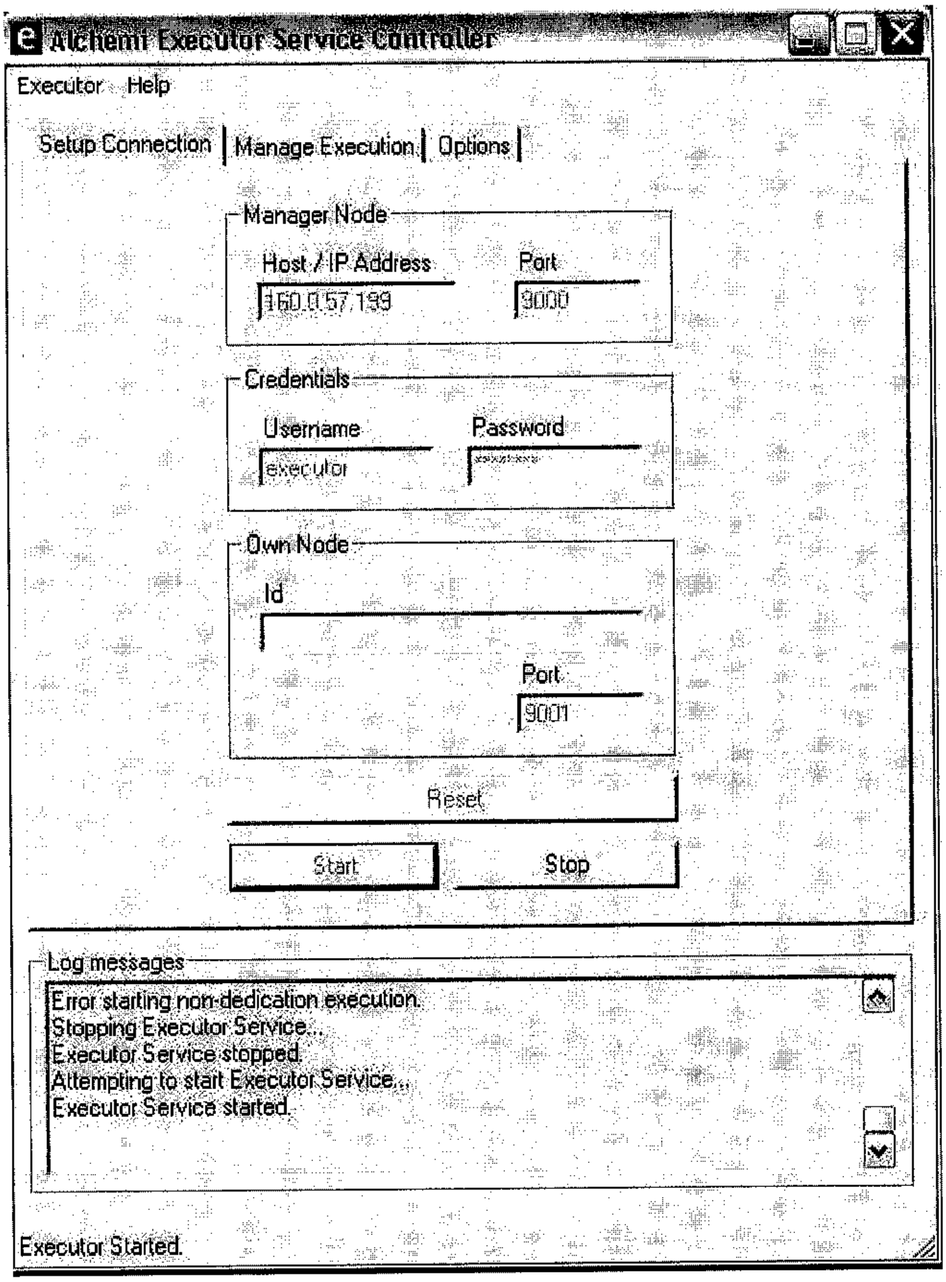


**Figure 17:** *The Alchemi Executor Service Controller*

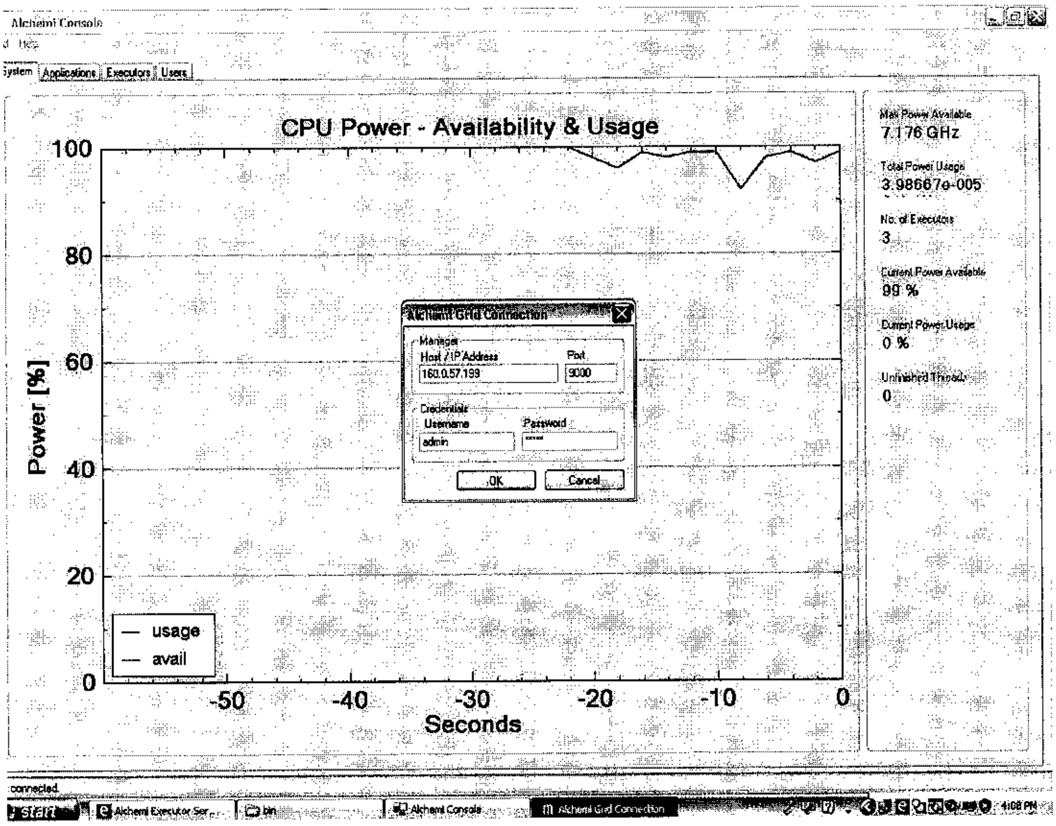


**Figure 18:** *Alchemi Console – user connection*

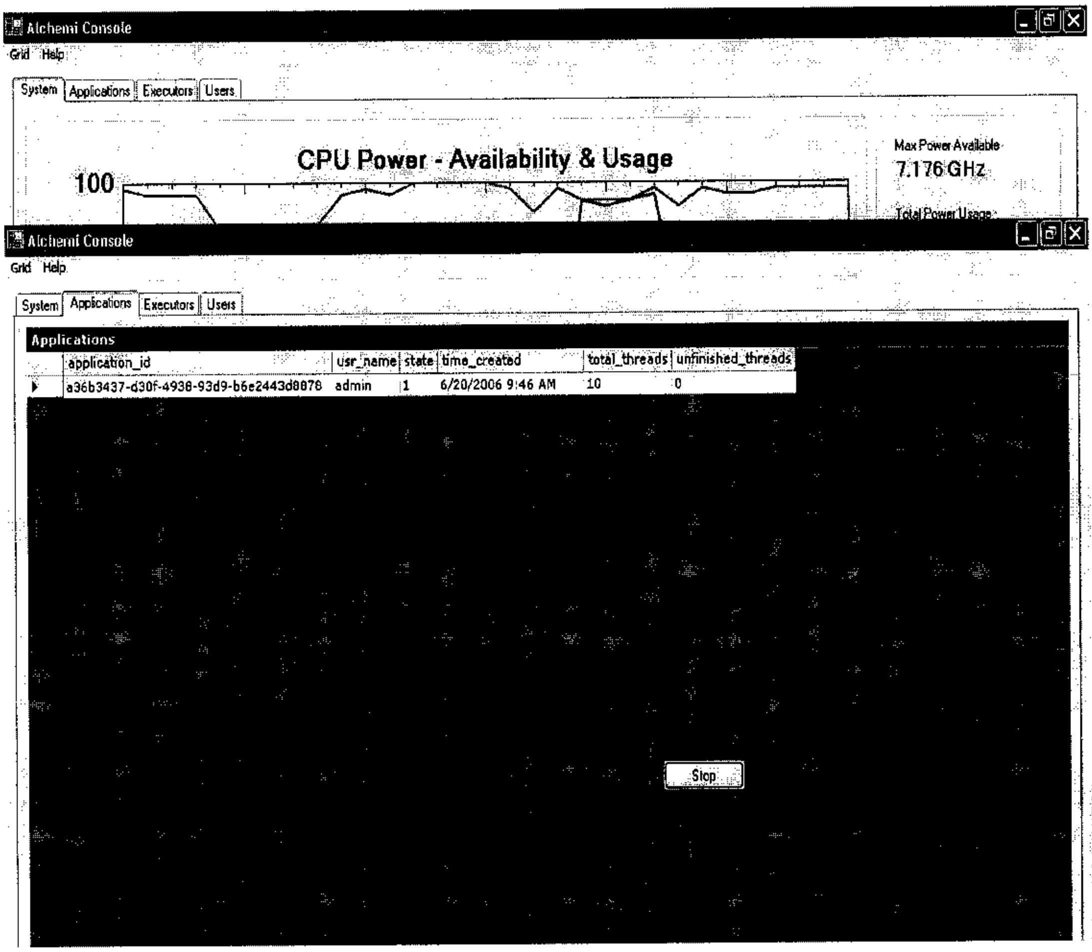


**Figure 19:** *Alchemi Console – Application*

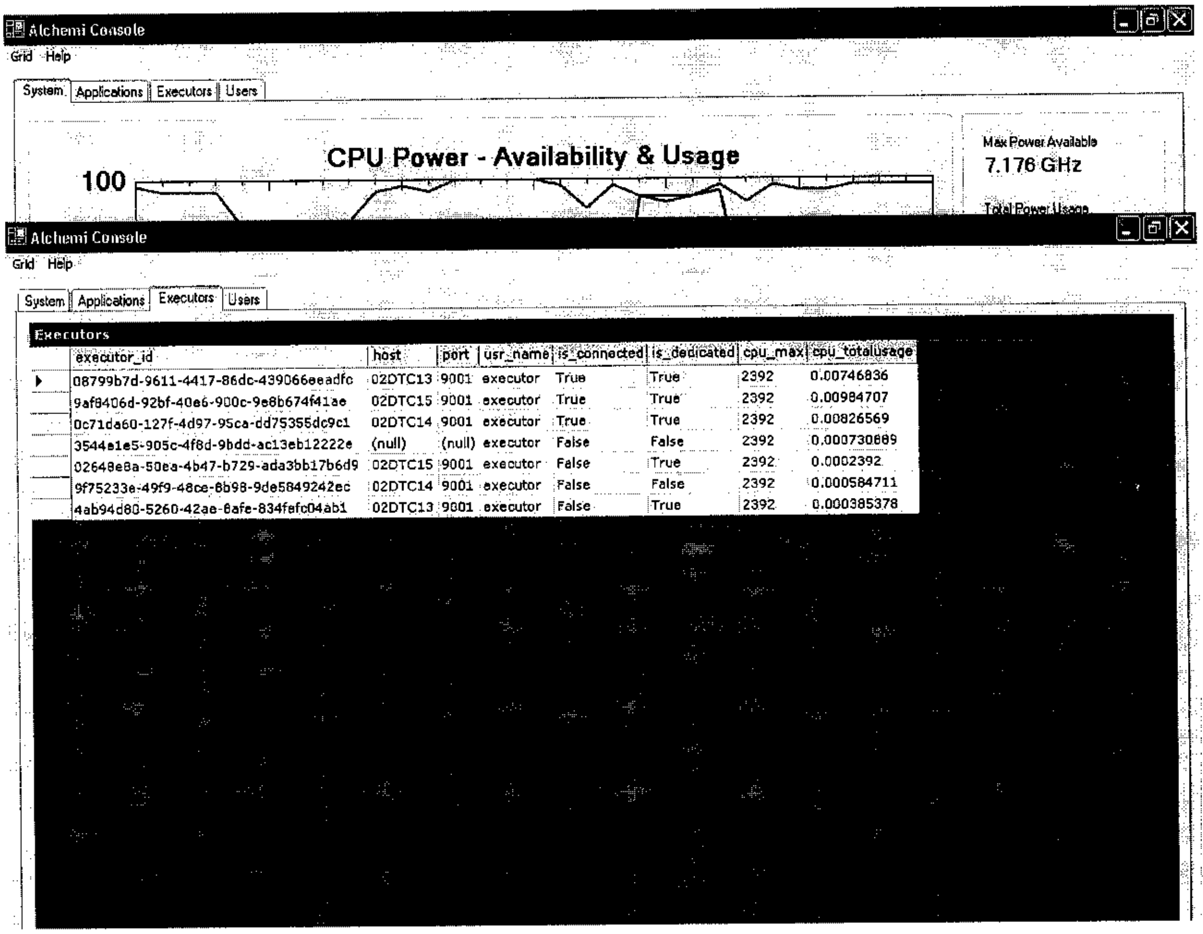


**Figure 20:** *Alchemi Console – System*


**Figure 21:** *Alchemi Console – Users*

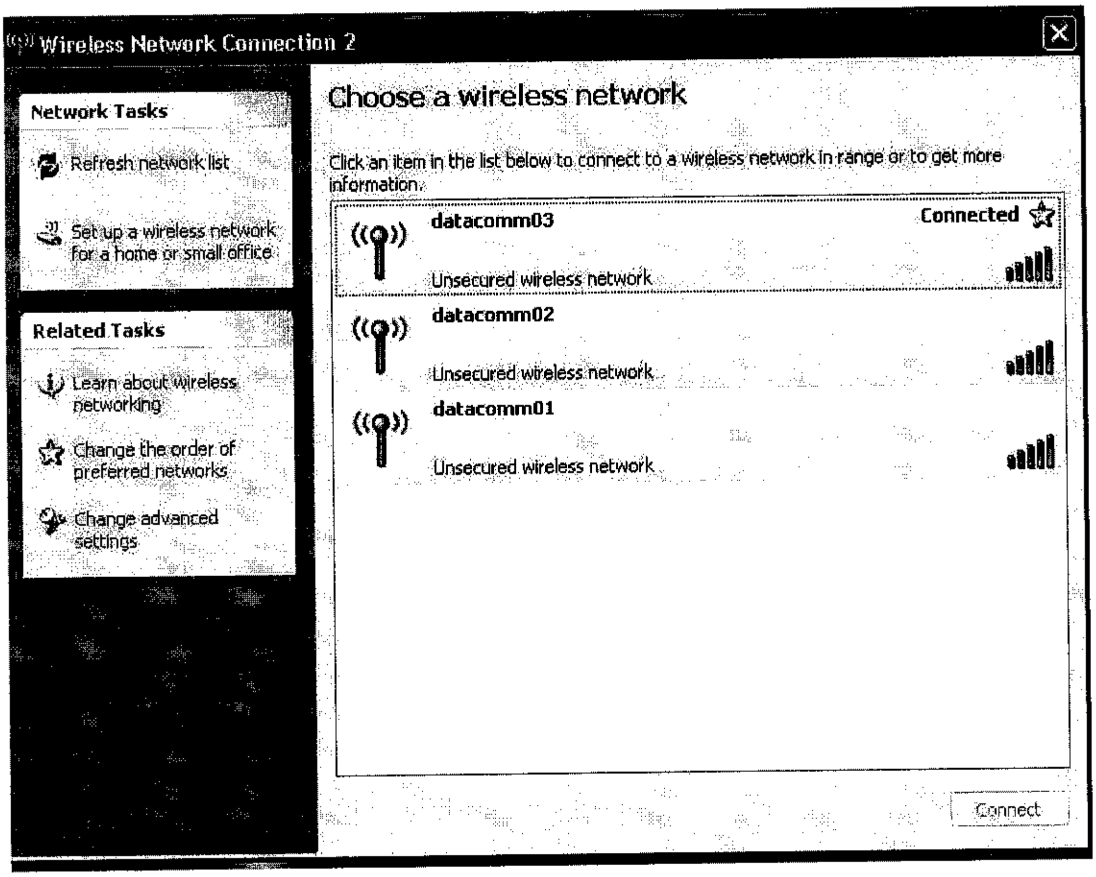


**Figure 22:** *Choosing Wireless Network connection*

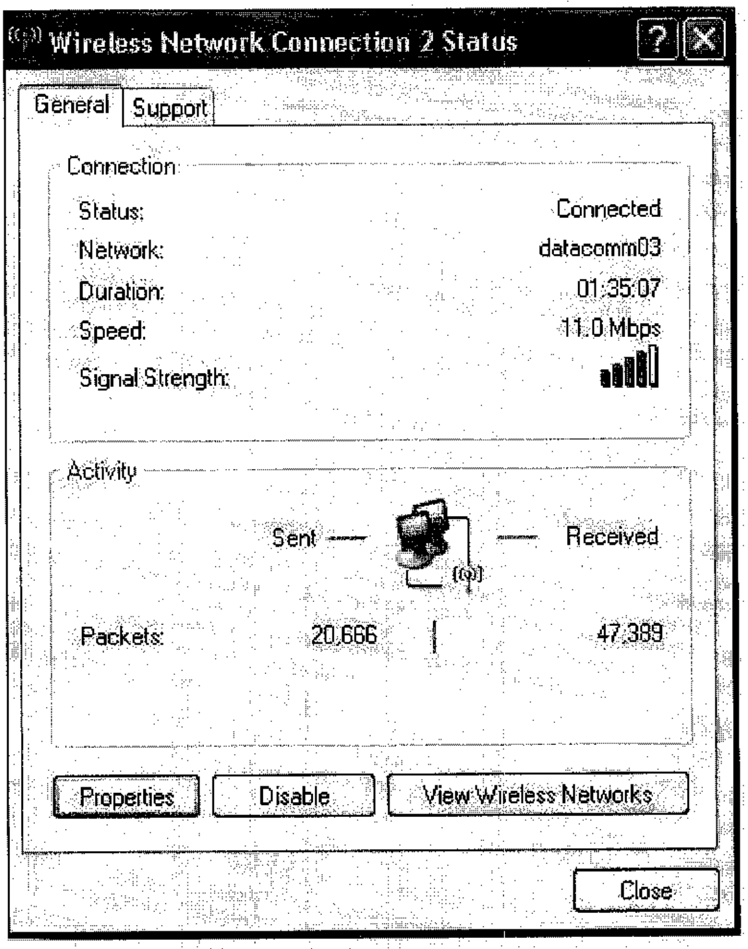


**Figure 23:** *Wireless Network Connection Status*