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Research Article

QOS by Priority Routing in Internet of Things

[1]G. Vithya and [2]B. Vinayagasundaram
[1]St. Joseph's College of Engineering, Chennai-119,
[2]Depertament of IT, M.I.T Campus, Anna University, Chennai-25, Tamil Nadu, India

Abstract: The aim of this study is to present a system which uses a new layered network architecture approach for IOT. Sudden and unpredictable large-scale changes are commonly prevalent in Internet of Things (IoT). The images or video data captured from the remote places have to be routed without delay. This is a tumultuous task in large scale. By using an Agents in various wireless networks and the packets are routed depends on the priority. The scope of this study is to avoid delay, interference during transfer of data from various wireless networks. This study deals with (i) congestion free data transfer under many cramped networks (ii) low processing overhead (iii) handling realistic failure scenarios, prioritized traffic in a flexible manner (iv) robust to both topology failures and traffic variations. This study presents a QoS routing method, by setting a priority to the networks to differentiate eclectic sensing vicinities in the smart space between sender and receiver.

Keywords: Context aware in IoT, IOT architecture, priority routing in IoT, QOS in IOT, routing in IoT

INTRODUCTION

The major idea of internet of things: (IoT) is to connect smart environments/spaces and self-aware things. Every speck in the world is linked and communicates with each other. For instance, Smart environments are smart transport, cities, buildings, rural areas and living conditions. They have their identities, physical attributes and interfaces. Then, they become active participants in the business, information and social processes.

Heterogeneous networks require technical innovation and design improvements in the types of wireless network such as infrastructure based network, infrastructure less networks. The IOT is designed by the way of IOT Network Layers.
The Internet of Things finds the following demands:

- A shared understanding of the situation of its users and their appliances
- Software architectures and pervasive communication networks to process and convey the contextual information
- The analytics tools in the Internet of Things that aims for autonomous and smart behavior (Gubbia *et al*., 2013)

A model is to be established to classify the complicated IoT technologies and a layer model is built for future IoT architecture. The issues required is related with how to represent, store, interconnect, search and organize information generated by the IoT.

With the fundamental grounds a smart connectivity and context-aware computation can be accomplished in some extent by the layered approach.

Design of IoT layers:
Physical layer: Accommodates the wide range of networks, their power variations and allocations in spectrum.

Data link layer: MAC: Differentiated medium access channel protocol is used such that it avoids collision, Interference, congestion and Multiplexing.

Link layer: This layer is designed to support reliability and retransmission.

Internetworking layer: The design supports Heterogeneous resilience.

Transport layer: Enhances the Reliability by End-to-End technique, Controls Congestion and overflow.

Application layer: Behaves Adaptive, acts supportive for different Applications.

IoT supports the types of Wireless networks such as WLAN, AdHoc, MANET, Sensor Network, Cellular and Wired Networks. Their choice of range of signal, antenna propagation depends on their Universal standards. MAC layer of all the Wireless networks and

Corresponding Author: G. Vithya, St. Joseph's College of Engineering, Chennai-119, Tamil Nadu, India

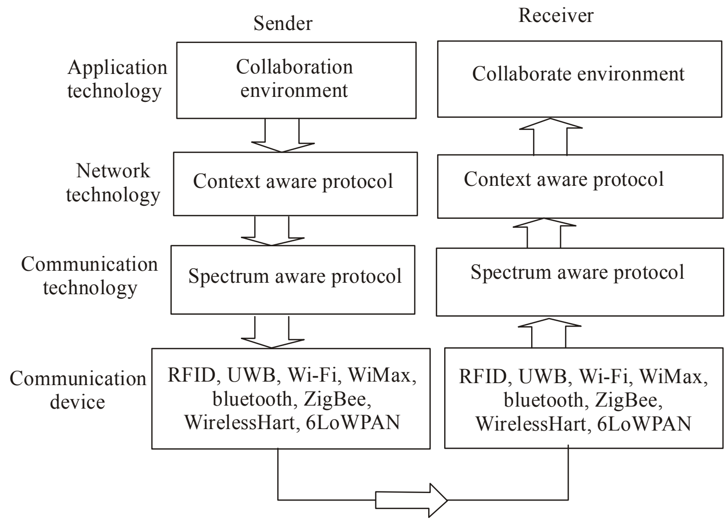

Fig. 1: Protocol stack of IoT

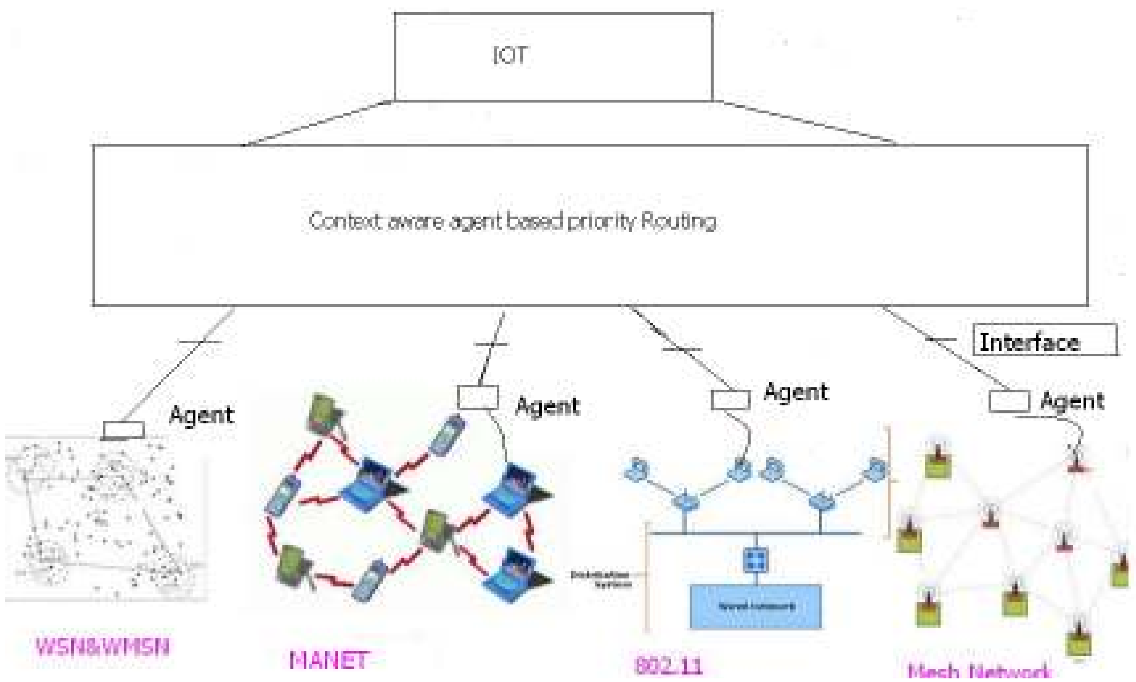

Fig. 2: Architecture of IoT

the Link layer use their own standards. IoT MAC is to be adaptable to all Wireless networks for accessing the medium. In Fig. 1 Protocol Stack of IoT explains the protocol used by different layers in the IoT.

For example different devices may use the communication links such as RFID/NFC/Bluetooth/ Zigbee/6LowPAn/ANT/WIFI/W LAN/GPS, GSM. The MAC Protocol called Spectrum Aware is an interface to all Networks.

The WSN, Adhoc, 802.11, Mesh uses the communication link such as RFID, 802.11a/b/c. They are connected to the context aware protocol by Spectrum aware protocol. One of the factors in the context aware protocol, the routing based on priority/Query based packet transmission.

Normally IP routing in the IOT is classified as exterior routing, Interior routing. Exterior Protocols are used for routing between autonomous systems in the IOT, while interior Protocols are used for routing within an autonomous system.

Figure 2 explains the collection of packets from the Individual Agents in the each wireless network. The cluster Heads are interfaced with agents in IoT. The agents are interacting with IOT by Context Aware Protocol.

Construction of a routing protocol for the internet of things will support Minimum route acquisition delay and distributed routing approach. The interrelations among the device capabilities and network layer are identified and the method of capturing this in our solution is explained in the later sections.

LITERATURE REVIEW

Existing transport protocols fail in the IoT scenarios since their connection setup and congestion control mechanisms may not be up to the level. Grouped the IoT into three categories:

- Technologies that enable “things” to acquire contextual information
- Process contextual information
- Improve security and privacy

The first two categories can be jointly understood as functional building blocks required building “intelligence” into “things”, that are indeed the features that differentiate the IoT from the usual Internet (Atzori *et al*., 2010).

The demand for multimedia services, such as voice over Internet Protocol, video on demand, information dissemination and file sharing, is increasing explosively in the wireless local area networks. These multimedia services require a certain level of QoS. Thus, it is important to provide QoS for multimedia applications (Gluhak *et al*., 2011).

Spectrum aware protocol needs maximum-weight-α scheduling can lead to the best queuing performance to meet the QoS requirement of multimedia services by using Enhanced Distributed Channel Access (Wang and Akyildiz, 2013).

Mobile Agent’s (MA) technologies are ideal, it offers a promising solution of routing problems, where it can reduce network traffic and maintain load balancing and thereby increasing routing performance (Wang *et al*., 2011).

In Incebacak *et al*. (2013) analyses the multipath routing and proposed a energy balancing that prolongs the network lifetime as compared to single-path routing, when utilization of a single route between a source node and the base station results in imbalanced energy dissipation.

Therefore, determination of the optimal number of routing paths in multi-path routing by considering the tradeoff in routing complexity and network lifetime extension and to investigate the impact of the number of routing paths in multi-path routing on network-wide is in need when an IOT is considered as an architecture.

In Bandyopadhyay and Sen (2011) mentioned in feature research area that a frame work model that dynamically provides an architecture design with some of the issues that need attention are: design of distributed open architecture with end-to-end characteristics, interoperability of heterogeneous systems, neutral access, clear layering and resilience to physical network disruption, decentralized autonomic architectures based on peering of nodes etc., are required.

Determination of the optimal number of routing between the wireless environments is by considering the trade off in routing complexity by ant-based hierarchical routing protocol. Multiple QoS metrics along with a traffic prediction based fast rerouting algorithm is developed for different classes of packets (Li *et al*., 2013).

In my previous work we provide an algorithm for qos routing in a multipath environment (Vithya and Vinayagasundaram, 2014).

By viewing and overwhelming problems in the existing works in the IoT in the area of Network and transport layer a small engineering work is required to support Qos routing and maintains energy of the network by contextual data transmission.

In this study the energy is balanced by keeping the agent for every network and transmission is by forming a Queue to avoid multipath routing between IoT and wireless network.

MATERIALS AND METHODS

The network traffic is increasing at an alarming rate due to increase in data rates, an increase in the number of Internet-enabled services. It is particularly challenging to develop a ‘‘One-Queue-fits-all’’ solution by following the classical approach.

It consist of two phases, all wired and wireless network in Phase 1 and Context aware agent based priority Routing in Phase 2. Each agent act as interface between Phase 1 and Phase 2.

In Phase 1, to balance the load in the IoT, the packets transmitted from various networks are scrutinized based on the priority of the wireless networks. Higher priority network Agent gets the chance of transferring packets to the IOT Network. Other Network Agents form a queue to transfer the data to IOT.

The priority based on a sequence of events in the networks is assigned to avoid delay, jitter in the multimedia packet, decay in the battery power of the node and reduction of lifetime of the network. Another important contribution by the priority based routing is Quality of Service (Qos) in the routing.

QOS is needed during routing for latency and to avoid packet loss, jitter. In this study Qos services such as integrated, differentiated service is supported in intra wireless Network and Inter Wireless Network.

In Phase 2, Agent based Priority Routing in IoT (APR) is a source initiated routing protocol. As discussed earlier, an algorithm APR acts as a bridge between agent on the intra-network and IoT.

The APR is an algorithm supported by the other algorithms such as Delay Sensitive Resilient Routing (DSRR) for Intra Wireless Network and Agents for Interfacing with IOT.

Methods (phase 1): The intra wireless networks are scrutinized by the algorithm called Delay Sensitive Resilient Routing (DSRR). Based on the factors such as, crucial of the data, number of packet transmissions due to the occurrences of events in the wireless networks, the Priority has been assigned to the packet, for transmission.
The overview of DSRR algorithm is given by:

- Selection of the cluster head is done by selecting a node rich in resources. An equal power alternate, is considered to be the buffer cluster head.
- The sensed data from the source node for t1 seconds is transferred to the cluster head and buffer cluster head.
- Other packets from the source node are transferred to the buffer cluster head where the frames are compared with and difference in the frames alone is sent to the cluster head for routing.
- Delay estimation is done by the expected travel time of the packet by the rate of forwarding, Residual energy, No of Hops, efficiency, data size.
- If two events occurred simultaneously in two different clusters priority is given to the cluster head with increased number of frames caused by the rapid changes in the vicinity.

The Event driven routing is divided into two phases. Phase1 is choosing two high power nodes that are neighbours, one is a cluster head and other is the Buffer cluster Head. The cluster Head collects the information from the group of nodes and transfers to the Buffer cluster Head that stores and forwards the multimedia frame simultaneously. The next frame from the Cluster Head is checked with previous frame, if there is a difference, only, the difference bit frame is passed on to the next cluster by entering the next phase.

If the High power nodes are not neighbors, then the highest power is the cluster Head that stores and forwards the multimedia frame simultaneously. The routing is established by transferring the packet to the next node which may be any node as Proxy cluster, Cluster Head or an ordinary Node.

Video data may be represented as a series of still image frames. The sequence of frames contains spatial and temporal redundancy that video compression algorithms try to eliminate or code in a smaller size. Similarities can be encoded by only storing the differences between frames, or by using perceptual features of human vision. The packet contains Region ID, Entity Id, packet Size, Source, Destination.

The operation of different Intra Wireless networks such as Intra Wireless Sensor Network (IWSN), Intra MANET/802.11 Networks (IM8N), Intra Mesh Network (IMN) with DSSR algorithm and their agents are explained as follows.

Intra Wireless Sensor Network (IWSN): The IWSN is a collection of Wireless sensor and Wireless Multimedia Sensor Node to capture the scalar data and Multimedia Data. The demand of WMSN is increased due to automatic transfer of surveillance data to the internet of things. While capturing real time multimedia images, videos more power is required to capture and forward the images to neighbour node or destination. Overhead in routing is avoided by calculating the travel time of the packet to choose the best path to support QOS in routing. Potentially higher delays and jitter are due to lower transmission rates.

To support QOS in multimedia packet transmission, the requirements are Loss tolerance, jitter, delay and throughput to route the packet to the destination. Due to the limitation of battery power of the node, calculating the delay for routing is important to avoid more battery usage.

These types of problems is to be solved to track and forward the captured data to base or sink before loss of power on the nodes to avoid loss of data. In this study, to support QOS in routing while transferring Images, Videos and Audio files an approach is designed to be delay sensitive and resilient by the algorithm DSSR.

Intra MANET/WLAN Networks (IMLN): MANETs is a particularly challenging task due to the fact that the topology of the network changes constantly and paths which were initially efficient can quickly become inefficient or even infeasible.

MANET Cluster Head or MANET Agent (MA) carries data and explore the network to collect routing information. They communicate with one another to exchange this routing information. By mobile agent exploration, the intelligence is put across the network, which enables the routing to be distributed and adaptive.

MA monitors, takes decision by the behaviour and does the action of data transfer to the IOT. The behaviour of the MA is identified by DSSR algorithm.

Intra Mesh Network (IMN): An Intra Mesh Network (IMN) consists of two types of components: wireless Mesh Routers (MR) and Mesh Clients (MC), MRs typically form a static mesh networking infrastructure called a wireless mesh backbone serving. MCs that are end-user mobile devices with wireless access capability. An IMN is also typically interconnected with the Internet through a gateway, which is a special MR that performs the gateway/bridge function.

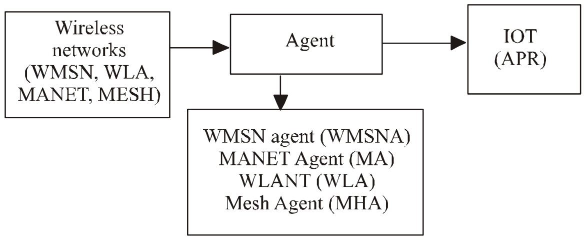

Fig. 3: Agent topology

Behaviour of the MR in IMN is calculated by DSSR algorithm.

Algorithm: Algorithm for DSRR.

First cluster ()
{Compare ()
{
Let f1 be the base image and f2 be the incoming image
Compare the images in cluster Head
If not equal append the image
}
Agent = collection of packet in T sec}
Neighbour cluster ()
{{compare ()}
Agent = collection of packet in T sec}
If first cluster [agent] >Neighbor cluster [agent]
Assign priority for first cluster
Else
Priority for Neighbour cluster

The above algorithms explains the priority for the clusters in the wireless sensor Networks. The same DSSR is implemented in the entire wireless network to identify the priority between group nodes in the same network.

Agent based priority routing (phase 2): An autonomous system comprises of a set of networks and routers controlled by a single administrative authority called Agent. Autonomous systems and routing domains depend on the administrative authority.

The administrative authority or the Agent acts as a bridge between intra-wireless and inter-wireless networking. The implementation of a highly scalable routing can relax range of mobility restrictions. Reducing the overhead associated with managing mobility across routing domains and overall complexity of the system architecture.

Agents can be categorized as Inter Agent (or IoT Mobile Agent (IoT NA)), IntraAgent (or Static Agent or User Agent). The IoT agent is responsible for transferring data from IoT to user Agent and user Agent operates vice versa. A query is generated from IoT to get information from the Wireless Networks in query based routing. And priority based routing transfer packets from Wireless Devices to IoT.

Intra agent: The types of user Agents used in the IoT are named as:

- Wireless Sensor Agent (WSA)
- MANET Agent (MA)
- Wireless LAN Agent (WLA)
- Mesh network Agent (MHA)

Figure 3 explains the topology of Agent. The user agent in the intra Wireless networks takes the responsibility of transferring the data in the IoT. Intra Agent or Network Agent’s (NA) technologies are ideal for routing, where it can reduce network traffic and maintain load balancing and thereby increase routing performance.

As discussed before, the each Agent collects the information from its networks and takes part in the transmission to IoT, meanwhile the cluster Head is ready for the next transmission.

Each packet has a unique identifier. This identifier for a packet is transformed into a single permanent name after it passes through its agent. That is, the stream of packets is encapsulated by the network agents ID to communicate with the IoT.

Algorithm: Agent based priority Routing Algorithm.
APR ()
{Max = 5 packet in t second
For i = 1 to NA [i]
{// NA [i] as network agents such as WMSNA, MA, WLA, MHA
Compare ()
{
If Max < = NA [i]
Assign Max = NA [i];
}}}

RESULTS AND DISCUSSION

DSSR algorithm is implemented in each Intra Network, to decide the priority of the packets in the intra Wireless Networks.

Figure 4 gives an idea of the priority in Wireless Sensor Network routing. The cluster Heads are compared up to T1 seconds to decide the priority of the packet. Higher the number of frames in the cluster, the higher is the priority because of the occurrence of events continuously.

The number of incoming packets at every stage of routing between the cluster and node is calculated by assuming that it follows a Poisson process.

Let PX (t) represent the probability of getting x occurrences in time t and x represent the number of

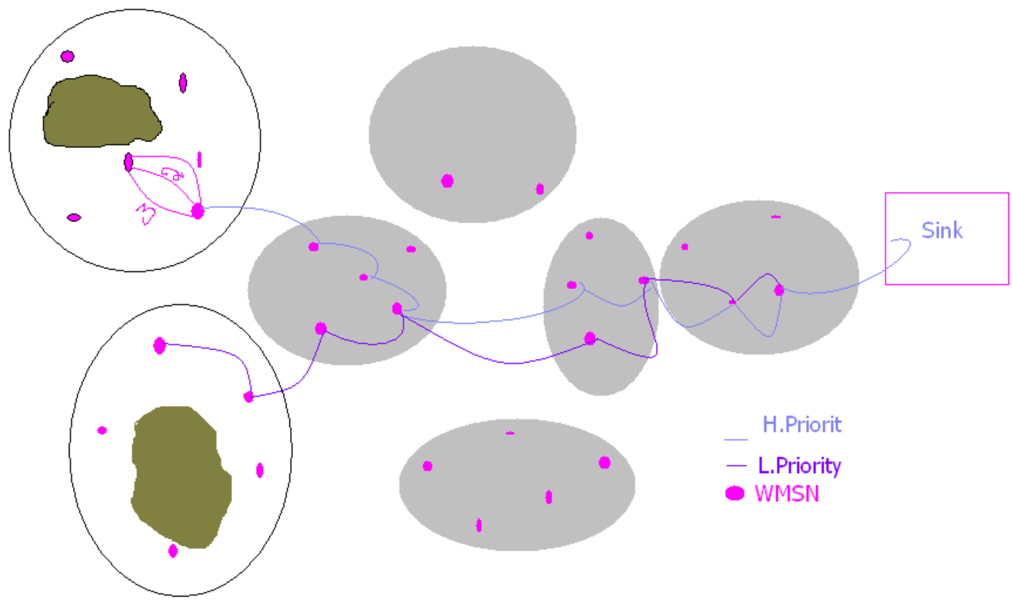

Fig. 4: Priority intra WNS routing

packets arriving at time interval t. Let λ be the mean rate of packet arrival:

$$P_x(t) = e^{-\Lambda t}\,(\lambda t)^x / X! \quad \text{Where } \Lambda = \sum_{T=0}^{n} x(t) \,/\, \text{Total time}(T)$$

The Main function of the proxy cluster is to continuously compare each frame of data and transmit only the non repeated data. This has been proven to be efficient by the following efficiency derivation.

Scenario:

DSSR algorithm: Consider a scenario in which events are occurring simultaneously in neighbouring clusters then priority is calculated by using Poisson process.

An area under coverage is observed for 10 sec say as in Cluster-1. It is seen that the time period is utilized by transmitting frames which is sent as 2 packets/sec. For any situation, the first and foremost frame to be transmitted is the independent frame. In the next seconds, significant changes are seen in the vicinity so the packets are sent after comparisons between frames. The mean rate of packet arrival in cluster-1 is given as:

$$\Lambda = \sum_{T=0}^{10} x(t) \Big/ \text{Total time } T \quad = 20/10 = 2$$

In the Neighbouring Cluster named as cluster-2, it is seen that after comparison the first 2 sec is utilized by transmitting the independent frame which is sent in 2 packets. In the next 4 sec, no significant changes are seen in the vicinity so the packets sent will be null after

Table 1: Comparison of packet between the cluster heads 1 and proxy cluster head 1 in cluster-1

Time (t) sec	Number of packets to be transmitted (x)	$P \times (t) = e^{-\Lambda t}\,(\lambda t)^x / X!$
1	2	0.270600
2	2	0.146500
3	2	0.044610
4	2	0.010734
5	2	0.002269
6	2	0.000442
7	2	0.000081
8	2	0.000010
9	2	0.000020
10	2	0.000000

∑p (1), (p (2)…p (7), p (8), p (9), p (10) = 0.475354

Table 2: Comparison of packet frames between the cluster head 2 and proxy cluster head 2 in cluster-2

Number of packets to be transmitted (x)	$P \times (t) = e^{-\Lambda t}\,(\lambda t)^x / X!$
2	0.183900000
1	0.270600000
1	0.149300000
0	0.018300000
0	0.006737000
0	0.002478000
2	0.022341100
1	0.002683701
2	0.004998000
1	0.000453900

Since 4, 5, 6 there is no significant changes the value is same case 3: t>6 ∑p (1), (p (2)…p (7), p (8), p (9), p (10) = 0.667~0.7

comparison is over. After the 6th sec, furtive changes appear in the vicinity.

The probability of all the sensed data reaching the second cluster is low which eventually makes the probability of the data reaching destination lower. So, each frame is compared with the previous frames and data, which has not occurred previously, alone is transmitted.

The mean rate of packet arrival in cluster-2 is given as:

$$\lambda = \sum_{T=0}^{10} x(t) \,/\, \text{Total time } T = 10/10 = 1$$

After comparison of the results in Table 1 and 2, it is seen that the probability of increase in number of frames is likely to happen in cluster-1. And hence cluster-1 is bestowed with highest priority.

Wireless Sensor Agent (WSA) collects the information and takes part in the transmission to IoT, meanwhile the cluster Head is ready for next transmission. Each packet has a unique identifier. This identifier for a packet is transformed into a single permanent name after it passes through its agent.

APR algorithm: Agents with the less number of packets in t seconds get more priority in IOT. Other networks form a queue during more number of data transmissions. Then the traffic congestion has been avoided due to minimum packet transmission at the same time redundancy is removed.

CONCLUSION

The Cost is optimized and energy is managed by separating the work into intra and inters Networking solutions. By less engineering efforts, the packets are ordered in priority queue easily with small modifications and extensions. The packets are configured and aligned to achieve the best transmission in time with Low latency. Traffic congestion is avoided by less number of packet transmissions. This is by comparing the packets and sent the packet only if there is any difference. So QoS routing in IoT proves, flexible and accurate.

RECOMMENDATIONS

Future work lies in developing Priority levels based on context and for query based routing. The Application layer built as web UI for easy browser-based configuration for Source and destination initiated routing.

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