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Routing Challenges in Internet of Things

Abstract: We are moving towards Internet of Things (IoT). Ubiquitous and pervasive computing is a nucleus of IoT. The number of sensors deployed across the globe is very huge in number and their rate of growth is very high. These sensors are acting like the digital skin of the earth. Sensors collect the raw data continuously and interpret this raw data for generating the knowledge out of it.

The routing of data from source to sink is a fundamental component of any large scale network. In IoT the communication devices works with dissimilar networking standards, may experience irregular connectivity with each other and many of them can be resource constrained. These characteristics raise several routing challenges which were not present in the traditional routing protocols. So it is essential to understand the context while routing the data on the future networks. This survey addresses routing mechanism and related challenges in IoT.

Index Terms – Internet of Things (IoT), context awareness, ubiquitous computing.

Introduction

Kevin Ashton from MIT coined the term "Internet of Things" in early 2000's. It stands for a "world-wide network of interconnected objects uniquely addressable, based on standard communication protocols"[2]. Though IoT is a widely used term, its definition is still fuzzy. IoT is a technological revolution that represents the future of computing and communications, and it aims at increasing the ubiquity of the Internet by integrating every object for interaction via embedded systems, which leads to highly distributed network of devices communicating with human beings as well as other devices[5]. Compared with the traditional information networks, IoT has three new goals, i.e. more extensive interconnection, more intensive information perception and more comprehensive intelligence service[3].

Due to the explosion of short range networks and occurrence of devices connected to these networks, a flawless interconnection between devices is steadily being created. These short-range networks contain wireless sensor networks (WSNs), radio frequency identification (RFID) networks, Bluetooth and Zigbee networks. It is predicted that the devices connected together for creating, gathering and sharing the information, which involves a sequence of communication steps with or without human interference.

At present, we need to build a reference architectural model that will allow interoperability in different types of systems. The new research areas in IoT visualize the interconnection of objects in of everybody's daily life. These research areas recommend the communication between the heterogeneous devices. This heterogeneity can be in terms of size, computational power, memory and energy. The energy of the device is one of the most important resources which may cause the network to experience the intermittent connectivity and results in making the routing challenge in IoT more complex.

IoT supports various types of communication such as device to device, device to human or human to device. The communication could be intradomain or interdomain. It can be single hop or multiple hops. For multihop communication devices relay information to achieve end to end communication between source and destination. Traffic patterns and data flows are highly directional. These patterns are classified into point to point, point to multipoint and multipoint to point. Due to the heterogeneous nature of IoT some intelligence is required in the communication process. Intelligence in this context is the ability to of a device to be aware of the environment in which it is operating and collaborate with the other devices to use the data it has collected from its environment[1].

Many large scale wireless networks uses low powered embedded devices for data acquisition and actuation related applications. These embedded devices works under severe energy constraints and communicate over a lossy channel. These low power devices which are the part of large scale wireless network containing more or less other devices may enter or leave the network at random times. So the upcoming wireless routing solutions that are going to be predicted must be highly energy efficient, scalable and self-sufficient.

This article is organized as follows: section II of this article discusses about the types of routing protocols, section III talks about routing challenges that are need to be addressed and last section concludes the article.

Types of Routing Protocols

Routing protocols are classified into proactive, reactive and hybrid routing protocols in terms of the way by which they make the routing decisions. Proactive protocols always maintains the route information in tabular format at any time, reactive protocols builds the on-demand route whereas hybrid routing makes use of both proactive and reactive routing algorithms. Table 1 states protocols of various types.

Table 1: Routing protocol types

Protocol Type	Protocol Name
Proactive	Optimized linked state routing (OLSR), Destination sequenced distance vector (DSDV), Topology dissemination based on reverse path forwarding (TBRPF)
Reactive	Dynamic source routing (DSR), Ad-hoc on demand distance vector (AODV)
Hybrid	Zone based hierarchical link state routing protocol (ZRP)

Reactive protocols utilizes the bandwidth more efficiently, it is more suitable to dynamic network whereas the proactive protocol is suitable for static network.

From the researcher's point of view reactive protocols are more suitable in WSN as the routes may get changed frequently which results into the need of constant upgradation of routing tables.

Akkaya et al[5] grouped routing protocols for WSNs which is a major component of IoT into following categories: (1) data-centric, (2) hierarchical, (3) location based, (4) QoS-aware. Data-centric protocols do not need a globally unique ID for every sensor node.

It does multihop routing by using attribute-based naming mechanisms. Hierarchical protocols partition the network into tiny clusters with a node performing as a cluster head. Location-aware algorithms exploit the knowledge of the geographical location of a node to achieve energy efficient routing. QoS-aware protocols can clearly deal with multi-constrained requests for data transmissions.

This classification is further enlarged by Boukerche et al.[6], who added two more categories in the routing protocols, flat and multipath. Flat category refers to the case in which a large number of nodes work together to sense the environment. The nodes are all analogous and global IDs are not assigned to them. The category multipath contains the algorithms that compute multiple paths from sources to destinations in order to handle failing nodes effectively.

Challenges in Routing

Routing in the network made up of smart objects has unique characteristics. These characteristics led to formation of a new WG known as ROLL, whose aim is to specify a routing protocol for low power lossy networks known as RPL[7]. In this section we have discussed the major challenges that can arise in the routing process of IoT.

1. Deployment of nodes: In contrast to the traditional networks where the topology of the network was known exactly before establishment of the network, it is very difficult in WSN which is a important component of IoT, to keep the topology fixed as the nodes are deployed randomly on the field.
2. Heterogeneous devices: Devices differs according to the type of network standards they use and the type of applications they support. Also these devices can be different in terms of the resources. Some devices suffer from resource constraints and some of them not.
3. Diverse networking standards: IoT is an umbrella which brings various technologies such as traditional network, WSN, Zigbee, WiFi etc together. The working principles of these technologies are diverse. They use different protocol stacks.
4. Intermittent connectivity: Due to the limited battery life, there is always a danger of change in the network topology. Intermittent connectivity can also be experienced due to the highly mobile devices, which get disconnected from the network when they move.
5. Multihop communication: Most of the devices used in IoT are low powered devices. These devices are short range transmitting devices thus they have to use relay mechanism while transmitting the data from source to destination.
6. Fault tolerance: Due to the environmental factors, deployment mechanisms or energy constraints there is always a danger of affecting the overall network performance. So there must be some mechanism in the routing protocols to handle such unexpected events.
7. Security: Because of some dishonest participants, the routing security issue arises. Hop to hop authentication is not enough. Cryptography can mitigate the effects to some extent but not completely.
8. Context awareness: Context aware computing includes five sub-technologies mainly: (1) getting context (2) context-modeling (3) context-reasoning (4) context-conflict solving and (5) context-storage and management[4]. In context aware environment, system has to use context information for doing necessary changes in the routing process.

Conclusion

In this article we tried to discuss the basics of routing mechanism and related challenges in IoT. Internet changed our lives to great extent since last two decades. Now it's a time to connect everything to internet, so that it will make our lives more comfortable. As we are going to connect every possible 'thing' to internet, we have to address routing issues that have already addressed in the article.

Future is IoT, but still lots of things are there that need to be resolved. At the edge of future internet, in upcoming years it is essential to make the routing a context aware mechanism.

References

[1] O Bello and S Zeadally, "Intelligent Device-to-Device Communication in the Internet of Things (IoT)", to appear in IEEE Systems Journal, 2014.

[2] INFSO D.4 Networked Enterprise RFID INFSO G.2 Micro Nanosystems in Co-operation with the Working Group RFID of the ETP EPOSS, "Internet of Things in 2020, Roadmap for the Future, Version 1.1," European Commission, Information Society and Media, Tech. Rep., May 2008.

[3] H Zhou, K Hou, "CIVIC: An Power- and Context-Aware Routing.

[4] Protocol for Wireless Sensor Networks," Proc. IEEE WiCom'07 , 2009, pp. 2771-2774.

[5] Zhikui Chen, Haozhe Wang "A Context-Aware Routing Protocol on Internet of Things Based on Sea Computing Model", Journal of computers, Vol. 7, No.1, January 2012, pp. 96-105.

[6] K Akkaya, M Younis, A survey on routing protocols for wireless sensor networks, Ad Hoc Networks 3 (3) (2005) 325–349.

[7] A Boukerche, M Ahmad, B Turgut, D Turgut, A taxonomy of routing protocols in sensor networks, in: A Boukerche (Ed.), Algorithms and Protocols for Wireless Sensor Networks, Wiley, 2008, pp. 129–160 (Chapter 6).

[8] T Winter et al., "RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks", IETF RFC 6550, Mar. 2012.

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