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Shortest Path Algorithm For Satellite Network

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Abstract:
In this paper we have proposed a new algorithm for finding the shortest path in a network which consists of host systems on land and satellites. Some classical network theories, such as shortest path algorithm using Dijkstra or Bellman Ford, cannot be applied to it availably. We have worked with Prim's Algorithm and modified it to suit our purpose.

Keywords*: BFS,Dijkstra's, Prim's, network, algorithm,spanning tree*

1.Introduction

Satellite networks, which provide a wide geographical coverage and a consistent level of services, play a more and more important role in such respects as NGN (Next Generation Network) and B3G (Beyond 3G), especially in the future air-space-ground integrated information network. In these future networks, as the core framework, satellites connect heterogeneous networks with each other. We need a fast, reliable algorithm to find shortest path between transmitter and receiver to transfer the data with minimum delay.

Shortest path algorithms are very important for the studying network communication. They have been the subject of extensive research for many years resulting in a large number of algorithms for various conditions and constraints. Two of such algorithms to find the shortest path between two nodes in a network are Dijkstra and Bellman Ford algorithm. Both of these algorithms are Breadth First Search (BFS) based. Dijkstra's algorithm stores the total cost from a source vertex to the destination vertex. In both algorithms, the approximation to the correct distance is gradually replaces by more accurate values until eventually reaching the optimum solution. Here the approximate distance to each vertex is always an overestimate of the true distance, and is replaced by the minimum of its old value with the length of a newly-found path. However, Dijkstra's algorithm greedily selects the minimum-weight node that has not yet been processed, and performs this relaxation process on all of its outgoing edges; in contrast, the Bellman–Ford algorithm simply relaxes *all* the edges, and does this $|V|-1$ times, where $|V|$ is the number of vertices in the graph. In each of these repetitions, the number of vertices with correctly-calculated distances grows, from which it follows that eventually all vertices will have their correct distances.

The network we are working will have edges whose weights are exponentially greater than the weights of other edges in the graphs (detailed explanation given in the Description section of the paper).The priority queue of Dijkstra's algorithm will contain all the paths for the destination. If the destination is a satellite node, the calculation of multiple paths to the destination can be costly on the convergence of the network.

In this paper we chose to work with Prim's algorithm as it only stores minimum cost edge and modify it to reduce our graph into a spanning tree.

2. ASSUMPTIONS

There are several assumptions made about the network or the graph in consideration. These are:

- The weights considered in the graph are the delay in a particular link.
- The weights cannot be negative.(as the delays cannot be negative)
- There are no double weighted in the graph.
- We define a delay as 'excessive delay' and call it 'p'. This 'p' is a very large delay.
- Major part of our network is made up nodes which has a delay very less when compared to 'p'.
- However there are one or more links or edges with delay comparable to 'p'.
- We define another term 'point nodes'. These are nodes which only has links or edges connected to it whose weight is comparable to 'p'.

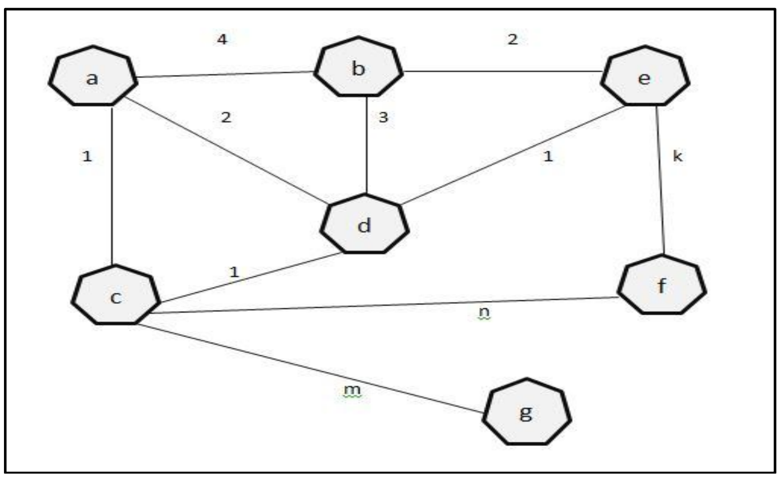

Figure1: Graph with 'excess delays' and 'point nodes'

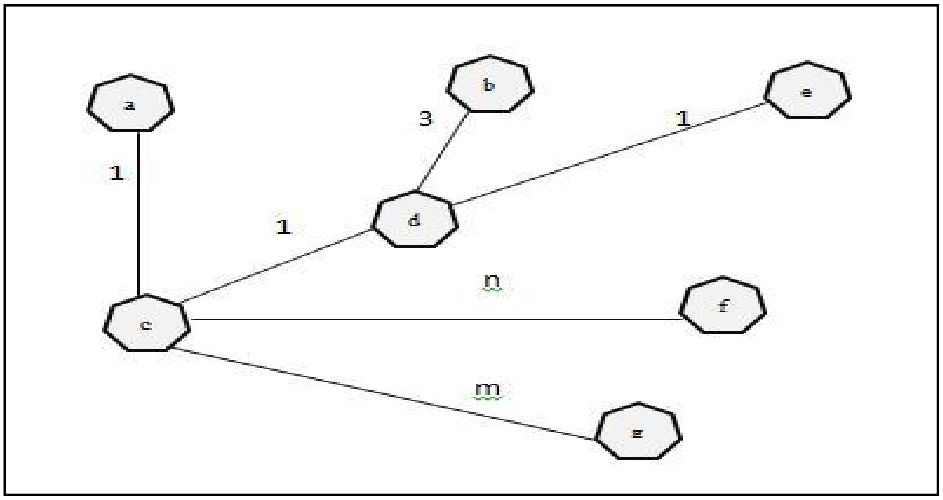

Figure 2: Spanning Tree

3.Related Work

3.1.Prim's Algorithm

Prim's algorithm is a greedy algorithm that finds a minimum spanning tree for a connected weighted undirected graph. This means it finds a subset of the edges that forms a tree that includes every vertex, where the total weight of all the edges in the tree is minimized. The algorithm was developed in 1930 by Czech mathematician VojtěchJarník and later independently by computer scientist Robert C. Prim in 1957 and rediscovered by EdsgerDijkstra in 1959. Therefore it is also sometimes called the DJP algorithm, the Jarník algorithm, or the Prim–Jarník algorithm.

3.2.Djikstra's Algorithm

Djikstra's Algorithm is a modification of the BFS(breadth first search.The modification made is that we replace BFS's queue with a priority queue.Vertices are added by their distance away from the source.

```
class Vertex implements Comparable
{
publicintcompareTo(Vertex v)
{...}
}
PriorityQueue<Vertex>pq; // Vertex must implement Comparable
```

4.Working

We consider the graph in Fig.1.The links marked ‘m’, ‘n’ and ‘k’ are greater than the excess delay ‘p’.The nodes ‘g’ and ‘f’ are point nodes.

We now try and reduce this graph into a spanning tree. For this we have used the Prims algorithm. In this algorithm we consider two sets ‘V’ and ‘E’. My set V will contain the set of vertices and set E will contain the set of edges in the spanning tree.

Initially

V = null

E= null

Now we consider the ‘a’ as the source vertex. We put this vertex in our set V, so now my set V and E becomes

V = {a}

E = null

We search for minimum edge connected to my source node and we add the edge to set E and the vertex connected with the edge to set V Fig.3

V = {a, c}

E = {e1} where e1 = ac

Now from the set of nodes in V we look for minimum weighted edge. We observe that the node ‘c’ is connected to a ‘point node’. Here m >p. We have found edges with excess delay. Along with the minimum edge we add this edge into the edge set E. The vertex set will contain the ‘point node’ along with the node attached to the minimum edge.Fig .4

V = {a, c, d, g, f}

E = {e1,e2,e3,e4} where e2 = cd and e3 = cg e4= cf

Similarly from the nodes a, c, d, g we look for the minimum edge or an edge connected to a point node.Fig. 5

V = {a, c, d, g, f, e}

E = {e1, e2, e3, e4, e5} where e5 = de

When notice that our vertex ‘e’ is connected with a ‘point vertex’, since we already have this point vertex in our set V we ignore. In this set E will only have an additional edge. Fig .6

V = {a, c, d, g, f, e, b}

E = {e1,e2,e3,e4,e5,e6} where e6=db

The set V contains all the seven nodes of the graph. Now we can plot the spanning tree. When we plot the vertex from set V corresponding to the edges in E we get a spanning tree as shown in Fig.2.The spanning tree shown is not a minimum spanning tree. This is done in order so that we can generate a spanning tree in less time.

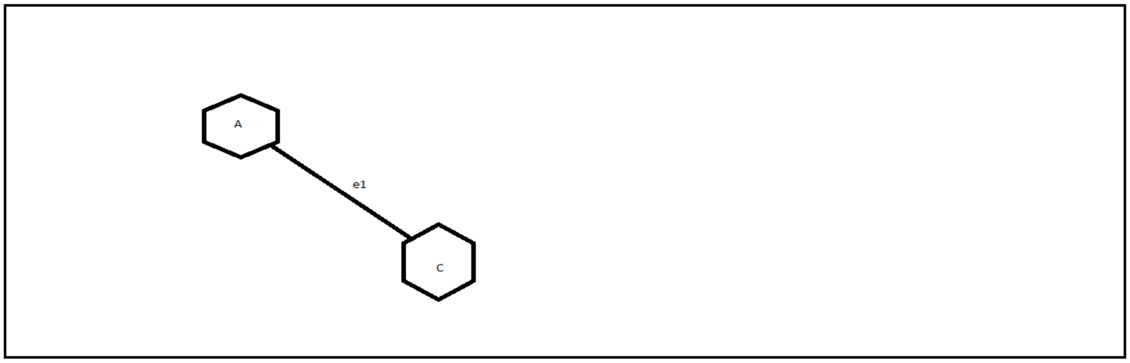

Figure 3

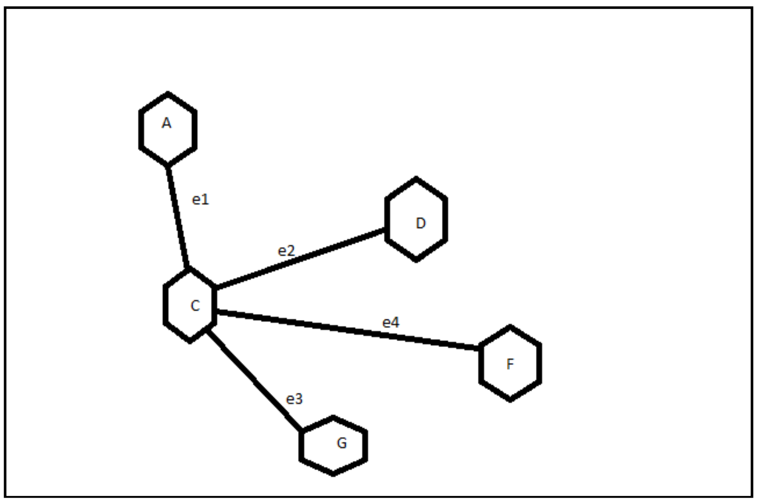

Figure 4

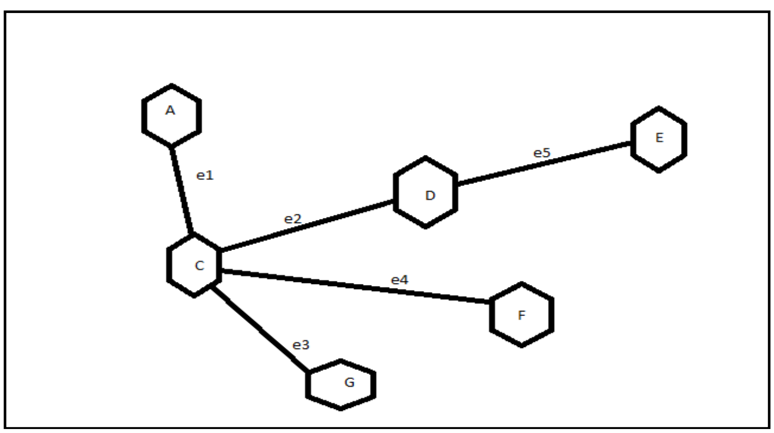

Figure 5

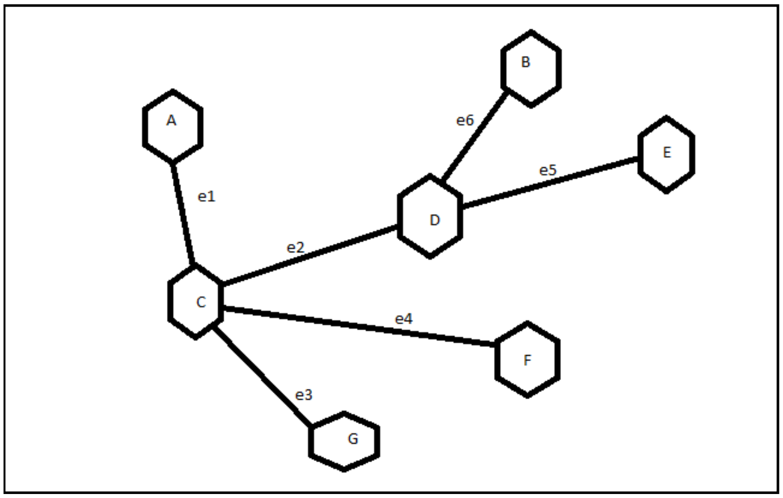

Figure 6

5.Application

The algorithm suggested in the paper can be used to convergence satellite networks. In ground to satellite communication the delay is large as compared to rest of the network. We have not used a minimum spanning tree so the network on ground will be slow, since we reduce the time in calculating the spanning tree the convergence would be faster. This will speed communication between the ground channels and the satellite.

The algorithm can also be applied to find the shortest path between various cities, given the number of highways connecting them.

For finding the paths for transmitting the data in routers, the algorithm can be used to find such paths which have to be used to minimize the delay for transmitting and receiving the data packets.

6.Conclusion

At present, the studies which are about the shortest path for satellite network are very few and some studies for other time-varying topological networkare not applied in satellite network valid. The paper proposes a method to speed convergence in a network containing edges of heterogeneous weights. Prims algorithm has been modified to suit the purpose. The algorithm finds the near best spanning tree and uses it to convergence the network. The algorithm can find its applicability in ground to satellite or satellite to ground telecommunications.

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