Ain Shams University
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COMPUTER AIDED NETWORK CONTROL DESIGN

By

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A THESIS

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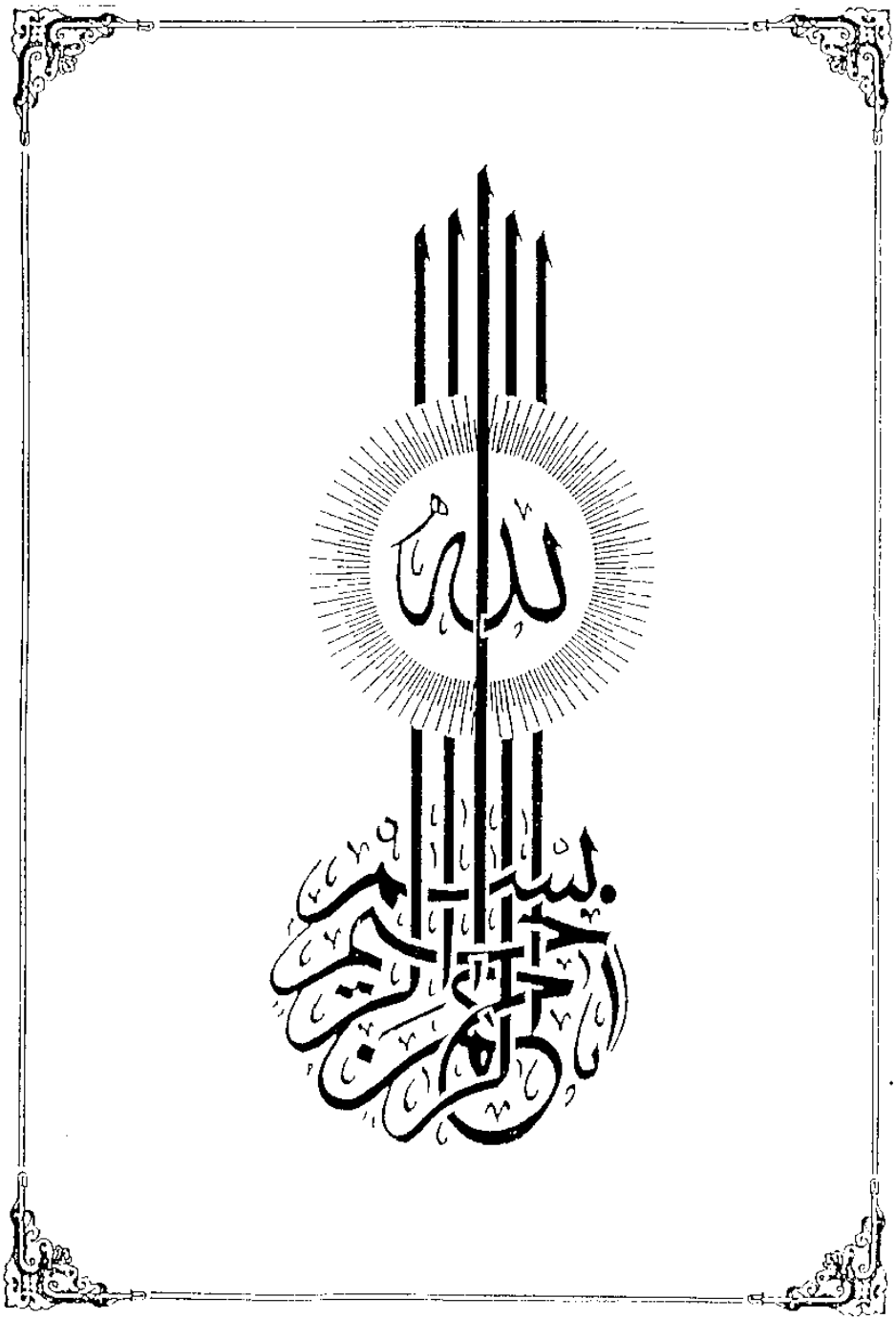

Affectionately Dedicated

To

MY PARENTS, HUSBAND AND CHILDREN

Whose Patience and Encouragement

Made This Work Possible.

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Computer and Systems Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at any university or institution.

Date : 11 /8/1993

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ABSTRACT

The problem of urban telephone planning is the problem of how to plan a telephone network in the new city. This type of problem is very suitable to be solved by an expert system approach.

This thesis presents an expert system for Urban Telephone planning. The system accepts the geographic map of a city in the form of its streets and intersection nodes coordinates, the specifications of the available cable sizes, the maximum available switch size, and the cost information for both the cables and the switches. The system determines the minimum cost telephone network that satisfies the demand required by the subscribers. The system has been developed by first acquiring the domain knowledge involved in the design of such networks from experts in the Egyptian Telecommunications Authority ARENTO. Furthermore, some procedural knowledge have been incorporated in the system for developing the minimum connecting network of cables among a set of points. This knowledge is based upon an algorithm for urban telephone planning [17], which is a modification of the algorithm developed by Kan [13]. The system has been implemented using an expert system tool written in PASCAL [22] under the UNIX environment and customized for DOS environment within the framework of this research.

Table Of Contents.

CHAPTER 1.

INTRODUCTION.

The problem of urban telephone planning is of key importance during the planning and construction of new communities and cities, in which telephone services have to be introduced as a component of the overall master plan of the city.

The problem of urban telephone planning can be formulated as follows:

"Given a geographic map of the city in the form of its streets, intersection nodes coordinates and the distribution of the subscribers load within that city, the available cable size and the corresponding cost for each size, determine the minimum cost telephone network that connects those subscribers in order to achieve a specified performance".

The process of network planning is divided into several subproblems [3]

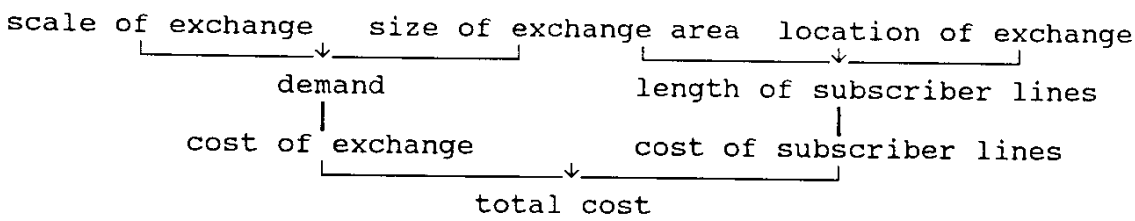
(1) Exchange location planning.

(2) Contruction of subscriber lines from exchange to subscribers to satisfy as optimization criterion.

Local exchange location planning involves determining when, where and how big an exchange office should be placed. There are many ways of offering service to subscribers in an area. For example, one can divide the area into a number of sub-areas, in other cases, an area can be served by a single exchange. There may be a plurality of plans for the location of exchange and boundaries of a

service area. In any case, subscribers may be offered a service quality that satisfies a prescribed set of values. The total network cost, however, largely depends upon how these values are set. Thus, the objective of an exchange location planning is to satisfy the demand and the set up value of service quality, and to establish a configuration of exchanges that minimizes the total network cost.

In developing an exchange location planning, it is important to consider the scale of the exchange (i.e. the number of subscribers to be offered the service), the size of the exchange area, and the location of the exchange as shown in fig (1.1).



fig(1.1) Component of local exchange location planning.

The equipment cost in a service area roughly consists of the following:

1-Cost of exchange office.

2-Cost of subscriber lines.

In a service area, if small-sized exchanges are installed according to the demand, it would result in a division of the service area into a large number of sub-areas. Consequently,

the length of subscriber lines become short and it reduces subscriber line cost, but brings on a greater cost of exchange. Conversely, if a large-sized exchange is installed in a service area, cost for exchange decreases , but the total length of subscriber lines increase,which leads to a higher cost of subscriber lines. A compromize between the cost of subscriber lines and cost of exchange office to obtain a minimum total cost.

When we construct subscriber lines from local exchanges to subscribers, If there are n intersections there are $n(n-1)/2$ potential lines, since each line may be present or absent, the number of potential topologies to consider is $2^{n(n-1)/2}$. For a small network of 10 locations, there are $3*10^{13}$ possible topologies to consider. Network planning requires a variety of conditions to consider, there is no universal method that is "absolute".

Clearly a brute force search will not work. In order to reduce the search time, we use heuristics methods to solve some problems, and use the experience of domain expert to solve other problems. This type of problem is very suitable to be solved by an expert system approach.

ORGANIZATION OF THE THESIS.

This thesis is divided into four chapters other than this introductory chapter. Having defining the objective, Chapter 2 contains a survey of using an expert system in network planning. The second part discusses a survey in topology design and finally we describe the algorithm for urban telephone planning [17], which is a modification of the algorithm developed by Kan[13]. Chapter 3 discusses the main concept of the expert system and how to build a successfully expert system and the second part describes the expert system tool which we have used in building our system. Chapter 4 describes the system. Finally chapter 5 contains the results, conclusion and recommendation for extensions of the system.

CHAPTER TWO

SURVEY.

2-1 INTRODUCTION.

In this chapter, we survey some of the work done in this field. In the first part we present a work done in the area of use of an expert system in the network planning . The second part we present a work done in the area of topology design in general.

2-2 SURVEY OF WORK ON USE OF AN EXPERT SYSTEM IN NETWORK DESIGN.

ROBERT G. SHELTON [23], describes an expert system program, called Trunck groups without design, or TGWD, involves selecting a design to meet the needs of proposed trunk groups. The TGWD is one of approximately 40 components within the facility design planning process, the facility design planning process is a component in inter-office facilities planning for telephone companies, which involves the translation of a strictly logical concept into physical units. It must therefore transform forecasted circuit demand into requirements for the physical terminal equipment and cables that will be needed for a projected five year period. TGWD is a complex process requiring multiple sources of information that are rapidly changing. In operation, the system analyzes the criteria for the needed trunk group, and looks for facility types that match the criteria. Once it has identified the appropriate facility types, it looks in the inventory database to determine if there