IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Vol.-7, Issue-4, April 2019 E-ISSN: 2347-2693

Literature Survey : Routing techniques in IOT

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DOI: https://doi.org/10.26438/ijcse/v7i4.624628 | Available online at: www.ijcseonline.org

Accepted: 11/Apr/2019, Published: 30/Apr/2019

***Abstract*—** The Internet of things is term basically composed of two word "Internet" and "Things" .The first word describes interconnecting every possible computing device in the world and second word describe everything that is addressable and communicable will be connected. Many issues in IoT include privacy, security, reliability, link failures, routing, heterogeneity etc. In this paper main focus on Routing. It is one of most important service in IoT. Routing is necessary to exchange the information in things and many protocols are designed and developed for optimum path selection. It depends on residual energy, delay and number of forwarding nodes in the path. In IOT continuous movement of nodes, frequently changing topology and limited resources it's become great challenge for the researcher in routing field. The paper provides literature survey on IoT with past research and discussion about applicability towards the IoT and routing challenges with comparison of different routing protocols using different parameters.

***Keywords*—** Routing, Protocols, IoT

I. INTRODUCTION

Internet is today one of the most important part of our daily life. There are large numbers of things that can be done using the internet and so it is very important. Communication is the most important gift that the internet has given to the common man. Email, social networking sites are some of the prime example of it. This is one such gift of the internet which is cherished by everyone and has made our life easier to much extent. In order to provide us better life, researchers, industries, academicians are attempting to connect all "things" in the world to internet. Which is called as internet of things.

The term "Internet of Things (IoT)" acts as an umbrella keyword that covers the various features such as the extension of the internet, the web as physical realm, deployment of extensive embedded distributed devices, sending and the actuation abilities [1]. The term IoT is also called future internet [2].

The term Internet of Things (IoT) according to the 2020 conceptual framework is expressed through a simple formula such as: -

IoT= Services+ Data+ Networks + Sensors [3]

It is anticipated that IoT will support heterogeneity at much higher level. The goal of the IoT is to be connected anytime, anyplace with anything and anyone ideally using any path and any device.

Kavin Ashton from MIT Auto-ID Centre proposed the term "Internet of Things". Author states that "The Internet of Things has the potential to change the world, just as the Internet did, may be even more so" [4]. According to US National Intelligence Council, "by 2025 Internet nodes may reside in everyday things [5].

The challenges that are addressed in the present routing algorithms can be rectified by using soft computing and computational intelligence. The future possibilities can be as follows [6].

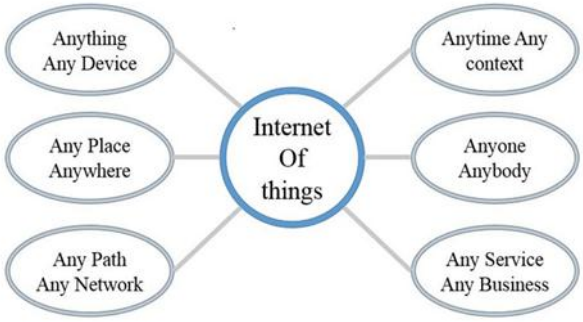

Figure 1

1) Design and applications:

The sensor nodes have to be constant movement position at some application due to this consistent topology changes. Routing is the biggest challenge for the researcher.It is very

important to focus on location, count of sensor node and design type for future application.

2) Routing based on Energy awareness:
To increase network lifetime is major factor also every time recharging of nodes is not possible because of cost expenses. To used proper routing methods to save memory utilization or also used network clustering. Energy harvesting nodes is also best solution.

3) QoS aware routing:
The quality of service metric based on parameters are bit rate,packet loss ,transmission delay, available bandwidth ,jitter and fairness etc. used for improve network performance.

4)Security routing:
Many of the routing algorithms are designed but very less importance given for security. To achieve more secure routing without any loss of network performance.

5)Development Platform:
Most of the routing algorithm used theoretical design and analysis it's important to used practical analysis for future research.

6)Heterogeneity:
The heterogeneity can be in the form of various software, hardware, protocols, vendors or manufactures. It is necessary to design standard protocol to easily switch between heterogeneous environments.

7)Context awareness:
Context awareness is essential in routing because for routings decision. Context can uses parameter in the form of residual energy, location, speed, memory and link quality.

8)Scalability:
Scalability is an important aspect in IoT network. The device will be adaptable to any changes in environment and meet the changing need in future.

9)Security:
Security is an important issue in IoT, it is require for communication between devices. The security in the form of secure constrained devices, Manage device updates, Ensure data privacy and integrity, Authorize and authenticate devices.

The main objective of this paper is to focus on routing Protocols with their challenges in the routing process. The rest of the paper is organized as follows. In section II classification of routing protocol. Section III Explanation about different routing protocol. Section IV Comparison of routing Protocol. Section V gives future direction and routing challenges.

II. CLASSIFICATION OF ROUTING PROTOCOL III.

Routing protocols are classified into two categories

1) ***Network structure***
2) ***Protocol operations***.

1) ***Network structure***

Network structure plays and important role in routing protocol.

a) *Flat routing protocol:* In this protocol no needs to take more efforts to arrange traffic and consolidate network.. Each and every node in flat network collect routing information and distributes its with neighboring routers. All nodes makes equal role in this protocol.

b) *Hierarchical Based Routing:* This protocol is outperform as compare to other protocol in saving energy, scalability and extending lifetime of Mobile network. In this protocol, if node having higher energy is used for sending data and other nodes are used for only sensing data. It contains two layers.

1) *Tree based routing:* In this routing tree is formed. Leaf nodes are sending data to its parent node and every parent node collect data and send to the next level parent node towards the sink.

2) *Cluster based routing:* It is used to form cluster and differtiate between cluster in terms of energy, load balancing and network lifetime. Future research to forming cluster require more time which is not suitable for IoT application.

c) *Location based routing (LBR):* The location based nodes shared information with each other to compute route. This is not issue, if all the nodes are owned by same user but in IoT has open architecture where all nodes are owned by different user are mixed and this will be shortcoming research related to sharing location between nodes cause problem of privacy.

i) ***Protocol Operation:***

Routing protocol operations are categories on the basis of communication, hierarchy and delivery methods. The different routing protocol operations are given below.

a) *Energy aware routing:* These protocols are used to saving energy of the specific nodes to maximize the network lifetime.

b) *Negotiation based routing:* In this protocol elimination of redundant data between source to destination. In this routing operation decision will be based on availability of resources.

c) *Query based routing:* This protocol consider two operations for route discovery

i) Request phase ii) Reply phase

Query phase sending data from source to destination. It generates query packet and sending to its nearest node and any node received this packet its send reply for the same.

d) *Multipath routing:* The number of possible paths is constructed but best possible path is selected based on node energy, minimum dealy and minimum hop count. The main purpose of this metric is reliable communication to improve QoS.

e) *Context Aware:* The context aware is based on residual energy of nodes, processing power of node, location and speed of device.

f) *Swarm intelligence:* These are used to solved complex optimization problem. Swarms are on the basis of logical transmission of data and mostly used in biological system.

IV. ROUTING PROTOCOL IN INTERNET OF THINGS

a) *CARP (Channel-Aware Routing Protocol) [6]:* It is scattered routing protocol used in under water wireless sensor network,for this reason its delivered packets in reasonable time with low energy demands. In addition CARP excellently avoid loops, route around connectivity. CARP maintain link quality information that is considered from history of successful transmission.

I. *Virtue in CARP*
- Link quality selection for packet forwarding
- High packet delivery ratio for increasing traffic

II. Shortcoming in CARP
- Security of data not considered
- Server technology not used
- Previously collected data not reused.

b) *CORPL [7]:* It is modified addition of RPL that is constructed for cognitive networks and employs Directed Acyclic Graph (DAG) topology generation. CORPL uses opportunistic data communication to forward the packet by selecting multiple forwarders (forwarder set). It coordinates them so as to choose the optimum next hop to relay packets to. CORPL is similar to RPL. Every node updates information of neighborhood through DAG Information Object (DIO) message. Every node dynamically prioritizes its neighbors in order to make the forwarder list. Cost function is used to assigned priorities.

I. *Virtue in CORPL:* Opportunistic forwarding approaches used based on RPL

II. *Shortcoming in CORPL*
- Security of data not considered
- No data storage management

c) *LOADng[14]:* It is basic version of AODV and it can be substitute to standard RPL protocol .The various application of IOT like MP2P and P2P which has RPL contains many of the drawbacks and for this LOADng is acceptable. It contains performance evaluation of energy spent,packet loss and latency .operations performed by LOADng are
- RREQ: Searching route to destination
- RREP: Generating route reply from destination to source (ACK).

I. Virtue in LOADng
- A lightweight variation of AODV
- Suitable for a more general traffic pattern

II. Shortcoming in LOADng
- Security of data not considered
- Route discovery required high dealy

d) *AOMDV-IOT (Ad-hoc on demand Multipath Distance Vector routing protocol for IoT):* This protocol is extension of AOMDV [8].AOMDV-IOT generates linking between regular nodes and internet nodes. Every node maintains two tables ICT (Internet connecting table) and routing table. Initially, sender node does not know which node are internet connected nodes for communication because many of the nodes connected to internet. When node needs to make a connection to internet .we define IP address as ILA (Internet Linking address).Then find ICT table and ICT having appropriate nodes linking to the internet. If it has, then the ILA address change to the destination node IP address, otherwise the originator node broadcast a RREQ to refresh its routing table and ICT. The protocol communicates through four messages.
- RREQ: find route from source to destination.
- RREP: destination sends reply through response.
- RERR: If the internet link is fail then neighbor nodes should send the RERR message and update their sequence number until every node in the network receive the message.
- HELLO: To increase network lifetime and maintenance of routing table .Every node should send HELLO message to neighbor node.

I. Virtue in AOMDV-IOT:
- Finding of multiple routes from source to destination. It used alternate route, if route failure
- It decrease average end to end delay and improves performance of packet loss

II. Shortcoming in AOMDV-IOT
- Security not consider for routing data
- It can improve if combine routing table and ICT and find function to select appropriate node for us
- This protocol does not understand context

e) *EARA (Energy aware Ant Routing Algorithm):* EARA protocol is extended version of ARA (ant routing algorithm) based on swarm intelligence algorithms [9].In this protocol, determining the nodes residual energy and structure for estimating a paths energy. EARA added two more fields in ant agent. The first one is, EARA computes the average energy of the nodes base on the number of hops a packet traveled. The second one, stores the lowest residual energy value an ant agent encounters on its path. EARA uses periodic energy ant agents (PEANTs) for updating the energy values in a nodes routing table. The Broadcasted PEANTs at the destination collect the energy

information on that path. Flooding PEANTs consumes more energy its very costly operation to avoid this algorithm sends packet occasionally.

The destination nodes in EARA complete this by keeping track of the residual energy of their own battery. If the residual energy has changed then EARA floods the network with a new PEANT. The time interval in which EARA will flood PEANTs might be large. It depends on two parameters

- The maximum battery capacity
- The threshold value.

I. Virtue in EARA:

- EARA is reactive routing protocol and also consider context.
- EARA handling route failure.

II. Shortcoming in EARA

- Security does not consider.

f) *REL (Routing protocol based on Energy and Link Quality):* This protocol increased reliability and energy-efficiency [10].It select the path based on link quality, hop count and residual energy. REL consider WeakLinks for comparing link quality is less than threshold value and updating WeakLinks counter. REL find routing solutions based on path selection and load balancing.

The path selection process is based on comparison of two threshold value

After getting the DIO message, the neighboring node can set its own rank based on its neighbor's rank.

RPL uses DAO (destination advertisement object) messages for reverse route construction.

In advanced Oana Iova et al. [12] proposed Multi-parent routing in RPL to considering metric of Expected Lifetime (ETX) to maximize network lifetime by identifying the bottlenecks of the network and creating energy balanced paths. They constructed a DAG based on the ETX metric, which accurately estimates the lifetime of all the routes

- Hop count threshold (HCdiffmax_allow)
- Energy threshold (Eth).

The load balancing mechanism is monitoring energy level of each node and stored residual energy percentage individually after each t time interval node compare current energy level E(t) with the previous energy level E(t-1). If the difference between E(t) and E(t-1) is higher than Eth then discharge of battery need to recharge it.

I. Virtue in REL:

- It contains mechanism to provide load balancing and avoid premature death of nodes.
- REL increase network lifetime and enhanced network availiblity.
- It considers link quality and energy efficiency to improve network lifetime.

g) *Multi-parent RPL (Routing protocol over low power and lossy networks) [11]:* RPL is simple and interoperable networking protocol. RPL is designed for IoT to interconnect thousands of devices through multihop mesh networks. RPL is distance vector routing protocol it builds (DAGs)directed acyclic graphs based on certain routing metrics and constraints. This DAG support upstream dominant traffic patterns with resource constrained nodes. DODAG (Destination oriented Directed Acyclic Graph) it is a forwarding tree in RPL. The links has

toward the border router. By selecting as parents the nodes with the strongest Paths (i.e., largest ETX).

II. Virtue in Multiparent RPL:

- Multi-parent RPL uses ETX metric which improve reliability and delay also consumes less energy.

III. Shortcoming in Mutiparent RPL

- It does not support for secure mode of operation

V. PARAMETER BASED COMPARISON BETWEEN DIFFERENT ROUTING PROTOCOLS

Protocol	Strategy	Structure	Security	Multi-hop Routing	Link Quality	Energy Efficiency
CARP	Reactive	flat	×	✓	✓	--
CORPL	proactive	flat and Hierarchical	×	✓	✓	-
LOADng	Reactive	flat	×	✓	×	Low
AOMDV-IOT	Reactive	flat	×	✓	×	Medium
EARA	Reactive	flat	×	✓	×	Low
REL	Reactive	flat	×	✓	✓	Medium
RPL	proactive	flat and Hierarchical	✓	✓	×	Low
Multi-parent RPL	Reactive	flat	×	✓	×	Medium

Figure 2

VI. FUTURE DIRECTION AND CONCLUSION

Routing is research area with rapidly growing set of research results. Many of the people puts the efforts to solve the problem in routing but still many more routing challenges are not fulfill. Performance of protocol is promising in terms of Energy, QoS (Quality of service), Security etc. Future trends and challenges in routing to improve network lifetime, QoS and Network overhead.We discussed existing routing protocols and also challenges in routing field for future direction.At the end ,we belive that routing issues will be addressing in the next forthcoming year.

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