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Optimal Flooding Protocol for Packet Routing in Cluster Based Ad Hoc Network

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ABSTRACT

Flooding gives extensive regulation and location discovery functionality for a number of unicast and multicast protocols in Mobile Ad Hoc Networks. Seeing its expansive usage as a building block for other network layer protocols, the flooding technique must distribute a packet from one node to all other network nodes using as few messages as possible. In this work, the Optimized Flooding Protocol (OFP), based on a variation of The Covering Problem, which is encountered in geometry, to reduce the unwanted communication extremely and still be able to cover the whole region, has been proposed. OFP rescues the powerful quantity of wireless bandwidth and incurs lesser overhead. To display the efficiency of OFP, simulation output is shown. Further, OFP is scalable with respect to density; in fact OFP requires smaller amount of communication at larger densities. OFP is also flexible to communication errors.

Keywords: Flooding protocols, Location discovery, Ad-hoc routing protocols, wireless network, OFP

1. INTRODUCTION

Mobile ad-hoc network is fast movable and independent network. Nodes are free to progress and established self-governing. So, the network topology alters regularly. In mobile ad-hoc network, devices are called as nodes, which have limited transmission range. Accordingly, communication reaches with the transmission range of nodes via intermediate nodes.

Flooding or Network huge transmission is the technique in which one node sends a packet to all other nodes in the network. Abundant operation as well as different unicast routing protocols such as Dynamic Source Routing (DSR), Ad Hoc on Demand Distance Vector (AODV), Zone Routing Protocol (ZRP), and Location Aided Routing (LAR) use broadcasting or a derivation of it. The main usage of flooding in all those protocols is for Location Discovery and for establishing routes.

A genuine method for transmission is blind flooding, in which each node will be required to rebroadcast the packet at any time it gains the packet for the first time. Blind flooding will generate many redundant transmissions, which will generate a huge severe transmission storm problem [3]. Given the expensive and limited nature of wireless resources such as bandwidth and battery power, reducing the regulation message overhead for route discovery is a high priority in protocol design. Many of the researchers have proposed major efficient broadcasting techniques. Centralized broadcasting patterns are conferred in [4, 5, and 6]. Techniques in [7] utilize neighborhood information to reduce redundant messages.

This paper discovers a new protocol to reduce the amount of transmissions needed for broadcasting by doing selective promoting, where only an extensive preferred node in the network do the broadcasting. It is assumed that each mobile node famous its location. Different algorithm like GPS [2], Time Difference of Arrival [10], Angle of

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Arrival [8] and Received Signal Strength Indicator [9] will be introduced to enable a node to discern its relative location. Recently, range-free cost effective solutions [8] have projected for the same cause. To select the transmitting nodes, the Covering Problem [1], which accord with sheltering a region completely using less amount of number of circles, is extended.

The major benefit of the protocol is: a) With OFP the number of transmissions required decreases as the density of the network increment; b) OFP reduce the amount of unwanted communication and outperforms other variations of flooding; c) In OFP, a node does not want to recognize locations/addresses of all its neighbors and hence OFP does not impose any bandwidth overhead such as hello messages; d) Behavior of OFP in large networks has been presented and it is shown that OFP performs well even in very large networks; e) OFP is able to reach a large fraction of nodes even when the nodes are moving at high speeds; f) OFP is powerful to communication errors as shown by the simulation results. Because of the above mentioned advantages, OFP can also be used as an efficient broadcast protocol for Sensor Networks that operate in adverse conditions.

The remaining of this proposal deals as follows: Section 2 introduces The Covering Problem and the modification of the Covering Problem, Section 3 explains the proposed method for optimal flooding, Section 4 gives the simulation results and Section 5 concludes.

2. BACKGROUND

2.1. Covering Issues

The Covering issue can be described as follows: “The minimal amount of circles needed to entirely wrapping a given 2-dimensional space.”

Kershner R. [1] showed that no arrangement of circles could cover the plane more efficiently than the hexagonal mesh adjustment described in Fig. 1. Initially, the whole space is covered with regular hexagons, whose every portion is R and then, circles are drawn to circumscribe them.

2.2. Modified covering Issues

Here, a modified method of the Covering issues that finds its application in ad hoc networks is described. The solution proposed here is to insert leading the instinct behind the protocol and the solution is just for an ideal case scenario.

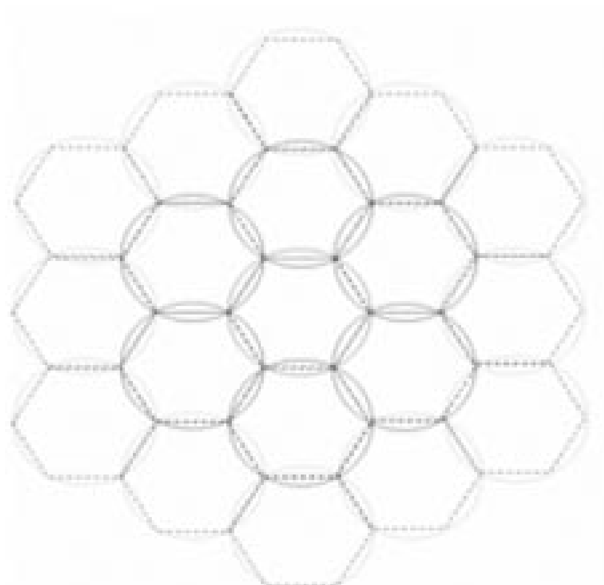

Figure 1: Covering a plane with circles in an efficient way.

The modified method of the Covering issues can be described as follows:

The minimal amount of circles of Radius R needed to cover a 2-dimensional space with the state that the center of every circle existing lies on the circumference of at least one other circle.

If the limit of a mobile node is treated to be R, then the reason behind the condition that the center of a circle should lay on the middle of next circle is that a Mobile Ad hoc node has to receive a message for it to retransmit the message. An essential result for the Modified-Covering Problem is shown in Fig. 2. As done for covering problem, startlingly the entire portion is enclosed with regular hexagons whose each side is R. Then, with each of the vertices as a center, circles of radius R are drawn.

The ensuing properties of the vertices in Fig. 2 should be noted:

Property-1: Each vertex v is joined to three other vertices.

Propery-2: The lines unite these three vertices to vertex v make an angle of 120^o (2ð/3 radians) with each other.

Propety-3: Every vertex is at a range of R from each of its neighboring vertices.

Thus, given a vertex v and one of its neighboring vertices, using the above properties, it is very easy to determine the other two neighboring vertices of vertex v. The method followed here is to solve the Modified-Covering problem is for an ideal case scenario. The common method to achieve broadcasting in a more general case, where there want not be any node at the specified location is used.

In this case Figure-2 can get skewed a lot. Even when the skew is very large, the number of transmissions required to cover the whole region remains very low.

Though, the solution presented for the Modified-Covering problem in this paper is the best, through simulations it is shown that the protocol implemented using this solution outperforms other broadcasting protocols. Also, the protocol can be easily adapted to any other geometric solutions of the Modified-Covering Problem.

3. OPTIMIZED FLOODING PROTOCOL (OFP)

In this section, the Optimized Flooding Protocol (OFP) is proposed. Flooding achieves the goal of location discovery by letting all the nodes that receive the message, retransmit it again. The intuition behind the protocol is that in order to attain the aim, there is no need for all nodes to transmit/retransmit the message. Instead, the goal can be achieved

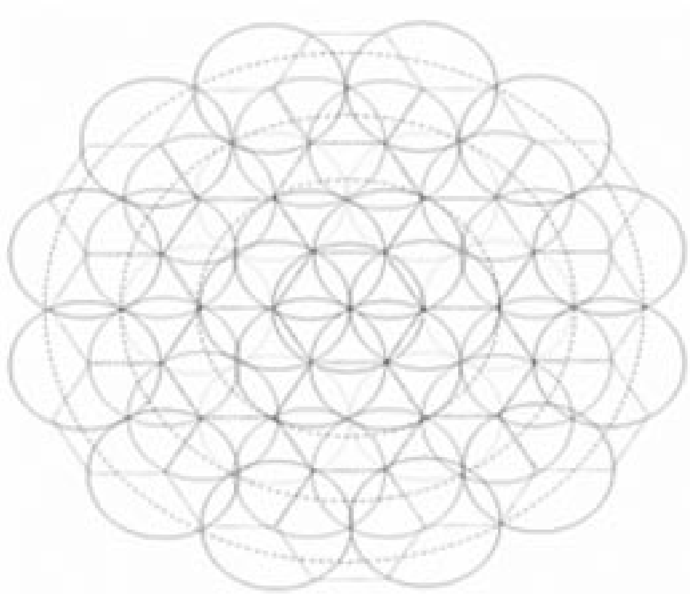

Figure 2: Our Solution for the Modified-Covering Problem.

by allowing some strategically preferred nodes to retransmit the message. The strategy to select such nodes is same as the strategy to solve the Modified Covering Problem presented in Section 2 B.

3.1. Proposed Method

Let S be the origin Mobile Node that transmit the route appeal. As seen in Fig-2, after the first circle centered on the middle of the portion (location of S), six more circles whose centers are located on circumference of the first circle are drawn. These can be considered as the begin stage retransmissions of the request. In the next stage again six circles are describe whose middle portion lie on the circumference of the circles driven in the beginning level. From now on using the properties 1, 2 and 3 presented in section 2 B, it is very simple to secure the middles of the circles to be drawn in the next stage.

In real life, though, it is seldom to have Mobile Nodes (MNs) located at the strategically selected locations. Thus, if the neighbor nodes are not in the specified method locations, the coverage figure will get skewed; moreover, the skew effect may propagate. The main aim is to boost the Modified Covering Issues to appropriate this restriction. A simple solution is to prefer the shortest node to the point selected and that receives the message to retransmit.

It should be noticed that a node will get a message more than once from different directions and from different nodes, every node define different optimal strategy location. This may cause two nodes very close to each other retransmit. To avoid these transmissions by having a node keep track of its distance to the smallest node that has retransmitted the packet and to have a node retransmit only when its distance to the nearest transmitting node is greater than a threshold (Th), has been defined.

To elaborate every broadcast packet, each node M stores the distance dm to the nearest node that has already transmitted the packet. A node does not retransmit, if dm for that broadcast message is less than a threshold Th. The choice of a right threshold will be the key to the success of the proposed algorithm. In section 4 B, the performance of OFP with various threshold values, has been studied and a Th value of 0.4*R is a good choice to ensure high delivery ratio while keeping the number of transmissions very low, is displayed. R is the transmission range.

3.2. The Algorithm

Every communication packet has two location fields, L1 and L2 in its header. Whenever a node transmits a broadcast packet, it fits L1 to the path of the node from which it received the packet and sets L2 to its own location.

The Optimized Flooding Protocol is as follows:

The Source Node S sets both L1 and L2 to its location (SX, SY, and SZ) and transmits the packet.

1. A node M, upon receiving a broadcast packet, first determines if the packet can be discarded.
2. If the packet isn't discarded, M determines if it received the packet directly from the broadcast Source S.
3. After delay *d*, M again determines if it has received the same packet again and if the packet can be discarded.

The delaying is used to make a node decide if it is the nearest node to the strategic location. Low delay values reduce the time requirement to communication a message all over the network, while high delay values help reduce redundant transmissions where two nodes are of about same distance from the strategic location. The delay function utilized here, generate a packet to be delayed a large of 50ms per retransmission, though typically this value lies around 10ms. In dense networks, the delay values are much less than 10ms.

The calculation risk of OFP is insignificant; when compared to flooding, the major additional computation is discovering the nodes range to the nearest specified point according to the modified covering problem, which can be efficiently generated using properties 1-3 mentioned in section 2B. The only bandwidth overhead due to OFP is because of addition of recent header fields to carry location information of two nodes which is not significant.

4. RESULTS TO BEOBTAINED

A network simulator is to be used to evaluate the performance of the protocol. A mobile Ad Hoc Network of different physical areas and shapes with different number of nodes are to be generated. The simulations are aimed at studying the performance of OFP in networks of different sizes and densities.Initially,the ideal case is to be simulated, where nodes always exist at the strategically selected location.Thus,by studying the performance of OFP in static networks, the algorithmic efficiency is done.

4.1. Ideal Case Scenario

The number of transmissions required to cover circular and rectangular regions in the ideal case scenario are observed and are presented in Table-1(a) and Table-1(b). It will present a lower bound on the number of transmissions required.As the density of the network increases, the number of transmissions required approaches the lower bound.

Table 1(a)
Number of transmissions required to cover a circular area

Radius of Circular region	*Number of transmissions*
2R	12
3R	24
4R	42
5R	60
6R	90
7R	126
8R	168

Table 1(b)
Number of transmissions required to cover a rectangular area in an ideal case

Size of therectangular region	*Number ofTransmissions*
$3R \times 3R$	8
$4R \times 4R$	10
$5R \times 5R$	16
$6R \times 6R$	26
$8R \times 8R$	42
$10R \times 10R$	74
$4R \times 6R$	18
$6R \times 8R$	36
$8R \times 10R$	54

4.2. Effect of Threshold

The purpose of this study is to evaluate the effect of different threshold values on the performance of OFP. Apart from the number of transmissions in each case, the delivery ratio in percentage for each case is indicated at each data point. *Delivery ratio* is the average number of nodes that receive the message to the total number of nodes in the network.

4.3. OFP Efficiency

The main purpose of this study is to evaluate the performance of OFP networks of different sizes and densities. Thus, a bound provided by the ideal case scenario is to be applied here. It is impossible for any algorithm to perform better than the performance in ideal case scenario and unlikely to perform worse than simple flooding. Thus, these two bounds provide a useful spectrum to gauge the performance of the protocol.

4.4. Effect of Transmission Errors

Wireless networks are characterized by losses due to transmission errors. Thus, the performance of OFP in networks with transmission is to be simulated. Consider the figure [3], where the performance of ofp and AHBP in a network of size 1800m × 1800m. Here, 144 nodes are randomly placed in the network. Transmission error rates up to 30% are simulated using the uniform transmission error model. It can be seen that the performance of OFP degrades gracefully with increase in transmission errors and OFP was able to achieve a delivery ratio of 84% even at a transmission error rate of 30%. At the same time, performance of AHBP degrades rapidly and the delivery ratio is less than 63% at an error rate of 30%.

4.5. Effect of non-uniform Radio propagation

A study on the performance of OFP in wireless networks, where wireless propagation is non-circular is done. The term *non-circularity* means that the range of a node might be different in each direction, the maximum being R,

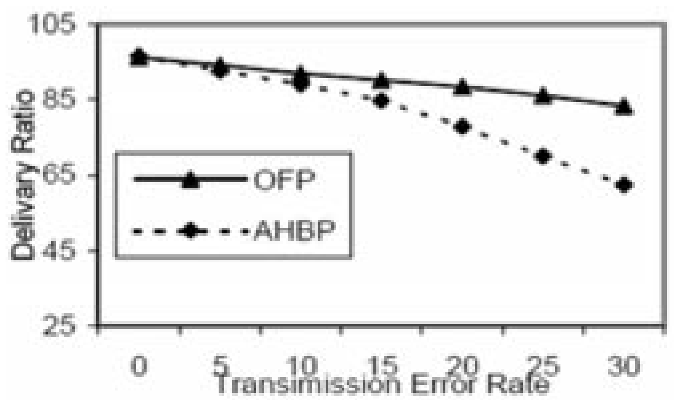

Figure 3: Performance comparison of OFP and AHBP in presence Transmission errors. Network size = 1800m × 1800m. Number of nodes =144.

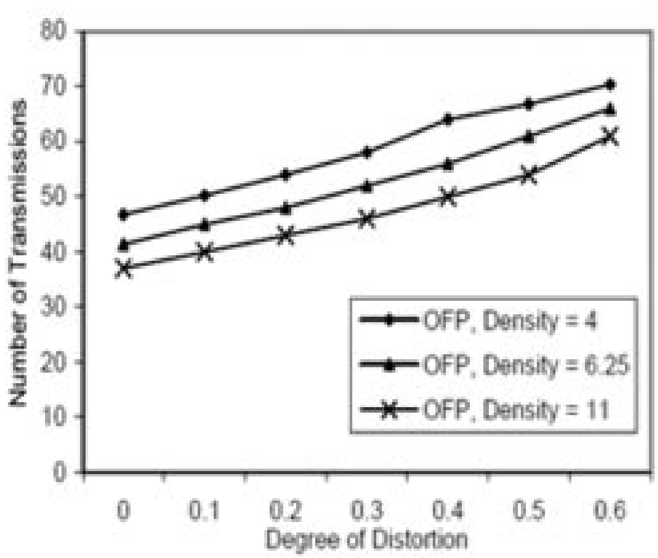

Figure 4: Effect of non-uniform propagation on OFP. Network size is 1800m × 1800m

which is the range in an ideal case. Contours of the terrain and obstructions like large buildings contribute in creating such non-uniform radio propagation. This sort of study is necessary, especially as the protocol is an extension of the Modified Covering Problem solution developed for an ideal case.

The purpose of the study is to see the performance of OFP in networks with non-uniform transmission ranges. As shown in the Figure [4], OFP's performance remains efficient even under such conditions. This can be attributed to fact that in OFP, the decision if a node retransmits or not is made locally at each node that receives the packet. Thus, even if a node very close to the strategic location does not get the packet, the reach ability is not affected as some other node that received the packet retransmits.

5. CONCLUSION

Building efficient broadcast protocols for ad hoc networks is challenging due to the dynamic nature of the nodes. In this paper an Optimized Flooding Protocol (OFP), a novel protocol for broadcasting, has been proposed. The protocol is based on a variation of the Covering Problem. OFP is performed in an asynchronous and distributed manner by each node in the network.OFP has a number of advantages over other approaches considered in the literature. The best feature of OFP is that a node needs only minimal local information to make a propagation decision and hence, OFP does not impose any bandwidth overhead in terms of hello messages. The efficiency of OFP remains very high even in large networks and OFP scales with density. Its efficiency in mobile networks and its robustness even in presence of transmission errors make it an ideal choice for MANETs and sensor networks.

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