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Routing, Applications and Research Challenges in IoT

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ABSTRACT: Internet of thing (IoT) is one of the most hot research topic in the present scenario where the intelligent data is stored in the clouds. The data can be retried by users anywhere and at anytime. In this paper we present the routing protocols for Internet of Things which are helpful in transferring the data into the clouds or to the users. Some of the popular routing protocols are reviewed in this along with the applications of IoT. The paper also gives the brief view on the challenges which comes when using IoT for real-time. Here IPv6, CoAP, MQTT and RPL routing protocols are discussed and elaborated. IoT has the potential to take large amount of data into the databases and the data will be routed efficiently.

Keywords: Routing, IPv6, RPL, IoT, Issues.

I. INTRODUCTION

The IOT is a system where the internet is connected to the real world by using sensors. The IOT is the network of physical objects or things which enables these objects to collect & exchange data. IoT can be defined as "Intelligent interacting between human & things to exchange information & knowledge for new value creation. IoT allows objects to be sensed & controlled remote across the existing network infrastructure" & results in improved efficiency, accuracy & economic benefit. Things in IoT can refer to a wide verity of devices such as heart monitoring impacts, automobiles with built in sensors etc.

The concept of the IOT first became popular in 1999, through the auto ID center at MIT.IOT is not the result of a single novel technology but it uses several complementary technical developments that provide capabilities such as communication and cooperation, addressability, identification, sensing, actuation and embedded information processing, localization, user interfaces that taken together helps to bridge the gap between the virtual man physical world. Integrations with the internet implies, that devices will use an IP address as a unique identifier. However due to limited address space IPv4, objects in the IoT will have to use IPv6 to accommodate the extremely large address space is required. On the other hand IoT systems could also responsible for performing actions rather than just sensing things. Internet of things is only known as tip of iceberg.

IoT should have following characteristics,

(i) Comprehensive Perception: Using RFID, Wi-Fi, Zigbee and Two Dimensional Barcode to get object information at any time and from anywhere. RFID is widely used in transport and logistics. It's easy to deploy RFID tags and RFID readers. The communication range and the frequency depends on the type of the technology used. Wi-Fi is very common and low coast. It is widely used both in indoor and outdoor environments. It is highly interoperable. Zigbee is very easy to deploy and low coast. It has very long battery life and large number of nodes. It is used globally. It supports for multiple network topologies.

(i) Intelligent Processing: By collecting IoT data into data bases various intelligent computing technologies including cloud computing will be able to support IoT data applications. Cloud computing technology is the promoter of IoT.

The paper provides brief information about routing protocols. The ultimate goal of IoT is to automate human life. IoT is an integrated appliance of network in communication system.IOT consisting of weak processing power devices. IoT is kind of wireless sensor networks (WSN's).

IoT has many applications such as for connected /smart home, for smart cities, in retail, in healthcare, in agriculture, automotive/transportation, for industrial automation, energy management. The sky's not the limit, its only the beginning with IoT.

Most of the research questions have focused mainly on systems with fixed sensors/devices deployment that are in particular locations without any mobility. Some of the research challenges are mobility induced sensor network design,robustness, co-ordination, concurrency, optimal data capture and processing, location based data storage and representation serve implementation via actuation and Integration with opportunistic computing.

II. ROUTING IN IoT

Routing protocols in wireless sensor networks: WSN shows the wireless communication, sensor capability and computation capabilities.

Sensor nodes are equipped with the weak processing units, low capacity of battery and limited bandwidth. This limitation acquires huge impact on routing protocol WSN.

Some major issues in WSN's:

Dynamic state of network: Stationary sensor nodes are conventional network. However WSN's exist in dynamic networks such as WSN target detection. Due to quick changing in routing path dynamic networks are becoming more challenging. The strategy for routing protocol is to simply generating routing path on demand. Due to instability of network pre-calculating routing path is not important as the pre-calculated path may be of no use when they are needed

Energy consumption without losing accuracy: The main aspect in WSN is energy consumption due to sensor node limited supply of energy. The routing protocol is required to maximize the energy conserving form of communication and computation to increase the life time of battery. But the communication and computation should maintain the accuracy on routing protocol.

The second aspects is in case of low power sensor it should maintain the accuracy .Due to malfunctioning some power failure may occurs .So this routing maintain the aware of this problem.

Scaling capabilities: WSN is likely to be used in some cases. For example a company may deploy hundred sensor nodes in the beginning and expand the network to the number of thousands of sensor nodes afterwards. Hence routing protocol should be designed to work not only in network with small number of sensor nodes but also in network with large amount of sensor nodes

Failure in tolerance: Due to lack of power, physical damages and environmental interference WSN may fails. The faults in the sensor nodes are greatly reduce and affect the performance of the network. For example packet needs to be routed through longer path a whole network is divided into two parts. The routing protocols should take into consideration some fault tolerance mechanism in case of unexpected failure. To give more priority to routing path, the more remaining energy and quickly detecting, the failure of particular node to recommend alternative routing path.

Node deployment: Network topologies are determined in the beginning of the network construction. Node deployment in WSN is either deterministic or randomized. Where in deterministic the topologies are decided in advance and in random nearly during the life time and data can be routed through pre-determined path .where as in random deployment sensor nodes are randomly scattered created an unknown and unstable network topology.

A. Routing Protocols In Internet Of Things

Three examples for routing protocols are presented

1) 6LWPAN: IPv6 [9] over 802.15.4is meant to extend IPv6 network to IOT network. The advantage of this approach is the possibilities of reusing and existing IPv6 technology an infrastructure. However this type of technology is used for computing device with higher processing capabilities and memory resources which is not suitable for IoT network entities.

2) RPL: IPv6 routing protocols for low power and lossy network. This protocol types are preparing for network comprising of constraints Devices in power, computations capabilities and memory. So data transmission in this type of network is unreliable and has a low data rate but high loss rate.

3) Constrained application protocol (CoAP): The most important feature in this type of routing protocols is the ability of translating to HTTP message so as to integrate with the web service .The protocols also supports multicast with little over head optimization technique in routing.

4) IPv6:it despite all short term solution, such as classless addressing ,dynamic host configuration protocols and NAT .so far depletion is the long term protocols for the internet.

IPv6 contains an16 bytes. It is 128 bit long. the IPv6 provides an transmission of audio and video .and such transmission requires an delay strategy and reservation of resources these are provided by the IPv6 protocols. The internet protocol wasextensively modified to accommodate the unforeseen growth of the internet. A communication expert predicts that IPv6 and its related protocols will soon replace the current IP version.The adoption of IPv6 has been slow because of the original motivation for its development, depletion of IPv4 addresses. Instead of IPv4, IPv6 is used in mobile IP,IP telephony and IP capable mobile telephony for fast spreading internet and new services.

Advantages:

1 .Larger address space: it has 128 bits. This is huge to increase the address space.

2 .Better header formats: for separating base header and inserted, when it is needed, between the space header and upper layer format IPv6 yeses a new header format.

3. New option: IPv6 having new option to allow new additional functionalities.

4. Allowance for extension: IPv6 is designed to extend the protocols if required by new technology.

5. Support for resource allocation: type of service has been removed here in IPv6 but mechanism is added to enable the source to request special handling of packet. so this is helped in supporting traffic such as real time audio and video.

6 .Support for more security: the encryption and authentication option in IPv6 provide confidentially and integrity ofthe packet.

7. Energy efficient in routing: It optimizes the energy requirement while selecting a path to destination that helps to increase the network lifetime. This tends to avoid the nodes which are consisting of the energy level below threshold value. It is sufficient technique to allocate the data to destination without any disturbance. So name itself shows the optimization and efficient technique in routing.

6) Elimination of redundancy data or bit: The information may be data or it may have data in the form of bits. If the more information is there means more number of redundant bits may present. These redundant bits are eliminated here to overcome from energy consumption. So it increases the lifetime of battery. Whereas reducing the redundant data in the information we have to increase the battery life.
7) Minimize delay: here Delay minimization is the advantage. It Means that IoT consist of enormous amount of data information. Expiry is associated with the data. From this within a time data is to be sent at the destination side. Because of this delay minimization is required.
8) MQTT (Message Queue Telemetry Transport) is an ISO standard client server publish subscribe based "light weight" messaging protocol is use on top of the TCP/IP for constraint environment such as machine to machine and IoT.

III. IoT APPLICATIONS

1. IoT applications for connected /smart home.
2. IoT applications for smart cities.
3. IoT applications in retail.
4. IoT applications in healthcare.
5. IoT applications in agriculture.
6. IoTapplications in automotive / transportation.
7. IoT applications for industrial automation.
8. IoT applications energy management.

A. IoT Applications For Connected/Smart Home

Smart home means one in which the devices have capability to communicate with each other as well as their environment. Owner has capability to customize and control home environment for increase security and efficient amount of energy utilization [6].

B. IoT Applications For Smart Cites

Smart cities are the best real time solutions for the troubles people usually face due to population outburst, pollution, less amount of energy supplies Smart surveillance, safer and automated transportation ,smarter energy management system.

Fig. 1. Smart Cities Using IoT.

These are the examples of internet of things of smart cities Solution how to built a smart city. Bigbelly smart waste and recycling system is a smart waste management system for smart cities. A Bigbelly system gives real time and data collection capability via cloud based services. It also helps with smart trash picking, avoid over flows and wastage management is truly smart by generating the notifications. Below is the example for smart cities using IoT.

C. IoT Applications In Healthcare

The IoT highly boosted the healthcare sector also, with advent of IoT. One of the health care IoT based application example is Urosence. Urosence is a smart fluid management solution offered by the future path medical. This sensor automatically measures the core body temperature and urine output of patients on catheterization. Smart monitoring of these vital signs helps in avoiding infection and also helps in early care of medical conditions like diabetes. Urosense also provide report data directly to nursing stations any where wirelessly.

D. IoT Applicatins In Agriculture

Agriculture sector needs very institutive and scalable technology solutions internet of things applications can deliver exactly the same to formers. One of the IOT based application in agriculture is phenonet project. The phenonet project is designed to help formers to monitor crucial vitals like humidity, air temperature and soil quality using remote sensors. This project also helps to the formers to improve the yield, plan irrigation as well as make harvest forecasts. Helps for biologist to study the effect of genome and microclimate about crop production. IOT based agriculture also can monitor the crop nutrients making use of carbon nanotubes –based sensor system. This information helps farmers to alter maturity rate or color of crop production. Clean grow device uses a nanotubes sensor that detects quantity and presence of specific ion in the production.

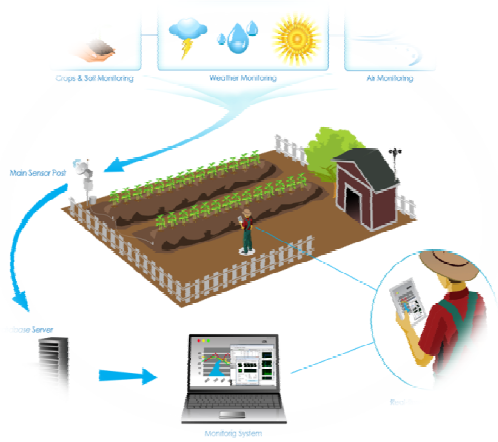

Fig. 2. IoT in Agriculture Section.

E. IoT Applications Inautomotive transportation

IoT application in automation/transportation in self driving cars knows to all. IoT is making connected cars slowly but it is possible as we know that any new technology establishment takes least couple of years to become successful.

Latest IoT based technology that GE evolution series tier 4 locomotives is loaded with 250 sensors to measure staggering 150000 data points in a minute. This data combined with other data and operating system helps in anticipating events and help in taking driving decisions in real time. Caterpillar's newest equipment is helps to anticipate problems, manage fleets and schedule maintenance proactively

F. IoT Applications For Indusrtial Automation

It is one of the most profound applications of IoT. IoT technology helps in infrastructure backed with advanced sensor networks, wireless connectivity, innovative hardware and machine to machine communication Automation process of industries transform completely. IOT is automation solution for industry than the other big names already exist in the market like NEC, Siemems etc.

Smart structure embedded data collector: In the construction it is important to determine the quality of concrete. The embedded data collector from smart structure helps with this big time. The system works by embedding the sensors in the concrete during process. The sensors provide vital information about the strength and quality of concrete directly to the smart structure work station. Some of the supported industrial protocols are CAN Bus, RS232and RS485. Application of all these nodes range from automation to military to manufacturing sector

G. IoT Applications For Energy Management

Smart grid concept is becoming very popular. Power grids of the future will not only be smart enough but also highly reliable .The basic idea behind the smart grids is to collect the data in automated fashion and analyze the behavior and suppliers for increase the efficiency and economic use. The smart metering will make energy management easier for everyone. The smart metering solution offered by Landis+Gyr consumers to understand their energy needs and help them with load management. The multi energy metering solutions to offer for reliable and efficient energy management Landis+Gyr's management solutions are programs which provide capabilities to automate analyze and response to energy requirements in a smarter manner. They also have leading edge tools which help both suppliers and consumers to reduce peak use problem as well increase the efficiency.

IV. RESEARCH CHALLENGES IN IoT

The objects would also remain connected to the internet even while moving around, this give rise to several innovation possibilities. Such possibilities will come with few research challenges .They are as follows [7],

A. Mobility Induced Sensor Network Design

The IoT devices would find it difficult to connect with each other and other components of IoT networks in presence of mobility.

B. Robustness

In case of IoT the topology of system will be highly uncertain and may vary. In such cases maintaining of a long –lived and dynamic system is problematic. Therefore there are challenges in device discoverability, power usage and communication protocols.

C. Co-Ordination

The real time co-ordination among mobile sensing and actuation platforms is a crucial research challenge that needs to be addressed if IoT is to become successful.

D. Concurrency

For example, aninternet connected car moving through more traffic could exhibit highly variable mobility patterns and travel times between its source and destination, managing communication and input/output operations among multiple cars, each of them are differing with their mobility patterns and this would be more challenging.

E. Optimal Data Capture And Pprocessing

A key issue in IoT system is more data is produced and transmitted on the network. Since most of the data is useless for user, techniques for optimally filtering the data before storage and this will emerge as a crucial research area.

F. Location Based Data Storage And Representation

Optimal storage and representation of IoT data is crucial topic, given the data volumes that may need to be stored from future analysis and for viewing purpose.

G. Serve Implementation Via Actuation

Users needs to make changes in the IoT network through actuation process.

H. Integration With Opportunistic Computing

The key research challenge is to determine the most optimal approaches to facilitate decentralized opportunistic instructions among human users and the IoT network.

V. CONCLUSION

Internet of things has the potential to change the overall scenario of the networking by providing data to anyone at any time. In this paper some of the routing protocols for internet of things are discussed. From review point it has been observed that Ipv6 works better in all scenarios and it is one of the efficient routing protocol compare to other routing protocols.

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