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Application of Strong Graphs in Wireless Networks

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Abstract : The objective of this paper is to form an efficient backbone structure based on my proposed algorithm (Caterpillar Algorithm) and to merge the network when the node moves thereby maintaining connectivity,ensuring mobility management and parameters like greater throughput, more packet delivery ratio, less packet drop,more energy efficient and less delay.The application of caterpillar algorithm in management is also introduced.

Index Terms: Graph Labeling, Strong Graph, Caterpillar Algorithm

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1 Introduction

In a mobile adhoc network, the nodes can join or leave the connection at any time. As a result connectivity among the mobile nodes becomes a major constraint. Mobility management is another important problem that needs to be addressed so that the mobile nodes can enjoy their services as they roam through the network. Connectivity based on virtual backbone formation is an effective approach. The objective of the paper is to form an efficient backbone structure based on my proposed algorithm (Caterpillar Algorithm) and to merge the network when the node moves thereby maintaining connectivity,ensuring mobility management and parameters like greater throughput, more packet delivery ratio, less packet drop,more energy efficient and less delay.The application of caterpillar algorithm in management is also introduced.

Definition 1.1 Graph Labeling

A labeling of a Graph G = (V, E) is a one-to-one mapping Ψ of the vertex set V(G) in to the non negative set of integers that induces for each edge$\{u,v\} \in E(G)$ a label depending on the vertex labels Ψ (u) and Ψ(v).

Definition 1.2 Strong Graph

A labeled graph G=(V,E) is a strong graph if it satisfies the condition that there exist a number δ where $0 < \delta < \text{Max}\ \{\psi(e)/e \in E(G)$ and ψ, the labeling$\}$ such that $\text{Min}\{\psi(u), \psi(v)\} < \psi(uv) < \text{Max}\ \{\psi(u), \psi(v)\}$

Note: 1.2.1: If the labeling is α then $\text{Max}\ \{\psi(e)/e \in E(G)\} = |E(G)|$ and $\psi(uv) = |\psi(v) - \psi(u)|$

1.3 Caterpillar Algorithm:

Let the total number of nodes in the given network be N.Let r be such that every disjoint spheres consists minimum 3 edges inside the spheres.Divide the network in to disjoint subnetworks such that each sub network consists nodes having Euclidian distance < r .

Consider a subnetwork with ‘n+2’number of nodes and ‘l’ number of links; we construct a complete graph by removing loops and introducing and maintaining one directlink between every two nodes.From this a Strong Graph is formed.Now label the nodes using the numbers {0,1,2,3,…,n} corresponding to the ascending order of energy at the nodes.If two or more nodes have same energy level, then assign consecutive numbers to label the nodes.This is the proposed Algorithm. Hence forth the network has various internal strong graph structures ensuring topology maintenance. The disjoint spheres are connected by an edge.

In the first phase the root nodes are selected. The node u corresponding to $\psi(u) = n$ is selected as the root node.From there a one hop distance is maintained to each node.Thus a network is constructed thereby covering all vertices.By network formation the packet can be transferred through energy efficient links and also better throughput can be achieved.By changing r, better parameters can be obtained and the performance of Caterpillar Algorithm can be improved.

Algorithm:

Step 1: Start

Input: Unconnected Network.

Step 2: Form disjoint sphere of radius r covering all nodes.

Step3: Select one sphere and name vertices $u0$, $u1$, $u2$, $u3$,…, un

Step 4: Join ui –uj for i= 0,1,2,…,n and j=i+1,i+2,…,n.

Step 5: Receive the signal

Step 6:Label the nodes using {0, 1, 2… n} according to the ascending order of signal strength.

Step 7.1:If two or more nodes have same signal strength, use consecutive distinct numbers to label the nodes.

Step 8: Selection of Root node.

For $\psi(u) = n$,Select Root node R= u

Step 9: Make all links 'uui' active and all other links inactive.

Step10: Check $\psi(u) = n$ in time [0,t].

If at t= t1, $\psi(u) \to k$, $k \in \{0,1,2,3,...,n-1\}$,Go to step 11, If not go to step 9.

Step 11: Search u , for $\psi(u) = n$ .Select R= u.

Step 12 : Select next sphere and perform steps 3 to 11.

Step 13: Repeat step 12 till all sphere gets active links.

Step 14: Connect pair of disjoint spheress using one link and make it active.If there remains nodes which does not belong to any sphere, join those nodes by active links.

Step 15: Stop.

2. PROPERTIES OF CATERPILLAR ALORITHM (CA)

Theorem 2.1: The active links of caterpillar algorithm simulates a caterpillar.

Proof: The active links of the algoritm are formed by connecting disjoint stars by disjoint links. There fore the removal of 1-degree vertices gives a path.Hence the proof.

Note 2.1.1: Due to this theorem, the algorithm is named as caterpillar algorithm.

2.2 Performance Analysis of C A

Using AODV protocol and NS2 simulation tool, the effectiveness of Caterpillar Algorithm (CA) is measured.It is discovered that Caterpillar Algorithm gives better parameters comparing with the existing method Tree Adjustable Plannar structure (TAP).The result for a 500mx500m region, deploying 100 nodes is shown in the following tables.

Mobile Nodes	10	15	20	25	30
Throughput (CA)	72	68	59	58	50
Throughput (TAP)	70	64	53	50	48

Mobile Nodes	10	15	20	25	30
End to end delay (CA)	0.07	0.08	0.09	0.1	0.11
End to end delay (TAP)	0.01	0.14	0.15	0.27	0.29

Time in seconds	1	2	3	4	5
Energy in Joule(CA)	19.7	19.4	19.9	19.8	19.8
Energy in Joule (TAP)	19.1	18.95	19.3	19.0	19.1

Mobile Nodes	10	15	20	25	30
Packet delivery ratio (CA)	0.6	0.59	0.61	0.7	0.81
Packet delivery ratio (TAP)	0.3	0.48	0.55	0.63	0.72

2.3 Application of CA in Management.

The structure of Caterpillar algorithm can be used for smooth functioning of an institution.Let the following be the main Committees in an educational institution.

1. Exam Committee
2. Audit Committee
3. Disciplinary Action Committee
4. Innovation and Startup Committee
5. Placement Committee
6. NSS Committee
7. Grievane Committee

Consider each Committee as a group (Sphere in algorithm),the members in each committee as nodes. Among the members based on interest and experience assign a label “incharge” or “team leader” to one member and consider him as root node.This root node is supposed to assign instructions and work out the activities of the committee using the team members. This can be done by preparing a list by the athaurity- Director.

Example:

1. Exam Committee
   Jijoy P Mathew (root node) , Value 3
   Safeena, Value 2
   Devi, Value 1
2. Audit Committee
   Leena (root node), Value 3
   Abitha , Value 2
   Chithra, Vlaue 1

After a time , the team leader (root node) fedup with the work or whenever the team leader wants to be free from the post (the value representing the variables familiarity, enthusiasm and availability reduces),the member who is then more familier with the activities of the committee is supposed to take the team leader position.i.e, the strong graph structure is to be maintained internally.

The Director has to connect the team leaders by monitoring the updations from the team leaders in a fixed time period through direct meetings or emails. Or the Director shall appoint a member (say) Principal in education based institution to monitor and report the updations.

This assures smooth functioning of the committees of the institution and hence the smooth functionin of the institution. The rotation scheme in positions is also a part of this algorithm. Rotation scheme means after a fixed time interval the team leader post changes.Most effective method is changing the positions based on the variables familiarity, enthusiasm and availability- together we shall call energy level.

2.4 Limitations

The structure is applicable only when team members are in the category of flexible employees and enjoys the team work. If the “incharge” stands only for position, then the functioning will not be smooth and so after a stage, there will be problems in functioning of the corresponding committee. At this occasion, the Director has to restructure the committee using new members or existing flexible workers.

2.5 Advantages

This structure ensures team work among same salary drawing members. So the leader is not supposed to offer more salary. In this structure, the leader will fed up or may think “why should I take additional incharge?” after some time period, at that time the familier member is ready to support the leader by taking the “in charge” position. So the initial leader feels relaxed. This team has long lasting team spirit. Same salary and status to all group members (nodes) is a better method for profitable functioning of the institution.The institution can fix affordable minimum salary for its profitable functioning. This brings feel of equal status , respect and team spirit among members.

Conclusion:

The application of Strong Graphs in wireless networks is discovered. A virtual backbone structure is constructed using Caterpillar Algorithm.The performance analysis of Caterpillar Algorithm shows that it is better than the existing method Tree Adjustable Planar Structure (TAP) .The application of Caterpillar Algorithm in management of an institution is discussed.

The method to find the number of strong and weak edges of labeled graphs is under investigation.

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