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Smart Convergence Platform for Software Defined Radio Application

Hyoseok Yoon, Ji-Eun Lee, Saet-Byeol Yu and Se-Ho Park

Korea Electronics Technology Institute, Contents Convergence Research Center,
03924 Seoul, Korea
{hyoon, jieun7583, sbyu, sehopark}@keti.re.kr

Abstract. There are several popular digital radio standards as well as a number of recent proposals being standardized that need different configurations to be used. To support multiple standards in a convergent platform, a concept of software defined radio is attractive which can support a range of standards and applications through relatively convenient software updates. In this paper, we propose a smart convergence platform for software defined radio application that enables software defined radio platform to communicate through Bluetooth for controlling and changing configurations of software defined radio and realizing connected audio applications.

Keywords: Bluetooth, Software Defined Radio, Bluetooth Profile, Smart Convergence.

1 Introduction

Various digital radio standards are available and adopted in different countries for providing localized and tailored broadcasting services. Digital radio standards that are already standardized or going through the standard process include HD-Radio, DAB (Digital Audio Broadcasting), DAB+, DRM (Digital Radio Mondiale), DRM+, CDR (China Digital Radio) and ISDB-Tsb. Since several standards are under the development, updated specifications need consistent updates. For this reason, a flexible update strategy such as “different levels of reconfiguration within a transceiver” [1] or “reconfigurable architecture” [2] in Software Defined Radio (SDR) is favored. In this paper, we explore and propose a Bluetooth connected smart convergence platform for updating and controlling multiple digital radio standards. We also present connected audio application use cases that show a use of the proposed convergence platform.

2 Smart Convergence Platform for SDR Application

We designed a smart convergence platform based on two main components, a multi-standard SDR platform and a Bluetooth connected SDR application platform to offer

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two functions. First function is to send the received multi-standards digital radio data to a connected audio application via Bluetooth communication. Second function is to check current statuses of the multi-standard SDR platform and control software updates through SDR control interface. Fig. 1 shows an overall architecture of the proposed smart convergence platform.

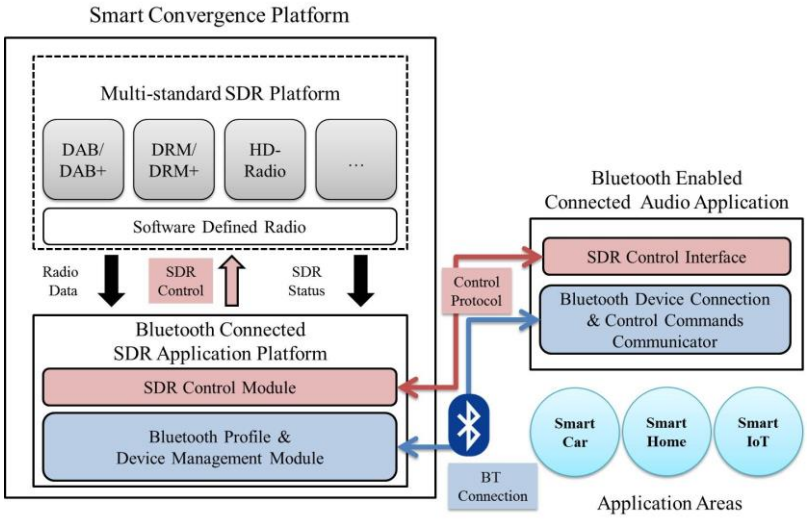

Fig. 1. Smart convergence platform architecture.

2.1 Support for Connected Audio Applications

To implement connected audio applications based on Bluetooth communication, we need to use and control Bluetooth software stack. For example, the smart convergence platform needs API (Application Programming Interface) to inquire, discover, connect, pair, and authenticate various nearby Bluetooth devices such as headset, video game controller, tracker, keyboard and speaker. Additionally, we need a mechanism to check and manage a list of connected Bluetooth devices for various use cases. To increase interoperability with previously developed Bluetooth devices, we integrated supports for various Bluetooth profiles (i.e., Serial Port (SPP), Human Interface Device (HID), Hands-Free (HFP) and a customized profile) into the Bluetooth connected SDR application platform. Through an established Bluetooth connection, the smart convergence platform transmit multi-standard radio stream to Bluetooth devices.

2.2 SDR Control Interface

In the Bluetooth connected SDR application platform, an SDR control module receives SDR control commands from a Bluetooth-connected device using a pre-

defined data packet protocol and control flow as shown in Fig. 2. Following this process, interpreting a received control command identifies a standard in-use and configures the multi-standard SDR platform dynamically.

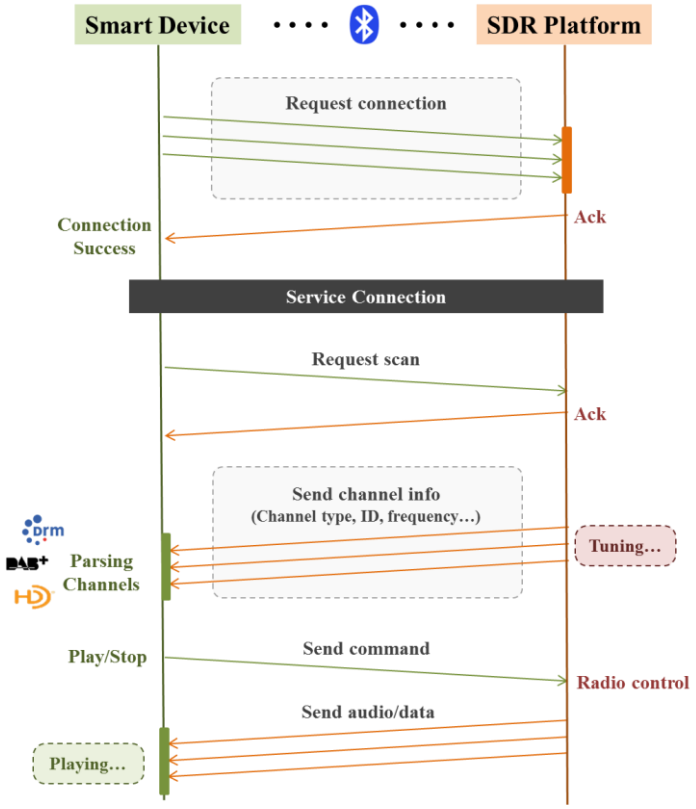

Fig. 2. An example of SDR control flow.

To send digital radio data and control commands, SPP and a custom profile are used. Different profile usages for connected audio application and SDR control interface are summarized in Table 1.

Table 1. Bluetooth profiles usages in the proposed smart convergence platform.

Bluetooth Profile	Connected Audio Application	SDR Control Interface
Serial Port Profile (SPP)	O	O
Human Interface Device (HID)	O	
Hands-Free Profile (HFP)	O	
Headset Profile (HSP)	O	
Customized (SPP & A2DP)	O	O

2.3 Implementation

We implemented and tested the proposed smart convergence platform with TI CC256X Bluetooth module and Bluetooth stack[1]. We also implemented a Bluetooth profile tester for several Bluetooth profiles including SPP (Server/Client), HID (Host/Device) and HFP to simulate different configurations of data communication, control commands and Bluetooth devices. The smart convergence platform sends and receives data as an SPP server and a connected SPP client (ex., Android smartphone) sends and receives control commands and responses as shown in Fig. 3. Fig. 4 depicts an implemented Bluetooth profile tester for SPP, HID and HFP where various Bluetooth APIs are available for testing on a PC using GUI.

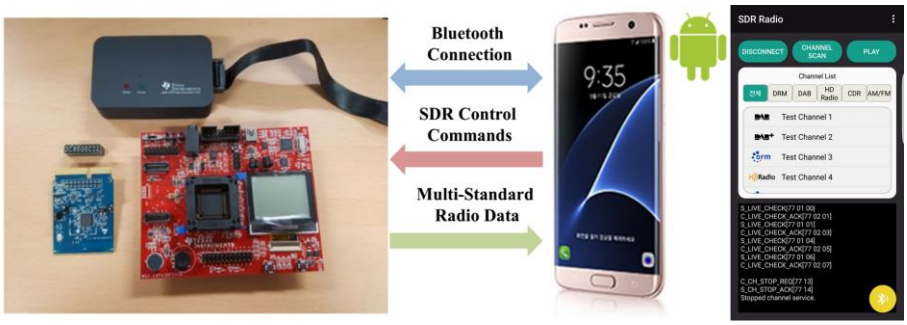

Fig. 3. Smart convergence platform implementing SPP server and client.

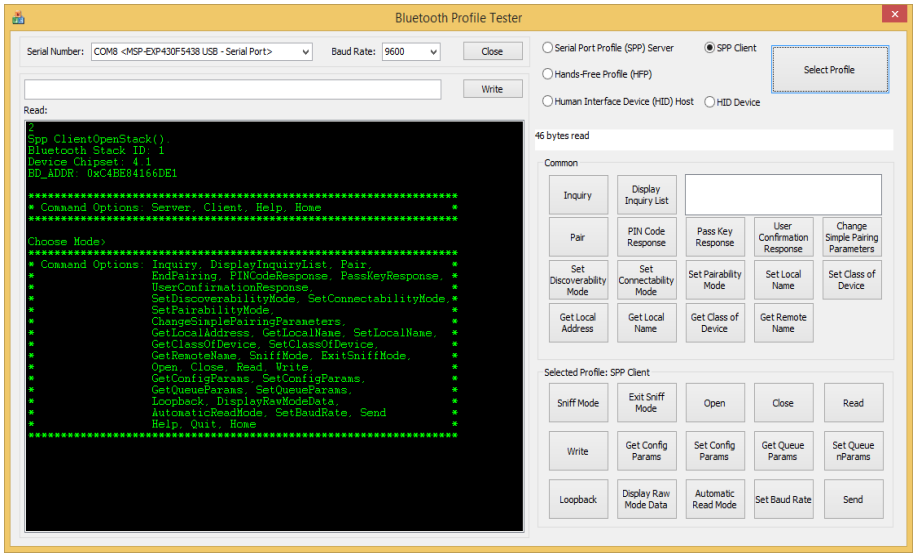

Fig. 4. Bluetooth profile tester GUI.

[1] http://www.ti.com/tool/tibluetoothstack-sdk

3 Conclusion and Outlook

In this paper, we proposed a smart convergence platform SDR applications based on Bluetooth connection and SDR control interface. The proposed platform can configure multi-standard digital radio by an SDR control interface and enable connected audio applications through Bluetooth profiles based communication. One possible application area is car infotainment system [3] with connected audio applications based on Bluetooth connection. Fig. 5 demonstrates two scenarios of car infotainment, and wearable IoT (Internet-of-Things) for various audio, video, navigation system by connecting multiple devices within a car.

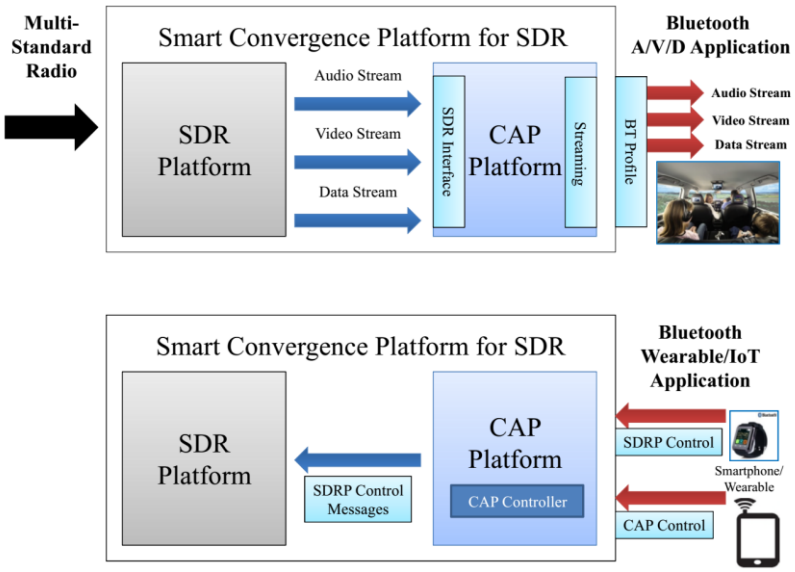

Fig. 5. Bluetooth enabled SDR applications.

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