PRIM-MST: AN Algorithm for Designing and Optimizing Local Area Network Planning

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Summary
This paper proposed n approaches to designing local area networks using Prim's MST Algorithm of an organization. Designing the local area network of an organization is a typical problem faced with how we optimally arrange the networks between computers nodes while faced the imperative of area and installment cost. One of the cost parts that value to be considered is the local network cable price. The shorter the aggregate link length of the network, obviously the installation cost will be less. The MST problem has essential applications in network design which is broadly concentrated in the study of literature. The MST problem shows up in the local area network design where computers and other nodes connect them and must be picked most gainfully. The application of Prim's algorithms is shown to the outline design of local area networks in an organization. This Prim's algorithm works by picking the shortest path beginning from the first node until all nodes in the graph are linked. The following research is planned to design a prims algorithm to solve local area network design problems. Our research is analyzed, and intriguing results are gotten. The outcomes got to justify the need to apply this sort of algorithm for benefit and efficiency.

Keywords:
MST, LAN, Graph, Minimum cost, network, Prim's, Algorithm.

1. Introduction

Planning to design a local area network of computers is not an insignificant activity. These networks are much expensive to implement, but these are much reliable. Such networks are fast and much reliable network which provides us high-speed local area network services. The reliable network and service quality requirements of LAN and the huge investment in network infrastructure have improved basic network design that meets the performance parameters [2]. We will consider the limitation of the area and implementation cost with a specific end goal to make an ideal design network. Implementation of such network designing in any organization improves the efficiency and reliability of local area networks. The PCs and nodes are frequently isolated over the building in rooms partitioned by dividers. On the following condition, some amount of cable length is required to establish the networks and therefore comes the outcome of network implementation cost. To minimize this implementation amount, we need to build a specific design that will interface every PC and node on the network in the shortest way. This case can be classified into a minimum spanning tree problem. Several approaches have been developed to solve the minimum spanning tree problems. One of the best well-known is the prim algorithm [5]. In prim's algorithm, every node will connect to the beginning, which node has the edge of minimum cost and moves until all nodes are connected in the minimum-way. The main objective of this research design a network by using his algorithm. Implementing a local area network in an organization is a much expensive task that needs proper planning and designing to make an efficient and reliable local area network. The Prims algorithm would make connected the buildings to the local area network in a minimal way. Many building and department in an organization which needs to connect with the proper link. In any node, no loop also found no redundant link allowed will increase the minimal cost. This research investigates the effectiveness of Prims Algorithm to elaborate a design model of local area networks, which can reduce the cost of network implementation and provide efficiency and reliability. We use a cisco packet tracer for simulation in network designing and use C language for finding minimum spanning tree.

2. Related work

There are several implementations of Prim's algorithms on network designing have been proposed. Prim's algorithm works on one of the initial nodes and finds the minimum weight that connects the initial node to the other network nodes [7]. Prim's algorithm has an application in finding the minimum length, commonly referred to as the cost of spanning tree Minimum spanning tree (MST) problem is one of the traditional optimization problems [6]. Prim's algorithm is a special case of the generic minimum spanning tree with operates for finding the shortest path in a graph [3].
The prim's algorithm is one of them in the classical algorithm [4]. The MST is a classical problem in graph theory. The MST is used to finding the minimum path using

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the prim's algorithm approach [8]. Prim's algorithm is related to graph theory which try to find an MST for the connected weighted graph. It finds a subset of the edges that structure a tree that includes every vertex, where the total weight of all the edges in the tree is minimized. If the graph is not connected, it will only find a minimum spanning tree for one of the connected components [5] [8].

3. Background

3.1 Graphs

Basically graph represent discrete objects also describe their relationship. We called here object is node and vertex called nodes which connected two lines. Graph $G = (V; E)$ consists of a set of vertices $V = \{V1, V2, V3, \ldots . Vn\}$ and set of edges which are describe as E. The graph G some time undirected some time directed. If G graph show as undirected, then each edge in vertices E is unordered pair of vertices E. When graph G is directed, then every edge of vertices e is form of ordered pair of vertices [10]. V called nonempty set of vertices or called nodes and E called set of edges that connects nodes (vertices) Given bellow figure 1 show undirected graph and figure 2 show directed graph.

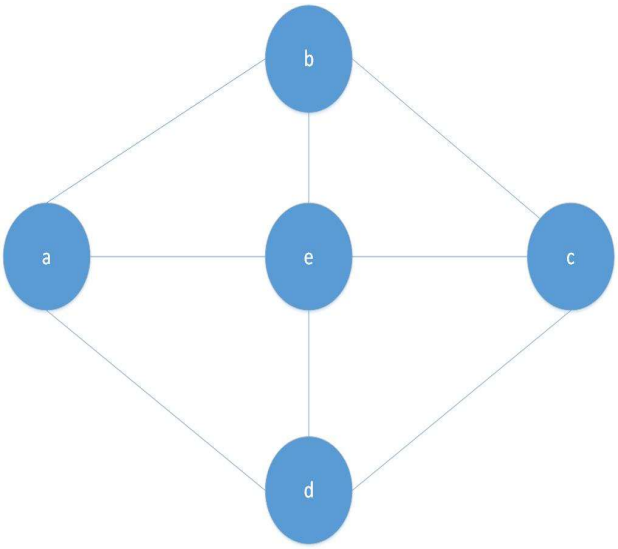


Fig. 1 *Undirected graph*

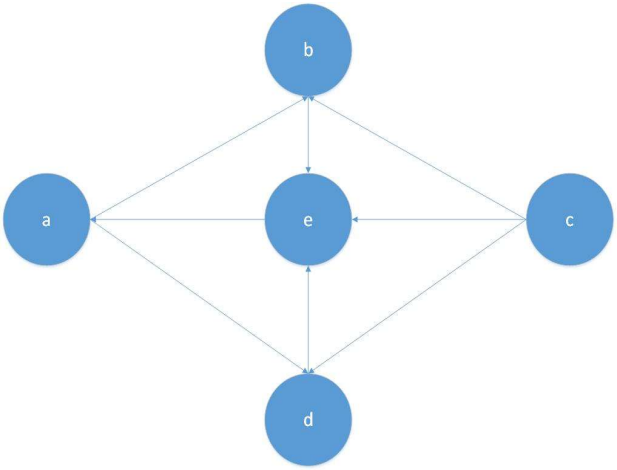


Fig. 2 directed graph

3.2 Prim's Algorithm

The aim of the Prims algorithm is to find a minimum spanning tree of a given network. The Prim's algorithm for finding a MST for an undirected graph is so similar to Kruskal's algorithm for the shortest path problem [10]. The algorithm grows the spanning tree starting from an arbitrary vertex [10]. The idea behind to this algorithm is to read the distance matrix of a local area network then it make a link matrix that contains the set of minimum links to construct the minimum spanning tree. The Prims algorithm can be discus as tool for solving indicated computational issue [11]. Prim's algorithm by Prim [23] seem like to Kruskal's algorithm, these are greedy algorithms which are used to compute an MST for an input graph G. In the paper over objective it find minimum spanning tree for finding the shortest path in networks by using prim's algorithm.

Algorithm: Prims Algorithm

PRIM-MST (G, w, r)

1 $for\ each\ u\ \in V\ [G]$
2 $\quad do\ key[u]\ \leftarrow\ \infty$
3 $\quad\quad \pi[u]\ \leftarrow\ NIL$
4 $key[r]\ \leftarrow\ 0$
5 $Q\ \leftarrow\ V\ [G]$
6 $while\ Q\ \neq\ \emptyset$
7 $\quad do\ u\ \leftarrow\ EXTRACT - MIN(Q)$
8 $\quad\quad for\ each\ v\ \in\ Adj[u]$

9 $do\ if\ v \in Q\ and\ w(u,v) < key[v]$

10 $then\ \pi[v] \leftarrow u$

3.3 Minimum spanning tree

The minimum spanning tree is which spanning tree of a connected, undirected graph with minimum weight [12]. Simple single graph consist of many spanning tree. We assign a weight every vertex in graph which use to assign weigh to spanning tree by computing every vertex (edges) weight in tree. The minimum spanning tree also called minimum weight spanning tree [12]. The minimum spanning tree (MST) connects each vertices of graph together with the least whole weighting for every edges of graph. The MST of a weighted graph G is a spanning tree over of G whose edges whole to least weight. We can say that, a MST is a tree framed from a subset of the edges in a given graph which is undirected graph, with of two properties first one its spans of the graph, for example it includes each vertex in the graph, and second one it is a minimum for example whole weight of number of edges is as low as could reasonably be expected. Now question is arise what is the MST for the weighted graph? Which is show in given bellow Figure 3.2. Main thing to notice that a MST not necessarily unique

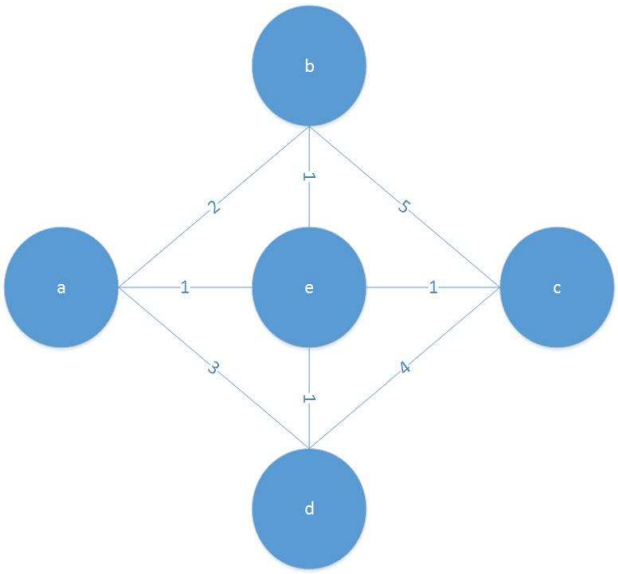
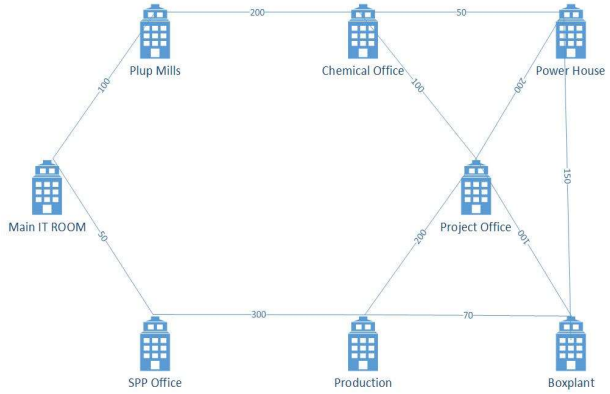


Fig 4 weighted graph

The size of the spanning tree is the whole of the considerable number of edges in the tree. There can be numerous spanning trees. The Minimum spanning tree (MST) is the spanning tree where the size is shortest among every spanning trees. There can be number of minimum spanning trees also. The Minimum spanning tree (MST) application use in the design of networks. The weighted edge is which graph where we connect weights with every edge. Basically minimum spanning tree (MST) of weighted edge graph is a spanning tree where number of all edges in graph is no bigger than the weight of some other spanning tree graph. To find minimum spanning tree in network of local area we use prim's algorithms. The spanning tree and minimum spanning tree are show in given bellow figures



3.2.1 and 3.2.2.

Fig 5 Spanning tree

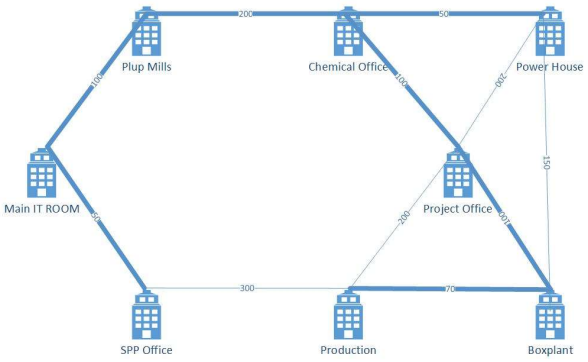


Fig 6 Minimum spanning tree

4. Implementation

4.1 Application for Prim's Algorithms

We develop a C# application which is windows base application for implements the Prim's minimum spanning tree algorithm which is given bellow.

```
private void button4_Click(object sender,
System.EventArgs e)
            {

                    int nxt_nod=0;

                    int arr_size=arr.Count;

                    int [] arr1 = new
int[arr_size];
                    long [,]nod_matrix = new
long[arr_size,arr_size];

                    for(int
i=0;i<arr_size;i++)
                            for(int
j=0;j<arr_size;j++)
                            {

       nod_matrix[i,j]=0;
                            }

                    int from,tO;

                    for(int
i=0;i<lnk.Count;i++)
                    {

       from=rtn_no( ((link)lnk[i] ).from);

tO=rtn_no(((link)lnk[i] ).to);


       nod_matrix[from,tO]=((link)lnk[i]).dis
tance;

       nod_matrix[tO,from]=((link)lnk[i]).dis
tance;

                    }

                    int Where=0;

                    long sum=0;

                    long min_no=0;

                    ArrayList linkaton = new
ArrayList();
                    for(int
i=0;i<arr_size;i++)
                    {

                            arr1[i]=Where;


       zero(nod_matrix,arr1[i]);


       min_no=getminimum(nod_matrix,arr1,out
Where,ref nxt_nod);

                            if(min_no!=0)
                            {

       sum+=min_no;

                                    link l1 =
new link();

       l1=return_link(((node)arr[nxt_nod]).na
me,((node)arr[Where]).name);


                    linkaton.Add(l1);

                            }
                                    }

       this.Refresh();
                    lnk=linkaton;
                    draw();
                                    }
```

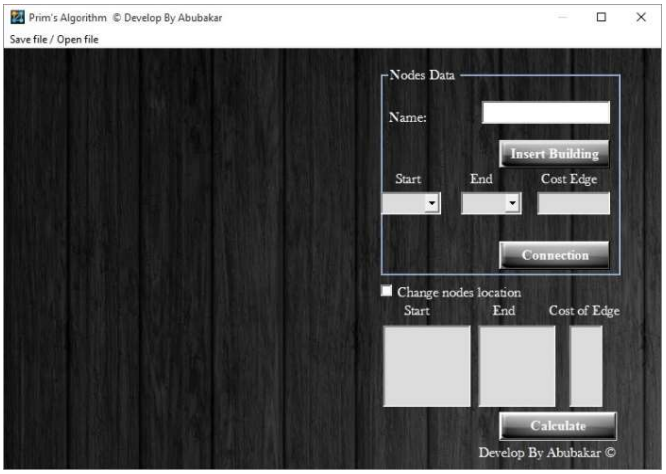


Fig 7 Prim's Application

First thing we done we keep track two sets. In prims algorithm we remembers each nodes in minimum spanning tree. Now we make an array and each time we include a node in minimum spanning tree, we mark it as included. While considering any edge of node in future, simply check if $MST[i] = true$; if it is true then node is include already minimum spanning tree then node not be included once more.

Second thing is to monitor distance of every node. At initial stage all nodes are at INFINITE distance between them. As we navigate the graph we update every nodes distance from current node. Keep an array [i] of whole numbers (integers) then initialized a value of INFINITE and each time we include a node in minimum spanning tree, distance update of neighbor nodes in the prospective view of edge cost from working node to them.

Final and last step is to locate the least cost edge between two sets. We can look over the distance array which we examined in above section and we get a node which has minimum cost and not already include in minimum spanning tree. Discovering least can be implemented utilizing min HEAP/PRIORITY QUEUES that should reduce the complexity of above algorithm.

4.2 Network of An organization

There are many way to design a local area network of an organization. For business prospective design an effective network with minimum cost. To achieve these target we use prims algorithm to find minimum spanning tree of organization network. Prims algorithm help to find one suited distance within the network. If we reduce distance of two nodes in network the expense of cable and travel times through nodes also reduce. By using prim's algorithm we choose the pair of minimum weight. Prim's algorithm also refer to greedy algorithms. Reliability of network is directly concern with network topology. Reliability point of view which network connected desired vertex pairs with exactly single path is not good solution. If link breaks or fail topologies then network disconnect and no more link between two nodes possible.

We design a topology which is more reliable and cost effective something from ring and some from start topologies. The topology of network represent geometrically relationship of all the connected the nodes. The topology of describe in two of ways one toward physical topology which describe the way physically connectivity and second one is logical topology which describe data flow details it means that how data flow over the entire network. In this research we discuss how to design best topology network by using prim's algorithm and fine find minimum tree of network and we represent simulation between end points using simulation tool. The Cisco Packet Tracer (CPT) is network tool which multi-tasking perform and network activities analysis such as design a network and implementation of topology on network or different topologies used, also use to select minimum path based on various routing algorithms, create router, create Doman Name Server and Dynamic host control server, perform sub netting. It use Cisco IOS same commands use for configuration and troubleshooting. Now we give over view of topologies of networks.

Bus Topology

In bus topology set of computers connected to single cable along with this communication line. In other words we say that it is simple way to connected computers or connected computer to each other's. It is not reliable when break connection from center problem occur for all others nodes

Ring Topology

In ring topology every node in network connected to two others nodes the cable passes in network from one computer or node to another node until all nodes/computer are connected in the form of a cycle shape or ring [17]. There is a direct P2P link between two nodes circular pathway look like a ring. Data transfer bit by bit in following topology.

Start Topology

The start topology we connect all node connected using some central media like switch or hub. All nodes no need to connect each other in start topology. Start topology much reliable and flexible that's why more use in current days. End points nodes are directly reachable from a central location (switch or hub) when network is expanded [16].

Table-1: Analysis these of topologies

Parameters	Bus Topology	Star topology	Ring topology
Cost	Less	High	Normal
Installation	Easy	Easy	Hard
Reliability	Low	High	High

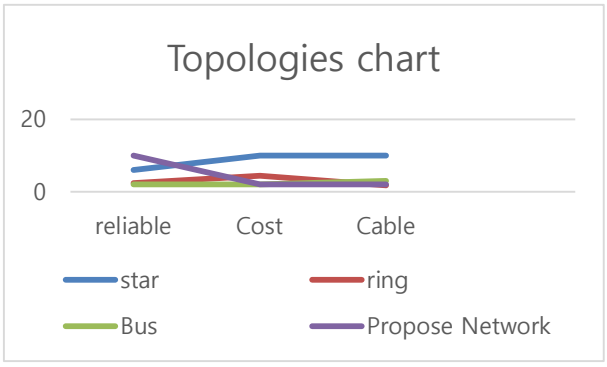


Figure 4.2.3 Comparison chart of topologies

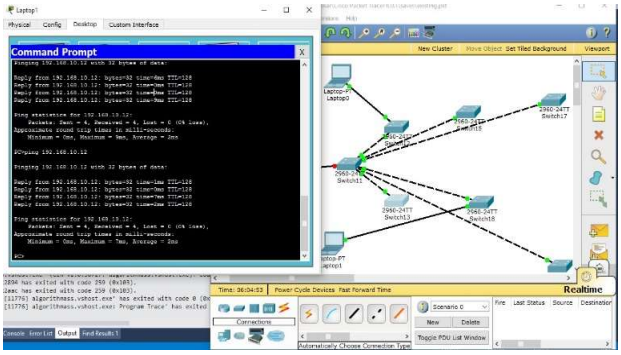


Figure 4.2.4 Existing network using star topology

Our research proposing local area network along with Prim's algorithm is used to find minimum spanning tree of network. Our design of local area network is best short path between nodes. If the network is not connected, then it goes to find a minimum spanning tree for one of the connected nodes. Our proposed network are given bellow which reduce the total cost of installation.

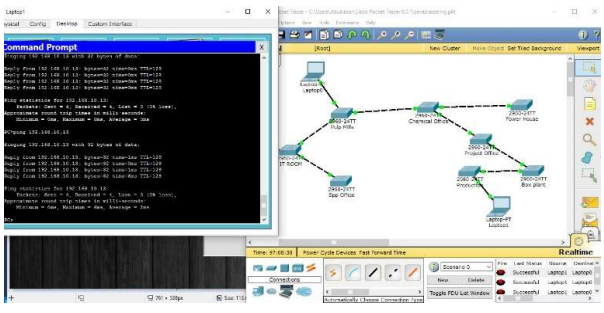


Figure 4.2.5 Minimum spanning tree of network by tool

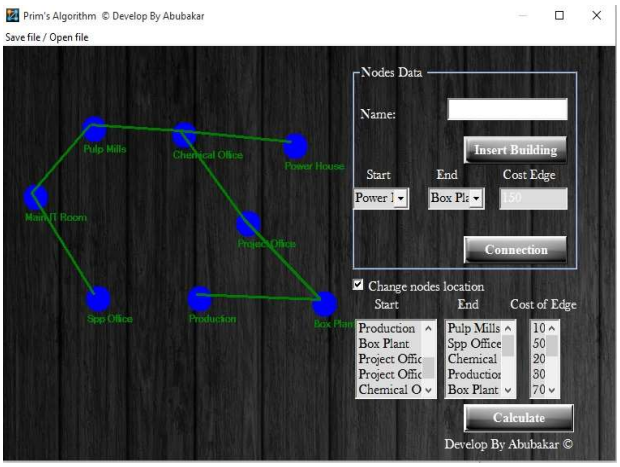


Figure 4.2.7 After Implementation of prims algorithm

Table 2. Results

Parameters	Existing network	Prims' Network
Number of Nodes	8	8
Cable Length	1520 M	670 M
Reliability	Yes	Yes
Flexibility	Normal	High
Troubleshooting	Difficult	Easy
Installation cost	45000	1250

5. Conclusion

In this paper the prim's algorithm can be used to design local area network of an organization that result in minimum installation cost of the entire network. The proposed solution of design network using prims algorithm is much better than the existing network at an organization, we say that implementation of this algorithm will definitely saving installation cost. The minimum spanning tree (MST) one graph which implies no network redundancy therefore brings higher performance of network. The Prims algorithm application vary valuable and attractive tool in the designing of networks such an organization. Because prims algorithm is greedy algorithm its greed nature since at every step it include to the tree the least edge which will contribute the minimum cost of the tree. The installation cost very reduced because the algorithm forever results in the minimum overall distance of network tree. Though the research was carried

out on the designing of local area network at an organization, our findings could be implement to any other local area network designing because our main concern to minimize the installation cost on implementation.

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