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Integration of Bluetooth Wireless Stack for Automotive INVANET Communication

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Abstract:
The Bluetooth LE 5 protocol stack is integrated as per the GENIVI standard for the automotive industry. The Bluetooth LE 5 wireless technology is a worldwide specification for a small-form factor, low-cost radio solution that provides links between mobile computers, mobile phones, other portable handheld devices, and connectivity to the Internet especially IOT. In this work the Bluetooth 5 LE protocol stack integrated for an automotive industry with the configured important profiles like A2DP, HFP, NAP and some basic profiles. This project work also covers that the integration of mobile telephony protocol stack, audio frame works and internet protocol. As an open source project it can forms a reusable software foundation for the efficient development of unique automaker.

Keywords: Bluetooth, Protocol stack integration, Ad-hoc network, Bluez.

I. INTRODUCTION

Bluetooth a short range wireless communication technology used to replace cable technology. Now it can be easily used for remote sensors, ad-hoc applications and some short range communications. Nowadays vehicles are in need of the advancement in wireless communication features. Such reasons like rollout phase in applications caused by the more number of vehicles are the major limitation to establish the VANET in the automotive industry. New Bluetooth 5 LE has the better efficiency than any other wireless devices and also especially well with the IoT applications [4]. The applications like V2I and V2V which are implemented with the Bluetooth 5, are cost efficient wireless technology. It ensures that the Bluetooth range can establish over 60m to 100m. A trial to use BLE for VANET applications provides encouraging results by the means of two experiments as investigate metrics such as range, signal quality and latency for different mobility scenarios [1]. Using open source software to develop Bluetooth based products is a very effective method of reducing development costs [5]. The rssi values of the Bluetooth are inaccurate and highly depend on the features of the Bluetooth module. The signal stability the Bluetooth in real scenarios need to be investigated [9]. The rssi test is really need to ensure the Bluetooth communication efficiency for power consumption and covering range or distance

II. THE BLUETOOTH PROTOCOL STACK

A protocol stack is a prescribed hierarchy of software layers, starting from the application layer at the top to the data link layer at the bottom. The Bluetooth device also has the same manner protocol stack.

A. Common Protocol stack

The Host layer covers the application frame work and socket libraries. The pseudo-protocol referring to any standardized communication between the host stack and the controller. An HCI decouples the host from the controller, allowing either to be swapped without affecting the other. The host stacks and controller can be implemented on the same microprocessor. In this case an HCI serves no purpose, and often implemented only as an internal software interface.

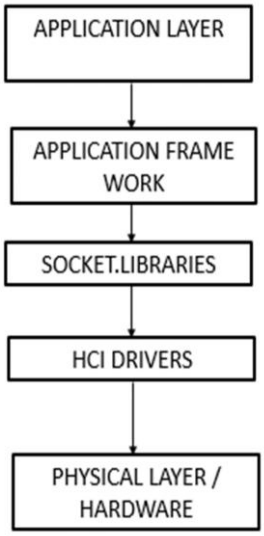

Figure.1. Overview of the protocol stack

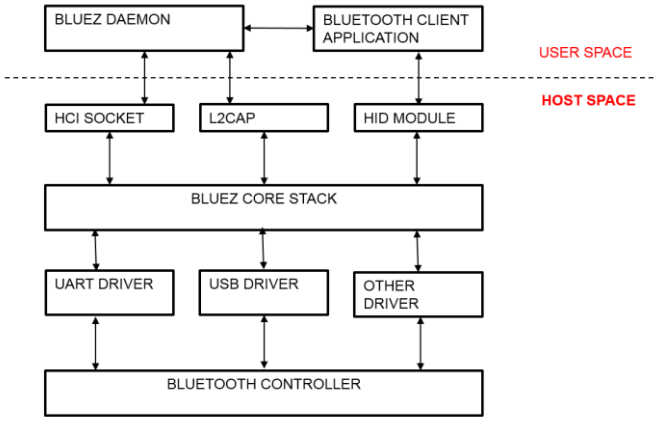

Figure.2. Bluetooth 5 LE Protocol Stack

Basically the Linux kernel is written in the C programming language supported by GCC which will be a host layer for the protocol stack integration, together with a number of short sections of code written in the assembly language of the target architecture.

III. INTEGRATION OF BLUETOOTH STACK FOR IMPLEMENTING INVANET FEATURES

This section explains that the internal requirements of a Bluetooth protocol stack and their applications over the total Bluetooth connectivity systems. Upcoming packages are the important framework libraries need to be integrated with the BLUEZ protocol stack. The packages have various versions depends upon the development process. As per the development each version of packages varies with the functionalities of integration with other packages. Some of the packages having advantages over the development and some need to be modified for our requirement. Each dependency packages need to be added over the protocol stack and also they are having their own important applications as reason to be added for the same. The table 1 shown above deals with some packages discuss what they are and reason to be added.
The integration of all required packages into the host layer is the important work to generate a protocol stack over the Linux kernel space. These are the libraries to be added in the host layer for Bluetooth protocol stack such as Mobile telephony stack, Audio driver packages, software bus and the Bluez 5. The Fig 3 shows the packages need to be integrated without any errors occurrence. The integration of all required packages into the host layer is the important work to generate a protocol stack over the Linux kernel space. These are the libraries to be added in the host layer for Bluetooth protocol stack such as Mobile telephony stack, Audio driver packages, software bus and the Bluez 5. The Fig 3 shows the packages need to be integrated without any errors occurrence.

Table 1. Common Bluez dependency Packages

LIBRARY PACKAGES	APPLICATION
BLUEZ	Official Linux Bluetooth protocol stack
DBUS	Software bus for inter-process communication
LIBICAL	Open Source implementation of Calendaring and Scheduling protocols
CMAKE	Used to control the software compilation process using simple platform
LIBFFI	Used for individual compilation of high level languages
PYTHON	Object oriented high level language
GLIB	low-level system libraries written in C and developed mainly by GNOME

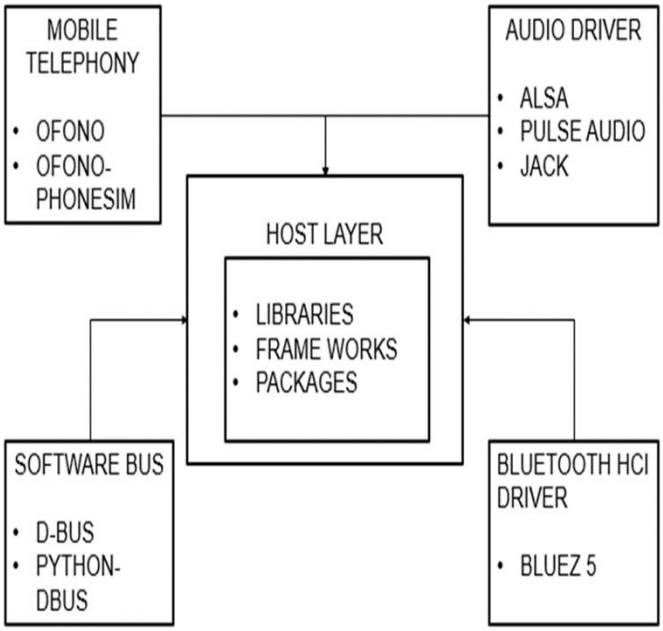

Figure. 3. Integration of all packages into the host layer

Commonly Advanced Linux Sound Architecture (ALSA) is a software framework and part of the Linux kernel that provides an application programming interface (API) for sound card device drivers. OFono is a free software project for mobile telephony (GSM/UMTS) applications. It is built on 3GPP standards and uses a high-level D-Bus API for use by telephony applications.

OFono is free software released under the terms of the GNU General Public License. The pulse audio frame works are enables the important profiles like A2DP, HFP, AVRCP and etc. D-Bus is a system for inter-process communication has such layers like libraries, an executable daemon message bus and the binding based wrapper libraries. This allows integration of the desktop session and communicates between desktop session and the operating system.

IV. REAL TIME IMPLEMENTATION ON VEHICLE

The cavity model resonant frequency equation (10) states that, the relative permittivity of a dielectric is indirectly proportional to resonant frequency. So that various single dielectric layers in a patch antenna shifts its resonant frequency.

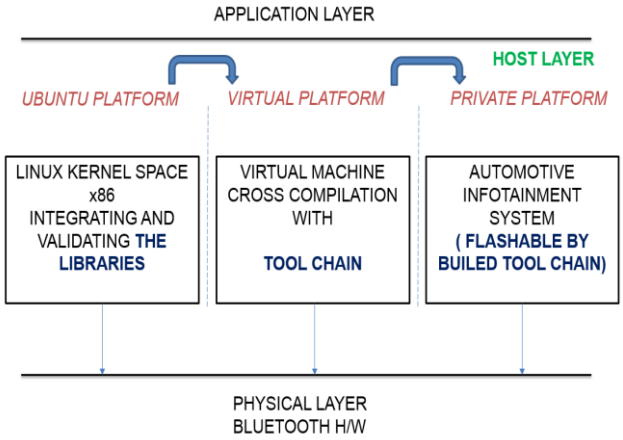

Figure.4. Work flow for implementing in real time application

Table.2.Covered profiles and their applications of integration

Profiles covered	Applications
GAP	General Access – Inquiry application
HFP	Carry a monaural audio channel
SDAP	To find out what services are available
A2DP	Multimedia audio streaming
NAP	Network Access through Bluetooth
AVRCP	Provide a standard interface to control TVs, Hi-fi equipment.

V. DISCUSSION ON ERRORS AND VALIDATION PROCESS

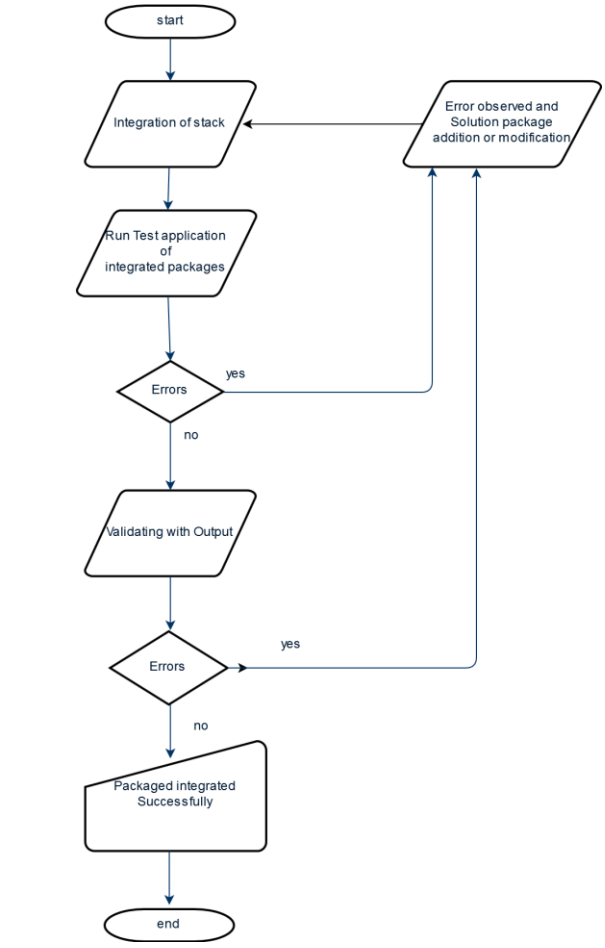

Figure. 5. Validation process the integrated Protocol Stack

The firm ware works differs with the package versions is the important scenario in integration work. The development among the packages needs to be tracked and the supportable versions should be integrated with the host layer. This tracking process contains the tabulation of errors and the solutions made from that package developers. These procedures helps us to map the development of the package and the integration interface can be explored. The validation of these packages is need to be intimated by the application layer test. Each package have their own testing packages to validate their working with the host layer. The integrated host must responds their validating tests and should generate an error or successfully pass through the host layer without any warnings. Every stack has number test applications deals with various interfaces, so that all test applications of a package should be tested for their validation. The validating procedure of a stack shown in the Fig 4. After this integration process the packages should be added to the tool chain of the hardware which is going to be the automotive infotainment system. The memory variation also leads to such effects of the infotainment process that also need to be absorbed for further development. This step by step integration will be helpful for figure out the exact error or any other misbehaviors of the total system.

VI. RSSI TEST AND OBSERVATIONS

Above analyzed and validated protocol stack is implemented with hardware drivers, to verify the physical layer components. The fig 6 shows the RSSI varies with the real time of testing in the open environment.

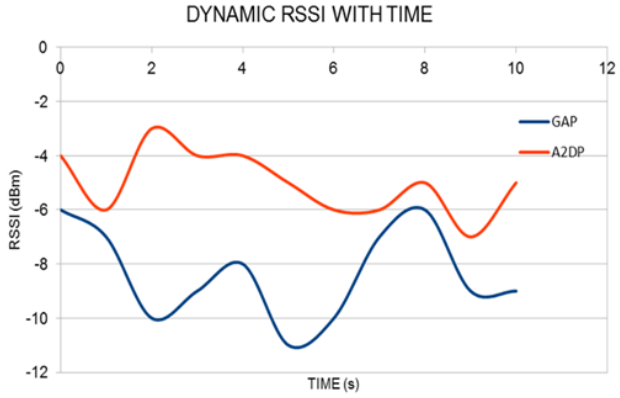

Figure. 6. Variation in RSSI with time for constant distance

So that the average value of n seconds was calculated using the equation 1 shown below and taken for the observation.

$$rssi.avg = \frac{\sum_{t=0}^{n} rssi\ (t)}{n} \qquad (1)$$

The results discussed above are absorbed in an open area and also it reminds that these magnitudes should vary with the locations. But the relative magnitude is taken to the account for the analysis. This result also remains the same discussed above as A2DP is more reliable than the GAP profile. And observed that the memory requirement is quite higher than older version of protocol stack. A2dp profile has more reliability because of audio streaming. Gap (inquiry profiles) consumes lower power than other profiles.

Fig ure.7. Variation in Average RSSI with distance

Figure. 8. Results of the host layer profile test with mobile

Sample References Section

VII. CONCLUSION

From this integration work of Bluetooth stack in GENIVI standard automotive communication network configured with the multiple application regions like IoT. In this work the Bluetooth 5 LE protocol stack integrated for an automotive industry with the configured important profiles like A2DP, HFP, NAP and etc. As an open source development project has the advantage of integration ability with various fields of applications required for INVANET communication. The ultimate future work of this project as to implement communication from a vehicle to any wireless device simply called Vehicle to Anything V2X.

VIII. REFERENCES

[1]. Raphael Frank, Walter Bronzi, German Castignani, Thomas Engel, "Bluetooth Low Energy: An Alternative Technology for VANET Applications", Interdisciplinary Centre for Security, Reliability and Trust University of Luxembourg, 1359, Luxembourg

[2]. RenC Nusser, Rodolfo Mann Pelz, "Bluetooth-based Wireless Connectivity in an Automotive Environment", Corporate Research and Development, Robert Bosch GmbH, 0-7803-65@7-0/00/$10.00 02000 IEEE.

[3]. Szymon Janc, "Bluetooth on modern Linux", Embedded Linux Conference, San Diego, 2016.

[4]. Manik Grover, Dr. Suraj Kumar Pardeshi NirbhowJap, Singh Sanjay Kumar, “bluetooth low energy for industrial Automation”, ieee sponsored 2nd international conference on electronics and communication system (icecs 2015).

[5]. C. G. C. Rocher and G. P. Hancke,” Implementation of a Bluetooth Protocol Stack on a Low-Cost Microcontroller”, Deporlmenl of Electrical, Ekclronic ond Crmpuhr Engineering. Universiv o/Preluria. Pretoria, South Africa.

[6]. L. Liping, L. Yonghua, and L. Shiwen, “Design of car Bluetooth hands free mobile phone system in Linux system,” International Conference on Automatic Control and Artificial Intelligence (ACAI 2012), 2012.

[7]. Y. Jijiang and L. Fiyu, “Design and implementation of an embedded VoIP system using Bluetooth technique,” 2010 2nd International Conference on Future Computer and Communication, 2010.

[8]. Leopoldo Angrisani (1), Matteo Bertocco(2), Giovanni Gamba(2) and Alessandro Sona(2, “Effects of RSSI Impairments on IEEE 802.15.4 Wireless Devices Performance Susceptibility to Interference”, Department of Computer Science and Control Systems, University of Naples Federico II, via Claudio, 21 – 80125, Naples, Italy.

[9]. J. Neburka, Z. Tlamsa, V. Benes∗, L. Polak, O. Kaller, L. Bolecek, J. Sebesta, T. Kratochvil, “Study of the Performance of RSSI based Bluetooth Smart Indoor Positioning” Institute of Microelectronic Applications (IMA), Prague, Czech Republic.

[10]. C. Gomez, J. Oller, and 1. Paradells, "Overview and Evaluation of Bluetooth Low Energy: An Emerging Low-power Wireless Technology," Sensors, vol. 12, no. 9, pp. 11734-11753, Aug. 2012.