The Review of 6LoWPAN Routing Protocols

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Abstract: The Internet of Things (IoT) is fast becoming a global phenomenon and many issues are arising such as standardization, deployment of IPv6, sensors' energy requirements and security among others. 6LoWPAN (IPv6 over Low-Power Wireless Personal Area Networks) standard allows heavily constrained devices to connect to IPv6 networks. 6LoWPAN is novel IPv6 header compression protocol, it may go easily under attack. However, without a secure network routing system IoT nodes will be exposed to malicious activities on the network, data compromises, privacy invasion and even acts of terrorism could be perpetrated via the teeming billions of IoT nodes. This paper surveys secure routing protocols in MANETs while proposing some secure MANET routing features for enshrining confidentiality and integrity in IoT routing.

Keywords: MANET, WSN, IoT, RPL, 6LoWPAN.

I. INTRODUCTION

Compared with traditional MANET and Mesh network, LoWPAN is more attentive to low-power consumption and sensor traffic upstream to Internet. Recent years, the IETF (Internet Engineering Task Force) 6LoWPAN working group has made relevant standards on IPv6 adaption, routing, addressing, and management on network.

Fig. 1. 6LoWPAN Architecture

6LoWPAN is an IPv6-based technology for Low-Power Wireless Personal Area Networks (LoWPANs), such as wireless sensor networks, that combines IEEE 802.15.4 and IoT (Internet of things). This integration provided a new dimension in the design of LoWPANs as it allows for a full interoperability with the Internet. It makes a large number of WSN nodes or smart machines access to Internet seamlessly, and enjoy the services include free addressing, end-to-end connection, and QoS support. Compared with traditional MANET and Mesh network, LoWPAN is more attentive to low-power consumption and sensor traffic upstream to Internet. Recent years, the IETF (Internet Engineering Task Force) 6LoWPAN working group has made relevant standards on IPv6 adaption, routing, addressing, and management on network.

II. ROUTING IN 6LOWPAN

Routing is one of the main task of the network layer as defined by the Open System Interconnection (OSI) model. Various other tasks include addressing of nodes and creation and maintenance of network topology. 6LoWPAN technology adopts the modified IPv6 protocol stack to achieve seamless connectivity between IEEE 802.15.4 based networks and the IPv6 based infrastructure. Routing protocols for WSN are standardised by Zigbee. The most commonly used is Zigbee AODV. However, as far as 6LoWPAN is concerned, standardization is still under draft level. Several RFC (Request For Comments) drafts have been released by IETF working group. 6LoWPAN routing protocol can be grouped into two approaches namely, MANET (Mobile Ad-hoc Network) based approach and ROLL based approach.

A. MANET Based Approach:

The MANET WG (Working Group) has produced a large number of routing protocols. Based on the routing technique, they can be categorised as distance-vector or link state and based on the route discovery process they can be categorised as proactive or reactive. However MANET is mainly considered for routing in ad hoc mobile networks using Wireless Local Area Network (WLAN) technology, where the majority of traffic is peer-to-peer. Common MANET routing protocols are Ad hoc On Demand Distance Vector (AODV), dynamic MANET on-demand (DYMO) and Optimised Link State Routing (OLSR). A neighbour discovery protocol is developed for collecting route information. In order to reduce the signalling overhead and to make suitable for embedded applications, protocols of MANET need to be modified.

B. ROLL Based Approach:

The IETFs Routing Over Low power Lossy Networks (ROLL) working group analyses the requirements for embedded applications. It also standardizes a routing protocol for these applications. Various ROLL based applications are industrial automation, building automation and home automation. These Low-power and Lossy networks (LLNs) are made up of embedded devices with limited processing, memory and power resources. This WG focuses only on routing for general IPv6 and 6LoWPAN networks. So ROLL differs from 6LoWPAN wherein LLN is used for LoWPAN, LLN.
border router is used in 6LoWPAN instead of LoWPAN Edge Router. Route metrics in ROLL are used for the path selection process in a routing protocol. They are used to choose the best route. Different types of route metrics considered in ROLL based approach are link, node, dynamic etc., where link metrics include throughput, latency and link reliability. Node metrics deals with memory, processing load and residual energy. Dynamic metrics deals with routing stabilities. The metric calculation should be consistent throughout the routing domain as it is useful for the path calculation. The architecture of LLNs is different from MANET. MANET is mainly meant for routing in ad hoc mobile networks, where the majority of traffic is peer-to-peer. Various MANET based applications include nomadic computing, emergency and rescue networks and military applications. Whereas ROLL protocol is a proactive distance-vector algorithm with options for constrained-based routing, multi-topology routing and traffic engineering.

III. CHARACTERISTICS OF 6LOWPAN ROUTING

6LoWPAN routers perform forwarding on a single wireless interface. They send and receive the information between nodes using the same interface. A 6LoWPAN has a flat address space, as all nodes in a LoWPAN share the same IPv6 prefix. 6LoWPANs are stub networks, and are not meant to be transit networks between two different subnets, which simplifies the requirements for 6LoWPAN routers.

IV. 6LOWPAN ROUTING PROTOCOLS

6LoWPAN includes two main classes of routing protocols they are distance vector routing and link state routing. Distance vector routing, each link is assigned a cost based on the appropriate route metrics. The routing table of each router keeps soft-state route entries for the destination, with the path cost. Routing information is updated either proactively or reactively depending on the routing algorithm (Zach Shelby and Carsten Bormann, 2009). Distance vector routing is commonly applied to 6LoWPAN owing to its simplicity, low signalling overhead and local adaptive in nature. The proposed novel Location Based Routing Protocol (LBRP) falls under the class of distance vector routing with an On-demand approach. In Link state routing, each node acquires complete information about the entire network, called graph. Link-state routing incurs a large amount of overhead, especially in networks with frequent topology. Link state routing is not suitable for distributed use among LoWPAN nodes because they incur a large amount of overhead, especially in networks with frequent topology change. Also they require substantial memory resources to maintain the state of each node. Constrained routing in 6LoWPAN networks uses compound route metrics, local route recovery, flow labelling to achieve Multi Topology Routing (MTR), forwarding on multiple paths with multipath routing, and traffic engineering.

A. Comparisons of Existing 6LoWPAN Routing Protocols:

Due to the constrained resources of 6LoWPAN devices, routing protocols in 6LoWPAN environments make the choice from existing pool of routing schemes very limited. AODV has been considered as a strong candidate for 6LoWPAN due to its simplicity in finding route. However, some modification must be done in AODV in order to suit it into 6LoWPAN environments. In this Section, two 6LoWPAN routing protocols, LOAD and DYMO-low which based on AODV routing scheme are discussed. Besides that, routing protocols such as HiLow also be discussed.

i. 6LoWPAN Ad-Hoc On-demand Distance Vector Routing (LOAD)

ii. Dynamic MANET On-demand for 6LoWPAN Routing (DYMO-low)

iii. Hierarchical routing (HiLow)

Fig 2. Protocol Stack of TCP/IP, ISO/OSI, and 6LoWPAN

V. REQUIREMENTS FOR ROUTING IN 6LOWPAN

This section defines a list of requirements for 6LoWPAN routing. An important design requirement is that LoWPANs have to support multiple node types and roles as mentioned below:

* Power-constrained nodes - Nodes drawing their power from primary batteries or using energy harvesting
* Power affluent nodes - mains-powered nodes
* High Performance gateway(s)
* Nodes with multiple functionalities.

Comparison with Wi-Fi:

The use of 6LoWPAN communications technology helps in end to end wireless communication which cannot be implemented in Wi-Fi or other networks since they need intermediate proxy server for communication. On the other hand, 6LoWPAN is also
known for its mobility factor. Mobility in 6LoWPAN is being utilized in realizing many applications where sensor nodes, while moving and transmit the data to a server. 6LoWPAN routing protocol supports multicast traffic pattern, i.e. point to point to communication or vice-versa, which is not possible in Wi-Fi (no point to point communication). 6LoWPAN is highly scalable with hundreds of nodes able to communicate whereas in Wi-Fi, a maximum of 10-15 devices can only be connected. The cost of 6LoWPAN is comparatively low when compared to Wi-Fi or other networks. The main advantage is that 6LoWPAN requires less power consumption. Wi-Fi needs high line power consumption for access points and very low battery life.

VIII. REFERENCES


