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Serial forwarding approach to connecting TinyOS-based sensors to IPv6 Internet
draft-sarikaya-6lowpan-forwarding-00

Status of this Memo

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Abstract

This document describes a simple approach to interconnect IEEE 802.15.4 sensor nodes to IPv6 Internet. The technique requires a gateway node that is connected to both the sensor network and the IPv6 Internet. The gateway node runs the serial forwarder over IPv6. Sensor nodes run the open-source TinyOS operating system and generate TinyOS packets. The sensor network can be accessed from IPv6 Internet using a Web interface and the serial forwarder that runs in the applets enables reception/transmission of TinyOS packets over

IPv6.

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1. Introduction

This document describes the serial forwarding architecture that allows interconnection of sensor networks with IPv6 Internet.

Serial forwarding is a different approach than the native approach described in [draft-ietf-6lowpan-format-01]. In the native approach, the sensor nodes are connected to IPv6 network, configure an address and receive/ transmit IPv6 packets. An adaptation layer is defined for 802.15.4 frame fragmentation and reassembly. The sensor node that is natively connected has the option of delivering IPv6 packet in the sensor network using mesh routing.

In this document we assume the base forwarding architecture shown in Figure 1. Stargate [platformx] is a PDA with an XScale board that has a serial port or USB connection to the sensor network as well as 802.3 interface to IPv6 Internet. This architecture is commonly used to connect TinyOS [tinyos] based sensor nodes such as Telos motes. Telos motes have 802.15.4 radios. TinyOS is an open-source operating system designed to run on sensor nodes.

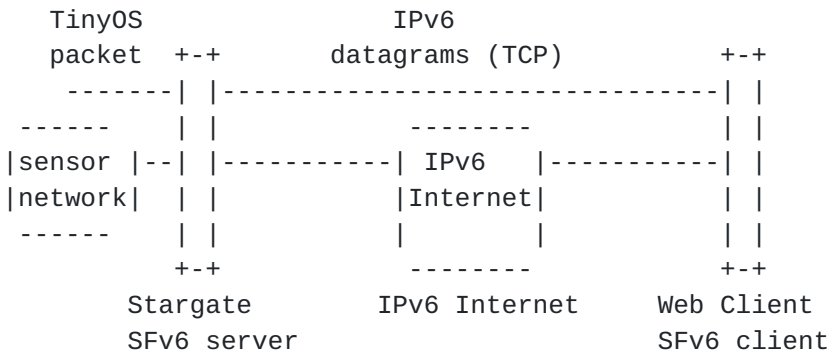

Figure 1: Base Forwarding Architecture

Stargate software includes apache Web server and serial forwarder which is originally developed to run in IPv4. Applications such as TinyDB, an environmental monitoring application are developed using Java and include an applet which is client of the serial forwarder. In TinyDB, the application sends queries to the sensor network to inquire about things like sensor readings and the sensor nodes send replies such as their sensor readings.

In this document, we present an extension to the base architecture for IPv6. Section 3 describes the serial forwarder, Section 4 presents our architecture for an IPv6 extension, Section 5 describes TinyOS packet format and Section 6 presents our conclusions.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 RFC 2119 [STANDARDS].

3. Serial Forwarder

Serial forwarder runs on Stargate as a TCP-based socket application. Serial forwarder was originally developed as part of TinyOS project and IPv4 version of the software is available in the TinyOS source tree.

Serial forwarder (SFv4) opens a TCP port and then forwards TinyOS packets from the serial port of Stargate to which an interface card to the sensor network is connected to the TCP port and vice versa. Web based applications such as TinyDB running on hosts contain an applet which is a client of the serial forwarder. The applet connects to the TCP port opened by SFv4 running on Stargate. The applet receives TinyOS packets encapsulated as IPv4 TCP data. The applet can also send the user queries encapsulated in TinyOS packet payload as TCP data to SFv4 on Stargate and the Stargate's TinyDB application is responsible for routing the query to the sensor network. Routing protocol is application-dependent and is mesh-oriented.

4. Experimental Work

The base architecture has two deficiencies: Stargate can not efficiently run a webserver and an IPv6 version of apache for Stargate was not available. The proposed extension to the base architecture is shown in Figure 2.

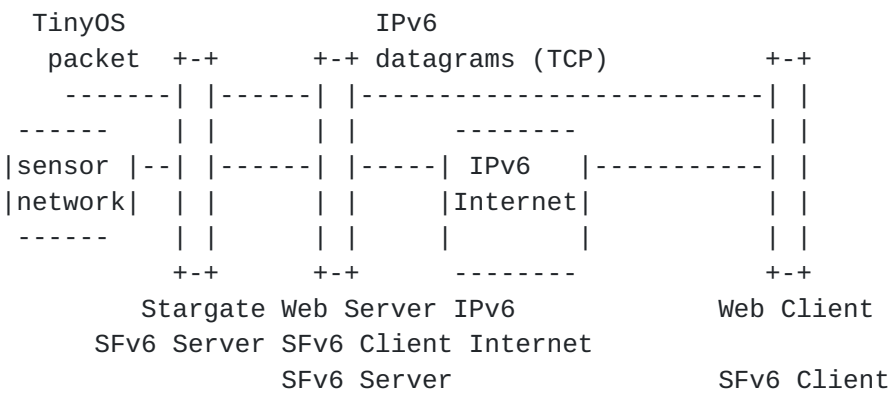

Figure 2: Experimental Forwarding Architecture

We first ported SFv4 into IPv6 and the resulting software is called serial forwarder v6 (SFv6). SFv6 running on Stargate opens a TCP port and forwards TinyOS packets back and fort from the serial port to TCP port.

We developed a serial forwarder v6 to be run on an IPv6 host. This version of SFv6 connects to the TCP port at Stargate and opens a TCP port itself.

Applications in IPv6 Internet need to run a serial forwarder that connects to the TCP port of SFv6 that runs on the host. We modified TinyDB Java applet for this purpose and obtained the applet that runs as SFv6 client.

5. TinyOS Packet Details

TinyOS packet has the format shown in Figure 3.

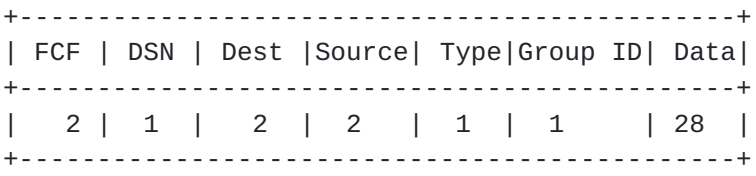

Figure 3: TinyOS Packet Format

where FCF is the frame control field and is 2 octets, DSN is 1 octet and is the destination sequence number. The Dest and Source fields are 2 octets and Dest is destination PAN identifier and Source is source sensor node ID (MAC address). Type field is 1 octet long and is the message type. Group ID is 1 octet long. User data (payload) is placed in the data field and is 28 octets long.

This format is used for IEEE 802.15.4 based sensor nodes such as Telos motes. Some fields like FCF, DSN, Dest and Group ID are Zigbee MAC layer specific.

6. Conclusions

We presented an alternative architecture for connecting Zigbee based sensor nodes to IPv6 Internet. Our architecture is based on a PDA that connects both the sensor network and IPv6 Internet. There is no need for an adaptation layer on sensor nodes in order to fragment/ reassemble 802.15.4 MAC frames. The application has to be aware of the frame format and be capable of receiving the data and generating queries to the sensor network.

7. Security Considerations

Security of the serial forwarder can be divided into two parts: IPv6 Internet and the sensor network. The security in the sensor network can be provided using link-layer mechanisms defined by IEEE 802.15.4. IPv6 Internet communication is on TCP and application-oriented. Such a communication should be secured using TLS.

8. Acknowledgements

The author gratefully acknowledges the contributions of Abbie Zheng of UNBC.

9. References

9.1. Normative References

[STANDARDS] "Key words for use in RFCs to Indicate Requirement Levels", RFC 2119, March 1997, <ftp://ftp.isi.edu/in-notes/rfc2119>.

9.2. Informative References

[draft-ietf-6lowpan-format-01] Montenegro, G. and N. Kushalnagar, "Transmission of IPv6 Packets over IEEE 802.15.4 Networks", October 2005, <http://ietf.org/internet-drafts/draft-ietf-6lowpan-format-01.txt>.

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