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RESEARCH ARTICLE

Investigation of New Approach to the Design and Development for Clumping Algorithm in MANET

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Abstract: Mobile ad hoc networks (MANETs) consist of mobile devices that form the wireless networks without any fixed infrastructure or centralized administration. The infrastructure based cellular architecture sets up base stations to support the node mobility. Mapping the concepts of base stations into MANET leads to the design of logical clump, where the clump heads in every clump play the role of base station. Clumping in MANET is the virtual partitioning of the dynamic nodes into various groups. In this paper, we have proposed protocols and algorithms for efficient design of clumping in MANET. Closer Clump Detection Protocol (CCDP) has been designed to help the nodes to probe their immediate neighbours. Energy Based Clumping Algorithm (EBCA) has been proposed that uses the node mobility and its available battery power for calculating the node weights. A Broadcasting Range Adjustment Protocol (BRAP) has been proposed which allows the isolated nodes to adjust their ranges to remain connected with existing clump heads. Each of the work is evaluated separately to analyse their performances and compared with the competent results.

Keywords: MANET, clumping, clump head, CCDP, EBCA, BRAP

1. INTRODUCTION

"A mobile ad hoc network (MANET) is a collection of mobile nodes that dynamically self-organize into peer-to-peer wireless network without using any pre-existing infrastructure."

The term self-organize is a key term in this definition. This term mostly refers to the routing of the packets in the network in the absence of any fixed infrastructure. The nodes of the MANET organize themselves to route the packets of the neighboring nodes by creating a multi-hop networking scenario while on-the-fly. Thus, the specially designed nodes should have the capability of a router to forward the packets in addition to its normal job of a transmitter or receiver. The term self-organize is also equally important when the topology control is taken into consideration. In this context, the nodes try to adjust their transmission ranges to remain connected to each other in the dynamic network. In MANET every node finds the route by route request. Routing protocol plays a crucial role to send the data from source to destination that discovers the optimal path between the two communication nodes. Each protocol has its own rules (algorithm) to finds the route or maintenance the route. There are various routing protocol proposed by researchers. MANETs are facing various challenges for e.g. No central controlling authority, Mobility models, limited power ability, continuously maintains the information required to properly route traffic. Mobility models are also a factor that puts a deep impact over the performance of a MANET and need to be concerned.

Technologies of Mobile Ad Hoc Networks

The present day communication system demands a high speed and reliable network where a wired backbone can be connected to several wireless networks as in figure 1.1. The category of wireless networks could be cellular networks, wireless personal area network (WPAN), wireless local area network (WLAN) or mobile ad hoc network (MANET). Most wireless technologies operate in the Unlicensed Industrial Scientific and Medical (ISM) 2.4 GHz band. For this reason, the network may suffer interference from microwave ovens, cordless telephones, baby monitors and similar other appliances that use almost the same band. In the earlier versions of mobile ad hoc networks, the packet radios sponsored by DARPA were used for communication. However, currently three main communication standards with ad hoc capabilities are used to address a specific range of commercial applications. They are the IEEE 802.11 family of protocols, the high-performance LAN (HiperLAN) protocols and Bluetooth [2].

IEEE 802.11: The purpose of the IEEE 802.11 standard was to foster industry product compatibility between WLAN product vendors. The most popular and widely used Wi-Fi networking technology is based on the IEEE 802.11 specifications. Under the IEEE 802.11 standard, the mobile communicating devices in a network can work in two different modes. They are the infrastructure mode and ad hoc mode. Infrastructure mode wireless networking connects a wireless network to a wired network. It also supports central connection points for WLAN clients. A wireless access point is required for infrastructure mode wireless networking.

There are already significant empirical studies discussing about testing effectiveness and quality [1,2,3,5]but no systematic review have been done for summary and classification of all the combined approaches. In this thesis the state of art about combined software quality assurance will be presented. This thesis will cover the empirical research in this area. The state of the art will be examined on the principles of a systematic literature review from Kichenham to gain a solid overall impression.

HIPERLAN: The European counterparts to the IEEE 802.11 standards are the high performance radio LAN (HIPERLAN) standards defined by the European Telecommunication Standards Institute (ETSI). While IEEE 802.11 standards can use either radio access or infrared access, the HIPERLAN standards are based on radio access only [6]. Four standards have been defined for wireless networks by the ETSI.

•HIPERLAN/1: It is a wireless radio LAN (RLAN) without a wired infrastructure, based on one-to-one and one-to-many broadcasts. It is well studied for both ad hoc and infrastructure based networks. The standard covers the physical layer and the media access control part of the data link layer. The features of the standard include the transmission range of about 50m at a rate of 23 Mb/s.

•HIPERLAN/2: It has a transmission range of about 200mts for wireless Asynchronous Transfer Mode (ATM) networks. It offers a wide range of data rates from 6 Mbps to 54 Mbps and uses 5GHz radio frequency. It supports centralized and direct modes of operation. The former is used in the cellular network topology whereas the latter is used in ad hoc network topology. Basic services in HiperLAN/2 are data, sound and video transmission with emphasis given on the quality of service (QoS). This layer can also be used on the physical layer to connect IP and ATM networks. This feature makes HiperLAN/2 suitable for the wireless connection of various networks.

•HIPERLAN/3: It is also called as HIPERACCESS network that enables establishment of outdoor high speed radio access networks providing fixed radio connections to customer premises. It has a range of 500mts and provides a data rate of 25Mbps. This network can be used for wireless local loop (WLL) communications.

•HIPERLAN/4: It is also called as the HIPERLINK standard that provides high speed radio links for point-to-point static interconnections. The transmission has a range of about 200mts and operates on the 17GHz frequency range. It provides a data rate of 155 Mbps.

BLUETOOTH: Bluetooth is a technology for wireless body area network (WBAN) and wireless personal area network (WPAN) that provides short range radio links between portable devices such as mobile PCs and mobile phones. Bluetooth specifies 10mts radio range and supports up to seven devices in a master slave mode. The master permits slaves to transmit by allocating slots for voice or data traffic. Bluetooth uses a combination of circuit switching and packet switching [7].

Bluetooth wireless networks are classified into two network topologies named piconets and scatternets. In a picnic, two or more slave devices can share the same frequency hopping sequence. A piconet comprises one master station and up to seven active slaves can participate in data exchange. So it can form a point-to-point or point-to-multipoint design. A direct link can exist between a master and a slave but not between slaves. So data exchange between the slaves has to be routed through the master. Independent piconets that have overlapping coverage areas may form a scatternet. A scatternet exists when a station is active in more than one piconet at the same time. A slave can communicate with the different piconets it belongs to, in a time-multiplexing mode. When two piconets overlap, the master of one piconet serves as the slave of the other piconet. No device can serve as a master of two piconets. When more piconets overlap with each other, one master serves as a slave of two piconets. Thus multihop communication can be achieved through the scatternet concept, where several masters from different piconets can set up links among each other. The bluetooth applications span from wireless headset to PDAs, networked computer peripherals like printers, scanners, digital cameras etc.

2. CLUMPING IN MANET

Clumping in MANET [9] can be defined as the virtual partitioning of the dynamic nodes into various groups. Groups of the nodes are made with respect to their nearness to other nodes. Two nodes are said to be neighbor of each other when both of them lie within their transmission range and set up a bidirectional link between them. Clumps in MANET can be categorized as overlapping clusters or non-overlapping clumps as shown in figure 1.1.The small circles represent the wireless nodes in the network. The lines joining the nodes denote the connectivity among them. Clump control structure forms the virtual backbone of communication where clump heads are the communication hot spots. The clump head works as the local coordinator for its member nodes and does the resource management among them similar to a base station of cellular architecture. These clump heads are responsible for inter clump and intra clump communication. Inter cluster communication is made possible through the gateway nodes. A gateway node is a node that works as the common or distributed access point for two clump heads. When a node lies within the transmission range of two clump heads and supports inter cluster communication, it is called the ordinary gateway for two corresponding clumps. A node having one clump head as an immediate neighbor in addition to which it can reach a second clump head in two hops is a distributed gateway that is linked to another distributed gateway of other clump.

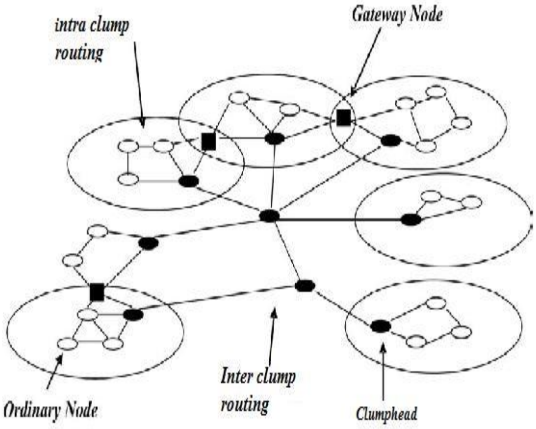

Figure 1.1: Overlapping and non-overlapping clumps with clump configuration

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3. CLUMP HEADS

Most clumping approaches for mobile ad hoc networks select a subset of nodes in order to form a network backbone that supports control functions. A set of the selected nodes are called clump heads and each node in the network is associated with one. Clump heads are connected with one another directly or through gateway nodes. The union of gateway nodes and clump heads form a connected backbone. This connected backbone helps simplify functions such as channel access, bandwidth allocation, routing power control and virtual circuit support [7]. Clump heads are analogous to the base station concept in current cellular systems. They act as local coordinators in resolving channel scheduling and performing power control [11]. However, the difference of a clump head from a conventional base station resides in the fact that a clump head does not have special hardware, it is selected among the set of stations and it presents a dynamic and mobile behavior [8]. Since clump heads must perform extra work with respect to ordinary nodes they can easily become a single point of failure within a cluster. For this reason, the clump head election process should consider for the clump head role, those nodes with a higher degree of relative stability [12]. The main task of a clump head is to calculate the routes for long distance messages and to forward inter-clump packets. A packet from any source node is first directed to its clump head. If the destination is located in the same clump, the clump head just forwards the packet to the destination node. If the destination node is located in a different clump, the clump head of the sending node routes the packet within the substructure of the network, to the clump head of the destination node. Then, this clump head forwards the packet to its final destination [13].

4. CLUSTERING ALGORITHMS IN MANET

In this section we describe following clustering algorithms.

4.1 Linked Cluster Algorithm(LCA)

The linked cluster algorithm (LCA) performs the job of initial three tasks such as topology sensing, cluster formation and cluster linkage. Whereas the link activation algorithm (LAA) performs the job of link activation between the nodes in the network. The routing algorithm covers the details of the routing operations for packet communication. The objective of the current work is to focus on the basis of neighborhood detection in changing topology and cluster formation. LCA could not meet certain criteria of the ad hoc network, but could become the base algorithm for other benchmark algorithms.

4.2 Lowest ID Algorithm(LID)

In this algorithm, every node is assigned with a unique non-negative identification number which is the deciding factor for the status of a node. In a mobile packet radio network, anode has no a priori knowledge of the locations of other nodes as well as the connectivity of the network. So, as a first task when the network comes up, the connectivity among the nodes is discovered by every other node. This is accomplished by every single node that broadcasts its own *ID* to its neighbors. At the same time it also receives the same from its neighbors if a node listens to all the *ID*s that are higher than its own *ID,* then it declares itself as the cluster head among its immediate neighbors. And the neighbor nodes whose status is not yet decided become the members of the newly selected head. This process is repeated till all the nodes are assigned with the role of ahead or a member of a cluster.

4.3 Highest Connectivity Algorithm(HC)

This algorithm aims to reduce the number of clusters in the network. In every cluster there exists a cluster head that belongs to the dominating set. In the HC algorithm, a node having highest degree of connectivity is selected as the cluster head. And the adjacent node whose status is not yet decided becomes the member of the selected cluster head. A higher degree of connectivity ensures efficient service to the member nodes by minimizing the number of heads. Here the efficiency means lowering the delaying communication through the head nodes

4.4 Mobility Metric Based Algorithm (MOBIC)

The algorithm uses mobility based metric as cluster formation basic and calculation of weights of the nodes in the network. MOBIC works almost same as the Lowest ID algorithm, where the node IDs are replaced by the relative mobility metrics of each node. In MOBIC the need of collecting the relative speed information from the neighbors degrades its performance, because continuous movement of the nodes in MANET may provide inaccurate mobility information during cluster set up time.

4.5 Distributed Mobility Adaptive Algorithm (DCA, DMAC)

This algorithm is a generic weight based cluster formation algorithm. DCA does not allow the change in network topology during the execution of the algorithm. A node having bigger weight among all its one-hop neighbors is selected as the cluster head. DMAC claims to be the most suitable algorithm for the cluster formation and maintenance in the presence of node mobility. It starts with the assumption that every node knows its own *ID*, *weight* and status in the network as well as the same for its one-hop neighbors. This proves that the cluster head is selected only with the knowledge of its local topology.

4.6 Weighted Clustering Algorithm(WCA)

In WCA re-election takes place with the occurrence of certain events i.e., when there is a demand for it. Node parameters like degree of connectivity, mobility, transmission power and available battery power are considered for selection of a cluster head and are given different weights depending on the network scenario. For example, sensor networks where energy is a major constraint, battery power could be given higher weight.

5. RELATED WORK

S.Rohini et al. in their paper [16] proposed a Probability Based Adaptive Invoked Weighted Clustering Algorithm (PAIWCA) that has been used to enhance the stability of the clusters by taking battery power of the nodes into considerations for the clustering formation and electing stable cluster-heads using cluster head probability of a node. The performance of their proposed algorithm outperforms WCA in terms of connectivity and stability.

Suchismita Chinaraet. al. [17] proposed a topology adaptive clustering algorithm for mobile ad hoc network that ensures better cluster stability and enhances the network life time by keeping a record of previous n set of movements of every node to predict their average mobility. To improve the cluster stability a node with lower mobility and higher battery power has been chosen for cluster head. The selection of non-volunteer nodes reduces the number of global reelection complexity and load on individual nodes.

Presented by Stefano Basagni [14], two distributed algorithms DCA (Distributed Clustering Algorithm) and DMAC (Distributed and Mobility-Adaptive Clustering) that requires only knowledge of the local topology at each node and allows each ordinary node to have direct access to at least a cluster head, thus guaranteeing fast inter and intra cluster communication between each pair of nodes. A weight based criteria has been introduced for the cluster formation that allows the choice of the cluster heads based on node mobility related parameters.

Vincent Bricardet. al. [15] proposed a local approach for the cluster heads election in a new distributed Mobility Prediction-based Weighted Clustering Algorithm with Local cluster-heads election (MPWCA-L). They have shown that their algorithm ensures a better stability of the dominant set and a better quality of service than WCA. Results show that their algorithm provides a better stability than WCA while the speed is increasing.

KaoutherDriraet. al. [18] presented a methodology for building distributed and dynamic virtual topology in ad hoc networks based on the concept of dominating sets. Their network topology can adapt to different mobility scenario without overhead. Their algorithm minimizes the number of exchanged messages and has the advantage of supporting scalability.

Yi Xu et al. in their paper [19] proposed a new clustering algorithm using the node mobility and energy information that maximizes the cluster stability by choosing the low mobility and high energy nodes to be the cluster heads and by keeping the constructed clusters unchanged to the extent of their maximum possible lifetime. Their proposed clustering algorithm performs equally well in small-scale ad hoc networks as in the large ones.

Yan Li et al. in their paper [20] have presented SACA (SCM-based Adaptive Clustering Algorithm), an accurate and efficient clustering scheme for various networks that can control the cluster size effectively and limit the number of orphan nodes. Their study indicated that SACA adaptively forms clusters to incrementally improve the clustering quality, taking node connectivity into consideration and it significantly requires less running time for random topologies.

6. PROPOSED WORK

Simulation based survey is made to study the strengths and weaknesses of existing algorithms that motivated us for the design of energy efficient clumping in MANET for longer network lifetime and reduced maintenance overhead. The protocols and algorithms have been proposed for the efficient design of clumping in MANET and evaluated separately to analyse their performances and compared with the competent results.

6.1 Closer Clump Detection Protocol (CCDP)

This detection protocol has been designed to help the nodes to probe their immediate neighbours. In this protocol, every node broadcasts its own information to the network, so that it is received by a node that lies within its transmission range. The receiver senses its neighbours and updates its neighbour table from time to time. This protocol is validated through simulation by using Color Petri Nets (CPN) prior to its implementation.

6.2 Energy Based Clumping Algorithm (EBCA)

This algorithm uses the node mobility and its available battery power for calculating the node weights has been proposed. A node having the highest weight among its immediate neighbours declares itself as the volunteer clump head. As the current head consumes its battery power beyond a threshold, non-volunteer clump heads are selected locally. The algorithm aims to utilize the battery power in a fairly distributed manner so that the total network life time is enhanced with reduced clump maintenance overhead. During the process of clumping, some isolated heads without having any members are formed. This increases the delay in communication as the number of hops in the routing back bone is increased.

6.3 Broadcasting Range Adjustment Protocol (BRAP) The broadcasting protocol has been proposed that allows the isolated nodes to adjust their ranges to remain connected with existing clump heads. The results show that, BRAP reduces the delay in communication by reducing the number of clump heads in the network. Validation for the base protocol NDP and algorithm EBCA are made through simulation by using the CPN tools.

7. CONCLUSION AND FUTURE SCOPE

In this paper protocols and algorithms are proposed for the efficient design of clumping in MANET. Closer Clump Detection Protocol (CCDP) has been designed to help the nodes to probe their immediate neighbours. Energy Based Clumping Algorithm (EBCA) has been proposed that uses the node mobility and its available battery power for calculating the node weights. The increase in the number of clump heads increases the length of the communication backbone in terms of number of hops. This may increase the end-to-end delay in communication for the packets. The proposed broadcasting range adjustment protocol (BRAP) helps the isolated nodes to get affiliated with existing clump heads instead of becoming new heads. It reduces the end-to-end delay by reducing the number of clump heads in the network.

The protocols in this paper mostly deal with the clump formation, clump maintenance and energy consumption that can be extended to some other areas of clumping in future likes load balancing among the clump head, fault tolerant clumping or privacy and security in clumped MANET.

REFERENCES

[1]C. Prehofer, C. Bettstetter. "Self organization in communicationnetworks: Principles and design paradigms".IEEE Communications Magazine. Vol. 43. Issue 7. 2005.pp. 78-85.

[2] J. Wu, J. Cao. "Connected k-hop clustering in ad hoc networks". ICPP. 2005. pp 373-380.

[3] I. Chatzigiannakis, S. Nikoletseas. "Design and analysis of an efficient communication strategy for hierarchical and highly changing ad-hoc mobile networks". MobileNetworks and Applications. Vol. 9. 2004. pp. 319-332.

[4] M. Frodigh, P. Johansson, P. Larsson."Wireless Ad Hoc Networking--The Art of Networking without a Network". Ericsson Review. Vol. 77. 2000. pp. 248-263.

[5] R. Rajaraman. "Topology control and routing in ad hoc networks: a survey". SIGACT News, Vol. 33. 2002. pp. 60-73.

[6] V. Kawadia, P. R. Kumar. "Power control and clustering in ad hoc networks". INFOCOM 2003, Twenty-SecondAnnual Joint Conference of the IEEE Computer andCommunications Societies. Vol.1. 2003. pp. 459-469.

[7] L. Bao, J.J. Garcia-Luna-Aceves. "Topology management in ad hoc networks". Proceedings of the 4th ACMinternational symposium on mobile ad hoc networking& computing. Vol. 9. 2003. pp. 129-140.

[8] C. R. Lin and M. Gerla. Adaptive clustering for mobile wireless networks. IEEE Journal on Selected Areas in Communications, 15(7):1265–1275, sept 1997.

[9] T. Ohtaaand S. Inoue and Y. Kakuda. An adaptive multi-hop clustering scheme for highly mobile ad hoc networks. In proceedings of sixth internationalsymposium on autonomous decentralized systems(ISADS'03), Pisa, Italy, April 2003.

[10] C. R. Lin and M. Gerla. A distributed control scheme in multi-hop packet radio networks for voice/data traffic support. In Proceedings of IEEEGLOBECOM, pages 1238–1242, 1995.

[11]M. Gerla, J. Tsai. "Multicluster, mobile, multimedia radionetwork". Wireless networks. Vol1. 1995. pp. 255-265.

[12] B. An, S. Papavassiliou. "A mobility-based clustering approach to support mobility management and multicast routing in mobile ad hoc wireless networks".InternationalJournal of Network Management. Vol. 11. 2001.pp. 387-395.

[13]Y.P. Chen, A. L. Liestman. "A zonal algorithm forclustering ad hoc networks". International Journalof Foundations of Computer Science. Vol.14. 2003.pp. 305-322.

[14] Basagni, S. "Distributed clustering for ad hoc networks." Parallel Architectures, Algorithms, and Networks, 1999.(I-SPAN'99) Proceedings. Fourth InternationalSymposium on, pp. 310-315). IEEE.

[15] Bricard-Vieu, V., Nasser, N., &Mikou, N. "A Mobility prediction-based Weighted Clustering Algorithm Using Local Cluster-heads Election for QoS in MANETs." Wireless and Mobile Computing, networking and Communications, 2006.(WiMob'2006). IEEE International Conference on. IEEE,2006.

[16] S.Rohini et al. in their paper " Consistent Cluster Maintenance Using Probability Based Adaptive Invoked Weighted Clustering Algorithm in MANETs" (2011).
[17] Chinara, S., &Rath, S.K."TACA: A Topology Adaptive Clustering Algorithm for mobile ad hoc network." The 2009 World Congress in Computer Science Computer Engineering and Applied Computing, July 13-16, Las Vegas, USA. Bentham Science Publishers, 2009.
[18] Drira, K., &Kheddouci, H. "A new clustering algorithm for MANETs." Telecommunications Network Strategy and Planning Symposium(NETWORKS), 2010 14th International, pp. 1-6. IEEE, 2010.
[19] Yi Xu et al. in their paper "MEACA: Mobility and Energy Aware Clustering Algorithm for Constructing Stable MANETs".
[20]Yan Li et al. in their paper "SACA: SCM-based Adaptive Clustering Algorithm"
[21] S. Basagni, I. Chlamtac, and A. Farago. A generalized clumping algorithm for peer-to-peer networks. In Proceedings of Workshop on Algorithmic aspect of communication (satellite workshop of ICALP), July 1997.