ANALYSIS OF ROUTING PROTOCOLS IN FLYING WIRELESS NETWORKS

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Abstract: The wireless network that are formed on the fly, without relying on the previous infrastructure, including the autonomous devices that lie nearby are called the flying wireless networks. Despite of the networks, self-configuring and self-healing nature, it incurs many challenges due to its mobile nature, limited battery span and the lack of the centralized control, so these wireless network requires a perfect routing protocol addressing the challenges and improving the performance of the network, so the paper presents the survey on the various routing protocols that enhances the performance of the flying wireless network. The survey is further continued with the analysis of the routing protocols to evince the capability of the same on the grounds of network life time, energy consumption and the quality of service.

Keywords: Flying wireless networks, routing protocols, performance analysis, network life time, energy consumption and the quality of service.

Introduction

The tremendous improvement in the tele-communication and the information technology lead to the emerging of the wireless network that subdued the complex setting up of the wired networks, along with the complications involved in it, in the process of transmission. The wireless networks were more preferred than the wired networks, as they allow the transmission over the free space using the electromagnetic waves that elude the necessity of using the large bunch of wires that are draped everywhere. Moreover the wireless network operates over an entire network coverage covering more area, unlike the wired networks that operates within a limited area. This convenience of accessing the network resources from anywhere that is under your network coverage, the easy expandability with the available equipment's, the robust security protections, the ability to move along anywhere without the necessity of being tied to a place for the access of the network and the cost-effectiveness has made the wireless networks to be more favored than the wired networks. The wireless networks that are constructed using the access–points that control and host the devices in the wireless connection are called the managed networks or centralized networks that

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are framed with infrastructure, they are certain wireless networks that are not under the control of any access-points and are framed as network on the move without relying the infrastructure, such networks are called adhoc as they purely serve a particular purpose. The nodes or the data-points take up a dual-action and play the role of both the host that initiates the transmission and the router that forward the information to the next node [21]. They form the network with the nearby available nodes whenever a necessity arises for the transmission. The nodes or the data points that are used in forming the network might be homogenous, if the network is contained with the same type of devices or heterogeneous, if the device contained are different. The nodes in the engaged in the network could possess different characteristics in terms of storage, energy availability and processing capability. Any devices can volunteer itself or leave the network, at any time without any intimation as they are mobile. This autonomous behavior and the mobile nature of the devices, causes the human intervention in its configuration to be seldom. This wireless network that forms a network without an managing point and transmits information with the nodes acting as the initiator and the forwarder, is also known as flying wireless network(WANET), due to their mobile nature and capability of framing a network on the move.

The limitations of the flying wireless network and the improvement in the transmission process of the network subduing the limitations, using various routing protocols are surveyed. Further the analysis representing the efficiency of the protocols are presented in the paper based on the survey.

The paper is organized with the section 2 detailing the limitations of the flying wireless networks, section 3 with the survey of the possible routing solutions that are available, section 4 the analysis of the routing protocols and its efficiency on different performance metrics such as energy consumption, network life time and the quality of service.

Flying Wireless Networks

The flying wireless networks as the name states are the networks formed on the fly with the available number of devices that exist nearby. The network framed is temporary without infrastructures and equipped with the devices (nodes) with the capability of high mobility [14].So the devices employed are certain of leaving the network at any time without a prior information. This mobile nature of the nodes makes the network unacquainted with its topology, and breaks the connectivity of the network making the location prediction difficult. The link stability of the network is also another challenge in the flying wireless network as they operate with the limited battery power of the nodes. Further the heterogeneity of the nodes, project limitations in the terms of processing capabilities and the storage capacities. The above characteristics of the network bring in the challenges for the process of transmission thus

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making it difficult. Some of the characteristics of the flying wireless networks, their causes, the challenges they bring into the network transmission process are tabulated as in the table 1 below.

Table 1: Characteristics of Flying Wireless Networks

Characteristics	Challenges	causes
Infrastructure less	No control entities	Error prone, weak signal, covers small geographical area, less secure,unpredictable interconnectivity , decrease in throughput, decreased reliability
Mobile	Dynamic topological changes	Frequent topological changes, coverage problems, throughput deteriorates, delay due to re-routing.
Battery Powered	Limited power availability	Node failure, link instability, interruption in the transmission, frequent path break, failure in the packet conveyance, affects throughput, increases delay
Resource Constraints	Limited storage and the processing capability	Low memory, low processing capability, limited bandwidth capability, throughput is affected
Hidden Node Problem	Difficulty in next node prediction, co-channel interference	Collision, difficulty in path prediction, latency, throughput reduction
Availability	Densely deployed	Nodes may remain in a network or leave the network any time, Propagation delay if not properly deployed, minimized throughput

The Table 1 shows the limitation of the flying wireless network, the causes for the limitations and the challenges they bring into the network in the process of the transmission. The routing protocols designed to overcome the challenges in the transmission process addressing the limitations of the network is presented in the next section that includes the survey of the routing protocols for the flying wireless networks. The characteristics of the flying wireless networks were obtained from the survey conducted through the [1], [2], [3], [10] and [48]

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Routing Protocols for the Flying Wireless Networks

The Routing protocol is a convention or a standard that allows the nodes (Data Points) to decide on the perfect route to convey the data packets between the source and the target nodes, using the other nodes within their path as forwarders. The routing protocols are essential to a network to increase its performance on the delay incurred, energy consumed, channel overhead, bandwidth utilization, throughput achieved and the packet delivered. So the routing protocols for the flying wireless network help in improving its network performance subduing its limitations and the challenges in the transmission process. The survey on the routing protocols for the flying wireless network is detailed in the table 2 below. The routing protocols developed are categorized as flat (reactive and proactive), hybrid, hierarchical, location based, and further as heuristic and metaheuristic based routing on the grounds of the methodologies used in it . The table 2 below lists the survey on the routing protocols to improve the performance of the flying wireless network in terms of energy, reliability, connectivity and susceptibility to the topological changes [1], increasing the lifetime of the network.

The paper proceeds the survey with the aim of having a prolonged network longevity for the flying wireless network. The table below gives the researches done to improve the performance metrics of the flying wireless network achieving an enhancement in the lifespan of the network.

Table 2: Routing Protocols for Flying Wireless Networks

Aim	Protocols	Research's surveyed	Proficiency
To have a routing protocol with the energy conservation so as to have enhanced network lifespan and quality of service	Flat (Pro-active and Reactive)	The capabilities of flat protocols[3], CAMP Protocol with proactive routing [4], secure AODV [7], New improved AODV[14], AODV and DSDV [19]	Capabilities of flat routing protocols[3] Uniform energy depletion, prolonged network lifetime[4], secure against the attacks[7], stable links, ruptured link prediction [14] provides with the stable link [19]
	Hybrid (Proactive +Reactive)	Taxonomy and the efficiency of the hybrid routing [10] , hybrid routing [11] ICA and RBF [16] RCA-HDRP[17], HYB-TGR[20], LB+HRP[47]	Energy efficient, reliable, fault tolerant [10][11],robust and scalable, provides stable link against the high mobility [16], effective path selection [17]

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			improved performance [20]
	Hierarchical	Spatio-temporal with decision tree algorithm [6], assessment of hierarchical routing capabilities[5], cluster routing efficiency[9], cluster aided multipath routing[4] secure ZRP[15] BPA-CRP[22] P-SEP [27]	Ensures secure transmission evaluating the trust nodes[6], details of the performance improvement achieved using the Hierarchical routing [5], details the taxonomy, merits and demerits of the clustering routing[9] secure and negligible overhead protection[15], causes balanced energy[22] and improved life the network[22] [27],
	Location –based	Location based routing protocols[11] DEAR-2 [21], greedy routing [50], position based[48], POPB [49]	reliable, fault tolerant, robust, scalable,[11] extends network lifetime[21], link stability, network lifetime and OOS improvement[48-50]
	Optimization based (Routing protocols +optimization techniques (heuristic and metaheuristic))	The swarm intelligence algorithm[13], ICA and RBF NN[16] NSGAII- based OLSR [18] EBRP[28],Si+fuzzy[29],ACO-RP[30][33], cukoo+HAS[31], OLSR+GA[32] , DL based [39],[40],[41], optimization techniques [43-45]	Energy aware, guaranteed performance, fault tolerant , scalable, optimal path selection [13], improved performance against the high mobility [16] automates the process of optimal path selection and improves the performance [18],[28], causes an optimal path selection, thus improving the network lifetime [29-32],[39-41], [43-45]

Analysis of the Routing Protocols

The routing protocols survey based on the categories of the methodologies used for the routing is analyzed for its performance using the Network Simulator -2. By considering the number of nodes that varies between 100 to 200, over a simulation area of 2500 *40 m and the simulation time of 100seconds. The packets size ranges to 1024bytes with the packet data rate of one packet per second. The routing protocols surveyed are simulated using the network simulator to know the lifetime of the network, the energy consumption and the quality of service. As the network

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lifetime decides the capability of the network in continuing the transmission process and the energy consumption is very essential for the extending the network lifetime of the nodes thus maintaining the stableness of the link. The QOS of the network is measured to ensure the delay less successful transmission through the network that is mobile in nature.

The Fig 1 shows the energy consumption of the routing protocols, which are based on the methodologies such as flat routing protocols (FRP), hierarchical (HRP), hybrid (HDRP), location based (LBRP) and the routing involving optimization (heuristic and metaheuristic)(RPWO), the simulation results evinces that the routing protocols including the optimization process that enables in finding the optimal path using the metaheuristic and the heuristic shows higher energy conservation than other methods that are reactive, hierarchical, hybrid , proactive and location based. The other methods have difficulties in identifying the optimal path, so the energy is wasted in identifying the path that are liable to be failed. But the heuristic and the metaheuristic method identifies the optimal path easily and proceeds with the transmission without much energy consumption.
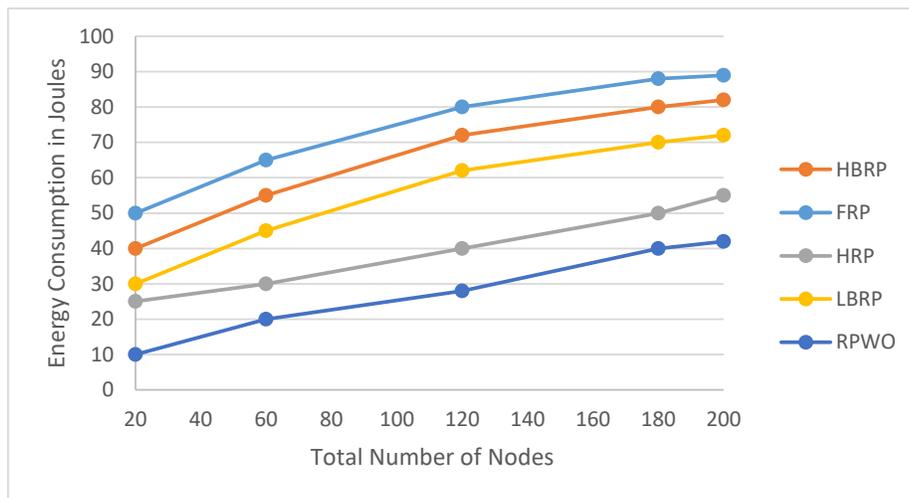

Fig 1: Energy Consumption

The fig 2 shows the simulation results for the lifetime of the flying wireless network applying the various protocols surveyed, the simulation result shows that all routing protocols with the optimization techniques allows the flying wireless network to have an extended lifetime than the other routing protocols that are reactive, proactive, hybrid hierarchical and location based. The comparison shows that the routing protocols with the optimization gives 35%
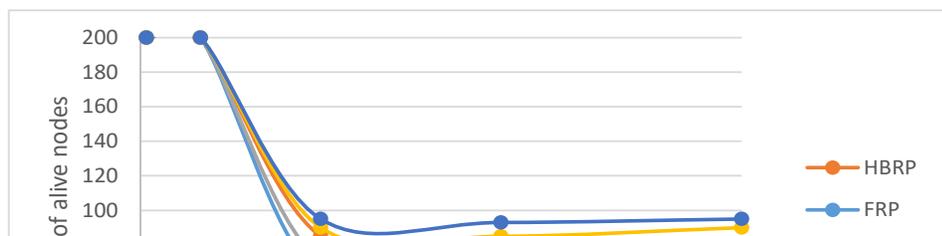
better results than the proactive and the on-demand methods and 26% better results than the hybrid and the location based.

The Fig 3 shows the simulation results that details the quality of service provided by each routing protocol, the routing protocol with optimization in the results is evinced to have higher quality of service than the others, the RPWO shows 42.3% higher quality of service than the FRP and 15.2% improvement than the HRP and 30% better quality than the hybrid and 37.08% better quality then the location based routing protocol.
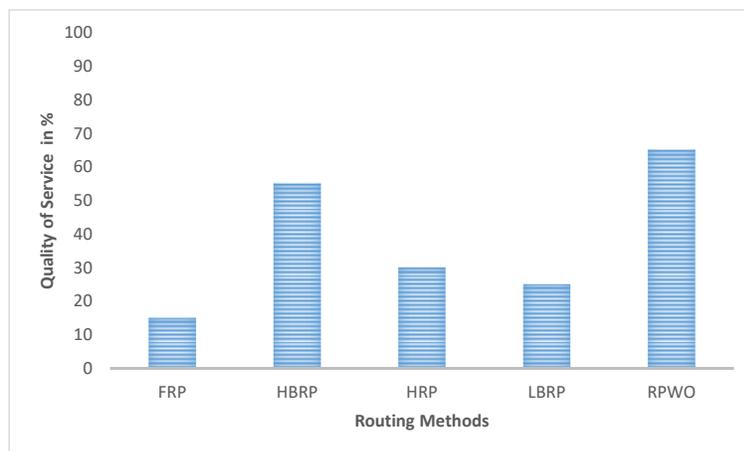

Fig 3 Quality of Service

Thus the analysis for the performance of the routing protocols for the flying wireless networks, by simulating through the network simulator-2 evinces that the routing protocol along with the optimization techniques shows higher efficiency then the flat, hybrid, hierarchical and the location based routing. Further the experiment analysis on the delay computations (D) and the time complexity (T) for the routing algorithms surveyed in shown in the table 3 below.

Protocols Rounds	FRP		HBRP		LBRP		HRP		RPWO	
	T	D	T	D	T	D	T	D	T	D
1	4.15	1.2467	3.25	1.2307	3.58	1.2301	4.17	1.0467	2.0	1.1227
50	4.25	1.2561	3.54	1.2326	3.16	1.2035	3.46	1.1461	2.18	1.0567
100	4.08	1.3670	3.27	1.1735	3.18	1.2274	3.10	1.1370	2.30	1.0246
500	4.11	1.3237	3.10	1.2032	3.09	1.1448	3.03	1.0237	2.13	0.8754
1000	4.02	1.1568	3.05	1.0185	3.02	1.0290	2.59	0.9568	2.08	0.8267

Table 3 Time Complexity and the Delay Computation of the Protocols

The Table 3 show the time complexity and the delay calculations for the routing algorithms under the methods FRP, HRP, HBRP, LBRP, and Routing protocol with optimization, the results obtained from the experiment shows that the Routing protocols integrated with the optimization techniques show better results compared to the other methods of routing, thus offering a better quality of service. So the survey conducted helps in identifying the routing protocols that enables in having an optimal path selection, reducing the time, energy consumption, delay and prolonging the network longevity. Further the elite optimized method of routing identification within the routing protocols integrated with the optimization technique is to be continued in the future.

Conclusion

The paper details the study on the routing protocols available for the flying wireless network, as the routing protocol ensures the performance improvement of the network addressing its limitations and subduing its challenges, the routing protocol enables the transmission process to take place establishing the optimal path between the source and destination eluding the delay, overhead, maximum energy utilization and the packet delivery losses. So the paper proceeded with the limitation of the flying wireless network and then continued with the survey on the various

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routing protocols that are developed for the flying wireless network. Further the performance analysis was done for the various protocols based on the metrics such as network lifetime, energy consumption and the quality of service to evince the optimal routing method and it was identified that he routing protocols along with the optimization techniques were better compared to the other methods as they involved the heuristic and the metaheuristic process in the selection of the optimal path that reduced energy and improved the network lifetime. So the survey done on the paper would enable the development of the routing protocol with the optimization techniques for the flying wireless network, further the paper is to proceed with the study on the able optimization technique that identifies the elite path for routing enable a considerable reduction in the energy and achieving heightened lifespan for the network.

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