International Journal of Engineering Trends and Technology
ISSN: 2231 – 5381 /doi:10.14445/22315381/IJETT-V68I12P224
Volume 68 Issue 12, 146-152, December 2020

Mobility Management Routing Protocol for Optimized QoS: A Review Study

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Abstract: *Routing conventions in small power systems with stationary nodes provide union and separation of nodes; similarly, RPL is also ready to manage nodes' Mobility. In any case, the technique toward identifying movable nodes and keeping up the direction-finding hierarchy is extremely moderate. Freedom of Movement is one of the major sources of irregularity in RPL. This article provides the outcomes of current methodologies based on different routing metrics and determines how the combination of multiple metrics can increase RPL performance.*

Keywords: *Wireless Sensor Networks, Internet Protocol, Low-Power Wireless Networks, Medium Access Control, Routing Protocol for Low-Power and Lossy Networks, Wireless Sensor Networks, QoS.*

I. Introduction

Wireless Sensor Networks (WSNs) is a basic portion of sensible locations like real-world households, communities, and cities [1]. Sensible locations trust upon the detected data from the existent world. WSNs contain specialized parts that ensure sensing, procedure, and communicative capabilities for watching distributed locations [2]. In the present-day time, innovation is advancing quickly. It makes our life more simple, robotized, and secure. A wireless sensor network (WSNs), as presented in figure 1, is one such innovation which plays a vital part in our everyday life. As the name shows, it is a network (without wire) with distributed and self-overseeing gadgets utilizing sensors for watching physical and natural circumstances. Military applications like battleground supervision initially livened up wSNs. However, now it discovers its importance in territories like medicinal services applications, environmental observing, zone checking, home computerization, traffic administration, and so forth [3][4].

Each node has the following segments, a microcontroller, a radio transceiver, a sensing device, and a power source (battery). However, some restrictions on assets like the sensor's memory, the network's bandwidth, and computational speed [5].

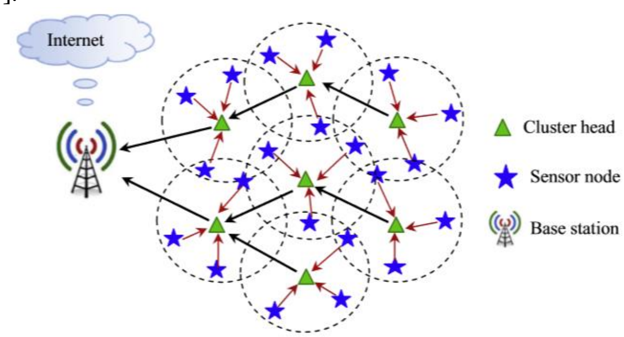

Fig 1: Wireless Sensor Network Model [1]

Why Wireless Networks?
In the present period, when the innovation is refreshing with the snap of a catch, the network needs to modernize themselves with the grade of their finger whenever - anywhere in this way require the hardware of a wireless network [6].

Advantages the primary purposes behind the acknowledgment of wireless networks:

***a) Convenience*:** Wireless Networks push interfacing with the web all the more effectively. Individuals can interface anyplace with a well-built indicator (signal) and an above a wireless network.

b) Availability: Wireless Networks WLANs are accessible anywhere and anywhere, even in difficult terrain.

***c) Easy arrangement*:** The area of the sensor nodes does not require to be settled area. They can be mounted worldwide, especially in unsafe spots, where cabling office isn't possible [6].

d) Reduction of Cost: However, essential investment prerequisites for wiring (wireless) LAN equipment are significantly more in contrast with the cost of wire (wired) LAN equipment, yet the general establishment expenses and life-cycle costs are impressively less. It will benefit the longterm investment as in the lively circumstances, regular changes and moves are required.

e) Mobility: WSN can provide real-time data, expanding yield, and make accessible services wherever in their general public, which they would not have been able to reach.

f) Scalability: WSN can be arranged in various topologies to satisfy the necessities of various applications. Designs can be changed from peer-to-peer networks (appropriate for fewer clients) to full infrastructure framework.

Today, the extension of utilizations like weather forecasting, savvy homes, insightful transportation, e-health, landslides early warning system made them increasingly valuable, even basic, in our regular daily existence. These applications convey an enormous number of articles, such as sensors, actuators, and RFID labels to perform detecting/I.D. errands and imparting the gathered data, for the most part, however remote connections, to specific sink hubs. These hubs will be accountable for transmitting this huge information sum to the server for management. The innovative Internet of Things (IoT) uses such an arrangement of billions of associated objects. On account of their qualities (self-governance, self-design, adaptation to non-critical failure, and so forth.), remote sensor systems (WSNs) are deliberated as an important innovation for IoT. WSNs may experience the ill effects of certain shortcomings inborn to sensor gadgets' legitimacies (for example, restricted memory and constrained battery) [7][8].

II. Internet of Things (IoT)

Internet of Things is a kind of set-up of several physical entities or pieces of stuff. This set-up comprises software, microelectronics, and sensors to achieve superior facility through exchanging facts with makers, operatives, and several other associated devices. Figure 2 shows the Internet Business Environment Architecture. Sensors are intelligent to gather personalized records and can transport these records to the Internet. Appropriate tools can instantiate layers for the IoT.

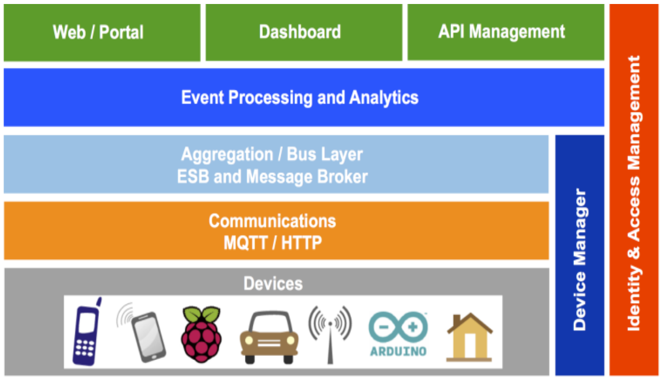

Fig 2: Internet Business Environment Architecture [10]

Primary Technologies for the IOT

RFID Technology

The IoT is a scientific revolution that represents the outlook of computing plus infrastructure, and its expansion wants support from some innovational technologies. Radiofrequency identification (RFID) is considering one of the fundamental enablers of the IOT. Things should be identified so they might be connected. RFID, which utilizes radio impressions to recognize items, can offer this function. Sometimes RFID has been labeled as a replacement of bar code, but the RFID system can do a huge agreement than that. In calculation to recognize matter, it also can follow substance in real-time to get significant information about their location and position. RFID previously had some precious applications in retail, health-care, and facilities management [9].

Sensor Technology

It is accountable for system facts gathering and is built on top of the existent world of vision and provides system facilities and uses.

Thread

Considered explicitly for clever home products, Thread services IPv6 connectivity to assist linked devices to talk among one another, contact facilities in the cloud, or act together with the consumer via Thread portable uses [10][11].

III. Routing Protocols for the IoT

One of the main recognized problems in WSNs is how to advance the information broadcast while extending the system lifespan. In this unique circumstance, the IPv6 Routing Protocol for Low-Power and Lossy Networks (RPL) [19] was suggested by the IETF [12]. RPL practices a hierarchical routing method for the static backbone network. The key characteristic of Movement is an extremely self-motivated topology, which marks in recurrent interruptions with neighboring nodes [13] [14] [15]. The RPL routes are constructed agreeing to an Unbiased Task and a well-known set of metrics and controls [16]. To talk about congestion glitches that happen in a substantial data traffic situation, Di Marco et al. take benefit of cross-layer strategy and recommend a Medium Access Control (MAC)-aware routing metric that proceeds into the justification of complex communications between MAC and routing. Two metrics labeled R and Q that cover ETX by seeing the effects of contention and MAC parameters were suggested [20].

An optimization problem is well-defined through an exploration space and an excellence or fitness function. The exploration space limits the thinkable formations of a solution vector related to a mathematical cost by the fitness function. Thus, resolving an optimization problem contains in discovery the least-cost formation of a solution vector.

Owing to the high complication that this type of difficulty typically shows, the usage of programmed intelligent implements is a compulsory requirement once facing them. In this sense, metaheuristic algorithms arise as well-organized stochastic practices will resolve optimization glitches [18] [19].

IV. Literature Review

Jamal Toutouh et al. [1], an arrangement of illustrative metaheuristic algorithms (PSO, GA, and S.A.), are considered in this artifact in command to discover optimal outlines of routing protocol automatically.

David Carels et al. [2] examine the glitches that halt consistent traffic activities to mobile strategies via RPL. A novel set-up is used to progress descending route modernizing is recommended. It is shown it attains the packet transmission ratio from 30% to 80% to moveable nodes while dipping the total RPL signaling overhead without using position information.

Belghachi Mohamed and Feham Mohamed [3] suggested using the remaining power and the communication interval as a direction-finding metric in the subsequent hop choice method for the RPL procedure. Project an impartial task for this metric built on ACO and associates RPL with the outcomes of these tests built on ETX.

H. Santhi et al. [4] offering a novel, and optimal effective routing protocol that delivers improved throughput, compact end-to-end delay calculated precisely for usage in multi-hop wireless ad-hoc systems of moveable nodes.

Meer M. Khan et al. [5] RPL does not deliver any management framework that can outline message conversation among dissimilar sink nodes to improve system performance. A sink-to-sink management framework is projected, which employs the episodic route repairs communications distributed by RPL to talk system position detected at a sink with its adjacent sinks.

Jeong GilKo and Andreas Terzis [10] present the ideals projected by operating teams and outline; however, the investigation community sharply contributes during this course by effective their strategy and providing open basis implementations.

Rahul Sharma and T. Jayavignesh [11]analyzed the performance of RPL grounded on dissimilar Objectives operated in varied radio models. Packet Delivery, Traffic Overhead, Power Consumed, and Network ETX are considered many performance constraints. The performance of ETX is improved in distinction to OF0 for totally the radio models and the scaled systems.

Hyung-Sin Kim et al. [13] examine the load assessment and congestion problem of RPL. Congestion is the main cause for packet harm in dense traffic, and a severe load balancing problem occurs in RPL in footings of routing parent selection. It proposes an effective queue operation based RPL (QO-RPL) that considerably enhances packet transfer performance compared to the normal RPL.

Mamoun Qasem et al. [16] propose a comprehensive Objective Function (OF) which equilibriums the volume of kids of the parent nodes to dodge the congestion problem and safeguard node lifespan maximization.

Hanane Lamaazi et al. [17] evaluate the RPL in three formations: compound sink, scalability, and movement prototypes. Outcomes show that RPL performances are significantly subjective by the number of nodes, the number of sink nodes, and the movement type.

Fatma Somalia et al. [18] propose a Bayesian prototype to precisely anticipate the sensor hubs' speed circulations. At that point, present the Movement based Braided Multipath RPL (MBM-RPL) to help portability over RPL. MBM-RPL sets up an essential way dependent on another steering metric that adventures the anticipated sensor hubs' speed esteem.

Vidushi Vashishth et al. [19] model the vitality requirement issue of gadgets in IoT applications as an enhancement issue. To moderate gadgets' vitality, the proposed convention utilizes grouping, bunch head political decisions, and least vitality costly way calculation for effective and continuous directing.

X. Xingmei et al. [21] suggested a way out of the Internet of things safety glitches. Also, they discussed the prospects and contests convoluted in applying Machine Learning and Deep Learning to IoT safety.

Table 1: Summary of RPL Enhancements

Author	Year	Approach	Findings
Jamal Toutouh	2012	Optimizing parameter values of the routing protocol through an optimization problem.	• The optimization techniques used for better QoS. • The simulated Annealing (S.A.) technique was also used for better optimization of QoS.
David Carels	2015	A novel technique to advance down track updating.	• End to End (E2E) delay in packet delivery ratio (PDR) enhanced up to 40% of QoS.
Belghachi Mohamed	2015	RPL protocol with two routing metrics remaining energy and the broadcast interval used in the next-hop	• RPL Energy competence is enhanced. • Evidence on assets accessibility of sensors, energy, and

		choice procedure.	delay conscious routing metrics.
H. Santhi	2016	A novel and optimal, efficient routing protocol provides increased throughput and reduced end-to-end delay, especially for multi-hop wireless usage.	• This novel enhanced version of the Associativity Based Routing protocol provides a simple and stable route and a more efficient and optimal route from the source to the destination.
Meer M. Khan	2016	A sink-to-sink coordination framework.	• Attains greater throughputs and extended the network's lifetime by allotting network burden between sink nodes.
Weisheng Tang	2016	RPL based composite routing metrics named CA-RPL is implemented to avoid congestion.	• The average time delay by CA-RPL is 30% reduced compared to the original RPL. Packet loss ratio is 20% reduced when the inter-packet intermission is short.
Hossein Fotouhi	2017	Mobility controlling structure (mRPL+) binding together two hand-off models: (1) hard hand-off, where a versatile hub needs to breakdown a connection before discovering another connection, and (2) software hand-off, where a portable hub chooses the fresh connection before disengaging from the present one.	• For complex traffic flow stacks, a delicate hand-off model can give great unwavering quality (≈100% PDR) with amazingly little hand-off deferral (4 ms) and extremely little overhead (like RPL).
Patrick Olivier Kamgueu	2018	Surveys recent works at RPL and features significant commitments to its improvement, particularly those identified with topology streamlining, security and portability.	• Researched security concerns identified with RPL, particularly those including inner hubs as the wellspring of the danger. Moderation methodologies gave to counter the distinguished dangers were surveyed and analyzed.

Table 2: Research Gaps

Author Name	Methodology	Research Gap
Hyung-Sin Kim, 2015	(QU-RPL) queue deployment-based RPL, which considerably enhances end-to-end delay and packet transfer performance.	• In dense traffic, packet losses are observed due to overcrowding. • In RPL, routing parent choice, a severe load balancing problem occurs.
Rahul Sharma, 2015	Used two objective functions 1) Expected Transmission Count, 2) Objective Function Zero) to analyze the performance of	• Congestion problem occurs due to flooding of overhead packets generated to retransmit loss of packets in the network. • Power con-

	RPL in various radio models.	sumption increased due to buffering of the data packet and sensing of channels.
Amol Dhumane, 2015	Examine the working of Routing Procedure above Low Power and Lossy Network (RPL), which is considered as a real routing standard in the Internet of Things	• Conventional routing rules bring up-to-date routing tables at times. • In RPL, this periodic bring up to date mechanism also not found suitable
FatmaSomaa, 2017	A Bayesian model to precisely foresees the sensor hubs' speed disseminations. At that point, present the Mobility based Braided Multi-way RPL (MBM-RPL) to help versatility over RPL.	• The arrangements proposed to help versatility over RPL just centered on the foundation of a unique way towards the sink from every hub in the Destination Oriented Directed Acyclic Graph (DODAG) • None of these arrangements perceived to utilize a substitute way to forestall the essential way of disappointment.
Licai Zhu, 2017	RPL based Adaptive multipath traffic loading scheme.	• Hubs around the sink still expend more vitality because of bear more traffic. • Bottlenecks occurred in the whole system.
Jad Nassar, 2017	A multi-objective	• Traffic sessions in Smart Grid

	function uses three metrics delay, residual energy in nodes, and quality of the links.	(S.G.) are not, however, consistent.
M.Qasem, 2017	To balance the traffic load over the network, a new RPL metric has been presented.	• The parental node in RPL can join further than one child if they select it as a wished parent. • The burdened favorite parents will go out to be breakable nodes as their energy possibilities, exhausting much quicker than other parent nodes.
Hossein Fotouhi, 2017	Developed a mechanism, assumes three parameters, window size, hysteresis margin, and stability monitoring.	• Even though the purpose of these parameters is to manage the mobility issues, they have several limitations. • The window size has to be provided with the total number of packets required to measure the average received signal strength (ARSSI). • This could be one research problem, and it is not appropriate in most of the cases. • Defining the hysteresis margin requires

		a threshold that has to be chosen wisely to start and stop the hand-off. • While stability monitoring, a negligible variation in the threshold can degrade the performance. • The ARSSI may get reduced below the threshold during the hand-off to new A.P. • Position updates are expensive in many ways. • Every position update raises the packet crash threat at the medium access control layer; consume node energy. Packet collisions origin data packet loss, which interrupts the direction-finding performance due to reduced accuracy in determining the precise local topology. • A vanished data packet does get retransmitted but at the expenditure of increased end-to-end delay.
HananeLamaazi, 2018	Three arrangements:	• All estimates of RPL activities

	system scalability, compounds sink, and movement models, are used to evaluate the enactment of RPL.	cannot be practical to all of them in the same situation.
VidushiVashishth, 2019	Use optimization approaches to preserve energy of devices in IOT by employing clustering, cluster head selection, and less energy-expensive path calculation for effective routing.	• Few nodes are dynamically involved in the network for message generation and transmission. • Remaining nodes in the network wait for interrupts or events to occur, resulting in wasteful energy consumption.

V. Conclusion

The following important parameters could be emphasized to achieve the optimized QoS of Routing Protocol for Low-Power and Lossy Networks:

- LPWNs: In Low-Power Wireless Networks (LPWNs), different variations are found in the environments due to electromagnetic noise, humidity, temperature.
- Mobility: Mobility is the major concern in RPL due to the network with different topological conditions.
- Internet Protocol- in the Internet Protocol (I.P.), LPWNs with the movement provision allows the network to be combined in other wireless strategies.
- As wireless nodes have some drawbacks, like compact energy and inadequate assets, consideration is compulsory while planning the movement managing arrangement.
- By spreading the data to the neighboring nodes in the low-power network, it can offer mobility maintenance, and this produces one of the mode techniques to work on the above problems. But, spreading the data needs a portion of processing and energy depletion.

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