Reconfigurable Vehicular Communication Platform Based on ETSI Radio Virtual Machine

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Abstract This paper assumes an inevitable necessity for reconfigurable vehicular communication platforms to cope with the evolution of communication standards. In spite of the keen requirement of the software reconfigurability, however, the conventional Software Defined Radio (SDR) technology that is based on Software Communication Architecture (SCA) suffers from a critical hindrance of the inefficient software portability for commercial applications. This paper presents a novel technology of resolving the problem of portability between the Radio Application (RA) software and communication platform hardware. The new technology is based on Radio Virtual Machine (RVM) about which the related protocols and interfaces have been published as a standard of European Telecom. Standard Institute (ETSI).

Keywords: Vehicular Communications, Software Reconfiguration, ETSI, Radio Virtual Machine

1. Introduction

More and more cars are equipped with the communication platform in order to support various applications through Vehicle-to-Everything (V2X) communications. The life time of vehicles (>10 years) is usually far longer than the period of communication evolutions (<2~3 years). Therefore, one of the most serious problems in the vehicular communications is an additional technology should be prepared in the vehicular communications to cope with the new communication standard which comes up after the purchase of the vehicle. It would be extremely painful for the car users to have to get the communication-related hardware of their vehicles exchanged whenever a new communication standard becomes dominant in the market after the purchase of the vehicles. In this paper, we address the solution of getting the vehicular communication platforms adaptively to cope with the emergence of a new communication standard through a software download without changing any hardware.

The conventional Software (SW) reconfiguration technology is denoted as SDR based on SCA [1]. One of the most critical issues in the SW reconfiguration technology is the portability between the RA SW and the platform hardware. In other words, the technology should provide a very efficient way of porting a given RA SW onto the various kinds of platforms, which might have all different hardware structures. In order to resolve the portability problem, SCA makes use of a middleware, which, however, fails to provide a joint optimization of SW and hardware, which eventually results in a serious inefficiency in power consumption and computational complexity [1, 2].

Considering the problems of the conventional SDR system based on the SCA, we present a novel technology, RVM, as a key technology for the portability between the RA SW and platform hardware. The RVM together with related protocols and interfaces have been published as a standard of ETSI by the Technical Committee of Reconfigurable Radio System (TC-RRS) [3-8].

2. Concept of Radio Virtual Machine

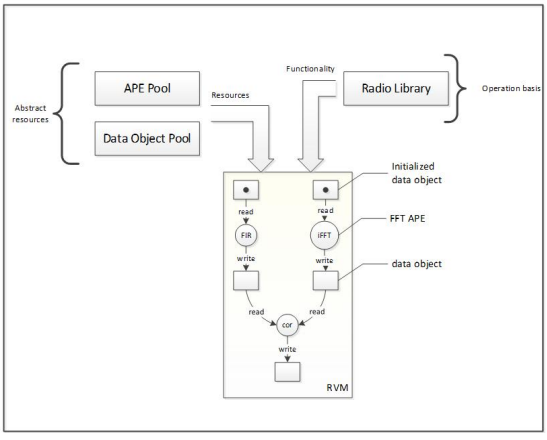

Figure 1 Conceptual Diagram of Radio Virtual Machine Processing, [4]

The RVM can be viewed as an abstract machine which abstracts a given RA SW, representing the corresponding Radio Access Technology

(RAT), to each of various kinds of platforms which might consist of all different kinds of hardware resources. Figure 1 illustrates a conceptual diagram of RVM processing. The RVM includes Data Object (DO) and Abstract Processing Element (APE) for abstracting a corresponding memory resource and computational resource, respectively. In order to abstract the computational resources to APE in accordance with a given hardware platform, Radio Library which includes the definition of each particular operation of the given hardware platform is provided as an input of the RVM. The RVM performs the operations through the procedure of data-driven control, which means each APE is automatically activated as soon as all the DOs are fulfilled [4], which guarantees a parallel processing for the entire APEs.

3. Application of RVM as an Enabler for Vehicular Communication Platforms

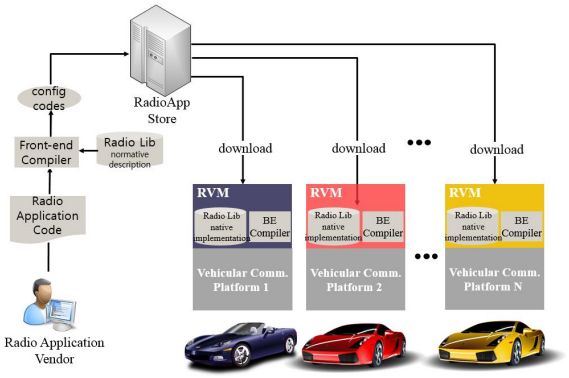

Figure 2 Application of RVM as an Enabler for Vehicular communication platforms

Figure 2 illustrates a conceptual diagram of porting a given RA SW into various kinds of vehicular communication hardware platforms through the RVM. The RA SW provided by the (3rd party) RA vendors is first transformed into a generic representation, i.e., Intermediate representation (IR), and the resultant IR is uploaded onto the Radio Apps Store [3]. The configuration code, i.e., IR, is downloaded into the communication platform upon user's request and it is back-end compiled according to each platform hardware using a proper RVM set-up through the joint optimization of platform hardware and RA SW as described shortly in Figure 1. Consequently, the 3rd party SW providers don't have to consider the hardware platforms for generating the RA SW because the RVM properly translates the RA configuration code for each platform in accordance with the Radio Library of each platform.

By adopting the RVM to vehicular communication platform, it becomes possible to cope with the evolution of communication standard without changing any hardware of the vehicles. The SW reconfiguration based on the RVM is very efficient in terms of power consumption and computational complexity mainly due to the fact that the RVM jointly optimizes RA SW and Platform hardware [4].

4. Conclusions

This paper presents how to apply the RVM as an enabler for a vehicular communication platform. The ultimate goal is to cope with the evolution of communication standard which is changing frequently during the car life time. The objective is to support the new communication standard without changing any hardware of the vehicle. The main contribution of this paper is to present a novel method, i.e, RVM, with which one can solve the problem of portability between RA SW and platform hardware in as efficient as possible. Indeed, the main issue of the SW reconfiguration [1, 2] would be resolved considerably by the RVM.

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