Architecture for 6LoWPAN Mobile Communicator System

Usman Sarwar, Gopinath Rao Sinniah, Zeldi Suryady and Reza Khosdilniat

***Abstract*—Wireless sensor network is one of the emerging technologies which will have impact on our daily life in near future. This paper presents a 6LoWPAN communicator, which is a mobile device system and responsible for bi-directional communication to retrieve sensor data and conFig sensor nodes. This paper discusses about the overall system and communication mechanism of 6LoWPAN communicator.**

***Index Terms*— 6LoWPAN communicator, 6LoWPAN communicator communication methods, a mobile device to communicate with 6LoWPAN sensor nodes,**

I. INTRODUCTION

Current trends have directed the usage of wireless sensor network for various purposes. The applications of using this technology are endless from agriculture to health monitoring to military purposes. The deployment of IP base wireless sensor network is a next step to integrate this technology with the Internet devices for global connectivity and provides end to end communications.

6LoWPAN is an acronym of IPv6 over low power wireless Personal Area Network. The low power wireless sensor devices which usually uses the low power wireless private area network (IEEE 802.15.4) standard are being widely deployed for various purposes and in different scenarios. But 6LoWPAN is not restricted to IEEE 802.15.4 standard rather can use other layer two standards as well. The biggest challenges in the deployment of these sensor devices, also called as motes, are to efficiently use the low power and low bandwidth.

IPv6 makes communication to become more visible across various networks and various devices. IPv6 low power wireless private area network (6LoWPAN) was adopted as part of the IETF standard for the sensor devices so that it will become an open standard compares to other dominated proprietary standards available in the market.

MIMOS Bhd., Malaysia.
Emails:{usman.sarwar,gopinath.rao,zeldi.suryady,reza.khoshdelniat}@mimos.my

Wired based sensor network have been used for decades for monitoring different applications. Wireless sensor network push it to next level by which it allows to monitor from those locations which are not possible with wired based sensor network. In addition, it provides flexibility of deployment and maintenance. Now IPv6 based wireless sensor network will take it to next stage where individual nodes can be part of Internet.

II. DISCUSSION

A- 6LoWPAN overview architecture

Standard 6LoWPAN architecture consists of several entities. Fig 1 illustrates the typical 6LoWPAN architecture in which 6LoWPAN gateway is a primary source for outside the network IPv6 clients to communicate with 6LoWPAN sensor nodes. Whereas it also shows web server, which retrieves sensor data from the 6LoWPAN gateway and publishes on the Internet. 6LoWPAN communicator is also depicted in Fig 1 which demonstrates communicating with sensor nodes.

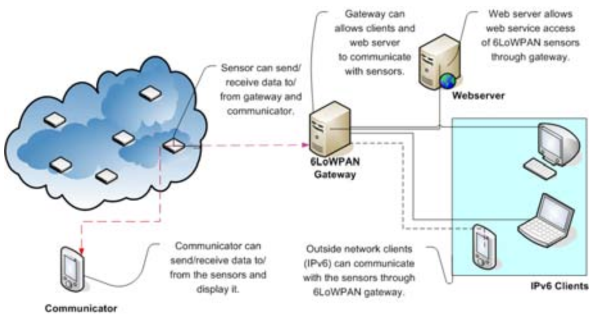

Fig 1 – 6LoWPAN typical architecture

B - 6LoWPAN Communicator Architecture

The 6LoWPAN communicator is a platform independent system on a portable mobile device that has multiple communication interfaces including IEEE 802.15.4, Ethernet and IEEE 802.11x. It is capable of bidirectional wireless communication with 6LoWPAN sensor nodes. The communicator conforms to 6LoWPAN and IPv6 IETF standards and drafts [1] [2] [5]. It supports various application specific protocols for interpreting sensor data for example Sensinode

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NanoSOAP and MIMOS MSCAN format. It has a graphical user interface which shows trace messages on screen. These messages are clustered into user friendly and developer friendly messages. User friendly messages can provide error information with less technical terminology. Whereby developer friendly messages provide technical information to understand and fix the problem in the WPAN. It communicates directly with the sensor nodes without packets routes through the router or gateway. Fig 2 demonstrates a typical network scenario for 6LoWPAN communicator in which a communicator accesses the nodes using IEEE 802.15.4 in hop-by-hop manner.

Fig 2 – 6LoWPAN Communicator network scenario

6LoWPAN communicator architecture consists of three main modules as illustrated in Fig 3. The user interface module handles all the graphical user functionalities to display extracted information in a user and developer friendly manner. Service modules are core system which is further divided into various components. These components will be explained in later sections. Communication modules are responsible for handling low level communication protocols for transmission.

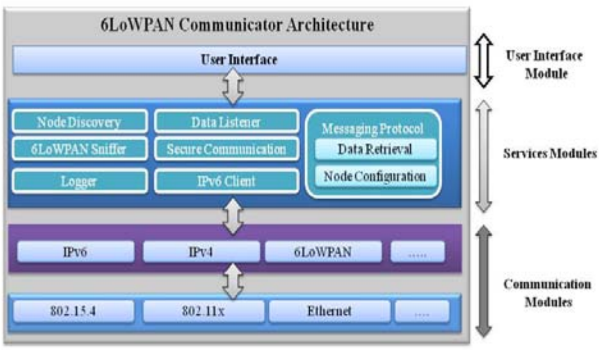

Fig 3 – 6LoWPAN communicator architecture

6LoWPAN communicator establishes packet transmission to 6LoWPAN sensor network by using IEEE 802.15.4 nano-router interface device, as well as application specific components which uses sockets to interact with the sensor nodes. Nano-router uses an FTDI USB chip, which is supported on all the operating systems. 6LoWPAN communicator configures the nano-router as a gateway and advertises 6LoWPAN ICMP router advertisement messages to sensor nodes. These messages are responded back by the sensor nodes with ICMP router solicitation messages. The 6LoWPAN communicator uses ICMP or UDP ping to discover the available sensor nodes on the network. Discovered nodes are shown in a tabular format along with the details of RSSI, RTT, hop count and the time stamp.

C- Communication methods of 6LoWPAN Communicator

6LoWPAN communicator is designed to use three types of communication methods for different purposes. These communication methods are discussed below:

Active communication method

6LoWPAN communicator works within a WPAN as an active communication entity using IEEE 802.15.4. Active communication allows the 6LoWPAN communicator user to read the sensor data in a single or multi-hops communication approach. Fig 4 illustrates the role of 6LoWPAN communicator in a 6LoWPAN sensor network as an active entity whereby it directly interacts with the sensor nodes. There are three components for this method; data retrieval, node configuration and data listener.

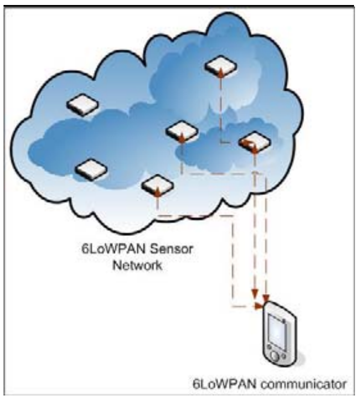

Fig 4 – 6LoWPAN communicator communicating with 6LoWPAN network

The bidirectional communication for data retrieval and configuration is accomplished by using messaging based protocol over UDP or cUDP. Fig 4 demonstrates an example of 6LoWPAN Communicator sending a request message to sensor node for retrieving sensor data. This event is triggered by the 6LoWPAN communicator user. Upon receiving the message from the 6LoWPAN communicator, the sensor node verifies

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the user and processes the request. Subsequently the sensor node responds back the requested sensor data to the communicator user. On receiving the data, the 6LoWPAN communicator verifies the response for validity of the node and extracts information from the packet. Extracted information is displayed in a user friendly representation. This procedure is described in the Fig 5.

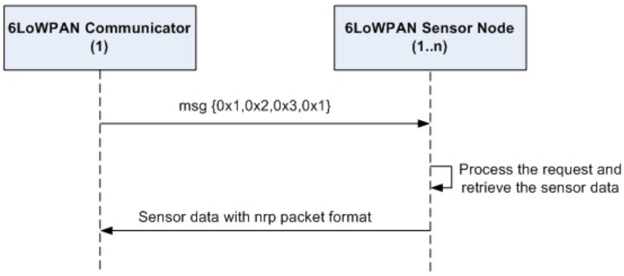

Fig 5 – Data retrieval through active communication messaging

6LoWPAN communicator is also capable of configuring the sensor nodes in real time communications for various purposes such as setting up time interval for sending sensor data. For node configurations, 6LoWPAN communicator sends a message to a node which consists of two parts. First part notifies about type of configuration and second part consists of values for configuration. Sensor node processes the configuration and concludes it by notifying for success or failure of configurations. Third component allows the 6LoWPAN communicator to listen for data pushed by sensor nodes to the gateway as shown in Fig 6.

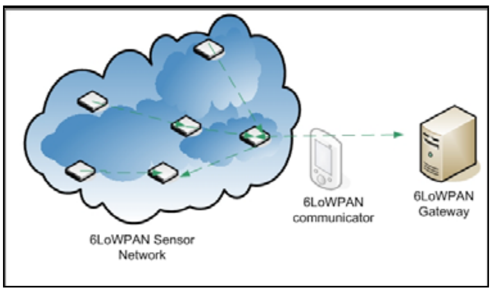

Fig 6 – 6LoWPAN Communicator as a data listener

Passive communication method entity in WPAN

6LoWPAN communicator also works as a passive communication entity by which it scans and monitors the network activity. It executes a packet sniffer for capturing 6LoWPAN traffic and extracts the information and displays in a user friendly representation. This allows the 6LoWPAN communicator users to examine 6LoWPAN network communication. Fig 4 exemplify 6LoWPAN communicator monitoring the 6LoWPAN network passively for network activities.

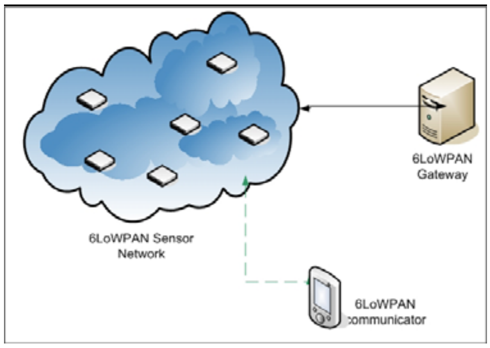

Fig 7 – 6LoWPAN communicator passive communication

Remote IPv6 client

6LoWPAN communicator is also capable of working as an IPv6 client. In this procedure, 6LoWPAN communicator accesses 6LoWPAN sensor nodes using Internet through 6LoWPAN gateway. This procedure is illustrated in Fig 8 in which a 6LoWPAN communicator communicates with sensor nodes through gateway using Internet.

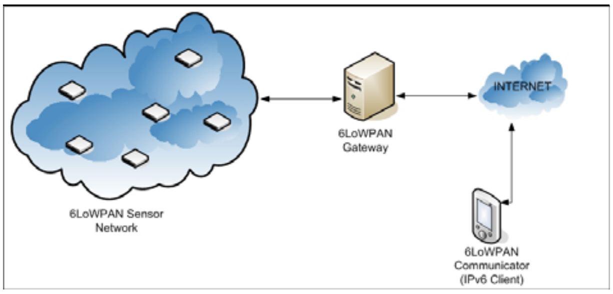

Fig 8 – 6LoWPAN communicator passive communication

III- IMPLEMENTATION AND EVALUATION

6LoWPAN communicator is implemented using JAVA (JDK 1.6). It can be use with various types of mobile device of different architectures for base platform. For current evaluation, we are using MIMOS iDola which is an Intel Atom based tablet PC as shown in Fig 2. The communicator is attached with the Sensinode's N601 router which is an IEEE 802.15.4 FFD device. Sensinode's N711 sensor nodes based on TI MSP 430 with CC2430 were used as 6LoWPAN nodes which were loaded with FreeRTOS and NanoStack. Sensor nodes 6LoWPAN stack was developed using SDCC. Fig 9 shows 6LoWPAN communicator's user interface with a wireless sensor network view which demonstrates discovered sensor nodes within the range for reading individual sensor node data.

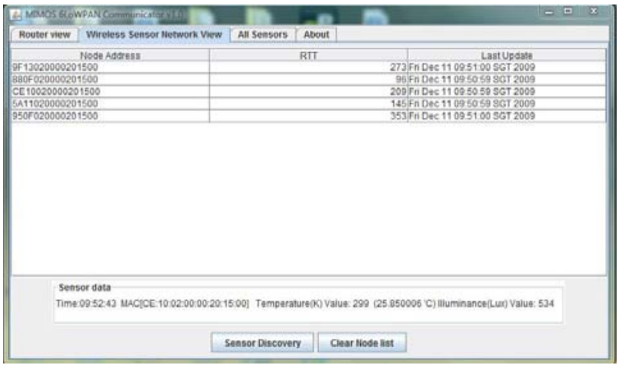

Fig 9 – Discovered sensor nodes in 6LoWPAN Communicator

IV- CONCLUSION

Wireless sensor network is considered to be a major technological milestone which will influence our future. A mobile device can provide useful functionality to wireless sensor network users. This paper discusses about 6LoWPAN Communicator as a mobile entity tool which can perform bi-directional communication with the sensor nodes and capable of performing various types of communication with the 6LoWPAN sensor network. Different mechanisms of communication allows 6LoWPAN communicator user to flexibly interact, debug and robustly perform analysis of deployed sensor network.

REFERENCES

[1] N. Kushalnagar, G. Montenegro, C. Schumacher, "IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs): Overview, Assumptions, Problem Statement, and Goals" in RFC 4919, August 2007.

[2] G. Montenegro, N. Kushalnagar, D. Culler, "Transmission of IPv6 Packets over IEEE 802.15.4 Networks" in RFC 4944, September 2007.

[3] Geoff Mulligan, 6LoWPAN Working Group "The 6LoWPAN Architecture" in Workshop on Embedded Networked Sensors, Proceedings of the 4th workshop on Embedded networked sensors, Cork, Ireland. Pages: 78 - 82, Year of Publication: 2007, ISBN:978-1-59593-694-3

[4] Karl Mayer, Wolfgang Fritsche, "IP-enabled Wireless Sensor Networks and their integration into the Internet" in ACM International Conference Proceeding Series; Vol. 138, Proceedings of the first international conference on Integrated internet ad hoc and sensor networks, Nice, France. Article No. 5, Year of Publication: 2006, ISBN:1-59593-427-8

[5] S. Deering, R. Hinden, "Internet Protocol, Version 6 (IPv6) Specification" in RFC2460, December 1998.

[6] J. Hui, Internet-Draft, "Compression Format for IPv6 Datagrams in 6LoWPAN Networks".

[7] Adam Dunkels, Fredrik Österlind and Zhitao He, "An Adaptive Communication Architecture for Wireless Sensor Networks" in Conference On Embedded Networked Sensor Systems. Proceedings of the 5th international conference on Embedded networked sensor systems. Pages: 335 - 349. Year of Publication: 2007. ISBN:978-1-59593-763-6

[8] Ayman Sleman and Reinhard Moeller, "Integration of Wireless Sensor Network Services into other Home and Industrial networks using Device Profile for Web Services (DPWS)". Third International Conference on Sensor Technologies and Applications. 18-June 2009.

[9] Zimmermann, A. Sa Silva, J. Sobral, J.B.M. Boavida, F., "6GLAD: IPv6 Global to Link-layer ADdress Translation for 6LoWPAN Overhead Reducing". Next Generation Internet Networks, 2008. NGI 2008. Publication Date: 28-30 April 2008. On page(s): 209-214. ISBN: 1-4244-1784-8

[10] Jeong-Hee Kim, Do-Hyeon Kim, Ho-Young Kwak and Yung-Cheol Byun, "Address Internetworking between WSNs and Internet supporting Web Services". International Conference on Multimedia and Ubiquitous Engineering (MUE'07) Seoul, Korea. April 26-April 2007. ISBN: 0-7695-2777-9

[11] Mathilde Durvy, Julien Abeillé, Patrick Wetterwald, Colin O'Flynn†, Blake Leverett, Eric Gnoske, Michael Vidales, Geoff Mulligan,Nicolas Tsiftes, Niclas Finne, Adam Dunkels, "Making sensor network IPv6 ready.". Proceedings of the 6th ACM conference on Embedded network sensor systems, Raleigh, NC, USA. Pages 421-422. 2008

[12] Zach Shelby, Sensinode Ltd. "Using Sensinode Products to Develop 6LoWPAN Networks - White Paper".

[13] A. Dunkels, B. Grönvall, and T. Voigt, "Contiki - a lightweight and flexible operating system for tiny networked sensors". Proceedings of the 29th Annual IEEE International Conference on Local Computer Networks, Pages: 455 - 462, 2004, ISBN: 0742-1303 , 0-7695-2260-2.

[14] Using the FreeRTOS Real Time Kernel - a Practical Guide uIPv6 FAQS. [Online] http://www.sics.se/contiki/uipv6-faq.html (30 Aug 2009)

[15] Sung Jun Ban, Hyeonwoo Cho, ChangWoo Lee, and Sang Woo Kim, "Implementation of IEEE 802.15.4 Packet Analyzer". World Academy of Science, Engineering and Technology volume 35, November 2007, ISSN: 2070-3724

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