A Multipath based Energy Efficient Path Approach for Internet of Things in Smart Cities

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Abstract: Enabling the electronic gadgets to share essential data and to communicate with the server and one another is carried out by Internet of Things (IoT).On a daily basis, devices are added gradually to the network of IoT by the progression in the technology. The amount of data that is being transmitted in the period of smart cities is huge. On the basis of significance like medical and fire safety data, the system has to prioritize the delivered data when transferring such an immense quantity of information. Inappropriate delivery of emergency packets and the system functionality rupture is caused by the deficiency of effective programming procedures. Moreover, the information has to resist attacks over the channel which was transmitted through the network. Every packet has the deadline before which it must reach the sink and a description of its significance in the existing EARS. Simple identification of the emergency nodes is enabled by it. Additionally, a Multipath based energy efficient path algorithm is proposed so that the overall sum of transmissions in the network is reduced. Consuming least correlation with the communication interference in the course of congestion, the normal data as well as emergency data packets are transmitted over an alternative path. The network congestion will be reduced by this. The existing state of the art methods and the proposed technique is compared the exciting approaches are outperformed by the produced outcomes.

Keywords: Data emergency, EARS, TDMA, MBEEP, Time scheduling, IoT.

I. Introduction

Internet of Things is the popularly known Innovative phenomena of this century. It has gained a number of reputations with the improvements inside the internet generation. IOT is a platform in which the person can join normal matters embedded with electronics, software and sensors to the internet, permitting them to gather and change statistics.

Figure1: IoT overview

Internet of Things essentially expands interdependence of persons to interact, make a contribution and collaborate to matters around us. Sophisticated sensors as well as chips are implanted in the physical matters used each day, every transmitting precious data.

This record ends in an improved understanding of how things work and work in partnership. Diverse records are brought together by Internet of factors platform and to communicate with one another, common language for the gadgets as well as applications are offered.

With the devices themselves, the method is initiated that communicate securely with the Internet of Things stage. In order to share the extreme prized information using the applications that deals with the desires of Industry-specific; this platform applies analytics and integrates the records from several devices. The producer additionally makes use of the platform for creating and manipulating programs which resolve specific troubles. There are 3 important concerns even in organizing in the IoT system:

- **Connect:** For the IoT system, to work with that one should ensure the right net connectivity. All the gadgets inside the community (network) need to be related in order to share the information.

- **Analyze:** the second step is processing of statistics where in the real-time analysis of incoming records streams with occasion aggregation, filtering and correlation happens. In this level, IoT has to recognize the raw information streams with contextual records and generate composite streams, query and visualize huge amounts of data with integrated cloud service aid and allow big data evaluation.
- **Integrate:** the very last step is corporation connectivity where in the essential IOT records and occasions dispatch dynamically to programs and manner flows. API primarily based integration with cloud applications and an IoT device takes place in REST APIs. Sending messages to the gadgets from the corporation and mobile apps, impartial of device connectivity occurs in command and control.

Current days this IoT in the smart cities is most widely used, this IOT method has a huge integrated scheme which involves of sensor networks, mobile communications, social networks, intelligent transportation plus so on. Sensors measure the raw records and send the values to the cloud, which is analyzed and used for different applications. Aimed at the Internet of Things, there are a sequence of protocols that are getting used, they may be CoAP (precise for a communication system verbal exchange between machine to machine but much less secured), MQTT, HTTP, XMPP, these kind of protocols are tremendously secured. The hardware utilized in IOT is open source hardware which includes the microcontrollers.

Those microcontrollers are small programmable gadgets and they may be related very easily without any problems. Wireless mesh networks, sensor networks, cellular communications, social networks, smart transportation in addition to smart transportation as well as intelligent transportation are involved in Internet of Things (IoT) for smart cities [1]–[3] which is a large integrated machine. It has turn out to be a warm topic in many programs currently [4].

Maximum of the present mechanisms in IoT through which the overall network performance for the smart cities is improved and the researchers primarily targeted on the progression of the routing set of rules (algorithm) [5], [6] as well as node energy saving control [7]–[11]. But, through the network scale and programs development, the information in network turn to a huge or complicated that traditional statistics programming methods, that remain insufficient to handle them. Similarly, there exist a number of statistics packets that must be dispatched soon towards the sink node, that packet is known as emergency packets, which include the alarm statistics in clinical rescue carrier, the hearth statistics in wooded area there the fire monitoring is provided, and so on.

Hence, statistics packets emergency reaction has turn out to be a severe task, in particular within the disaster restoration scheme [12].

Compared to the finishing of the deadline [13]–[15], the end-to-end packet transmission delays is reduced and the emergency packets is made to reach the sink node earlier and extra packet scheduling procedures with large records are proposed for the massive-scale networks. First-come first-served (FCFS), earliest deadline first (EDF) and emergency task first rate monotonic are the three types in the investigation where the data packet scheduling is distributed mainly in the recent centuries. FCFS is mostly utilized at this point. Mostly in the multilevel priority queues (PQs), this algorithm is utilized [16]. A few addition and investigations mainly deals with single node's data packet scheduling such as packet scheduling in sensor networks [17], [18], which include the packet with the better significance can prevent the packet with the lesser significance.

By this it is known that algorithms are not affecting the other nodes, hence there might exist some additional period, by seeing this, the alternative data packets are dispatched towards the sink node. Therefore, to allocate community (network) resources rationally, an effective packet scheduling set of rules is required. On the basis of the efficiency of non-emergency data packets in addition to their emergency data which could make certain relevance of emergency data packets, the scheduling of packets is done.

The classical QoS technique, inclusive of differentiated offerings (diffserv), undertakes this concept. Inobservance with the type of the sensor and characteristics of the statistics in networks, the

their emergency information that can make certain timeliness of emergency data packets are assigned in addition to the time constraints of transmitted packets. But, for community (network) traffic management, it is a class-based, coarse-grained method. Within the packet scheduling method for smart cities, along with the significant data like alarm data in fire tracking service, a few more pleasant-grained facts have to additionally be provided.

In EIoT, there are many scheduling schemes for the sensor networks organized such as collection Tree [19], ZigBee [20] and many others. But, those schemes can't assure the throughput of networks. We have another scheme i.e., Backpressure-based scheduling scheme which is an adaptive as well as distributed scheme, and may also effectively control the community (network) congestion and the throughput of networks is guaranteed [21].

The Internet of the Future (IoF) is anticipated for being ruled by means of massive content oriented traffic, in depth communications in-between billions of people frequently on the flow, unrelated interactions amongst hosts as well as smart items, and provisioning of hundreds of thousands of (new) offerings, by means of strict actual necessities as well as placing easiness in connecting every person in addition to the whole thing. Main aspect of the IoF is that the net of Service (IoS), that is geared toward creating each promising facility (from the management of the personal residence pantry to the management of the entire organization manufacturing procedure) extensively and effortlessly available from the internet yielding to better productivity. Strictly connected toward the IoS is the internet of Things (IoT), that's intended to express into the internet, a huge amount of gadgets that over popular communication protocols as well as particular addressing methods deliver offerings for the ultimate users. IoS is having some portion of the IoT at that time, while the statistics furnished by way of the objects are realized as services that might remain in certain for making data regarding the physical international existing on the internet [22].

Powerful network of assets is created by a huge value of the IoF that resides on its capacity as in creating social resources. Such social relations could greatly facilitate the detection of assets which has the capacity that is essential to remedy for a specific mission. To achieve this aim can be achieved by enabling the IoF to define, construct, manage, and to get connected with social relationships in-between the resources. While this is presently a truth for the relations amongst people via the technology for the social Web, yet need to keep effective efforts are wished control of the social relationships for the alternative types of assets with handiest high-level remedies are seemed in the literature.

The social relationships introduction is proposed by the motivating papers among the objects in the world of IoT. The idea of objects in a position to take part in conversations that were formerly handiest available to human beings as an illustration, in [23] is introduced by the authors. Correspondingly, the activities of studies suggested in [24] keep in mind that, being matters consisted to the collected network by the human beings, on the basis of the internet of factors; social networks can be constructing primarily and remain significant to inspect the members of the family and progression of things in IoT.

This has moreover added to the models of social network as well as the convergence of IoT that depicts the situations as evaluated in [25], in which the character can distribute the services provided using the way of objects accompanied by widespread matters through extensive social networks. Explicitly, the Social IoT (SIoT) conception is established in [26] as well as [27] that are meant in place of a social network where in each node is an item able to establish social relationships with further matters in a self-sustaining manner consistent with guidelines set via the proprietor. Using the idea that the numerous are smarter compared to the little [28], this novel pattern is similarly inspired so as to converge, to critiques as well as facts maintained by the group, that objects must engage extremely.

Till this period, the fact of concern has remained focused towards the description of the relations in these proposals and towards the description of orientation designs as well as protocols in addition to communications between the gadgets.

However, the pattern nonetheless shortages in a few essential components together with expertise how the records furnished with the aid of the opposite

participants must be processed which will construct a consistent gadget on the premise of the conduct of the items. Certainly, deprived of powerful trust control foundations, malfunctions and attacks in the IoT would be greater than any of its blessings [29].

In order to guarantee reliable as well as effective data transmission in WSN, an energy efficient reliable multi-path data transmission (ERMDT) protocol is proposed intended for the healthcare presentations in this paper. With respect to its critical behavior in the sensing field, the sensed information is classified using the ERMDT protocol. A patient and number of patients in the hospital, the bandwidth for a zone are fairly allotted based on the necessity as well as dependability.

Over the alternate paths during congestion, the sensitive and emergency information are transferred. By calculating a proper chance transmission of data in the buffer of the intermediate node, the data is transmitted to the next-hop for every traffic flow. The fair and efficient data delivery is supported by the partitioning of the buffer of each forwarding node by means of buffer managing. In computing the congestion possibility at the intermediate nodes, the congestion is avoided to the extent that is possible by the proposed procedure. The congestion is mitigated by routing the traffic over alternate paths otherwise.

By hop by hop loss recovery and acknowledgement, the dependability of the proposed protocol is attained. Here our mechanism can support to both normal and emergency data transmission processes at a time. So maximum number of iterations can be reduced.

II. Literature Survey

There are 3 types of packet scheduling algorithms in IoT, they are:

- Deadline-based scheduling
- priority based scheduling
- packet type based scheduling

Deadline-based scheduling: In scheduling we use the RMS algorithm. The nature of data packets is static in the RMS process [30]. The packet deadlines are used and processed primarily in the scheduling of packets. In the RMS algorithm we use Static priorities of the packets. As the significance of the packets are present in static RMS procedure that is not that much efficient and it will have some limits.

Priority Based Scheduling: overcoming the problems in the deadline scheduling the developers brought this priority scheduling [31] into existence. These priority based scheduling algorithms are mainly categorized into dual categories namely: Preemptive scheduling as well as non-preemptive scheduling. In the non-preemptive scheduling algorithm, the process is done in a specified order. The first started packet is sent first in the process even if the priority of the second packet is higher than the first. It will allow the second packet after the process of the first packet is completed. Preemptive scheduling is somewhat opposite to non-preemptive [32]. Here, the processing of sending the packet happens according to its priority. If the priority of the packet is higher than its preceding packet, it has to be sent first.

Packet Type Based Scheduling: The packet type based scheduling scheme is classified into two categories namely real-time as well as non-real-time packets. In the real-time packet scheduling, real-time packets are prioritized first, by a least end-to-end delay. The non-real-time packets are very low in their priority and hence these information will receive with some amount of delay to the base station. By observing the type of the packet which is being used we can determined the packets priority. Chennakesavula proposed [33] a scheduling property, named efficient real-time packet scheduling policy (ERTS). In this algorithm, the intermediate node helps to find the deadline of the packet, these intermediate node are used in the processes of forwarding order of data packets. Lee proposed [17] a scheduler scheme named as multi-level queue scheduler scheme. Queue relies on the location of the sensor nodes and then it sends the data.

EARS:

This EARS scheme is mainly designed for applications like fire monitoring facility comprising the alarm data, network data as well as sensor data. In this process, the data packets are basically classified into three categories according to the priority, they are Emergency data packets (pr_1), General data packets (pr_2) and Non-Emergency

data packets (pr_3). Before going to learn about the data packets one should learn about the *sink node*.
Sink node is a place where the data collected by the sensor node in wireless networks is received and stored. The time when the data packets reach the sink node is as follows in Eq. (1):

$$D_{e2e} = \sum_{j=1}^{n}(k_j + k_j^l + 2)T \quad \ldots. (1)$$

Emergency data packets (pr_1): as the name it suggests these packets are of very high priority. The information from these packets should be sent as early as possible to the sink node by ignoring all the low prioritized packets (e.g., the alarm data in fire monitoring provision).
General Data Packets (pr_2): these packets are mostly seen in the network. They may be acquired using emergency data packets (e.g., the network data which is present in fire monitoring facility).
Non-Emergency Data Packets (pr_3) : these data packets have the least importance when compared to other two types of data packets, so the limits of these data packets stay longer than the other data packets(e.g., the sensor data of fire monitoring system).

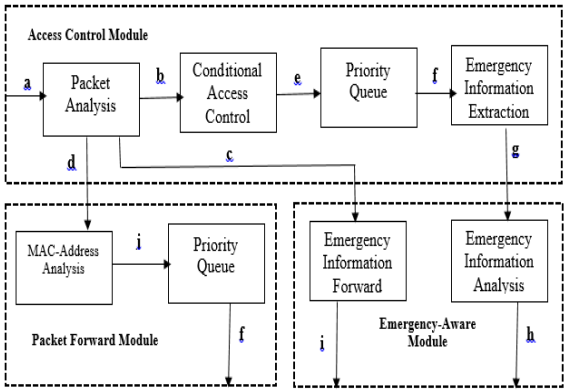

Figure2: EARS Structure

III. Proposed Framework

Energy Efficient Reliable Multi-path Data Transmission (ERMDT) Protocol

3.1 Bandwidth Allocation

The hospital is distributed into exceptional zones in the proposed protocol for fair bandwidth allocation with recognize to the requirement of reliability. Compared to sufferers of various zones, the patients admitted in ICU as well as burn cell are supposed to be in additional significant situation.
Every area's sensitivity is extraordinary as a consequence bandwidth must be shared pretty amongst the zones. At the sensing reliability of the area, the bandwidth is assigned dynamically to each zone based finally and the quantity of patient who is admitted in that zone. By using the administrator, by manually based on the node deployment time, we assign the sensing reliability of a zone.
Assume that the data rate of each zone is proportional to the sum of patient admitted in that zone, i.e., a sensitive zone that includes extra critical information (emergency and sensitive) and sensing reliability of sensing (rs_j).When compared with the non-sensitive zone, it more over consumes traffic whenever transferring, since patient strength is extra (s_p) in that zone, this non-sensitive zone has additional traffic load paralleled to sensitive zone. For handling the load of traffic, fair bandwidth allocation is required. The bandwidth (BW_j) on behalf of a single zone j is allocated in a dynamic manner using Eq. (2).

$$BW_j = \left\{ BW_{total} \times \left(\frac{sr_j}{\sum_{i=1}^{zn} rs_i} \times \frac{s_{p.j}}{\sum_{i=1}^{zn} s_{p.i}} \right) \right\} - BW_{SG} \quad \ldots$$

In the Eq. (1), BW_{total} represents the overall bandwidth offered for communication of data in the system. The reliability of zone j is represented by rs_j. The total number of zones that exist in the network is represented by z_n. BW_{SG} remains the safety measure concerning the twofold conjunctive streams that are employed to keep away from the interference. On the basis of the number of patients admitted in that zone as well as patient's situation i.e. patient sensitivity (s_p), the bandwidth assigned to a patient (BW_p) admitted in a zone j is calculated from Eq. (3). The medical professional or medical technician allocates the s_p when a patient is admitted in the clinic or hospital. The value of s_p ranges between 1 and 2 depending on the condition of the patient. For the steady condition of a patient, the value 1 (one) is allocated and for the most critical condition of a patient, value 2 (two) is allocated.

$$BW_p = \frac{BW_j}{\sum_{i=1}^{n_{p.j}} sp_i} \times sp \ldots \ldots (3)$$

3.2 Multipath Route Selection

When congestion take place in this segment, an alternate route for packet transmission is selected and is called as multipath routing.
Compared to the single path routing, the multipath routing undergoes route coupling problem and moreover the energy consumption is more. On behalf of data forwarding on request, an alternate

path with low correlation is selected and a principal path for every source node is selected by the proposed procedure.

Followed by the selection of primary as well as alternate path, the routing phase is constructed. The route construction is initiated by BS after the node deployment. The HELLO (Beacon) packet is broadcasted by the BS that initiates the construction of route after the deployment of node. The path cost (C_{path}) as well as the path information is held by the HELLO packet. The path information holds the Identifications of the entire intermediate nodes and that particular node which is transmitting the information towards the BS. In the opposite order by means of path cost quantity from BS towards the source node, the computation of the path is achieved. From Eq. (4), the path cost of node i is calculated.

$$C_{path.j} = \sum_{j=1}^{i-1} C_{path.j} + \{W_d(E_{resd.i} + B_{aval.i} + l_{s.i})\} \quad \text{..... (4)}$$

From the equation 5 we compute the residual energy (E_{resd}) of a node i. Where $E_{initial.i}$ is the initial energy level of node i as well as $E_{curr.i}$ is the current energy level of node i. By current path status (P_{curr}) and the total path (P_{total}) of the sensor node we decide the buffer factor. From the equation 6 we compute the path available for a node i.

$$E_{resd.i} = E_{initial.i} - E_{curr.i} \text{..... (5)}$$

$$P_{aval.i} = P_{total.i} - P_{curr.i} \text{..... (6)}$$

A sensor node basically performs the transmissions i.e., the sensed information or received data are forwarded it towards BS, over the primary path. In case of congestion messages or fail to receive a message we go for the alternate path for forwarding the data, this is identified when the sensor node fall short to accept the acknowledgement. Through an alternative path, the sensitive and emergency data traffic is forwarded from the circumstance of above congestion. Intended for energy balance of the sensor network, the novel primary as well as alternate paths are selected and the path costs are updated periodically.

3.3 Congestion Avoidance and Control

The critical issues in the healthcare uses are packet loss. By this lost packets retransmission experiences extra energy consumption. By the proper congestion control method, the packet loss in the network can be reduced. The scheduling technique for efficient data delivery and efficient buffer management is presented in this segment near the BS. Furthermore, we represent for the congestion avoidance and control we process the rate adjustment and packet dropping.

3.3.1 Buffer Management and Packet Scheduling

The partitioning of the buffer of the intermediate node is done in the proposed method. The dedicated buffer is first used by the sensitive, regular and admin traffic. In worst cases this available space in the distributed buffer is used when, the dedicated buffer space remains dependent. Before using its dedicated buffer, this shared buffer space will allocate to the emergency traffic. If no open space exists in the shared buffer, then the data will be stored in the space of the dedicated buffer. From the shared buffer, the emergency data packets are arranged primarily and later from its dedicated buffer.

Based on the current scenario the network traffic load varies its content of the data packets (admin, emergency, regular and sensitive). Therefore, on the basis of the expected traffic load, the buffer partition is allocated for traffic load weight values (w_v) and for every kind of traffic flow.

By the stable and the unstable patients they will generate the regular traffic and sensitive. The sensitive as well as regular packets quantities generally use the shared buffer but if there is more traffic or no space present in the shared buffer then they will use the dedicated buffers space.

3.3.2 Rate Adjustment and Packet Dropping

The avoidance of congestion is far superior than controlling it. By this scheme of congestion avoidance, the conservation of energy, reliability as well as data delivery ratio can be improved. Consequently, rather than mitigating congestion to the extent that is possible, the proposed method attempts to avoid the congestion. If we predict the congestion occurrence before itself correctly then we can avoid it. The proposed protocol alerts before itself by estimating its position and the congestion of the current buffer to the source nodes for adjusting its transmission rate.

3.4 Reliability

As a result of a smaller amount of data transmissions towards smaller distance, a hop-by-hop reliability is adopted for event reporting owing to its energy efficiency in the proposed protocol.

Hop-by-hop loss recovery is performed by every intermediate node in the proposed protocol. Through the next-hop neighbor node, each data transmission is approved in the routing path. By the data transmitted node we identify that the packet loss has taken place and also by not receiving the acknowledgement for transmitting of data packet in the relaxation time. The lost packet towards the destination node is retransmitted.

IV. Result and discussion

Over a 1000x500m ^{2} field, 30 sensor nodes are randomly distributed in this paper. An equal capability of static sensors where no hole exists in the sensing field is assumed in this paper. The system parameters that are used in the simulations are shown in Table1.

PARAMETER	VALUE
Application Traffic	CBR
Transmission rate	1024bytes/ 0.1ms
Radio range	250m
Packet size	1024 bytes
Routing protocol	AOMDV
Simulation time	10000ms
Number of nodes	30
Area	1000x500
Initial energy	100j
Max_threshold	45
Interface	Queue/MOD

Table1: Simulation parameters

4.1 Evaluation Results

The Multipath based energy efficient path algorithm is used in this unit so that several experiments in the sensing field are conducted. The experimental outcomes of the algorithm that are introduced below are presented In relation to the movement path of hop node as well as the lifetime of the network.

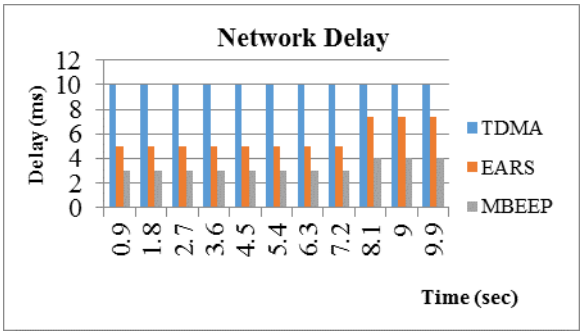

Figure3: Performance on Delay

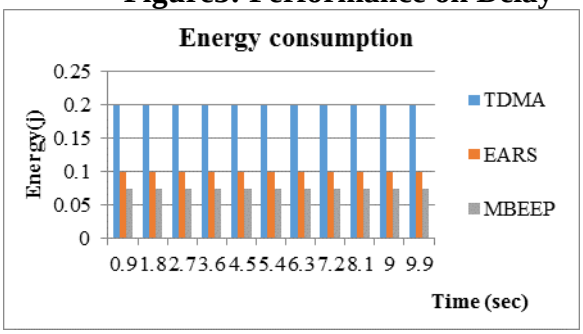

Figure4: Energy level routing

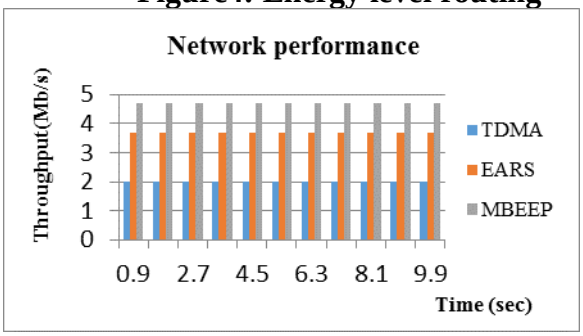

Figure5: Network performance

Network delay, energy consumption as well as throughput are used to measure the performance of the network. In relation to the TDMA, EARS as well as MBEEP method, the packet delay time is depicted in Figure 3.Compared to TDMA method and EARS algorithm, the delay time is increased by the performance of Multipath based energy efficient path algorithm which means that the delay between the communication nodes is reduced.

Fig 4 represents energy consumption graph and it demonstrates a simulation time versus energy graph. Compared to EARS and TDMA method, the energy values are improved by the performance of Multipath based energy efficient path mechanism. Fig 5demonstrates throughput graph and it displays a simulation time vs. throughput graph. Compared to EARS algorithm and TDMA method, the throughput is enhanced by the performance of Multipath based energy efficient path algorithm. Fig

5 represents throughput and it presents simulation time versus throughput graph.

V. Conclusion

A Multipath based energy efficient path algorithm for WSNs is proposed in this paper. In order to share the traffic load, bandwidth allocation is performed by the proposed method. By reducing the load of traffic of the congested node, it efforts to avoid congestion and the occurrence of congestion probability is calculated from its buffer status for every class of traffic. The congestion is mitigated by reducing the sensor node transmission rate. For emergency packet level traffic, the reduction of transmission rate is unfavorable. Therefore by the alternative path, the traffic flow is splitted and the traffic load of congested node is decreased. By using hop-hop method, the proposed protocol reliability is attained. Lastly using simulations, the proposed protocol performance is calculated. With regard to energy efficiency, end to end delay as well as throughput, the proposed protocol is more efficient compared to EARS and TDMA schemes which are presented in Simulation results. In further we may work by analyzing the relationship between the behaviour of MBEEP/ EARS and the number of flows present in that. Based on the performance of MBEEP under different scheduling policies it is very different (firstly we see the deadline, then rate monotonic, later fixed priority, and so on) and will study how to improve the reliability by optimizing the scheduling policy based on this for industrial IoT.

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