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Balance Cluster Routing Algorithm for Expanding Wireless Networks (BaCRA-EWN)

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Abstract

Objectives: The wireless routing model has been specifically designed for the energy efficient and secure routing among the ad-hoc networks. **Methods/Statistical Analysis**: The proposed ad-hoc routing model is designed to remove the possibility of the connectivity holes, which may be produced due to the false network route injections or due to the wormhole or blackhole attacks. In this paper, a robust connectivity integrity assurance (CIA) model has been proposed based upon the genetic algorithm in order to realize the highly flexible blackhole avoidance model. **Findings:** The proposed model has been tested over the standard wireless ad-hoc network topology for the performance based assessment of the wireless network performance under the security paradigm where the parameters of maximum throughput, end-to-end transmission delay, and overall network load, etc. The proposed model has been found efficient under all of the experiments, and have clearly outperformed the existing paradigms and security models for the secure routing over wireless ad-hoc platforms. **Application/Improvements:** The proposed model has been specifically designed for the energy efficient, lifetime enhancement and higher order security and privacy of the data over the ad-hoc networks.

Keywords: Route Exchange Integrity, Secure connection establishment, Quality routing paradigm, connectivity hole prevention and correction, quick response fast convergence model.

1. Introduction

The wireless ad-hoc networks are the self-converging wireless networks and also known as the unstructured networks due to the absence of the base station nodes (known as the centralized architecture network).[1-4] The wireless ad-hoc networks are either designed for the inter-nodal communications or the data transmissions towards the sink or base station nodes.[5,6] The wireless ad-hoc topologies differ according to the geographic situations, which makes it complicated for the establishment of network.[7] It reveals the important of the energy conservation across the target wireless networks for the control of the communications overhead and for the realization of the efficient data delivery mechanism.[8,9] Ad-hoc nodes are primarily designed to work in the even-based mechanism, where the data transmission becomes the demand-oriented response call.[10] The aim of aggregation is to eliminate redundant data transmission and enhances the life time of energy in wireless network node network.[11] It has been learned that the models, who offers the bestowed new data packets during the propagation during the transmission, and protects the data transmissions for the target packets traversing or transiting through the target nodes or paths.[12] During this theme every packet traversing constant path carries constant symbol.[13-15] Path symbol fits in every single packet therefore the victim will straight off filter traffic when receiving only 1 attack packet.[16] Hierarchical routing mechanisms are the efficient routing protocol in the case of energy consumption, which is hierarchical and based cluster.[17] In this protocol, the base station selects Cluster Heads (CH)[18,19] The selection procedure is carried out in two stages.[20] The cluster head generates two schedules for the cluster members is sleep and TDMA transmission function.[21]

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2. Experimental Design

The secure, flexible and robust routing based mechanism has been designed under the proposed model routing scheme for the wireless ad-hoc networks, which is based upon the combination of dynamic route selection based upon genetic programming mechanism and connection integrity assurance algorithm. The new combination is capable of adding the higher level of security for the prevention of the connectivity holes and the fake route injections in the given network. The smart path selection across the multipath network becomes very important in the voice based ad-hoc networks, which requires the dedicated connections for the exchange of the voice data over the ad-hoc channel. The creation of the adaptive ad-hoc network routing solution takes the perfectly layered amalgamation of the genetic programming based routing solution along with the connection integrity assurance model in order to realize the robust ad-hoc routing algorithm.

2.1 Connection Integrity Assurance (CIA) Model

The CIA model relies upon the availability assurance and connection integrity model in order create the secure and flexible routing model across the given network. The ingress and egress queues play the important role in the establishment of the channel, where the size of these queues must be verified to check the availability of the queues for the prevention of the connectivity holes. The compact tunneling mechanism embedded within the CIA model ensures the integrity of the receiver and sender end to prevent the alien nodes from unethically joining the ad-hoc network. The CIA mechanism utilizes the directed graphs in the different directions for the creation of the network connections between the nodes within the given transmission range as per defined in Figure 1.

The non-structured wireless ad-hoc networks or sensor networks are designed with the adaptive architecture according the current network situation. The control of the unstructured ad-hoc networks are spanned across the M x N area, where the neighboring nodes of each wireless node are found and localized by incorporating the distance based methods to measure the transmission range. The CIA based secure and efficient ad-hoc wireless networks utilizes the directed graphs over the given set of nodes, which may be forming the contrast non-directed vertices in the special cases. The following example elaborates the ad-hoc consisted of the 10 ad-hoc nodes, which demonstrates the application of directed graph based connection formation in Figure 2.

The network availability relationships are determined under the fully structured and layered model, which is given by the set of rules and symbols for the CIA model. It denotes the node availability, whereas F denotes the node unavailability and both returns the probability for nodes. N denotes the number of nodes, s handles the sparse matrix across the network and f gives the alternative routes in the sparse matrix. Hence it can be clearly defined that the availability of the node is computed by subtracting the probability of failures from 1 and vice versa for failures.

The smart routing using the game theory algorithm has been employed in order to build the smart routing solution around the ad-hoc networks integrating the routing based upon high-order elasticity. For the ad-hoc networks, network data propagation around the randomly organized wireless ad-hoc network nodes constructed in the non-directive architecture. In this approach, the game theoretic approach is primarily deployed to compute the resource availability on the individual nodes or regional cluster and network in

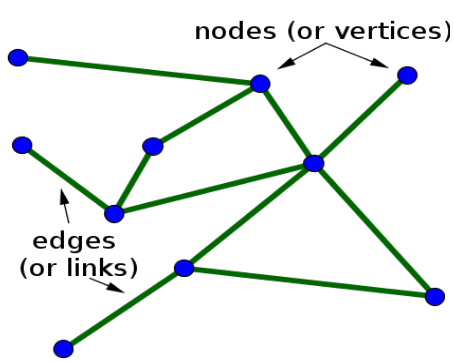

Figure 1. The directed path mechanism of CIA model.

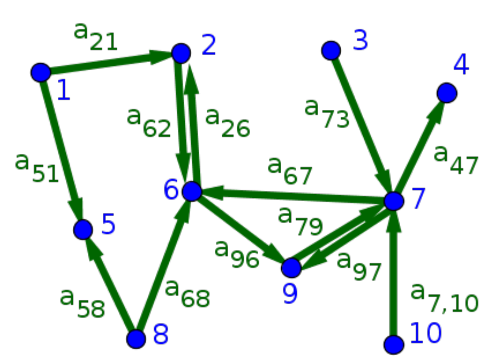

Figure 2. Wireless ad-hoc network using CIA model.

order to compute the best route towards the destination, where the two primary factors are known as the Physical Resource Block (PRB), which is denoted with the symbol RSINR (u) for the u number of users in the given wireless network zone. The ad-hoc cell handles each call (defined as individual channel) for the adaptive allocation of the resource bandwidth, which is defined in the URAs (Units of Resource Availability). The data or frame rate across the given ad-hoc network cell is denoted with Ku, whereas the Nt gives the number of total users across the network:

$$Ku = \frac{D_u}{RSINRu.\,Nt} \tag{1}$$

In (1), the Ku is computed with the overall network load across the wireless ad-hoc cell representing the user density, which is given by the symbol Nt. The total network load across the given ad-hoc network cell (denoted c), is given with the following formula:

$$c = \sum\nolimits_{\downarrow}(u \mid X(u) = c)\; Ku \geq 0 \tag{2}$$

The X gives the array of user's resources and contains the information about all of the users or resources in the given network, which is assigned to c symbol known as the cell load. The condition of Ku, used to denote overall load, which must be higher or equal to 0. The utility can be computed with the following equation:

$$utility_i = \begin{cases} U_i + x_i \; if \; 0 \leq c_i \leq 1 \\ \left| \dfrac{U_i + x_i}{c + \sum_{j=1}^{x_i} k_u} \right|, & otherwise \end{cases} \tag{3}$$

2.1.1 Algorithm 1: Balance Cluster Routing Algorithm for Expanding Wireless Networks (BaCRA-EWN)

1. Obtain the path information among the wireless network for each and every available path in the given wireless cluster.
2. Process each node's individual resource availability by obtaining the on-link factors to compute the load for each node and
3. Compute the given network segment resource availability by using the information from Step 2
4. Compute the cluster utility index, which gives the overall status of the wireless cluster in case of inter-cluster link establishment
5. Utility index is added to each micro-cluster in the wireless network to compute the priority among the neighboring units
6. Apply the decision making algorithm to select the best path among the given network to choose the final path for path forwarding

3. Result Analysis

The results have been obtained from the proposed model simulation for the realization of the robust and flexible routing algorithm. The major parameters of PDR (Packet Delivery Ratio), energy consumption and transmission (end-to-end) delay have been analyzed (Figure 3).

3.1 Packet Delivery Rate

Packet delivery ratio factor evaluates the percentage of the successfully delivered packets among the given network or link in the given time (1 second in our case). The PDR shows the rising trend in the following graphs, which elaborates the rising network ability with each passing second, whereas the stability or straight line after 10^{th} second shows the performance of the fully converged network, which is communicating on the nearly constant speed to deliver the packets among the given networks.

3.2 Energy Consumption

The energy consumption has been observed in the Joules for each node-to-node connection. In this simulation, the initial energy is assigned to each of the node during the beginning of the simulation, which is tracked and reduced with the transmission, receive and routing (for intermediate nodes only) phase. The remaining energy in the end is recorded in Figure 4, where the steep falling curve has

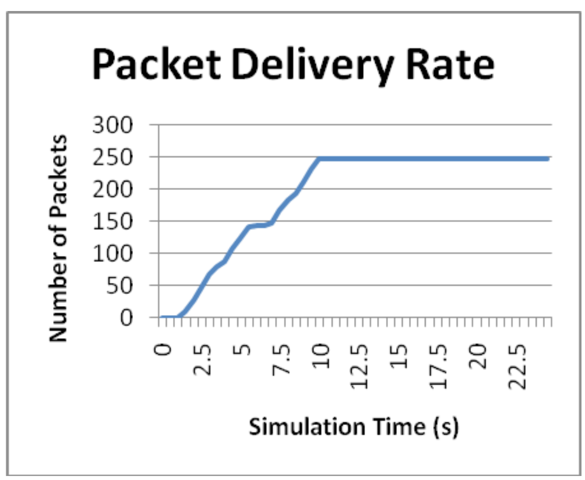

Figure 3. Packet delivery rate.

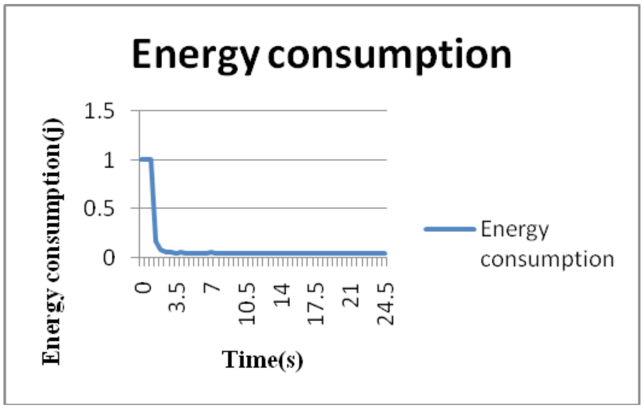

Figure 4. Energy consumption.

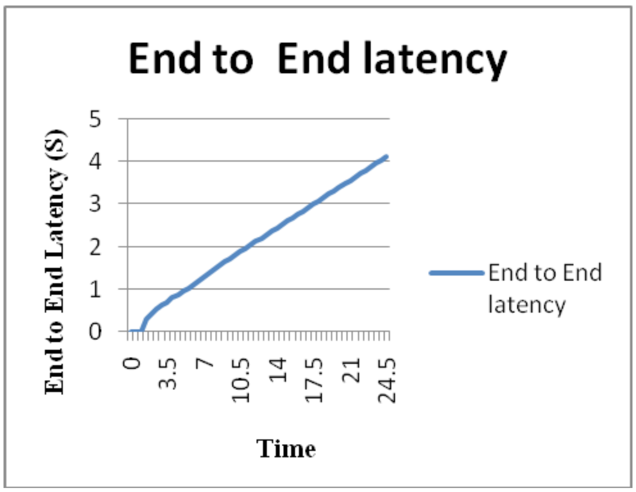

Figure 5. End to End latency in data forwarding.

been observed in contrast, which shows the energy consumption with rising number of packets, whereas after nearly 7th second, the curve remains nearly constant to show the network convergence.

3.3 End to End Latency

The total (ultimately average) transmission (end-to-end) delay across the ad-hoc network, which is computed between the source and destination node for the delivery of data packets. The delay must be lower for the data transmission, and it is inversely proportional to the volume of data across the given ad-hoc network in Figure 5.

4. Conclusion

The proposed model has been composed with the various balance methods, which involves the genetic programming along with the graph theory (particularly the bi-directional directed graphs) and physical and hop-based distance metric. The strategic routing model has been specifically designed for the stout and strong ad-hoc networking paradigm. The revolutionized proposed model aims at the prevention and elimination of the wormhole and balckhole nodes. The analyzed performance of the proposed routing based connectivity hole prevention mechanism shows the robustness of the proposed model in comparison with the existing routing security models. The proposed model has been found efficient to handle the larger amounts of data among the given wireless network.

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