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Development of 6LoWPAN in Embedded Wireless System

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Abstract

In the proposed system, implementation of the low power sensor nodes is proposed. 6LoWPAN is an acronym of IPv6 over Low power Wireless Personal Area Network was developed to enable the Wireless Embedded Internet by simplifying IPv6 functionality, defining very compact header formats and taking the nature of wireless networks into account. Our solution contains two types of nodes Wireless Sensor Node and Border Router/Gateway Node. Wireless Sensor Node: These nodes have sensors integrated and are used to gather the information and send to the Border Router/Gateway Node. They create a mesh network among them, forwarding the packets of other nodes in order to make the information reach the Border Router/Gateway Node. Each Wireless Sensor Node is equipped with a 6LoWPAN (802.15.4) radio, sensors and a battery. It can be either a microcontroller based or Linux based embedded platforms. Border Router/Gateway Node: This node takes the information sent by the Wireless Sensor Nodes and sends it to the Tunneling IPv4 / IPv6 server by using the Ethernet IPv4 interface. Each Border Router/Gateway Node is equipped with a Linux based Single Board Computer, 6LoWPAN (802.15.4) radio and an Ethernet interface and a battery.

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Keywords: 6LoWPAN,IPv4, IPv6

1. Introduction

In today's world to provide internet based services to wireless sensor node there are wide range of technologies available but are difficult to integrate with larger networks. Some 40 years after it was created to connect computers to one another and allow file transfer, remote login, and access to distant computation, we find computational processing embedded in almost every device, machine, appliance, and instrument. And, they are

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increasingly able to communicate. These Bhosts hardly resemble their classic Internet forbearers, and rather than the human-generated information and documents that are exchanged over the classic Web, these deeply embedded computers present physical information sensor readings, observations, actions, and events that occur over time at particular points in the real world. The web of real world data is used to optimize production, improve safety, and reduce energy consumption, waste, and pollution. The emergence of this new tier of the Internet has largely been enabled by a decade or so of intense research on low-power wireless embedded networks, or sensornets. But early on, that thrust explicitly eschewed the design principles and constraints of the Internet architecture, arguing that conventional layering was impractical for the resource constrained devices that were being embedded in the physical world; that the underlying physical communication structure was essential to applications that would utilize such information and should not be abstracted away; and that without a human being in close attendance, these devices would need to configure themselves into networks without manual intervention. Ironically, this freedom of thought produced innumerable good ideas locked away in disjoint, no interoperable little stovepipes with little opportunity to impact the real world. At the same time, portions of the Internet design community were pushing on these very issues of accommodating huge numbers of hosts, auto configuration, and extensibility to embrace unanticipated innovation in IP version 6.

Each Wireless Sensor Node is equipped with a 6LoWPAN (802.15.4) radio, sensors and a battery. It can be either a microcontroller based or Linux based embedded platforms. Border Router/Gateway Node: This node takes the information sent by the Wireless Sensor Nodes and sends it to the Tunneling IPv4 / IPv6 server by using the Ethernet IPv4 interface. Each Border Router/Gateway Node is equipped with a Linux based Single Board Computer, 6LoWPAN (802.15.4) radio and an Ethernet interface and a battery

2. Related Work

2.1 6LoWPAN

Low bandwidth, low-power resources and the maximum link-layer packet size of 127 bytes are the most relevant characteristics of the IEEE 802.15.4 [2] standard. Implementing standard IPv6 headers over LoWPAN would result in extremely small payloads for higher-level protocols The IEEE 802.15.4 standard is broadly accepted as the PHY and MAC layer protocol for WSN. The network layer protocol must comply with the constraints imposed by the lower layer protocol in use. In fact, the requirements of the IPv6 protocol don't fully match with the IEEE 802.15.4 constraints. MTU is 127 bytes. Beside to this incompatibility, using standard IPv6 headers would result in extremely small payload for high protocols. To address these issues, the IETF 6LoWPAN-working group were created to define the support of IPv6 over IEEE 802.15.4.

The 6LoWPAN [5] working group were mainly focused on the following items: *i*) to define limited extensions to IPv6 neighbour discovery protocol more adapted for WSN; *ii*) to describe mechanisms to compress 6LoWPAN headers and *iii*) to define 6LoWPAN routing approaches and protocols adapted to WSN characteristics. Instead of defining a single header, like IPv4, the 6LoWPAN use stacked headers as the original IPv6 protocol does. In this case, it does not need to use unnecessary header fields for mesh networking or fragmentation and it uses only the minimum necessary headers. The 6LoWPAN standard defines four header types: *i*) the dispatch header, *ii*) the IPv6 header compression header, *iii*) the fragmentation header, and *iv*) the mesh header. In the simplest case, only the dispatch and compression headers are used. At the beginning of each header, a header type field identifies the header format.

3. Proposed System.

The proposed system includes realization of communication based on the cc2520 and 6LoWPAN subsystem on a cheap and low power embedded platform supporting Linux.The term 6LoWPAN is referred to WPAN network having IPV6 based protocols. As most of the networks deployed are based on IPV4 there is a need to interoperate legacy IPV4 with newly introduced IPV6 network.

6LoWPAN protocol does two operations on IPV6, encapsulation and header compression so that IPv6 compliant packets can be transmitted and received from the IEEE 802.15.4 based network. There are two types of node in such network, viz. end node and gateway. End node is composed of 6LoWPAN compliant radio, sensors and also battery for power. The end node collects the information and send them to the gateway i.e. it basically creates the mesh network. Gateway takes the information from end node and passes it to IPv4/IPv6 server using Ethernet interface. Gateway is composed of 6LoWPAN radio.

3.1 Advantages of Proposed System

- IPv6 offers the potential to build a much more powerful Internet.
- IPv6 provides better end to end connectivity than IPv4.
- IPv6 has better ability for auto configuring devices than IPv4.
- IPv6 contains simplified Header Structures leading to faster routing as compared to IPv4.
- IPv6 provides better security than IPv4 for applications and networks.
- IPv6 gives better Quality of Service (QoS) than IPv4.

4. Implementation Description

4.1 Network Topology

The unequal properties of IPv6 and IEEE 802.15.4 cause many requirements to the 6LoWPAN protocol, which have to be considered in order that the underlying network still fulfils the needs of a modern WSN.4919. The most important characteristics of the IEEE 802.15.4 standard are its low bandwidth, the requirements for low power and the maximum link layer packet size of 127 bytes. Implementing IPv6 unaltered over 802.15.4 would result in extremely small packet payloads for higher-level protocols as the following calculation shows. According to IEEE 802.15.4-2006, in the worst case the maximum size of an IEEE 802.15.4 frame is 88 bytes. The IPv6 header has a size of 40 bytes, which results in 41 bytes for upper-layer protocols like TCP or UDP. The length of the TCP header is another 20 bytes.

Thus, only 28 bytes per packet are available for application-layer protocols. The sensor nodes uses the 6LoWPAN protocol over the 802.15.4 link layer to create a mesh network which interconnects any device in the network with the Gateway (GW).

- Once the GW takes the 6LoWPAN packets, it changes the IP header to IPv4 while keeping the UDP transport layer.

- Then it sends the information to the IPv4 / IPv6 Tunneling machine which will change header to a the proper IPv6 format and will send the information to IPv6 Servers located on the Internet, where users are connected

Fig.1.Implementation structure of 6LoWPAN

5. Work Flow

The proposed system includes realization of communication based on the cc2520 and 6LoWPAN subsystem on a cheap and low power embedded platform supporting Linux. The term 6LoWPAN is referred to WPAN network having IPV6 based protocols. By default Raspberry Pi comes with Raspbian image free OS.There will be no 6LoWPAN support.

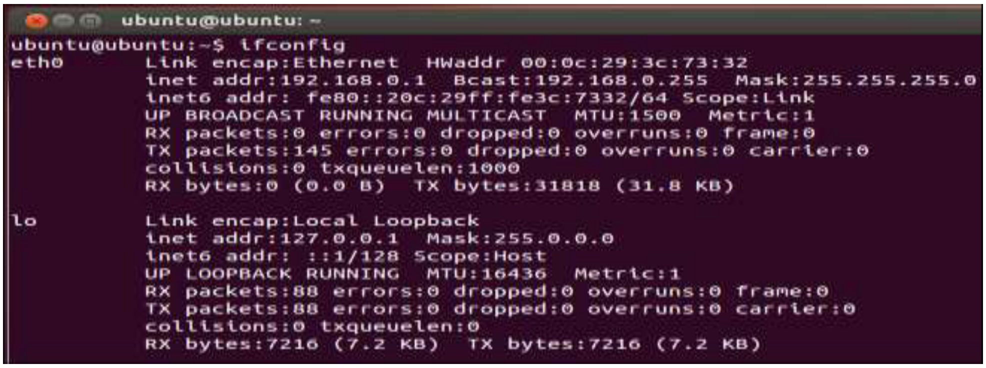

Fig.2. Default ifconfig-without 6LoWPAN

5.1 Preparation Of Linux SPC

- Taken a Linux kernel which was 4.0 version.
- Added the configuration support for 6LoWPAN IEEE 802.15.4

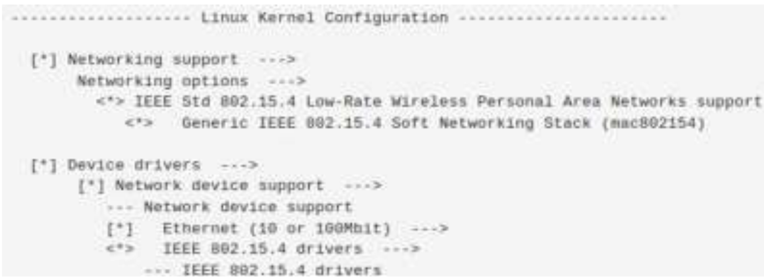

Fig.3. Linux Kernel Configuration

- Configure the rest of the kernel for RPI.
- Then after the compilation integrated cc252 driver and modified some pin configuration.
- Prepared U-Boot for Raspberry Pi
- Downloaded bare U-Boot and customize it for Rpi which enable Rpi to boot from SD card.
- Modified device tree file for enabling cc2520 pin or to enable SPI communication.
- After this much work we loaded kernel U-Boot and device tree file into SD card and made Raspberry Pi up and running.

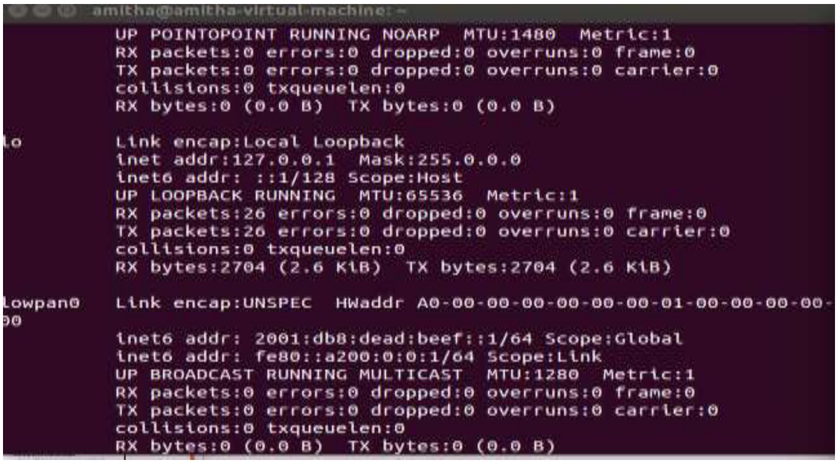

Fig.4. 6LoWPAN Support

6. Results and Discussions

6.1. Configuration of IEEE 802.15.4 layer

We will configure the two devices to use the PAN ID 0x0777, the hardware addresses a0::1 and a0::2, and the short addresses 0x8001 and 0x8002. Then, we will give them IPv6 addresses and test 6loWPAN communication with standard GNU tools.

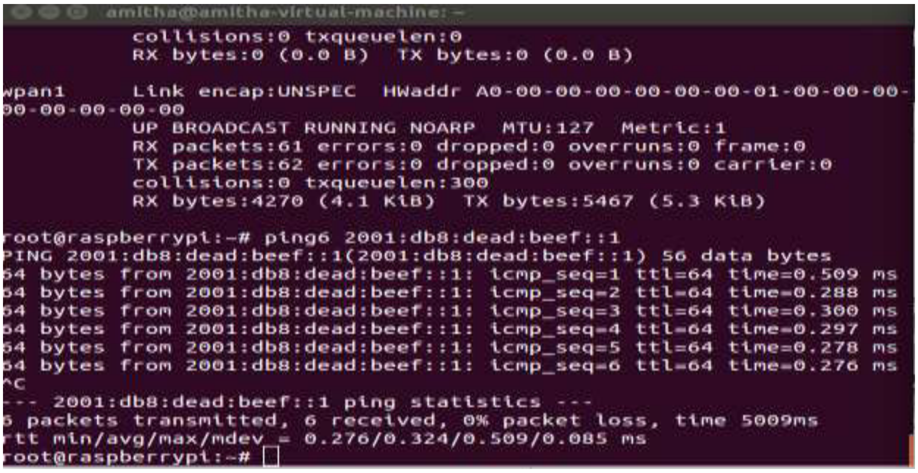

Fig.5.Configuration of IEEE 802.15.4 layer

6.2. Configuration of the 6loWPAN layer

By using the 6loWPAN protocol on top (the lowpower equivalent of the IPv6 protocol), we can allow standard Linux network applications to communicate over the IEEE 802.15.4 link with standard sockets.

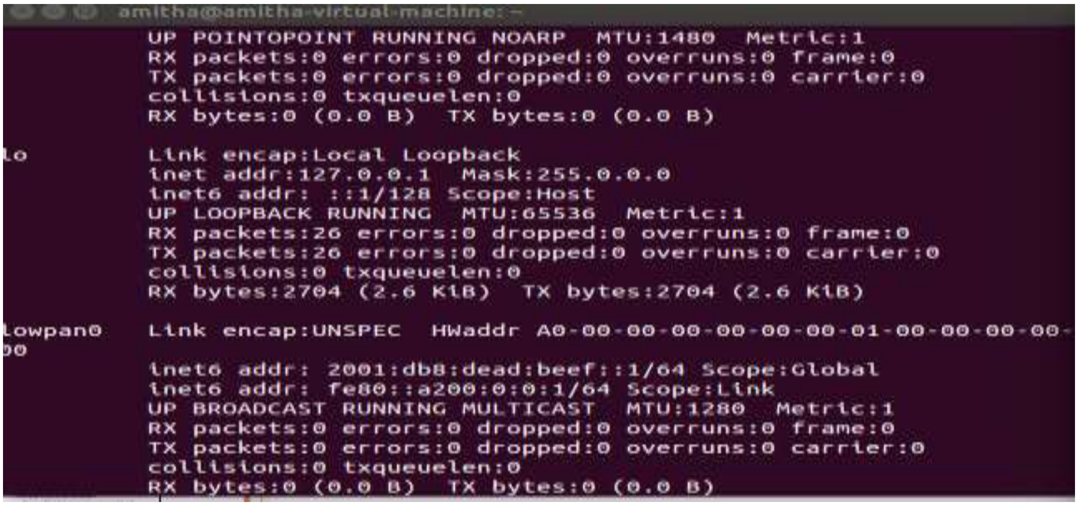

Fig.6. Configuration of 6LoWPAN Layer

- Testing the communication

For first node
root:/> ping6 2001:db8:dead:beef::2

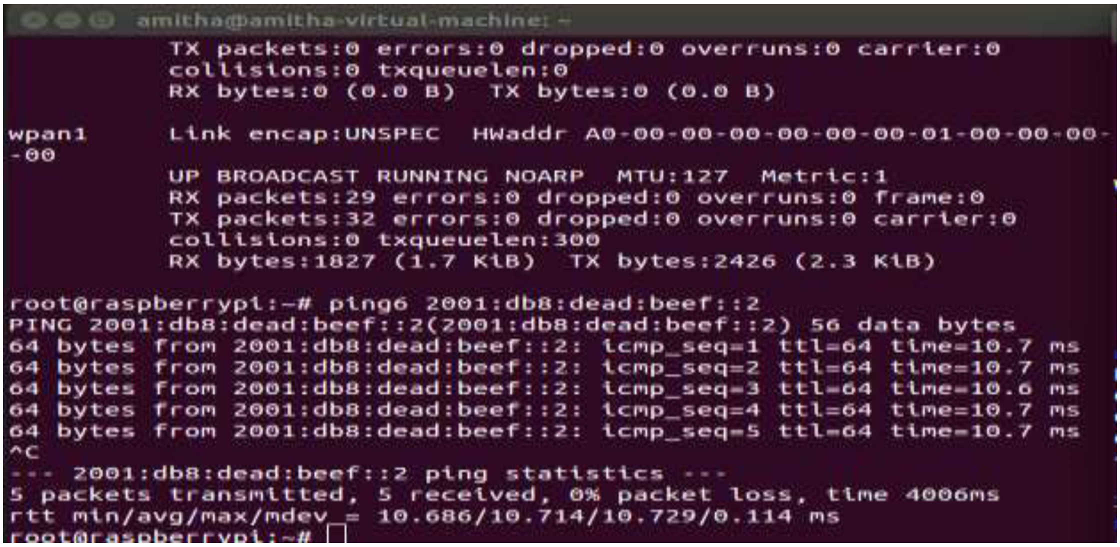

Fig.7. Communication for First Node

- For second node

root :/> ping6 2001:db8:dead:beef::1

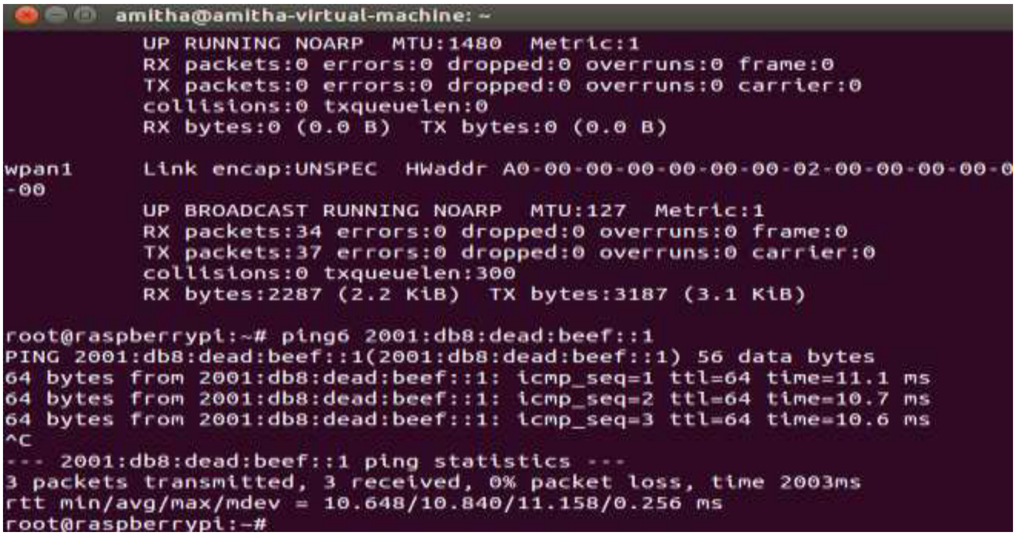

Fig.8. Communication for Second Node

7. Conclusion

Implemented a 6LoWPAN node using an embedded linux platform and a low power 802.15.4 radio. The main advantages of using IPv6 in sensor node networks was that it enables the use of standard networking tools, which were originally developed for the Internet, also for WSNs. Furthermore, it simplifies the task of interlinking WSNs over the Internet, as there was no need for an advanced gateway. The packets can simply be forwarded on the link-layer. IPv6 is important for the long-term development of the Internet, but a switch to IPv6 is almost impossible as long as most services are not offered over IPv6.

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