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Packet Reserving and Clogging Control via Routing Aware Packet Reserving Framework in MANET

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***Abstract*—**In MANET, mobile nodes communicate with each other using the wireless channel where transmission takes place with significant interference. The wireless medium used in MANET is a shared resource used by all the nodes available in MANET. Packet reserving is one important resource management scheme which controls the allocation of bandwidth among multiple flows through node cooperation in MANET. This paper proposes packet reserving and clogging control via Routing Aware Packet Reserving (RAPR) framework in MANET. It mainly focuses the end-to-end routing condition with maximal throughput. RAPR is complimentary system where the packet reserving utilizes local routing information available in each node. Path setup in RAPR estimates the security level of the system, and symbolizes the end-to-end routing by controlling the clogging. RAPR reaches the packet to the destination with high probability ratio and minimal delay count. The standard performance measures such as network security level, communication overhead, end-to-end throughput, resource utilization efficiency and delay measure are considered in this work. The results reveals that the proposed packet reservation and clogging control via Routing Aware Packet Reserving (RAPR) framework performs well for the above said performance measures compare to the existing methods.

***Keywords*—**Packet reserving, Clogging control, Packet reservation in MANET, RAPR.

I. Introduction

MOBILE nodes communicate with each other using wireless channel where transmissions take place with significant interference. To expand a high-performance mobile ad hoc network, a key step is to develop scheduling algorithms. More specifically, scheduling algorithm stops a subset of connections with respect to the known network state information to avoid unwanted interruptions and network collisions.

Wireless medium is a shared resource, which is used by all nodes in the network. Throughput measurement, efficient controlling of the access to insufficient resource is a complicated task. Resource management schemes in mobile ad-hoc network play a chief role in achieving the task. Packet reserving is one such resource management scheme which controls the allocation of bandwidth among multiple flows through node cooperation. Packet reserving focuses in solving the problems associated with multiple sessions, within a single node, shares the wireless link.

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II. Related Work

Position-based Opportunistic Routing (POR) protocol [1] takes benefit of the stateless possessions of geographic routing and transmits to the wireless medium. When a data packet is sent out, some of the neighbor nodes have overheard and the transmission will offered as forwarding applicant. The concept of in-the-air backup considerably enhances the robustness of the routing protocol and decreases the latency and duplicate forwarding source by local route repair.

In actuality, due to the broadcast environment of the wireless medium, a single packet transmission will lead to multiple responses. Single packet transmission is used as considerably enhanced with the strength of the routing protocol. The perception of such multicast-link routing strategy has already been established in opportunistic routing. Conversely, most of them use link-state style topology database to decide and prioritize the forwarding candidates for resource management. In order to acquire the inter node loss rates, periodic network-wide measurement is requisite, which is unrealistic for mobile environment.

As declared, the batching used in [1], [2] proved that protocols also has a tendency to delay packets and is not preferred for much delay sensitive applications. Recently, location-aided opportunistic [3] routing honestly uses location information to direct packet forwarding. Conversely, just similar to the other opportunistic routing protocols, still measured for static mesh networks and focus on network throughput. The robustness bring upon by opportunistic forwarding has not been well explored for packet reserving.

Continuous user authentication and intrusion detection in high security as described in [4], to solve the security problem for a large network with a variety of nodes. Distributed continuous user authentication and intrusion detection scheduling problem fails to consider more node's states in making the reserving decisions in MANET.

Network partitions can occur regularly, since nodes move generously in a MANET, causing some data to be often inaccessible to some of the nodes. Therefore, data accessibility is repeatedly a significant performance metric in a MANET. Data are typically replicated at nodes, other than the innovative owners, to increase data accessibility to handle with recurrent network partitions. In universal, replication concurrently improves data accessibility and reduces query delay, query response time, in a MANET. Mobile nodes together have adequate memory space to hold together all the replicas and the creative data.

Joint topology control and authentication design in mobile ad hoc networks with cooperative communications is formulated in [5], as a discrete stochastic optimization problem. Discrete stochastic optimization does not necessitate prior faultless channel status and channel estimation. Topology Control and Authentication Design fails to deal with the imperfect routing knowledge and dynamic changing topology. To achieve this, reserving scheme holds the challenging task such as changing topology, multi hops and shared wireless medium in mobile ad-hoc network. In this work, route aware concept is explained to have the knowledge of route conditions. The condition refers to the quality of the channel which measured in terms of suitable metrics.

Route conditions in wireless networks are broadly classified as local and end-to-end route conditions. For mobile ad-hoc networks, local and end-to-end routing is different. The difference between the local and end-to-end routing information is better by considering their typical characteristics. Local routing information consider four categories as frequency monitoring of the route state, granularity of route state, accuracy and measured-time with respect to packet delivery.

Typical parameters are used to represent the local route information such as established signal strength, signal-to-noise values, queue-length, burst-error mode, packet losses, and single hop delay and link lifetime. Whereas, parameters that perhaps symbolize the end-to-end channel conditions are path lifetime, end-to-end packet delay and queue length at each node.

III. Theory of Proposed Routing Aware Packet Reserving Framework

In this proposed work, focus is made on end-to-end route awareness and represents the end-to-end route quality in terms of path lifetimes. Routing Aware Packet Reserving (RAPR) framework is developed in MANET that takes into account both the clogging state and the end-to-end throughput maintenance.

During the path setup in RAPR, estimates of the path lifetimes are collected and stored. The path lifetime value is used as a parameter to symbolize the end-to-end routing by controlling the clogging. During packet reserving, RAPR selects packets, which has high probability of reaching the destination, and takes into account the cost of a link. The break gives priority to flows that have a longer regularize with path residual lifetime backlog queue.

A. Architecture of Routing Aware Packet Reserving Framework in MANET

RAPR reserving framework for mobile ad hoc networks takes into account local clogging information and end-to-end throughput information. RAPR begin with describing the importance of considering route awareness in general and delay in particular. RAPR formally define the problem and describe the approach to resolve the effective resource allocation based on node clustering, node cooperation and higher security level. The architecture diagram of RAPR framework is shown in Fig. 1.

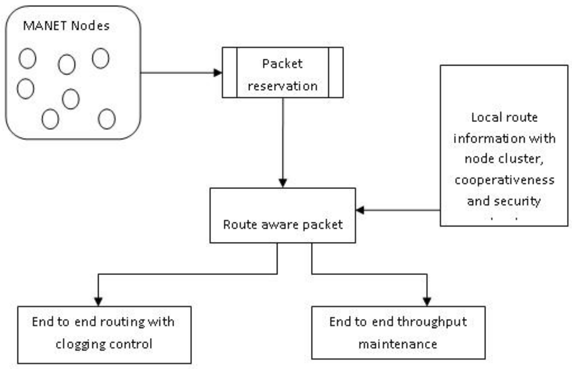

Fig. 1 Overall architecture diagram of RAPR framework

Fig. 1 describes, set of nodes in mobile ad-hoc network contains the packet for processing. Initially, packets are reserved using the routing aware packet reserving. The packet reserving in RAPR framework uses the local route information. The location route information for packet reserving is based on the node clustering, cooperativeness and security level. RAPR framework uses the routing quality to attain the end to end route information with clogging control and maximal throughput maintenance.

B. Problem Formulation

RAPR framework is a key idea is represent end-to end route quality in terms of throughput maintenance. The network security level reflects the current end-to-end route state. The route state keeps changing continually which has temporal interval for which they are valid. RAPR define the time interval for which the path associated for a flow of packets. If the time taken to perform each and every link of path ‘Q’ from node ‘i’ to node ‘j’ is estimated as d_1, d_2, $d_3, \ldots\ldots, d_n$ then the delay time is,

$$Q_{i,j} = \min(d_1, d_2, d_3, \ldots, d_n) \tag{1}$$

Path ‘Q’ delay time value is computed using (1), where the packet reserving performed with shortest path travel earlier approach. Shortest path earlier approach selects the packets which traversed for shortest distance, so that the remaining packets are reserved. The remaining packets lifetime is typically obtained using inference technique which incorporates with local route information.

A packet flow, along with its start and end times, is also defined by its divide-line and continuous period in RAPR framework to identify the packet transfer rate with effective resource utilization. A divide-line is the duration of time during which an attempt to transmit a packet from source to destination mobile nodes. RAPR framework frequently uses the divide-line in MANET to handle the packet reserving. The continuous episode denotes the time during which the flow receive the packet service. It is to be noted that after a continuous episode, the source pauses for some time and start transmitting on a different path with next reserved packet. Therefore it is important for all the packets of a flow to reach its destination successfully before the end of continuous episode.

For any specified moment of time, RAPR deal with single value of divide-line and continuous episode for any given flow, as RAPR have information about the node clustering route, node cooperation and security level values. Using the local route information RAPR framework, packet queued at the intermediate node reach the destination after the continuous episode.

C. Packet Reserving on Mobile Nodes

Each packet flow 'i' in RAPR running through a path is described with tuples $\{R_i, D_i, b_i, t_i, s_i, l_i\}$. R_i is the least amount of packet inter arrival time, D_i is the highest amount packet transmission time over a link. $b_i, and\ t_i$ are begin and end of the episodes of a packet flow. Finally s_i and l_i are the sets of continuous duration between the link and divide-line episodes respectively. $s_i, and\ l_i$ represent single continuous episode of packet flow 'i'. The relationship among s, e is illustrated in Fig. 2.

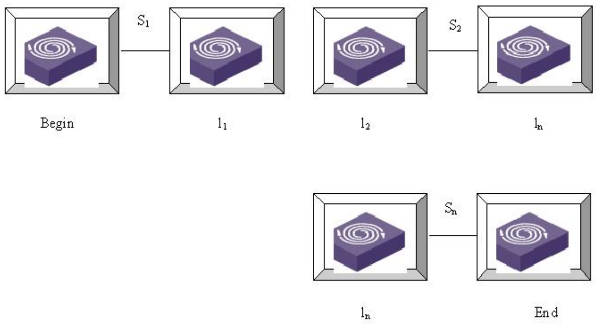

Fig. 2 Continuous Episode of Packet Flow in RAPR

Fig. 2 illustrates the continuous flow of the packets from begin to end of the mobile nodes with intermediate node links. RAPR span of a packet flow 'pf' as the interval {b, t}. The packet flow 'pf' served within this span. Let's define a packet reserved example 'E', as a sequence $\{pf_1, pf_2, \ldots\ldots, pf_n\}$. Formally a packet for E seen as a function H, which defined as

$$G : R \rightarrow \{pf_1, pf_2, \ldots, pf_n\} \cup \{\varphi\} \quad (2)$$

where, G (p ⊆ security-span (pf_n)) =pf_n. That is, n^{th} packet flow is served at time p. Further G (p) = φ means no packet flow is being served. At moment p_i, a packet belongs to flow 'pf' receives a service (G (p_i,) = pf) at any of the mobile nodes. The service at the one before the last node is performed, and then the packet transferred end to end with maximal throughput. Further, to denote the pending state of any packet flow 'pf', indicating the amount of workload remaining to be served for the queue at any time moment 'p', at any node, define residue of flow as γ (pf, p).

The important optimizing factors in RAPR framework is defined as the amount of packets that remain in the network at the end of their respective continuous episode of all the packet flows. The amount of packets that remain in the network defines the resource utilization of RAPR framework.

$$\sum_{i=1}^{n} \gamma\left(i, S_i^p\right) \quad (3)$$

$$\sum_{i=1}^{n} pr\left(i\right) \quad (4)$$

where, $pr(i) = \gamma(i, s_i^p)$. s_i^p is the set of continuous duration between the link at time 'p'. For each packet flow, the reserved packets gains the merit based on the number of completely served packets. Packets which do get transmitted for a few hops get transmitted to the intermediate nodes for the merit of the effective resource utilization in MANET. The RAPR design a framework, which over an episode attains maximum throughput and minimum delay time, and also fairly distributes the achieved throughput among all flows. Minimizing delay time served in two purposes where, initial work it reduces the delay and second, it reduces the loss due to link breakages.

D. Single RAPR Model with Multiple Packet Flows

RAPR consider a simple model with multiple flows over a single bottleneck link. After the single shared link, these flows use different links with different resources. RAPR assume a routing packet reserve form which schedules these packet flows T_i. Let us consider a single continuous episode o of "n" flows, with arrivals within this continuous episode, and no further arrivals. That is, RAPR take a single snapshot in time of 'n' flows with each flow having single continuous episode of varying durations. For simplicity, let all flows have same R = 1, and D = 1. Therefore, T_i reserve the packet in s_{max} period, where s_{max} the maximum continuous episode of packet is flow and o_i represents the number of packets existing for packet flow 'i'. The maximum number of packets existing in all the queues is

$$o_{sum} = \sum_{i=1}^{n} o_i \quad (5)$$

Let call this value as o_{sum}. Therefore, percentage ratio of throughput would be $\frac{o_{max}}{o_{sum}}$. Now, adopt a fairness criterion, where ratio is maintained across all the flows. In other words, the throughput measurement is proportionately distributed across all the flows. The idea here is that all RAPR treated fairly by assigning the proportionally equal throughputs. That is, for each flow i, the throughput receive is

$$Throughput\left(packet\ flow\ i\right) = o_i * \frac{o_{\max}}{o_{sum}} \quad (6)$$

The rationale behind (6) is based on the argument that shorter continuous episode of flows are merely due to the inherent property of ad-hoc networks. Therefore, penalizing packet flows follows the inherit properties of the local route network. The local route network follows the clustering of nodes which is reorganized on its own self with the evaluation of normal co-operative mobile nodes. The node clustering prohibits unauthorized node to engage in the communication between the nodes in ad-hoc network. The reorganized nodes are clustered to avoid the frequent dropping of packets leading to secure communication among the nodes using local route inherit properties in RAPR framework.

E. Algorithmic Description of RAPR Framework

RAPR consider end to end routing condition represented as enhanced network lifetime for route awareness, and also included a queue size parameter to make the scheduling scheme with clogging control. The combination of parameters avoids the clogging and reduces the accumulation of packets at the end of flow on time. A single queue with multiple packet flows is maintained in RAPR framework, and described through algorithmic flows.

Begin Packet Reserving in RAPR

Step 1. Consider the set of packets 'p'
Step 2. From set of 'p' packets Formulize
Step 3. Select the queue for packet reserving, such that for every queue q = TRUE in local routing mobile nodes
Step 4. If clogging occurs then
Step 5. Fails to perform end to end routing
Step 6. Else
Step 7. End to end routing performed with node clustering, cooperation and security factors
Step 8. End If
Step 9. Follows the shortest path travel earlier approach in RAPR
Step 10. Attain maximal throughput from source to destination mobile nodes.

End

RAPR performance varies as the accuracy of link inference varies. A set of packet flow in mobile nodes attains the end to end throughput maintenance through RAPR framework. The notion of packet reserving takes RAPR framework to make the effective resource utilization decisions for given values. Further, neighbor management and packet reserving list scheme in RAPR attains the security level with minimal cost average.

IV. Experimental Set-up of RAPR Framework

Packet reserving in mobile ad-hoc network via routing aware packet reserving framework is evaluated using NS2 to estimate the performance. The RAPR framework is evaluated in an efficient manner using 45 nodes in an area of 950 * 950 m. The nodes' incoming time (sec) is noted as t1, t2….tn. The resources are allocated effectively from node '1' to 'n' nodes.

The simulation results show that it takes 750 sec to transmit the packet securely from source to destination by choosing the path (i.e.,) route efficiently. During the simulation, 40 nodes were contributed in the process. For evaluation purpose, the network topology is generated by NS2 compared RAPR against joint topology control, authentication design, continuous user authentication, and intrusion detection.

In our simulation initially 40 clients were taken. Each nodes play again one user's outline composed from synthetic data sources. In addition, some of the request section of normal surfers are identified and play again to compute the delay time. The interval between two continuous requests is determined depends on three samples counting stable routing, growing rate of routing and arbitrary pulsing routing.

Simulation experiments are conducted with the set of mobile nodes using RAPR framework, Joint Authentication and Topology Control (JATC) [5] scheme in mobile ad hoc networks and Partially Observable Markov Decision Process (POMDP) [4]. Simulation experiment are performed on the factors such as network security, communication overhead, end to end throughput rate, resource utilization efficiency, average cost and delay measurement based on node count.

Network security level is evaluated using NS2 simulator, is defined as the provisions and policies adopted by a RAPR framework to prevent and monitor unauthorized access, and misuse of packet flow. RAPR involve in securing a computer network infrastructure. Communication overhead factor is a measure of the additional workload incurred in a RAPR algorithm due to irregular communication between the mobile nodes of the system.

RAPR end to end throughput factor defines the rate of successful packet delivery over a communication channel. Packet may be delivered over a logical link through a certain network node. The throughput is usually measured in Mega bits per second (Mbits/sec) based on node count. Resource utilization using the RAPR is the use of a resource in such a way that increases end to end throughput level. The RAPR aim is to use these assets efficiently so as to maximize user service levels. Average cost factor generally measured in terms of milliseconds (ms), is equal to total cost divided by the number of packets produced to the destination using the RAPR framework. Delay measurement after performing the test is defined as the amount of time interrupted when compared to the accurate simulation time, measured in terms of seconds (sec).

V. Performance Result of RAPR Framework

Routing aware packet reserving framework in MANET is matched to the existing joint authentication and topology control scheme in mobile ad hoc networks and partially observable Markov decision process for performing the simulation result comparison. The below evaluation value through table and graph describes the RAPR Framework improvements with beneficial end to end throughput maintenance simulation results when compared with existing system.

A. Performance with Network Security Level

Network security level is measured in JATC [5] scheme, POMDP [4] and RAPR framework. Security level varies with different schemes, measured in terms of percentage (%).

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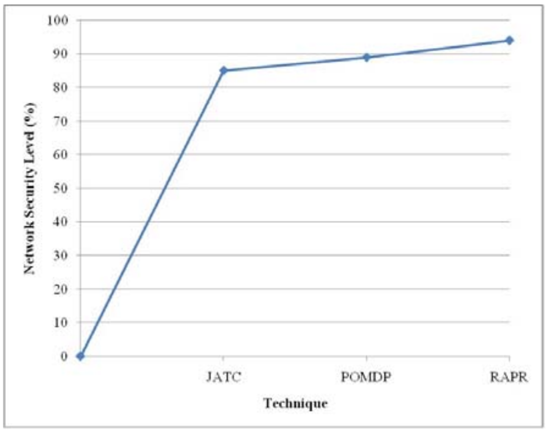

Fig. 3 Performance Measure of Network Security Level on Various Techniques

Fig. 3 describes the security level in mobile ad-hoc network. The network security level reflects the current end-to-end route state in RAPR framework. The route state keeps changing continually which has temporal interval for which they are valid in (2). In RAPR uses the security span to improve the security level when the packets transferred from source to destination. In RAPR, n^{th} packet flow is served at time p and increases the security percentage by 5 when compared with the POMDP proposed by [4]. At moment p_i, a packet belongs to flow 'pf' receives a service (G ($p_{i,}$) = pf) at any of the mobile nodes, so the security percentage is also improved by 9 when compared with the JATC scheme designed by [5].

B. Performance with Communication Overhead

The JATC [5] scheme, POMDP [4] and RAPR framework overhead in NS2 simulation result is measured in terms of bits per second (bps). As the node count increases, communication overhead is reduced in RAPR framework when compared with the existing system.

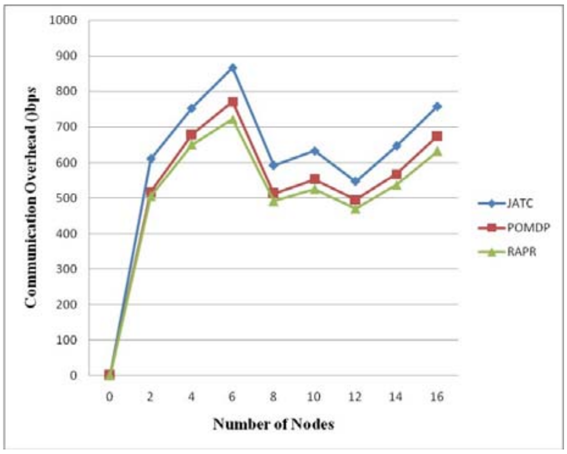

Fig. 4 Performance Measure of Communication Overhead

Fig. 4 depicts the communication overhead on varying node count. Shortest path earlier approach selects the packets which traversed for shortest distance, so that the remaining packets are reserved. The packet reservation makes the RAPR framework to communicate effectively with reduced overhead measure when compared with the JATC scheme, POMDP. The remaining packets lifetime is typically obtained using inference technique which reduces the overhead by 13–17% when compared with JATC scheme proposed by [5] and 2–6% reduced when compared with the POMDP proposed by [4].

C. Performance with End to End Throughput Rate

Fig. 5 illustrates the end to end throughput rate based on the node count. The packet reserving in RAPR framework uses the local route information. The location route information for packet reserving is based on the node clustering, cooperativeness and security level. RAPR framework uses the routing quality to attain the maximal throughput maintenance with 24–32% higher when compared with the JATC [5] scheme and 12–19% higher when compared with POMDP [4].

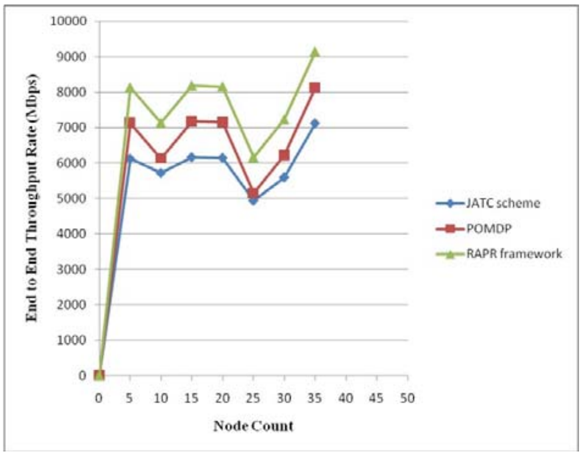

Fig. 5 Performance Measure of End to End Throughput Rate

D. Performance with Resource utilization Efficiency

The resource utilization is measured based on the user group in mobile ad-hoc network. A packet flow, along with its start and end times by its divide-line and continuous episode in RAPR framework identify the packet transfer rate with effective resource utilization. A divide-line is the duration of time during which an attempt to transmit a packet from source to destination mobile nodes with effective resources.

The resource utilization in RAPR is effectively managed using (3) and (4) Where, $pr(i) = \gamma(i, s_i^p)$. $s_i^p$is the sets of continuous duration between the link at time 'p'. RAPR is 4–7% increases resource utilization when compared with JATC [5] scheme and 8–16% improved when compared with POMDP [4].

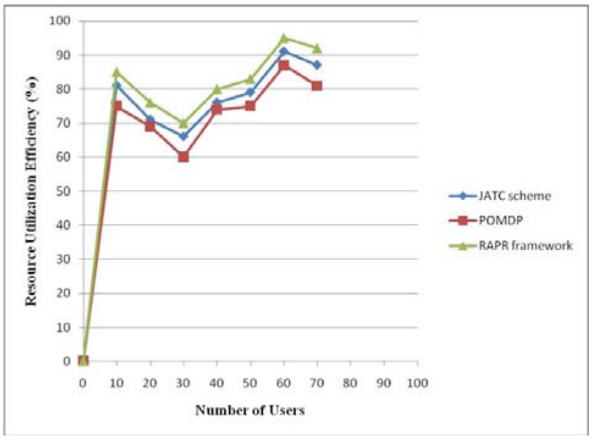

Fig. 6 Performance Measure of Resource utilization Efficiency

E. Performance with Average Cost

Average cost measures the amount of overall packets flow through all the mobile nodes, within minimal time.

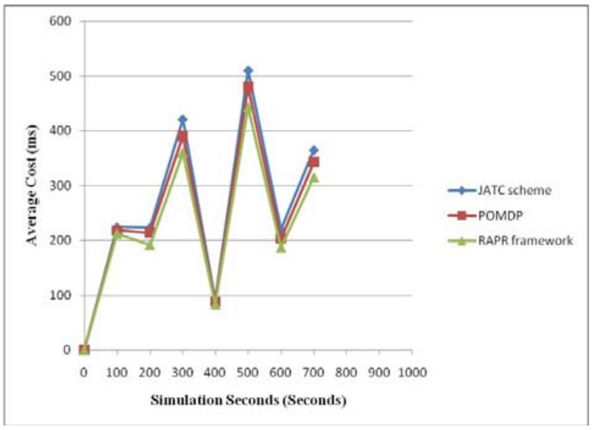

Fig. 7 Performance Measure of Average Cost

Fig. 7 illustrates the average cost based on simulation seconds. RAPR assume a routing packet reserve form which schedules these packet flowsT_i. T_i reserve the packet in s_{max} period which reduces the average cost in RAPR. Therefore, penalizing packet flows follows the inherit properties of the local route network, which reduces the average cost by 5–14% when compared with JATC [5] scheme and 2–10% reduced when compared with POMDP [4].

F. Performance with Delay Measurement

Fig. 8 describes the delay count based on the node speed. Node speed is measured in terms of meter/seconds (m/s) and delay count measured in terms seconds. RAPR define the time interval for which the path associated with packet flows. If the time taken to perform each and every link of path 'Q' from node 'i' to node 'j' is estimated as $d_1, d_2, d_3, \ldots\ldots, d_n$ then the delay time is measured in RAPR using (1). The reorganized nodes are clustered to avoid the frequent dropping of packets leading to minimal delay in RAPR when compared with JATC scheme, POMDP.

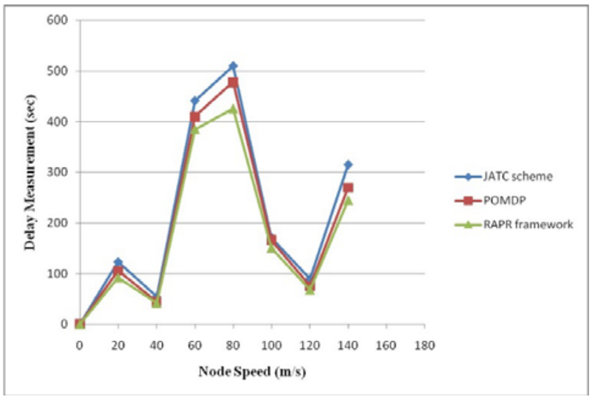

Fig. 8 Performance Measure of Delay Measurement

RAPR framework reduces delay count by 11-25% when compared with JATC [5] scheme and 4–12% lesser when compared with POMDP [4]. Finally, RAPR framework uses the local route information for effective throughput maintenance on mobile nodes using the node clustering, cooperation and security level. Therefore, penalizing packet flows follows the inherit properties of the local route network with minimal delay time.

VI. Conclusion

Routing aware packet reserving framework in MANET considers the end to end routing condition with maximal throughput. RAPR is complimentary system where the packet reserve utilizes local routing information. The local routing holds the information of the node clustering, node co-operation and security level. RAPR follows the approach of shortest path travel earlier approach. The mobile nodes select the packet which travels in shortest distance earlier from the queue to reduce the delay count. Path setup in RAPR estimates the security level of the system, and symbolizes the end-to-end routing by controlling the clogging. RAPR reaches the packet to the destination with high probability ratio and minimal delay count. Simulation results attain the maximal network security level, end to end throughput rate and resource utilization efficiency. On the other hand simulation result also reduces the communication overhead, cost and delay time in RAPR framework. Finally RAPR designed to perform effective resource utilization with 15.353% improved end to end throughput maintenance.

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