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CONTEXT AWARE ROUTING IN MANET WITH ANT COLONY OPTIMIZATION

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ABSTRACT

Mobile Adhoc Networks (MANETs) have attracted significant research due to their flexibility. MANETs are a collection of mobile nodes using radio waves as transmission medium to communicate using multihop links without any infrastructure. This study uses Context Aware Routing (CAR) in MANET with Adhoc On-demand Distance Vector (AODV) and Ant Colony Optimization (ACO) to improve performance metrics like average end to end delay, average packet delivery ratio, average number of hops to sink and jitter. Results prove that the new ACO-CAR performs better.

Keywords: mobile adhoc networks (MANETs), context aware routing (CAR), adhoc on-demand distance vector (AODV), ant colony optimization (ACO).

INTRODUCTION

Wireless nodes form a temporary network without infrastructure in MANETs [1-4] and they move freely. Two arbitrary nodes, which want to communicate with each other, may not be within radio range and so direct communication is impossible. Hence, a routing path of other network nodes is established before ensuring actual communication. Due to this, routing protocols are the key to success of MANETs and is an active research area [5-7].

A routing protocol in an adhoc network transmits packets through nodes. There are many routing protocols in literature for adhoc networks. Discovering a packet delivery path and delivering packets to correct destinations are these protocols functions. Reliability increases if MANET routing protocol is distributed in a specific manner. Proactive routing protocols: on exchanging topological information among network nodes, they continue to learn network topology. Reactive routing protocols: are based on query-reply dialogs which establish routes to destination only when needed. Hybrid routing protocols: combine reactive and proactive features ensures a better solution compared to a specific routing protocol [8, 9].

AODV [10] is a distance vector routing technology that locates routes when needed. It does not maintain routes from a node to other network nodes but improves system performance by reducing wide packets broadcasting in extreme networks. When source node wants to transmit information to a destination node for which it lacks a routing Table entry it sends a RREQ (Route Request) packet to neighbors [11, 12] who check their Tables. A RREQ has source and destination addresses, IP address and broadcast ID to identify every request, the last being the sequence number of destination and also source node sequence number. Sequence numbers avoid looping and provide up-to-date routes. When a node realizes that it is in the RREQ destination field, it checks destination sequence number and specified RREQ register. If the routing table has no entry, it broadcasts packets and records it in its routing table which received RREQ which is then forwarded from node to node till it lands at the destination. On reaching this, it sends message back and creates a route reverse reply with RREP (Route Reply) packet to confirm path.

ACO is a meta-heuristic, multi agent approach simulating ants foraging behavior to solve difficult NP-hard combinatorial optimization problems [13]. Ants are insects whose behavior is directed to survival of colony than that of one individual in the colony. Ant colony's behavior is its indirect co-operative foraging. ACO is inspired by foraging behavior of some ant species which deposit pheromone on ground to mark a favorable path to be followed by other colony members. When walking from food sources to nest and vice versa, ants lay a pheromone trail. Ants smell pheromone. They choose, with high probability, paths marked with strong pheromone concentration (shorter path) and so after some time, the entire colony converges to the path [14].

This study performs context aware routing using ACO Technique. Section 2 surveys some literature, section 3 explains methods and techniques used in the study, section 4 deals with results and discussion and finally section 5 concludes the study.

LITERATURE SURVEY

A new context-aware routing framework for MAET multicast and unicast routing is introduced by Menchaca-Mendez and Garcia-Luna-Aceves [15]. Called Context-Aware Routing over Ordered Meshes (CAROM), it uses Regions of Interest (ROI) to identify connected network components that span sources and destinations of interest to restrict signaling within such regions. Context information computes routing meshes of shortest-paths located inside ROI. Experiments through simulation reveal that CAROM attains better data delivery and end-to-end delays than conventional unicast and multicast MANET routing schemes (AODV, OLSR, ODMRP). CAROM

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incurs only a fraction of signaling overhead of conventional routing schemes.

Security is essential for adhoc network communication to secure data delivery between source and destination nodes. A known harmful attack is Sybil attack where a node pretends multiple identities of numerous target nodes. An on-demand trusted approach to defend Sybil attack was introduced by Hazra and Setua [16]. AODV is chosen and a trust computation based Sybil attack avoidance mechanism is proposed in AODV, enhancing protocol with context aware Trusted On-demand Routing (TOR) model. The new model has Node Manager, Trust Module and Decision Manager Modules. Decision Manager secures routing path based on trust value, computed in Trust Module. Node Manager reacts according to AODV. The new analysis and simulation reveal the proposal's effectiveness against Sybil attack.

Context-aware based architecture of car navigation service recommendation system was presented by Songhui *et al*., [17]. Through this, users customize navigation service to recommendation system by the car's navigation device and it searches and computes optimal paths according to real-time traffic information of roads, and dynamically adjusting optimal paths in line with real-time traffic information. Then, the model proposes assessing context information and routing optimization. Q-method computes optimal driving paths based on dynamic traffic networks real-time information. Finally a simple data case verifies the model to assess context information and routing optimization. The results prove that the new method is superior to conventional ones.

Current mobile service discovery approaches do not address service selection and robustness of mobility totally. The mobile service infrastructure must be QoS-aware plus context-aware (i.e.) aware of user's required-QoS and QoS offered by other networks in user's context. A cluster based QoS-aware service discovery architecture using swarm intelligence was proposed by Siddarth and Seetharaman [18]. Swarm intelligence establishes intra/inter cluster shortest path routing. Simulation shows that the new architecture attains good success rate with reduced delay and energy consumption, as it satisfies QoS constraints.

A context aware routing in Distributed Sensor Network (DSN) for data gathering and dissemination was proposed by Bhajantri *et al*., [19]. A DSN has intelligent sensors geographically dispersed in ROI and interconnected via a communication network. Data (acoustic, seismic, and infrared) is transmitted over network through leaf senor nodes and integrated at the processing element to derive correct interferences about environment for various purposes like location, target tracking and surveillance. Context aware routing is simulated for data gathering/dissemination to test operation scheme regarding performance parameters.

A context aware framework to address a modern enterprise's diverse communication needs was developed by Choudhury *et al*., [20]. These are characterized by workers in various locations, subject to different policies, using varied communication devices with varying skill sets. This diversity is a challenge to locate the most effective human worker (agent) for tasks like fielding customer requests, helping another with expert knowledge or completing a task like a supply chain exception. The new method's focus is on the issue of routing communications to most effective agent using a contextual knowledge spectrum: media type, availability, expertise, activity and location. An optimal 'request-to-agent' routing is based on many effectiveness metrics depending on communication context. Optimal agent communicates on specific media to reduce expected interaction duration while increasing successful call completion probability. Simulations are conducted by involving context aware and non-context aware routing scenarios based on the new model. Results indicate that context aware routing outperforms conventional request-routing techniques. This work impacts routing algorithms and also addresses enterprise staffing and temporal variation of context related issues for agents.

Core thought of context-aware technology and WSN routing protocol are syncretized by Wei *et al*., [21] bringing forward CATRP protocol, adapting it through research on context-aware technology belonging to kernel technologies of pervasive computing. This paper designs the directions of the protocol in work flow, data structure and quantitative algorithm and others. Finally, simulation analyzes CATRP work performance indexes with congeneric classical protocols in contrast proving its energy efficiency, theory validity and high reliability. This paper enriches theory base and contributes to WSNs technology transiting to future pervasive computing in the research phase.

MATERIALS AND METHODOLOGY

Context Aware Routing in literature revealed improved performance based on prediction capabilities. Routing's QoS parameters is NP Hard due to most QoS parameters additive nature. This work plans to find optimal solution for CAR using ACO.

Context aware routing (CAR)

CAR design goal is to support communication in intermittently connected MANETs. A main issue solved by the protocol is carrier selection. The new solution is based on forecasting techniques application and utility theory to evaluate the systems various aspects relevant for routing decisions. Let us consider the protocol's key aspects. CAR delivers messages synchronously (without storing in buffers of intermediate nodes when lacking network partitions between sender/receiver). CAR is optimized by context attributes' predicted future values to make routing decisions, instead of using available current context information, to ensure a more accurate estimation of the time series trend associated with every context dimension. For example, in collocation patterns, a host HA not collocated currently with host HB may be thought of scarce utility for acting as a carrier for HB when evaluated at this moment. But, HA may have been collocated with

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HB for last three hours and, so the likelihood of being collocated again, given the proposed model's assumptions are high and represented accordingly. Context information prediction and evaluation is summarized as follows.

- A host calculates delivery probabilities for a given hosts set. This is based on utilities calculation for every attribute describing context. Then utilities future values are predicted and composed with multi-criteria decision theory [22] [23] to estimate overall delivery probability. Calculated delivery probabilities are sent to the other hosts periodically in the connected cloud as part of routing information update.
- Every host maintains a logical tuples forwarding table describing next logical hop, and associated delivery probability for known destinations.
- Each host uses local delivery probabilities prediction between information updates. Prediction process is used during temporary disconnections and carried out till accuracy is guaranteed.

- A host maintains neighbor's node mobility.
- A host maintains neighbor's link quality.

Ant colony optimization (ACO) based routing

Combinatorial optimization problem like routing is solved through ACO in computer networks. Observing optimization of ant's food gathering is this optimization's basic idea. Real ants foraging behavior was implemented by ACO. Initially, ants walk randomly when multiple paths are available from nest to food. A chemical substance, pheromone is laid by the ants when traveling to food and during return serving as a route mark. The path with higher pheromone concentration is chosen by new ants and it is reinforced. A rapid solution is got by this autocatalytic effect [24].

Forward Ants (FANTs) and Backward Ants (BANTs) create new routes. A pheromone track is established to source node by a FANT and to destination node by a BANT. A small packet having a unique sequence number is known as FANT. Depending on sequence number and FANT source address, duplicate packets are distinguished by nodes [25].

Route from source to destination node changes in MANETs as it includes mobile nodes. The routing algorithm performs detection of dynamic topology, generation of intra node path and handling route failures in three phases.

- Route discovery phase - All paths from source to destination node are located.
- Route maintenance phase - Path between nodes is strengthened.

An artificial ant builds a solution in an ACO by traversing a fully connected construction graph GC (V, E), where V is a vertices set and E is a set of edges. As Dorigo M. states, artificial ants move from vertex to vertex along graph edges building a partial solution. The first ant colony optimization algorithm known as Ant System was proposed in early nineties. Since then, many ACO algorithms were proposed. Given below is an ACO meta-heuristic algorithm that iterates over three phases [26]:

a) Construct ant solution: A set of m artificial ants constructs solutions from elements of available solution components finite set

b) Apply local search: When solutions are constructed, and before updating pheromone, this improves solutions got by ants through local search.

c) Update pheromones: It increases pheromone values associated with good/promising solutions, and decreases those associated with bad ones. This is done through (i) decreasing all pheromone values through pheromone evaporation, and (ii) increasing the pheromone levels associated with a chosen good solutions set.

ACO optimizes routes based on context, link quality and node mobility in this study.

RESULTS AND DISCUSSIONS

In this study, ACO-CAR is proposed and the results are compared with AODV and CAR. Table 1 to 4 and Figure 1 to 4 shows the results of Average Packet Delivery Ratio, Average End to End Delay, Average Number of Hops to Sink and Jitter.

Table-1. Average Packet Delivery Ratio.

Number of nodes	AODV	CAR	ACO - CAR
50	0.886	0.921	0.9428
100	0.8363	0.8681	0.8987
150	0.8191	0.8401	0.8755
200	0.7814	0.8067	0.8411
250	0.7327	0.7538	0.7747
300	0.6323	0.6423	0.7326

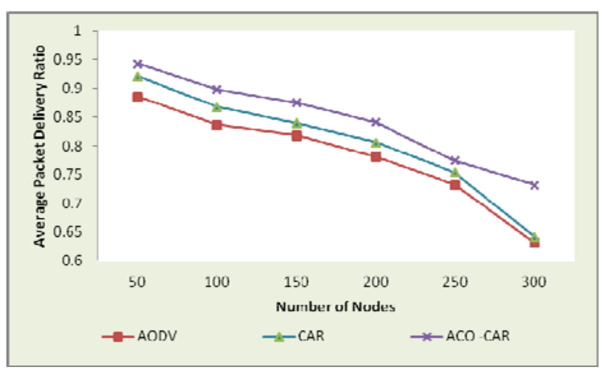

Figure-1. Average packet delivery ratio.

From Table-1 and Figure-1 it is observed that the average packet delivery ratio is obtained in a better way for proposed ACO-CAR when compared to AODV and CAR. When the number of nodes is 50 packet delivery ratio for ACO-CAR increases by 2.33% when compared to CAR and by 6.21% when compared to AODV. When the number of nodes is 300 packet delivery ratio for ACO-CAR increases by 13.13% when compared to CAR and by 14.69% when compared to AODV.

Table-2. Average end to end delay.

Number of nodes	AODV	CAR	ACO - CAR
50	0.000852	0.000841	0.000803
100	0.001054	0.001051	0.000951
150	0.002282	0.002267	0.001102
200	0.00341	0.003328	0.001159
250	0.10486	0.10363	0.006848
300	0.072818	0.71351	0.11313

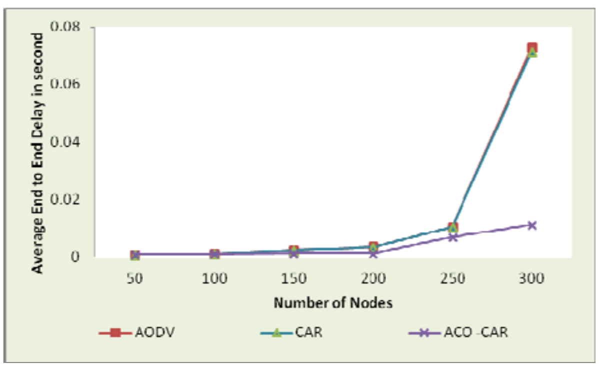

Figure-2. average end to end delay.

From Table-2 and Figure-2 it is observed that the average end to end delay decreases for proposed ACO-CAR when compared to AODV and CAR. When the number of nodes is 50 end to end delay for ACO-CAR decreases by 4.62% when compared to CAR and by 5.92% when compared to AODV. When the number of nodes is 300 end to end delay for ACO-CAR decreases by 145.25% when compared to CAR and by 146.21% when compared to AODV.

Table-3. Average number of hops to sink.

Number of nodes	AODV	CAR	ACO - CAR
50	3.09	2.85	3.09
100	3.91	3.82	4.03
150	4.13	4.43	4.45
200	4.9	4.64	4.72
250	5.18	5.09	4.86
300	5.25	5.2	5.03

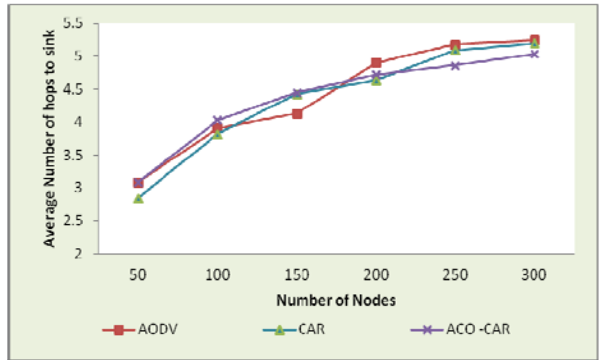

Figure-3. Average number of hops to sink.

From Table-3 and Figure-3 shows the average number of hops to sink for proposed ACO-CAR, AODV and CAR. When the number of nodes is 50 Average Number of Hops to Sink for ACO-CAR increases by 8.08% when compared to CAR and is same when compared to AODV. When the number of nodes is 300 Average Number of Hops to Sink for ACO-CAR decreases by 3.32% when compared to CAR and by 4.28% when compared to AODV.

Table-4. Jitter.

Number of nodes	AODV	CAR	ACO - CAR
50	0.000393	0.000399	0.000353
100	0.000897	0.000911	0.000803
150	0.001205	0.001234	0.001101
200	0.001211	0.001244	0.00109
250	0.001651	0.001679	0.001484
300	0.001765	0.00177	0.001579

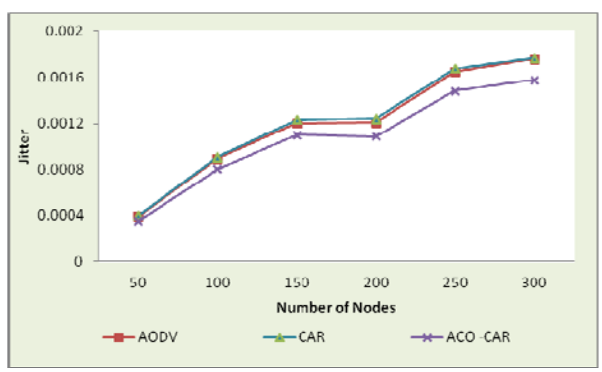

Figure-4. Jitter.

From Table-4 and Figure-4 it is observed that the Jitter decreases for proposed ACO-CAR when compared to AODV and CAR. When the number of nodes is 50, jitter for ACO-CAR decreases by 12.23% when compared to CAR and by 10.72% when compared to AODV. When the number of nodes is 300, jitter for ACO-CAR decreases by 11.40% when compared to CAR and by 11.12% when compared to AODV.

CONCLUSIONS

This study, compared results between AODV, CAR and ACO-CAR with ACO-CAR achieving improved Average End to End Delay, Average Packet Delivery Ratio, Average Number of Hops to Sink, and Jitter. When the number of nodes is 300 packet delivery ratio for ACO-CAR increases by 13.13% when compared to CAR and by 14.69% when compared to AODV. When the number of nodes is 300 end to end delay for ACO-CAR decreases by 145.25% when compared to CAR and by 146.21% when compared to AODV. When the number of nodes is 300 Average Number of Hops to Sink for ACO-CAR decreases by 3.32% when compared to CAR and by 4.28% when compared to AODV. When the number of nodes is 300, jitter for ACO-CAR decreases by 11.40% when compared to CAR and by 11.12% when compared to AODV.

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