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Distributed Client Tracking in Autonomous Mobile Mesh Networks

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***Abstract*— Portable impromptu systems (MANETs) are perfect for circumstances where a settled framework is occupied or infeasible. Today's MANETs, be that as it may, may experience the ill effects of system parceling. This impediment makes MANETs inadmissible for applications, for example, emergency administration and front line interchanges, in which colleagues may need to work in gatherings scattered in the application territory. In such applications, intergroup correspondence is urgent to the group coordinated effort. To address this shortcoming, we present in this paper another class of impromptu system called Autonomous Mobile Mesh Network (AMMNET). Dissimilar to customary lattice organizes, the portable cross section hubs of an AMMNET are fit for taking after the cross section customers in the application territory, and sorting out themselves into a suitable system topology to guarantee great network for both intra- and intergroup interchanges. We propose a disseminated customer following answer for manage the element way of customer versatility, and present systems for element topology adjustment as per the portability example of the customers. Our recreation results demonstrate that AMMNET is powerful against system parceling and fit for giving high hand-off throughput to the versatile customers.**

Keywords—Mobilemesh networks, dynamic topology deployment, client tracking.

I. INTRODUCTION

Remote innovation has been one of the most changing and enabling advances as of late. Specifically, portable specially appointed systems (MANETs) are among the most prevalently concentrated on system communication advancements. In such a domain, no communication base will be needed. The portable hubs additionally assume the part of the switches, serving to forward information parcels to their destinations by means of different jump transfer. This kind of system is suitable for circumstances where an altered framework is inaccessible or infeasible. They are likewise a financially savvy arrangement on the grounds that the same impromptu system can be moved, and reused in better places at distinctive times for diverse applications.

One awesome test in planning strong MANETs is to minimize system parts. As self-ruling versatile clients move about in a MANET, the system topology may change quickly and erratically over the long run; and bits of the system might irregularly get to be apportioned. This condition is undesirable, especially for mission-discriminating applications, for example, emergency administration and front line interchanges. We address this challenging issue in this paper by proposing another class of powerful versatile specially appointed system called Autonomous Mobile Mesh Networks (AMMNET).

When a mesh node fails, it can simply be replaced by a new one; and the mesh network will recognize the new mesh node and automatically reconfigure itself. The proposed AMMNET has the following additional advantage. The mobility of the mesh clients is confined to the fixed area serviced by a standard wireless mesh network due to the stationary mesh nodes. In contrast, an AMMNET is a wireless mesh network with autonomous mobile mesh nodes. In addition to the standard routing and relay functionality, these mobile mesh nodes move with their mesh clients, and have the intelligence to dynamically adapt the network topology to provide optimal service. In particular, an AMMNET tries to prevent network partitioning to ensure connectivity for all its users. This property makes AMMNET a highly robust MANET.

The topology adaptation of an AMMNET is illustrated in Fig. 1:

- Fig. 1a: The mesh clients initially concentrate in one group. All the mesh nodes position themselves within the same proximity to support communications inside the group.
- Fig. 1b: The mesh clients move northwards and split into two groups. The mobile mesh nodes, in this case, reorganize themselves into a new topology not only to facilitate intragroup communications, but

also to support intergroup communications effectively preventing a network partition.

. Fig. 1c: The same mesh clients now move southeast and form three groups. The mobile mesh nodes adapt their topology accordingly to archive full connectivity for all the mesh clients.

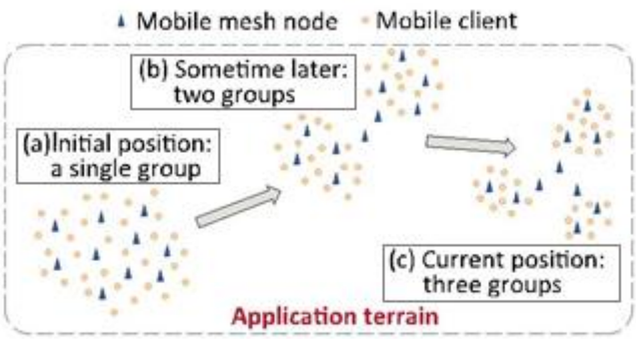


Figure1:topology adaptation of ammnet.

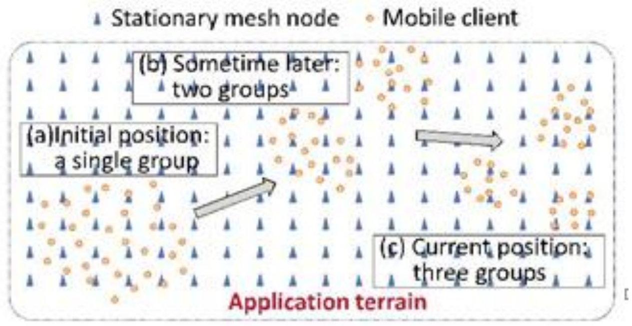


Fig. 2. Fixed grid-based square topology under three scenarios illustrated in Fig. 1.

AMMNET is a good candidate because it can adapt to a every dynamic environment..Delay tolerant network is another option to support opportunistic communications for mobile networks.

Our Challenges in designing the proposed AMMNET are two fold.First the mesh clents do not have knowledge of their locations making it difficult for the mobile mesh nodes to synthesize second, the topology adaptation needs to be based on highly effecient distributed computing technique.

II. DISTRIBUTED CLIENT TRACKING IN AMMNET

We first give a diagram of the AMMNET structure, and after that present how the versatile cross section hubs naturally adjust their areas to following portable customers.

A. *Ammnet Overview*

Like stationary remote cross section organizes, an AMMNET is a lattice based base that advances information for portable customers as demonstrated in Fig. 1. A customer can interface with any adjacent cross section hub, which helps hand-off information to the destination network hub by means of multihop sending. For simplicity of portrayal, in this paper we utilize the expressions "network hub" and "switch" conversely. Like stationary remote lattice systems, where switches are sent in settled areas, switches in an AMMNET can forward information for versatile customers along the directing ways manufactured by any current impromptu steering conventions, for instance, AODV. Not at all like stationary remote cross section systems, where switches are sent at settled areas, switches in an AMMNET are versatile stages with auton-omous development ability [5]. They are outfitted with situating gadgets, for example, GPS, to give navigational help while following versatile customers. Customers are not needed to know their areas, and just need to intermittently test guide messages. When network hubs get the reference point messages, they can distinguish the customers inside its transmission range. With this ability, network hubs can persistently screen the portability example of the customers, and move with them to give them consistent integration.

A couple of presumptions are made in our outline. We consider a two-dimensional airborne territory, where there is no obstruction in the target field. Network hubs can trade data, for example, their areas and the rundown of identified customers, with their neighboring cross section hubs. The radio scope of every hub is not an immaculate hover in an application area with snags. This component may influence the exactness of the sensing instrument and, to a minor degree, the scope. Notwithstanding, this does not influence the general materialness of the proposed strategies for AMMNETs. For effortlessness, we expect that the radio scope of both lattice hubs and customers is a flawless circle. .

- Intragroup routers. A mesh node is an intragroup router if it detects at least one client within its radio range and is in charge of monitoring the movement of clients in its range. Intragroup routers that monitor the same group of clients can communicate with each other via multihop routing. For example, routers r_1 and r_2 in Fig. 4 are intragroup routers that monitor group G_1.

- Intergroup routers. A mesh node is an intergroup router, i.e., square nodes in Fig. 4, if it plays the role of a relay node helping to interconnect different groups. For each group, we designate at least one intergroup router that can communicate with any intragroup routers of that group via multihop forwarding as the bridge router, for example, router b_1 for group G_1.

- Free routers. A mesh node is a free router if it is neither an intragroup router nor an intergroup router.

We consider a scenario where clients originate in one given location, and can be covered by the radio range of a single mesh node. Thus, the initial configuration of the AMMNET consists of only one intragroup router; and all remaining routers are free. In tracking the mobile clients, the mobile mesh nodes change their operation modes based on Algorithm 1 as follows:

- Adapting to intragroup movement. As a group of clients moves from place to place, the area they occupy may change over time. The intragroup routers must track these changes to move with the clients and dynamically adjust their topology accordingly to sustain the communication coverage for the clients.

- Reclaiming redundant routers. When the topology changes due to client mobility, some intra- and intergroup routers might become redundant and should be reclaimed as free routers for future use.

- Interconnecting gatherings. Customers of a gathering may park into little gatherings that move in distinctive headings. For this situation, some free switches ought to change their operation mode to end up intergroup switches to interconnect these partitioned gatherings.

Algorithm 1. Distributed Client Tracking for Router r.

```
for each Beacon message interval do
    switch mode of router r do
        case Intra-group
            if detect missing clients then
                Request the client list from neighboring
                intra-group routers;
                if all its clients are covered by neighbors
                then
                    Switch to the Intergroup mode;
                else
                    Assign free routers to navigate its
                    coverage boundary;
                end if
            end if
        case Intergroup bridge
            Piggyback its location in the forwarded
            packets;
            Retrieve the locations of other bridge routers
            and the identity of the intergroup routers along
            the bridge networks from the forwarded packets;

            Initiate topology adaptation if necessary
            (see Algorithm 3);
        case Free
            if receive the tracking request from intra-
            group routers then
                Navigate the assigned segment to detect the
                missing clients;
                if locate the missing clients then
                    Switch to the intra-group mode;
                    Request some of the free routers to follow
                    this new intra-group router;
                end if
            end if
    end switch
end for
return
```

Fig. 3. Autonomous airborne mesh networks for crisis management.

B. ADAPTING TO INTRAGROUP MOVEMENT

We review that every customer persistently telecasts guide message to advise its available inside the degree scope of an intragroup switch. At the point when this switch no more hears the normal signal messages, one of two conceivable situations may have happened. The main situation is shown in Fig. 5a. It demonstrates that customer c moves out of the communication scope of switch r into the correspondence scope of a neighboring switch r0 in the same gathering. The second situation is delineated in Fig. 5b. It demonstrates that the missing customer c moves from the correspondence scope of switch r to a space not at present secured by any of the switches in the gathering. The switch r can recognize the over two situations by questioning its neighboring switches for their arrangements of observed customers. In the event that c is in any of these rundowns, r confirms that the first situation has happened. For this situation, since a percentage of the neighboring switches give the scope to c, no further activity is needed. Then again, if none of the customer records incorporates c, which shows the second situation, topology adjustment is obliged to extend the scope to incorporate c at its new area.

Figure

C. RECLAIMING REDUNDANT ROUTERS

At the point when the intra- and intergroup switches are no more needed because of customer portability, the AMMNET ought to recover them for future utilization. We examine the instance of intragroup switches. Recovery of intergroup switches will be dealt with in Section 3. Consider the sample demonstrated in the right-hand side of Fig. 5b. All the customers in the radio scope of switch r are likewise secured by the neighboring intragroup switches. For this situation, switch r is no more required and can be recovered as takes after: Router r asks for the customers rundown of the neighboring intragroup switches. On the off chance that r identifies that every one of its customers are secured by the neighboring switches, it makes an impression on educate these neighbors of its aim to switch the operation mode. In the wake of getting the affirmation from every one of these neighbors, r can change to turn into an intergroup switch. There are three focuses important. To begin with, this changing convention is to maintain a strategic distance from the circumstance where numerous neighboring intragroup switches all the while switch their mode, rendering a few customers with no covering intragroup switches. Second, the repetitive in-tragroup switch can just proclaim itself as an intergroup switch, rather than a free switch, on the grounds that it may be a scaffold interconnecting two apportioned gatherings. Third, this exchanging convention may produce more repetitive intergroup switches,

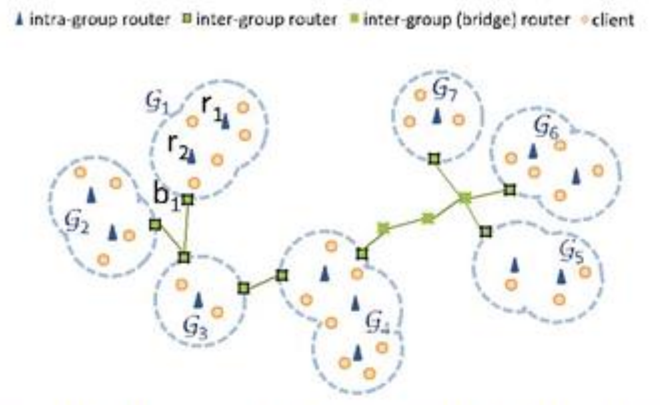


Fig. 4. AMMNET Framework. Routers are partitioned into two groups. Intragroup routers support intragroup communication; and intergroup routers prevent a network partition.

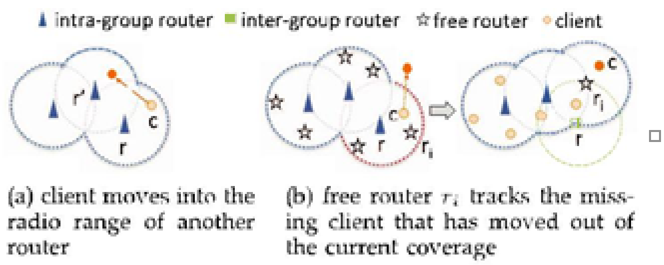


Fig. 5 Tracking the clients. If the client moves from one router area to another router area as in (a), no action is required. If a client moves out of the current network coverage area as in (b), free routers are triggered to track the missing clients.

C. INTERCONNECTING GROUPS

Given an arrangement of intragroup switches that give communication scope for a gathering of versatile clients, these portable clients may move out of this scope range in littler gatherings. To keep away from system dividing, each of the new gatherings must be upheld by their nearby intragroup switches; and intergroup switches must sort out themselves into a subnetwork of extensions to backing the intergroup correspondences.

Give us a chance to consider the case in Fig. 6a. We at first have a solitary gathering of portable clients with a neighborhood system comprising of intragroup switches r1 and r2. At some point later, some of these customers are moving far from this scope zone in three separate bearings as demonstrated in Fig. 6b. Give us a chance to concentrate on gathering G2. As the two customers of this gathering move out of the introductory scope zone, a free switch joins the system as another intragroup switch to give scope to these two withdrawing customers. This is done as examined in Section 2.2. As of now, r2 can change itself to turn into an intergroup switch, as talked about in Section 2.3, on the grounds that it no more has any customer inside its radio reach. r2 now serves as a system extension to interconnect the two gatherings G1 and G2 as demonstrated in Fig. 6b. On the off chance that the gathering G2 keeps on moving more distant far from G1, the above methodology rehashes and more intragroup switches in G2 get to be intergroup switches. They develop the system connect, one intergroup switch at once along the direction of the gathering G2, to keep up the integration in the middle of G2 and G1. Fig. 6c outlined three spanning systems associated with interconnect bunches G2, G3, and G4 to their unique gathering G1. These connecting systems keep up the integration for all customers and avoid system parcel. In the wake of interconnecting all the gatherings, free switches can be redistributed such that all the parti-tioned gatherings have a comparable number of free switches to enhance following productivity. After redeployment, every free switch sends its recognizable proof to the extension switches in its gathering, and thus, any scaffold switch can track the quantity of free switches in its gathering.

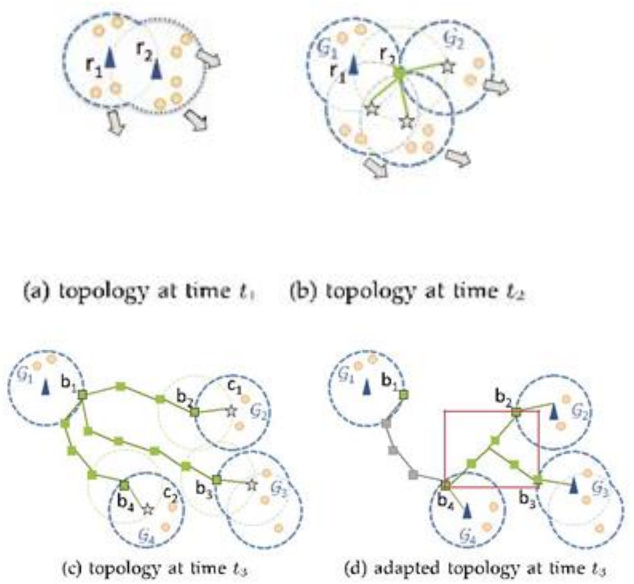


Fig.6 group partition

III. Topology Adaptation

The convention talked about so far guarantees that the lattice hubs keep up the network for all customers. The subsequent systems, then again, may bring about long end-to-end delay with conceivably numerous superfluous intergroup switches in light of the fact that the connecting systems are developed freely.

A. local adaptation

Consider again the sample in Fig. 6c. To spare intergroup switches, we can supplant three autonomous crossing over net-lives up to expectations with a star system as demonstrated in Fig. 6d. A star topology by and large gives shorter hand-off ways, and, subsequently, requires less intergroup switches. To build a star topology, we let the scaffold switches trade their area data shrewdly, and perform nearby adjustment as indicated in Algorithm 2 when some extension switches recognize that they are near to one another.

Algorithm 2. Topology Adaptation (initiated by router r).
input:

(Collected in Algorithm 1) Rb: set of bridge routers known by r opportunistically; Lb: location of router b 2 Rb; Ri: set of intergroup routers connecting all known bridge routers b 2 Rb

1: if number of free routers in r's group < _ then
2: Call Algorithm 3 to perform global adaptation;
3: else
4: Compute the single star topology S for Rb;
5: Build a bridge network B connecting to any bridge router b^0 62 Rb;
6: N_i^0 number of intergroup routers needed for S and B;
7: if N_i^0 _ _jRij then
8: Trigger the assigned intergroup routers to adapt their topology to S [B after a three-way handshaking;
9: Reclaim the rest of intergroup routers to the free-router poor;
10: end if
11: end if
12: return

B. Global adaptation

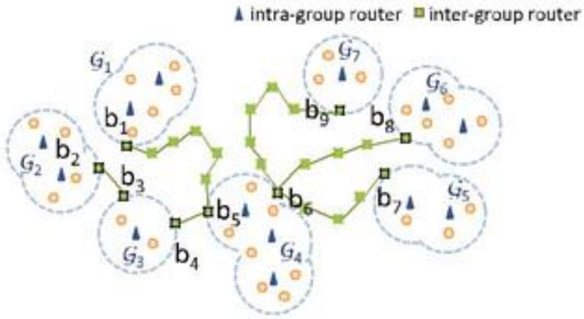
Nearby topology adjustment gives neighborhood streamlining. It is attractive to likewise perform worldwide topology adjustment to attain to worldwide optimality. The inspiration is to attain to better general end-to-end defer and free up intergroup switches for resulting nearby adjustment. A basic alternative for worldwide advancement is to apply Algorithm 2 to develop a star system for all the scaffold switches in the AMMNET. Such a star system, nonetheless, would be wasteful and require more intergroup switches than should be expected, particularly.

Algorithm 3. Hierarchical Star Topology Construction.

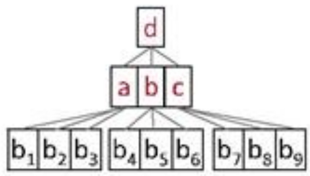
Input: M: size of a bounding box
Broadcast a message to all the bridge routers to collect information and coordinate global adaptation;
Rb set of bridge routers;
Lb location of routerb 2 Rb;
Ri set of nonbridge intergroup routers;
Classify all r 2 Rb into cluster Ci; i ¼ 1; 2; . . . ; k;
M jCkj;
T R-Tree(Rb; Lb; M);
for all vertex v in T do
while v is a leave node and any ri; rj 2 v belong to the same group do
Remove rj from v;
end while
if not all elements r 2 v are interconnected then
Deploy a subset of intergroup routers in Ri as a star topology to connect all r 2 v and remove those routers from Ri;
end if
end for
Reclaim the remaining routers in Ri as free routers;
returen

By applying the progressive grouping system to the scaffold switches in an AMMNET, we can send a star system to interconnect the extension switches in every rectangle at the leaf level of the R-tree. At each of the resulting more elevated amount in the R-tree, the star systems in every bouncing rectangle are further interconnected into a star system in a progressive way. This interconnection procedure is rehashed until it achieves the rectangle at the base of the R-tree. Give us a chance to consider the sample in Fig. 7a with seven gatherings of customers. On the off chance that the wanted number of articles every bouncing rectangle M is 3, the R-tree is developed as demonstrated in Fig. 7c with the relating progressive star system outlined in Fig. 7d. In this illustration, the star system of rectangle an interconnects the scaffold switches b1, b2, and b3. The star systems for the rectangles b and c are developed comparably. At the following more elevated amount, i.e., the foundation of the R-tree, a star system is made for the rectangle d to interconnect the three star systems of rectangles a, b, and c, separately. For every bouncing rectangle, the star systems from the lower level are interconnected through the extension switches nearest to the middle of their separate jumping rectangle as represented in Fig. 7d. This plan enhances the general end-to-end delay for the system.

To further lessen the quantity of intergroup switches, we consider two extra methodologies. In the first place, we don't have to fabricate a star switch for the extension switches at some leaf rectangle in the R-tree in the event that they are as of now interconnected. For example, the extension switches b1, b2, and b3 of rectangle an in Fig. 7d needn't bother with a star system. Second, if a customer gathering has various scaffold switches, stand out necessities to take an interest in the star system. The other scaffold switches can be liberated for future utilization. See the sample in Fig. 7d. Since both extension switches b5 and b6 in rectangle b are related with customer gathering G4, b6 is uprooted, i.e., liberated, before interfacing b4 and b5 as a star topology. The aftereffect of neighborhood adjustment, connected to Fig. 7a, is given in Fig. 7b. Contrasting Figs. 7b and 7d, we watch that worldwide adjustment attains to two objectives, to be specific better end-to-end defer and utilizing less intergroup switches.

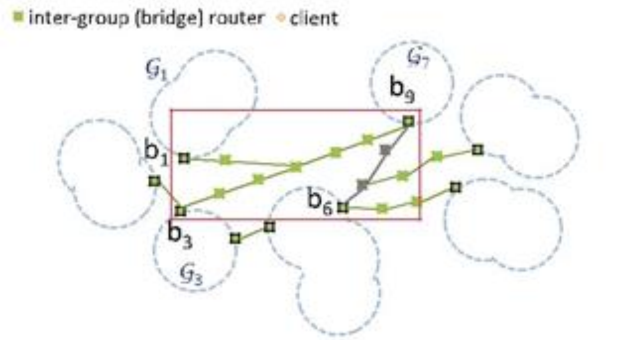


(a) Without adaptation, routers are deployed along clients' trajectory

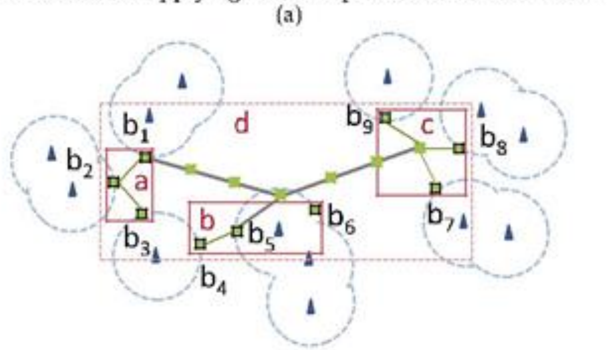


(c) R-Tree built based on the topology in (a)

Worldwide adjustment is activated when system part ing is going to happen at some customer gatherings because of absence of accessible free switches. We review that every customer gathering has a scaffold switch that tracks the quantity of free switches for this gathering. At the point when this number drops underneath a predefined edge, i.e., _ in Algorithm 2, which is situated to one free switch in our usage, the comparing extension switch goes about as a direction and shows a message to all the scaffold switches in the system to start worldwide adjustment (streamlining). Any extension switch accepting this message answers its area and the quantity of generally accessible free switches (if known) to the facilitating scaffold switch.



(b) The result of applying local adaptation to the network in (a)



(d) Cluster groups as a hierarchical star topology based on R-Tree in (c)

Furthermore, the facilitating extension switch likewise needs to gather the data about all the intergroup switches. To this end, we let every intergroup switch piggy-backs its ID and area in the answer message of any scaffold switch. At the point when the organizer gets positive answers from all the extension switches, it continues to begin the adjustment process. It executes Algorithm 3 to develop the progressive star system and produce the comparing task list. Every intergroup switch is appointed to the sending position in the various leveled star tree that is nearest to its unique area. This procedure lessens the separations the intergroup switches must go to their positions in the new topology

IV. EVALUATION

We direct broad recreations, actualized through NS2 [19], to study the capacity of AMMNET in adjusting to the element development of versatile customers and the information sending productivity of such systems. Our execution assessment thinks about the accompanying system plans:

.Grid-network. This basic plan utilizes a framework based square topology for the versatile lattice hubs. This portable lattice system takes after the clients by following and taking after one haphazardly chose customer. The system keeps up the same framework topology as it moves over the application territory.

AMMNET. This is our configuration of AMMNET, in which switches adjust their areas utilizing just provincially stored area data about a percentage of the extension switches. Worldwide adjustment is additionally performed when the quantity of free switches at some client gatherings drops underneath a predefined limit.

Global-AMMNET. This is like the above AMMNET, aside from that worldwide adjustment is every shaped by an arbitrarily chosen span switch at whatever point any customer moves out of the current system scope zone.

Oracle. This is an incorporated plan that accept area data of all customers is accessible. The switches can move to the appointed areas in the system immediately as soon as possible. This plan is just utilized as a headed with the end goal of execution correlation. Not at all like AMMNET that uses the areas of the extension switches to approx-imate the circulation of the client assembles in the application landscape and develops the R-tree in light of these switches as needs be, Oracle builds the R-tree utilizing the definite areas of the versatile clients. At the point when there are insufficient accessible switches to give full integration to all the customers, this plan favors client bunches (R-tree hubs) with a higher thickness of customers.

- performance on network coverage
- performance on data forwarding
- System overhead

V.RELATED WORK

We group the works identified with AMMNET into three classes: 1) stationary remote lattice systems: AMMNET is another sort of cross section systems, yet bolsters dynamic topology adjustment, 2) sensor covering: the strategies for sensor covering is identified with the outline of covering portable customers in AMMNET, and 3) area following: following versatile customers in AMMNET is an utilization of area following.

Stationary remote cross section systems. In the most recent couple of years, stationary remote cross section systems have been created to empower last-mile remote broadband access . Past take a shot at stationary lattice systems concentrates on directing activity in a cross section topology to best use the system limit. A few literary works further study how to use nonoverlap-ping channels and unequivocally control the system topology to enhance the

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system limit of a stationary cross section. Our work expands on the idea of such a stationary cross section based foundation, and stretches out it to empower correspondence among parceled versatile customers. We ponder dynamic sending of an AMMNET in this work, and leave using non overlapping channels to enhance system limit as our future study.

Sensor covering. Our work on switch arrangement is additionally identified with late chip away at sensor covering in a stationary sensor system. These plans guarantee that every point in a target field is in the inside of at any rate k diverse sensors. A few work further considers vitality effectiveness, and allocates every sensor a slumber dynamic timetable to ensure sensor spread and, in the meantime, draw out the lifetime of a sensor system. All the more as of late, some work misuses sensor portability to enhance the execution of sensor covering. A game plan toward oneself proto-col is proposed in to empower haphazardly scattered sensors to naturally move to the target arranged positions. As opposed to conveying stationary sensor hubs to cover the whole observing field, an option is proposed in to utilize portable donkeys to move around distinctive screen ing territories and assemble information along the navigated ways. All the above studies concentrate on sending sensor hubs to screen a given target region. Our work contrasts from the sensor scope plots in that it assembles an element network foundation for versatile customers that have flighty moving examples and move around a non predefined application landscape.

CONCLUSION

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REFERENCES

[1] E. Dahlman, S. Parkvall, and J. Sko¨ld, 4G LTE/LTE-Advanced for Mobile Broadband. Academic, 2011.
[2] L. Nuaymi, WiMAX: Technology for Broadband Wireless Access. John Wiley & Sons, 2007.
[3] K. Fall, “A Delay-Tolerant Network Architecture for Challenged Internets,” Proc. ACM Special Interest Group on Data Comm., 2003.
[4] A. Petkova, K.A. Hua, and S. Koompairojn, “Processing Approx-imate Rank Queries in a Wireless Mobile Sensor Environment,” Proc. 11th Int’l Conf. Mobile Data Management (MDM), 2010.
[5] “Quadrocopter LLC,” http://quadrocopter.us/, 2013.
[6] R. Roy, Handbook of Mobility Models and Mobile Ad Hoc Networks. Springer, 2010.
[7] Y.-C. Chen, E. Rosensweig, J. Kurose, and D. Towsley, “Group Detection in Mobility Traces,” Proc. Sixth Int’l Wireless Comm. and Mobile Computing Conf. (IWCMC ’10), 2010.
[8] T. Camp, J. Boleng, and V. Davies, “A Survey of Mobility Models for Ad Hoc Network Research,” Wireless Comm. and Mobile Computing, vol. 2, no. 5, pp. 483-502, 2002.
[9] X. Hong, M. Gerla, G. Pei, and C. Chiang, “A Group Mobility Model for Ad Hoc Wireless Networks,” Proc. Second ACM Int’l Workshop Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM ’99), 1999.
[10] K. Blakely and B. Lowekamp, “A Structured Group Mobility Model for the Simulation of Mobile Ad Hoc Networks,” Proc. Second Int’l Workshop Mobility Management & Wireless Access Protocols (MobiWac), 2004.

[11] Y. Zhang and Y. Fang, “ARSA: An Attack-Resilient Security Architecture for Multihop Wireless Mesh Networks,” IEEE J. Selected Areas in Comm., vol. 24, no. 10, pp. 1916-1928, Oct. 2006.
[12] J. Sun, C. Zhang, and Y. Fang, “A Security Architecture Achieving Anonymity and Traceability in Wireless Mesh Networks,” Proc. IEEE INFOCOM, 2008.
[13] B. Salem and J. Hubaux, “Securing Wireless Mesh Networks,” IEEE Wireless Comm., vol. 13, no. 2, pp. 50-55, Apr. 2006.
[14] T. Shuai and X. Hu, “Connected Set Cover Problem and Its Applications,” Proc. Second Int’l Conf. Algorithmic Aspects in Information and Management, pp. 243-254, 2006.
[15] R. Gandhi, S. Khuller, and A. Srinivasan, “Approximation Algorithms for Partial Covering Problems,” Proc. 28th Int’l Colloquium Automata, Languages and Programming, pp. 225-236, 2001.
[16] A. Guttman, “R-Trees: A Dynamic Index Structure for Spatial Searching,” Proc. ACM SIGMOD Int’l Conf. Management of Data (SIGMOD), 1984.
[17] J. MacQuene, “Some Methods for Classification and Analysis of Multivariate Observations,” Proc. Fifth Berkeley Symp. Math. Statistics and Probability, 1967.

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