Specifications of APIs for exchanging Information based on ITS dedicated Communication

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***Abstract*— Conversion technology between IT(Information Technology) and automotive technics creates the new industry of ITS (Intelligent Transport systems) and the new paradigm in electronics, communication and traffic fields. Specially, Vehicular communication in ITS field is one of the most important technologies necessary to connect among driver, vehicle and provider to provide quality services. Solutions for vehicular communication based on IEEE 802.11 are described in IEEE 802.11p. IEEE 802.11p WAVE (Wireless Access in the Vehicular Environment) defines amendments to IEEE 802.11 that are necessary to support ITS applications. In Korea, V2V (Vehicle-to-Vehicle) and V2I (Vehicle-to-Infrastructure) communication systems called VMC (Vehicle Multi-hop Communication) are being developed by the Electronics and Telecommunications Research Institute. In this paper, we define the API(Application Protocol Interface) and communication sequence to provide the quality services about the reliability data exchange based on VMC.**

***Keywords*—** VMC, WAVE, API, ITS, V2V/V2I

I. INTRODUCTION

Conversion technology between Information Technology (IT) and automotive technics creates the new industry of Intelligent Transport systems (ITS) and the new paradigm in electronics, communication and traffic fields. In addition, ITS have become more important research and development areas in mobile computing and intelligent automobiles. Specially, Vehicular communication in ITS field is one of the most important technologies necessary to connect among driver, vehicle and provider to provide quality services. Research about wireless communication in the fields is highly reinvigorated to exchange information with accuracy and reliable.

Solutions for vehicular communication based on IEEE 802.11 are described in IEEE 802.11p. IEEE 802.11p Wireless Access in the Vehicular Environment (WAVE) defines amendments to IEEE 802.11 that are necessary to support ITS (Intelligent Transportation Systems) applications. To promote safe and efficient highways, the Federal Communications Commission (FCC) has allocated the 5.850-5.925 GHz band to be used for Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications [1].

In Korea, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication systems called Vehicle Multi-hop Communication (VMC) are being developed by the Electronics and Telecommunications Research Institute (ETRI).

The VMC communication system aims to provide ITS services such as traffic information, visual information service to avoid intersection collision, avoid conflicts between vehicles, unforeseen circumstance warning services and vehicle diagnostics alert services.

We define the API (Application Protocol Interface) using the VMC communication and communication sequence to provide the quality services about the reliability data exchange based on VMC.

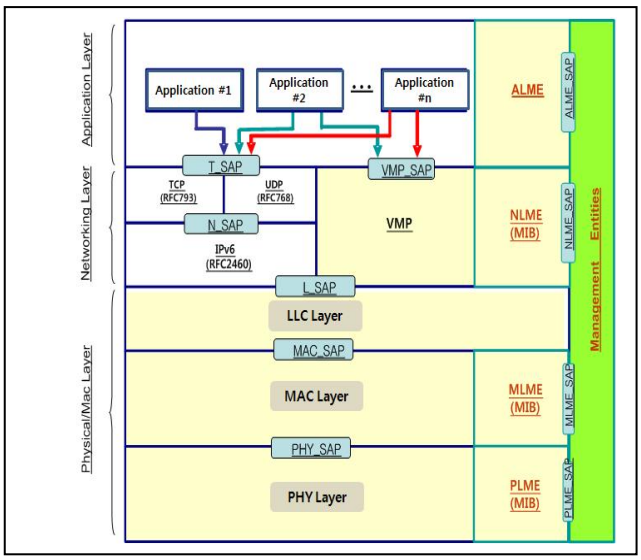

Figure 1. VMC service architecture

The remainder of this paper is organized as follows. In Section II, we first introduce a brief overview of the IEEE 802.11p WAVE and VMC. In Section III, we define the APIs based on the VMC. Finally we summary and conclude this paper in Section IV.

II. VMC COMMUNICATION TECHNOLOGY

VMC system is based on the WAVE standard and being developed the physical, data link and network layer to provide the vehicle communication environment. We introduce a brief overview of the IEEE 802.11p WAVE and VMC in this section

Figure 1 is the communication structure of WAVE and VMC. The physical layer and MAC layer is standardized in the IEEE 802.11p WAVE and extended MAC for vehicular environment, also network layer and application layer is standardized in IEEE 1609.1~1609.4 [2,3,4]. VMC is based on these standards and adds more standardization in order to improve efficiency for each layer by ETRI.

WAVE communication technology, basically a wireless LAN technology that uses OFDM (Orthogonal Frequency Division Multiplexing) of IEEE 802.11a and EDCA (Enhanced Distributed Channel Access) mode of IEEE 802.11e [5]. However WAVE, due to the high mobility, has a short connection time in a network environment to provide specific ITS services a lot of parts have been optimized for the vehicular network environment [6].

The biggest feature of the WAVE is access quickly and omitted the authentication and security procedures during the initial connection as shown figure 2. Also periodic beacon frames have been omitted without the transfer of the exchange of information. Only when necessary Time Advertisement frame to communicate with each other through synchronization of communication parameter values are aligned.

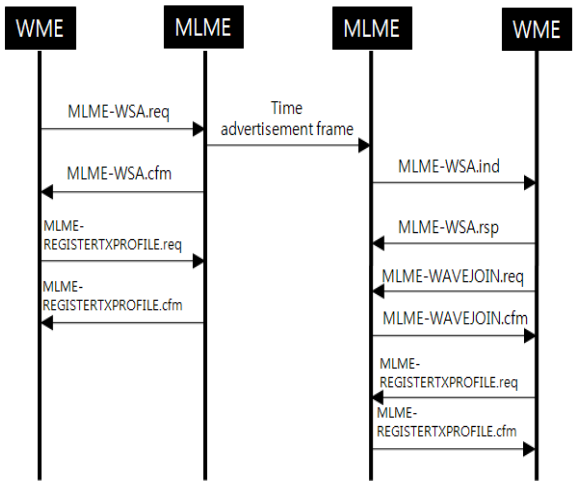

Figure 2. WAVE and VMC initiation sequence

To provide ITS services such as conflict prevention and emergency rescue in the vehicular network, EDCA mode shall be separated into CCH (Control Channel) and SCH (Service Channel) by the service priority of data.

Also the network layer defines the WSM (WAVE Short Message, called VM in VMC) in the Non-IP type, and provides the reliable and fast access service. VMC is based on the above described WAVE communications technology to increase efficiency, more reliable communications to ensure Physical layer, MAC layer and Network layer are complementary.

In the physical layer the midamble using the long 1 symbol is added periodically the middle of PLCP (Physical Layer Convergence Protocol) frame and synchronization problems due to the rapid mobility are complements by channel estimation. MAC layer based on competition defines the TS-DCF (Time Slot Distributed Coordination Function) based on the time slot to improve the communication efficiency. To provide the extended services such as avoidance of chain collision, WSM in the network layer provides not only single-hop transaction, but also VMP (VMC Message Protocol) to support multi-hop.

III. VMC-BASED APPLICATION PROTOCOL INTERFACE

In this section, we define the APIs to provide ITS services based on VMC. The APIs, proposed in this paper, have features that fast access and exchange of information [7].

A. *VMC-based ITS information service system*

Figure 2 describes the components addressed in this paper to provide services and to exchange data in the dedicated ITS communication.

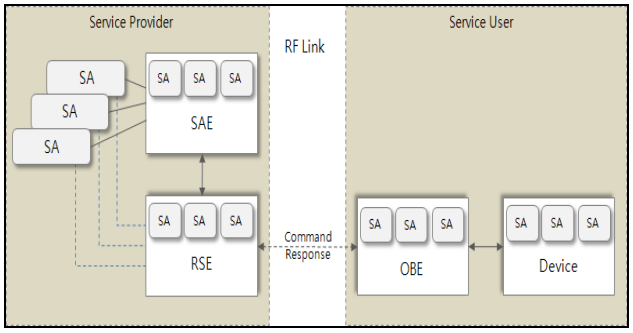

Figure 3. VMC information service system

The components classify two parts of elements which are the Service Provider and the Service User. In detail, whole component can be composed of the SA (Service Application), SAE (Service Application Entity), RSE (Road Side Equipment), OBE (On Board Equipment), and Device. The Service Provider that initializes services is possible to be not only one system composed of the SA, SAE, and RSE but also each system composed of them. Service User composed of OBE and Device is also possible to be not only as one system but also as each system.

B. *VMC-BASED ITS INFORMATION SERVICE SYSTEM*

The system is designed to follow the communication sequence to provide services using VMC communication , such as in Figure 4.

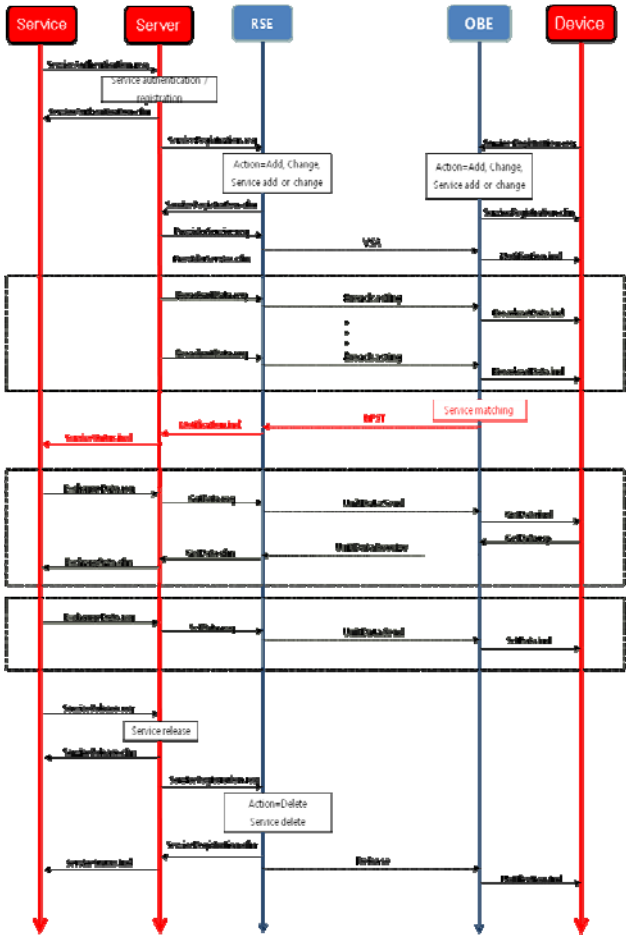

Figure 4. VMC information service sequence

The procedure for the operation is as follows.

- Each SA which is desired access to the OBE shall be authenticated to activate the SA in the SAE. After authenticating, the SAE returns response to the SA that has requested.
- The SAE and Device request the registration to add or to change an available service in each MIB of the RSE and OBE.
- The RSE transmits the Provider Service Table (PST) using the Vendor Specific Action (VSA) frame. The PST in the VSA frame includes the list of available service applications and is generated by the Management Information Base (MIB) in the RSE.
- Upon receipt of the PST, the OBE announces available service applications to the Device and scans own list for a match on any service application that it hosts. If there is a match (and if the service application is retrieval or writing of information), OBE generates the Response to the Provider Service Table (RPST) and transmits it to the RSE.
- Upon receipt of the RPST, the SAE notifies to the associated the SA that it is in the presence of the OBE-Device that desires to use or provide any possible service.
- After completing the session as above, it is possible to exchange data for the GET or SET service between the Service Provider and the Service Provider. The GET service is to retrieve information of the Service User and the SET service is to write or rewrite information of the Service User.
- If authentication and registration is completed, a broadcast data service is possible to provide for the Service User without exchanging the VSA and RPST frame.
- If the service application is completed or the Service User is out of communication range, the SA requests that the SAE release the service. Upon receipt of a request from the SAE, the RSE deletes the service in the MIB and terminates the session by sending release message to the OBE.

C. *Definition of Application Service Interface Protocol*

This section specifies the service primitives interoperating between the APIs and describes the attributes included in each service primitive. Table 1 and 2 show all service primitives for APIs defined in this paper. Also, attributes included in each service primitive is described in Table 1 and Table 2.

Table 1 shows the service primitives interoperating between the SA and the SAE. The service primitives interoperating between the SAE and the RSE or between the OBE and the Device are shown in Table 2.

Table 1. Service Primitives (Service Provider – Server)

Service Primitive	Description
SERVICE AUTHENTICATION -Request	The SA requests the SAE to authenticate the service when the SA gets ready to communicate with the OBE.
SERVICE AUTHENTICATION -Confirmation	The SAE returns the confirmation with the status of the authentication.
SERVICE STATUS -Indication	When the SA registered in the Service Provider is started or terminated, the SAE informs the SA of the status of the service.
EXCHANGE DATA -Request	After completing the session, the SA requests the unicast service (GET or SET service) exchanging data between the Service Provider and the Service User. If the TransferServiceType value is the GET, the Service Provider shall provide the GET Service. If the TransferServiceType value is the SET, the Service Provider shall provide the SET Service.

EXCHANGE DATA -Confirmation	The confirmation is transmitted to the SA by receiving the corresponding EXCHANGE DATA-Request
SERVICE RELEASE -Request	When the service application terminates to provide the service, the SA requests that the SAE release the service.
SERVICE RELEASE -Confirmation	The SAE returns the confirmation of the SERVICE RELEASE-Request.

Table 2. Service Primitives (Server and RSE or OBE and Vehicle device)

Service Primitive	Description
SERVICE REGISTRATION -Request	The SAE requests that the RSE register to add, change or delete the variable of the service in own MIB. The Device also requests that the OBE register to add, change or delete the variable of the service in own MIB.
SERVICE REGISTRATION -Confirmation	The RSE returns to the SAE the confirmation as follows to notify the registration of the service.
PROVIDERSERVICE -Request	The SAE requests that RSE transmit the VSA frame including the PST.
PROVIDERSERVICE -Confirmation	The RSE returns the confirmation of transmitting the VSA frame to the SAE.
NOTIFICATION -Indication	The RSE or the OBE notify a receipt of the PST or the RPST to higher entity (the SME or the Device) to announce available application services in the communication range.
BROADCASTDATA -Request	To initialize the broadcasting service, SAE requests that the RSE transmit the broadcast message to the OBE.
BROADCASTDATA -Indication	The OBE informs the Device of the receipt of the broadcast message, receiving the broadcast message from the RSE.
GETDATA -Request	Upon the receipt of EXCHANGE-Request, if the TransferService Type value is the GET, the SAE requests that the RSE provide the GET service for the OBE.
GETDATA -Indication	Upon the receipt of the unicast data transmitted by the GETDATA-Request, the OBE informs the Device of its indication.
GETDATA -Response	Upon the receipt of the GETDATA-indication, the Device retrieves information requested by the Service Provider from its resource and then responses so that the OBE can return it to the Service Provider.
GETDATA -Confirmation	The RSE transmits the confirmation to the SAE, receiving the unicast data retrieved by the Service User.
SETDATA -Request	Upon the receipt of EXCHANGE-Request, if the TransferService Type value is the SET, the SAE requests that the RSE provide the SET service for the OBE.
SETDATA -Indication	Upon the receipt of the unicast data transmitted by the SETDATA-Request, the OBE informs the Device of its indication. If the ResponseMode boolean value is true, the SETDATA-Response following the SETDATA-Indication shall be existed.

IV. CONCLUSIONS

The development of the ITS industry enables more effective operation of the traffic environment while operating within the confines of existing infrastructures. In particular, this new kind of ITS wireless communication is key technology for individual vehicles, thus communication services and technologies are currently developed and researched by many companies and research groups.

In this paper, the Application Protocol Interfaces at the application level in vehicular environment based on VMC has been specified. Through the paper, it can be considered that more efficient Application Protocol Interfaces are provided for the principle ITS services. Especially, the reduced communication latency for the safety such as the emergency situation and the platform independent V2V and V2I communication services for various vehicular communication environments could be expected.

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