Dynamic Design of Cellular Wireless Networks via Self Organizing Mechanism

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***Abstract*—In our paper, we are utilizing the cellular wireless network with high reliability using fixed relay nodes. The size and scope of wireless networks continue to grow with more clients or users, and introduction of innumerable devices and sensors at homes and businesses. These, in conjunction with short and dynamic flow of information, is adding to the spatiotemporal complexity of the network topology and dynamics requiring self organization.**

***Index terms*— Load Balance Server, Fixed Relay Nodes, Self Organizing, Primary server.**

I. Introduction

Recently, with the availability and analyses of volumes of traces and statistics on the behavior of nodes, two major approaches to describe complex networks have been proposed: the small world and scale-free concepts. It is observed that complex networks self-organize themselves into a scale free state. Our ultimate goal is to design robust, reliable, scalable, and efficiently utilized wireless networks via self-organizing mechanisms. We are simulating our project in terms of client and server technology.

A. Network Models

Some complex networks such as Internet, World Wide Web, Social networks and biological systems are self-organizing in nature and exhibit some common properties such as the power law degree distribution.

Some important parameters used to describe or characterize the complex networks:

L-Average path length
C-Clustering coefficient
D-Degree of a node

Complex networks (e.g., Internet, airline networks) exhibit small average path length, high clustering coefficient, and power-law degree distribution, and neither regular nor random graphs can be used to represent all these properties. Recently, two models (Small World and Scale-free network models) have been proposed and successfully used to describe the nature of such networks. In this paper we investigate whether these concepts can also be applied to cellular wireless networks, which typically do not exhibit self-organizing or scalability properties due to the limited range of the wireless nodes.

II. Architectural Design

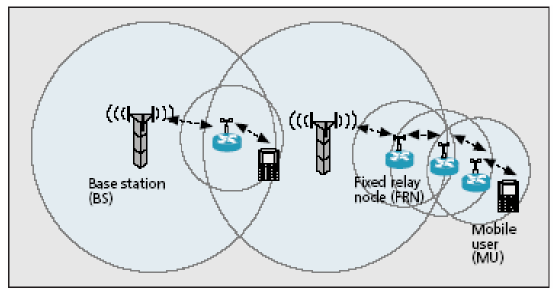

Figure 2.1 Architectural Diagram

The Figure 2.1 describes the concept of the project. For example when mobile users want to send some information directly to other users with the help of the base station, congestion is increased in the wireless networks. To avoid this problem, mobile users not covered by BSs, can connect to a base station through FRNs over multiple hops. Based on FRN the congestion is avoided.

A. Registration Module

- Every client requires a registration process. This process is used for only prescribed clients entering the network to avoid unauthorized access.
- Client and server have a registration entry which is to differentiate between them.

B. Client Module

- Following the registration process, the client sends a query to the user.
- In response to the query the server sends the corresponding file to the client.

ISBN:978-988-98671-5-7

C. Server Module

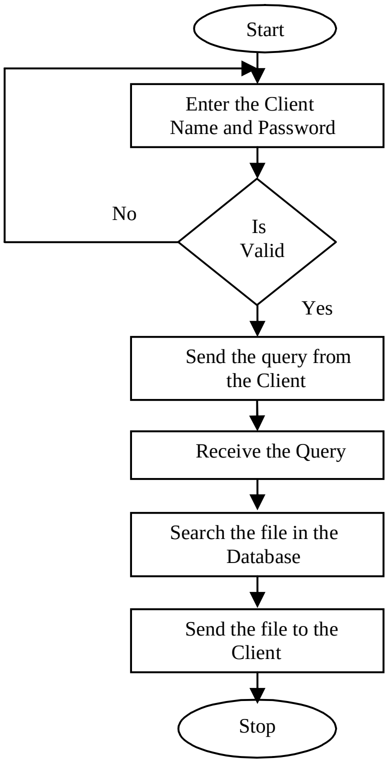

Figure 2.2 Server Process

D. Load Balancing among Primary Server only

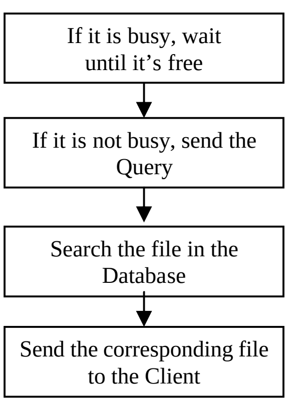

Figure 2.3 Load Balancing among only Primary Server

E. Load Balancing among Proxy and Primary Server

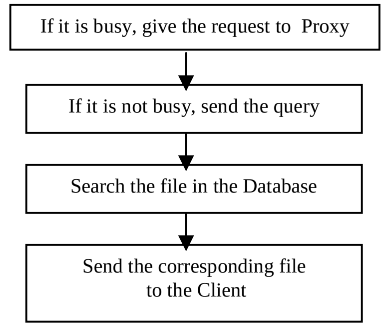

Figure 2.3 Load Balancing among only Primary Server

F. Load Balancing among Secondary Server

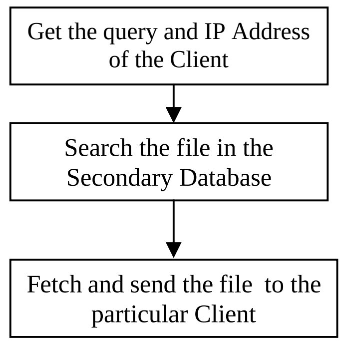

Figure 2.5 Load-Balancing among Secondary Server

III. System Design

Fundamental concepts of software design: It includes abstraction, refinement, modularity, software architecture, control hierarchy, structured partitioning, data structure, software procedure, modular decomposability (that includes modular compos ability, modular continuity, modular understanding & modular protection), etc.

A. Registration Module

Every client needs a registration process. This process is used for only prescribed clients or users entering the network thus eliminating unauthorized access. Client and Server have a registration entry to differentiate between them. Before accessing the server, every client should give his user name and password for security confirmation. In this process, the server gets three inputs from the client. They are IP address, client name and password.

B. Client Module

In this module, the client sends the query to the server. As a response the server sends the corresponding file to the client. The client requested file is in primary server or secondary server. Based on the free state of the server, it retrieves the desired file and sends to the client.

C. Server Module

On the server side, it checks the client name and its password for ensuring security. On clearance of the security check, the server receives queries from the client and searches the corresponding files in the database. Finally, the desired file is found and sent to the client. There are few considerations;

they are the destination base station (primary server), Fixed Relay Node (proxy server) and yet another base station (secondary server). The primary and the secondary servers have the same database for avoiding the access refusing factor. First, let us assume that there is no load balancing. When a mobile user (MU) wants to establish a new connection, he sends a request to a nearby node (BS) if it is covered by one. Client sends the user name and password for security confirmation. If it is valid, server receives the query from the client and searches the corresponding file in the database and sends back the file to the particular client.

D. Load Balancing in the Primary Server

Let us assume that there is load balancing in the primary server (BSs) alone. In this approach, when a mobile user wants to make a connection, if he is covered by a BS, gets connected to the BS upon no congestion. If the BS covering the MU is congested, either the MU is queued or an alternative route to another BS is found through the FRNs. If the MU is not covered by any BS, but is covered by the FRNs, a route to BS is formed via the FRNs. The choice of the BS to which the MU is to be connected depends solely on the load at the BSs (i.e., the load of the intermediate FRNs is not taken into account). Therefore, all the packets belonging to an MU follow the same route to a given destination BS.

1). Routing of Traffic via Fixed Relay Nodes

Once the FRNs are placed in the geographical area, the next step is to route the traffic among the FRNs. The routing criteria include minimized number of hops, minimized number of congested links, maximum network throughput, minimum delay and so on. Therefore, location, selection, and number of FRNs become an important design parameter.

In this work, the routing scheme will be designed to achieve high system utilization. To this end, we design a load balancing-based scheme. The objective is to pick the route with the fewest number of hops to the least loaded BS. Since the least loaded BS may not be the one that can be reached by minimum number of hops, joint performance metric needs to be formed.

Figure 3.1 represents the growth and preferential connection procedure from three nodes to eight nodes, where new and existing nodes are shown in dark and light colors respectively.

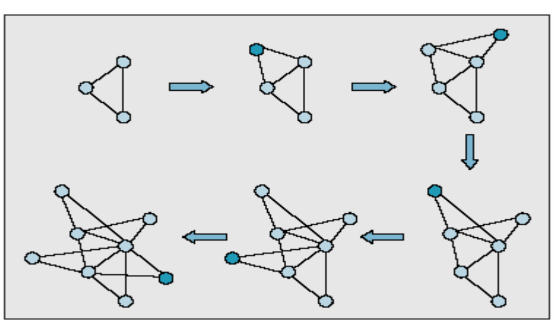

Figure 3.1 Typical Hierarchical Scale-Free Networks

E. Load Balancing in Proxy and Primary Server

With load balancing only in the primary server (BSs), FRNs may change but there is no change in the destination BSs. In this approach, when a mobile user requests service, it connects to a BS directly or via FRNs depending on its location. In this approach the destination BS is decided while initiating the connection and does not change throughout the connection. However, depending on the load of the intermediate FRNs, the route on which an MU sends each packet can be different. Once a packet reaches an FRN, the next hop is decided by taking into account the load of the neighboring FRNs and the number of hops between the neighboring FRNs and the destination BS. The load is defined as the number of packets in the queue of a node (BS or FRN).

1) The Approach

In this topic we investigate if and how the small world and scale-free network concepts can be created in cellular wireless networks so that they become scalable (e.g., average number of hops between node pairs is minimized). Here, a node pair consists of a BS and an FRN. We assume that the FRNs basically receive the signal from various mobile users and other FRNs (within their range), and transmit the received data to the next FRN or BS in the route. The FRNs do not have any (wired) infrastructure. Since connectivity between a mobile device and an FRN is single hop and an FRN functions as an aggregator and a traffic forwarder/router, we do not call the mobile terminal a node from the standpoint of the graph formulation.

We formulate our problem as designing an overlay wireless network that exhibits scale-free characteristics and self-organizes itself into a load-balanced state. There are basically two levels of organization, one at the physical reachability /connectivity level and other at the logical packet routing level. Topology generation is relatively static, whereas routing topology is more dynamic and takes into consideration the congestion at various nodes. In the following we study both these problems (i.e., topology generation and routing) in detail.

2) Topology Generation

We assume that the topology of the BSs (designed by the service providers taking into account the mobile user's distribution, topography, traffic patterns, etc.) is known. A number of FRNs will be placed according to some criteria such as covering a given geographical area with the fewest number of FRNs or such that the overall average path length in the system is small (i.e., each FRN can reach a BS with a small number of hops).

In wired networks, attaching a new node to a highly connected node and hence developing topologies of varied degree distribution of the nodes, show that the power-law characteristics are possible. However, this is not directly applicable to wireless networks, since being highly connected in the wireless case means the FRNs have many neighbors in their coverage area (i.e., the FRNs are clustered around a few FRNs). Therefore, in wireless networks the inclusion of a new node (i.e., an FRN) to the already existing connected nodes must also take into account the transmission range of the node and its reachability to neighboring nodes.

Reachability is determined from the transmitted power of the node such that it does not increase interference on neighboring nodes beyond a certain acceptable limit. In summary, depending

ISBN:978-988-98671-5-7

on the number of FRNs and the size of the geographical area that needs to be covered, the placement of the FRNs may become an important issue. From the service provider's point of view, it is desirable to cover a geographical area with as few FRNs as possible, reducing overlapping areas to the minimum.

F. Load Balancing among Secondary Server

Let us assume there is load balancing only among the primary server (BSs) and FRNs with change in the destination BSs. Although a least loaded BS is chosen to be the destination while initiating the connection, it can be changed during the connection. Once a packet reaches an FRN, a next hop is decided by taking into account the load of the neighboring FRNs and the number of hops between the neighboring FRNs and all BSs in the geographical area. In this case we take into account all BSs, since the distance between the least loaded neighboring FRN and the initially chosen BS might be too high.

IV. Scope

The main objective of the project is to design robust, reliable, scalable and efficiently utilized wireless networks. When the congestion increases in the wireless network packet loss is unavoidable. Searching the tower for the particular signal is very difficult. Flexibility and scalability are also limited in wireless networks.

To avoid this problem, small world and scale free concepts are formed in clustered formats that should be placed nearer to the tower. These clusters are individual nodes and with the help of this cluster (FRN) the users can track the towers easily. With the help of the clusters, congestion is avoided as the communication is done via the nodes. Packet losses are also avoided as transfer take place via nodes and can easily be traced. With the help of FRN, searching the tower can be done in a faster manner and time is saved. Flexibility and scalability are also increased in a clustered format.

A. Generation Description

1) User Characteristics

The main users are the Network Administrators and the Internet World.

B. Specific Requirements

1) Input design

The design decisions for handling input specify how data is accepted for computer processing. The design specifies the means by which the end user and the system operators direct the system as to what actions are to be taken. Online system includes a dialogue or conversation between the user and the system. The input design is the link that ties the information system to the world of its users.

2) Output design

Output refers to those results that are generated by the system. Designing the computer output should proceed in a well organized and well thought out manner. The right output must be developed while ensuring that each output element is designed so that people will find the system easy to use effectively. The basis of the output generated is to evaluate the usefulness of the application.

3) Inputs and Outputs

The system has four inputs and produces three outputs. These are

a) Input File_1

This contains the information regarding primary server user name and password for security confirmation.

b) Input File_2

This contains the information regarding secondary server user name and password for security confirmation.

c) Input File_3

This contains the information regarding the address to which the network belongs i.e. the client server communication. At the time a logout screen for three servers is displayed.

d) Input File_4

In client side it checks the ip address, user name and password. It contains the information regarding new users and connection establishment.

e) Output File_5

The output at last describes that the data is transferred to all the servers in an efficient way.

4) External Interface Requirements

a) User Interface

Only the user needs to send data. Every thing else can be controlled by program.

Interface design mainly focuses on the design of interface among software modules, external entities and the user. The design of internal program interfaces, sometime called inter modular interface design, is driven by the data that must flow between modules and the characteristics of the programming language in which the software is to be implemented.

External interface design begins with the evolution of each external entity represented in the DFDs of the analysis model .Both internal and external interface design must be coupled with data validation and error handling algorithms within module. Because side effects propagate across program interfaces, it is essential to check all data following from module to module to ensure that the data conform to bounds established during requirements analysis.

User interface design has much to do with the study of people as it does with the technology issues. It should analyze facts like who the user is and how the user learns to interact with a new computer-based system. So the system should be developed in a user-friendly manner.

V. Production

A. Software Production

The model we made resembles a network where data can be transmitted to particular servers in the network efficiently. But naturally it will take time to transfer the data will be more and also there will be more network traffic between the nodes. Whenever we want to send the data to the particular client sends the data through the fixed relay node. With the help of this node the users can track the towers easily. With this model the network traffic will be reduced and also the time taken to transfer the data will be very less. Support is the relativity of the activity when compared to another activity.

B. Confidence

Confidence is the strength of occurrence of an activity.

i. The software has monitoring editor.
ii. The product mainly aims at making efficient transmission of data to the clients with the help of different servers.

VI. TESTING APPROACH

Validation is mainly concerned with providing an assurance that the software provides all functional, behavioral and performance requirements. It incorporates the 'Black Box' testing method where the system is tested for the correctness of the output with respect to the input. Further any kind of irregularities, deviation from target and mistaken identities are spotted and fixed here.

Some forms of testing are:

- ➢ Black box Testing
- ➢ Unit Testing
- ➢ Integration Testing
- ➢ Validation Testing
- ➢ System Testing
- ➢ Acceptance Testing

A. Feasibility

Feasibility study is to determine the possibility of either improving the existing system or develop a totally new system and a measure of how beneficial, the development of an information system would be to an organization, and it is mainly conducted and to determine whether there is a new and better way to do the job that will benefit the end user.

We look for the following feasibilities:

- ➢ Economic Feasibility
- ➢ Technical Feasibility
- ➢ Operational Feasibility

B. Implementation

Implementation includes all those activities that take place to convert from the old system to the new. The new system may be totally new; replacing an existing manual or automated system, or it may be a major modification to an existing system. Proper implementation is essential to provide reliable system to meet the organizational requirements. Successful implementation may not guarantee improvement in the organizational using the new system, as well as, improper installation will prevent any improvement.

The implementation phase involves the following tasks:

- ➢ Careful Planning.
- ➢ Investigation of system and constraints.
- ➢ Design of methods to achieve the changeover.
- ➢ Training of staff in the changeover phase.
- ➢ Evaluation of changeover.

VII. SCREENSHOTS

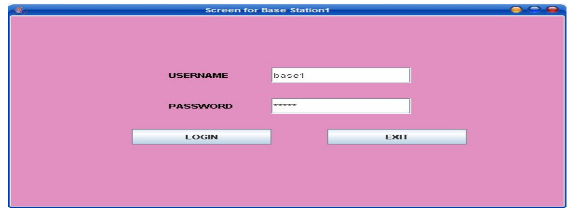

Figure 7.1 Base Station1 Registration Process

Figure 7.2 Base Station2 Registration Process

Figure 7.3 Logout Screen for Base Station1

Figure 7.4 Logout Screen for Base Station2

Figure 7.5 and figure 7.6 represents the client screen which involves three processes. There is ip address, user name and password which is used to registered and connected with the servers.

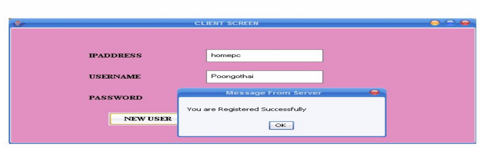

Figure 7.5 Client Registration Process

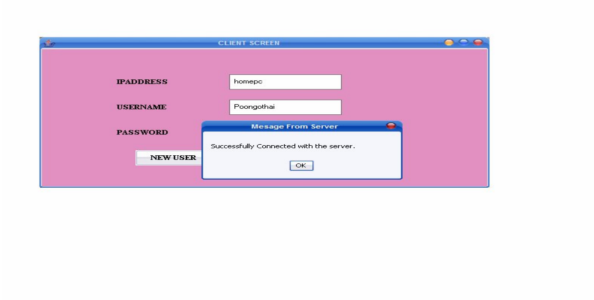

Figure 7.6 Connection Process

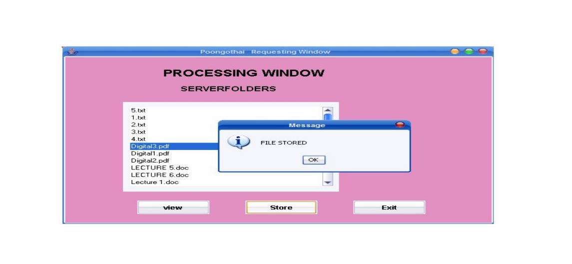

Figure 7.7 File Retrieval Windows

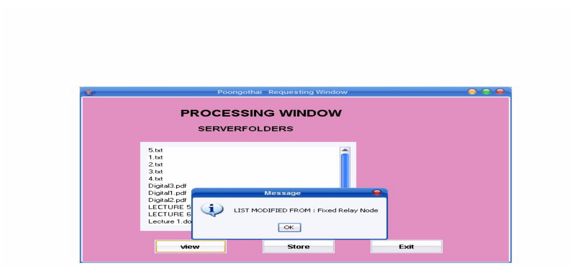

Figure 7.8 List Modified from the Fixed Relay Node

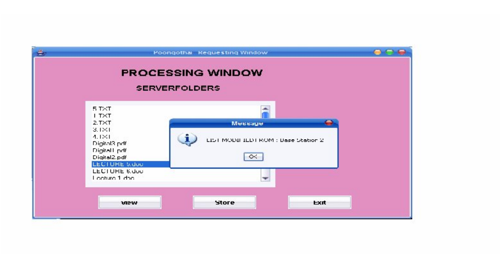

Figure 7.9 List Modified from the Base Station2

VIII. CONCLUSION

With a few adjustments, having high number of neighbors might introduce vulnerability to the network; for example if a highly connected node that relays the traffic of many other nodes goes down, the service of several nodes might be disrupted. We are currently in the process of determining the optimum number of neighbors to achieve scalability, small average path lengths, high coverage, and low vulnerability to failures. We would like to determine if and to what extent these properties can be achieved, and provide guidelines for the design of such networks for different network sizes. Another important point of view is the implications of having a scale-free wireless network on having self-organizing capability. Although it has been reported that several self-organized networks (e.g., the internet, airline networks, etc.,) exhibit scale-free properties, it is not yet clear to achieve sufficient self-organization.

Finally, we anticipate that the approach can be extended to other wireless networks with or without centralized controllers as well (e.g., wireless ad hoc and sensor networks) with large number of nodes.

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ISBN:978-988-98671-5-7