Charging Station Advertisement on Digital Multimedia Broadcasting Platform*

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Abstract. This paper first designs and implements an advertisement management framework based on digital multimedia broadcasting facilities and then presents a status posting system for charging stations, aiming at facilitating a battery charging service to electric vehicles. The implemented system consists of advertiser interfaces, data service managers, and provincial broadcasting equipments, making it possible for an advertiser to create or change contents via Internet connection, while the update latency remains below 10 seconds. The charging station information on the queue length, waiting time estimation will be automatically sent to the telematics server via telematics networks to complement the absence of upload path in digital broadcasting. With the interaction between the telematics server and data service manager, this service can distribute electric vehicles over multiple charging stations, reducing the average waiting time.

Keywords: digital multimedia broadcasting, transport protocol experts group, advertisement information frame, update time, advertiser interface.

1 Introduction

DMB (Digital Multimedia Broadcasting) is a digital radio transmission technology capable of sending multimedia content such as TV, radio, and datacasting to mobile devices [1]. It can operate via T-DMB (Terrestrial DMB) and S-DMB (Satellite DMB) transmission. T-TMB works even in vehicles moving up to 120 *kmh*. In tunnels or underground areas, the broadcast is still available. S-DMB incorporates a high power geostationary satellite, extending its outdoor coverage. Through DMB, a variety of digital contents, generally consist of text, moving pictures, and location information, can be delivered to customers in a low price and updated in real-time. Being an instance of the digital content, the advertisement additionally has both location-dependent and time-dependent features.

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The advertisement on DMB can provide an online status update such as parking lot availability, seat availability, waiting time estimation, and the like, by means of an integrative cooperation of advertisers, content managers, and the system operator.

TPEG (Transport Protocol Experts Group) technology was developed to facilitate the delivery of information messages within the multimedia broadcasting environment from a service provider′s database to an end-user′s client device [2]. The key principle of TPEG technology requires hierarchically structured messages to be delivered to client devices, which is capable of decoding and filtering the content to provide language-independent presentation either directly for human use, or for agent systems. TPEG was founded in 1997 by the European Broadcasting Union. It is a group of experts coming from all areas of the Traffic and Travel Information businesses, as well as broadcasting. The group developed the TPEG specifications for transmission of language independent multi-modal traffic and travel information. Accordingly, TPEG is a good candidate for delivering advertisement messages in the DMB infrastructure.

TPEG transport also follows the layered protocol [3]. In addition, as shown in Figure 1, TPEG frame can be delivered on top of DMB layer synchronized with other images, sounds, and texts. Layer 7 is the top level and referred to in TPEG as the application layer. Initially, this layer includes the service & network information application and the road traffic message application. Layer 4 is the packetization layer, where components are merged into a single stream and encrypted and/or compressed. Layer 3 specifies how to synchronize and route, and this is the lowest layer belonging to the TPEG protocol. Layer 2 consists of a wide range of different bearers, which are suitable carriers for the TPEG protocol. An adaptation layer may be required in order to map the TPEG stream onto that bearer. Finally, layer 1 defines the transmission medium such as radio waves, wire, optical, and the like. A single bearer can make use of different physical layers.

In the mean time, many countries are making an effort to prompt the penetration of electric vehicles [4]. Even though many researchers and developers are working to improve driving range while decreasing charging time, weight,

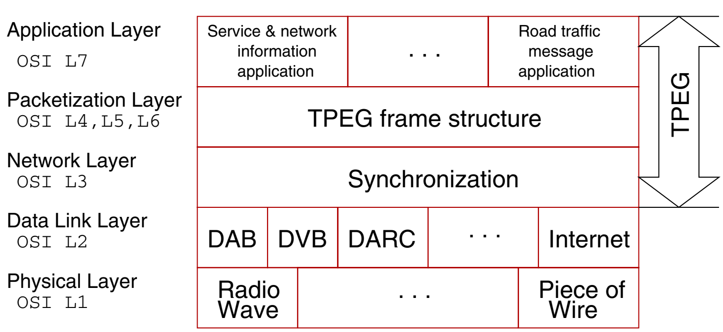

Fig. 1. TPEG and DMB

and cost of batteries, it still takes tens of minutes to charge an electric vehicle [5]. The drivers are highly likely to want to know where the available station is and how long he should wait in those stations. If this information is available to in-vehicle telematics devices, they can even make a new routing plan according to the charging station selection. However, the DMB receiver cannot expect such automation. Instead, drivers must select the charging station by themselves with the provided information on the DMB terminal. This service can distribute electric vehicles over multiple charging stations, reducing the average waiting time as well as helping electric vehicle to permeate into our daily lives.

2 System Design

Figure 2 illustrates the system we have implemented for advertisement broadcasting via DMB. Basically, the advertisement contents are uploaded to the data service domain via the Internet. As everybody can access the Internet, the membership management is important as other Internet services. The advertiser can purchase the right to create, modify, and delete the content. The price for the content transmission can be decided by the price plan for peak, mid-peak, and off-peak interval, respectively, while it can be paid on hourly, daily, and monthly basis [6]. After the operator endorses the advertisement content, it will be registered in the server system. This step is necessary to prevent illegal content from being displayed to the public clients.

The created contents are sent to the provincial DMB facility via the reliable and high-speed optical fiber network. The data service domain and provincial DMB stations can be spatially apart from each other. The DMB station decides the local schedule and converts the contents to the TPEG frame to transmit via the provincial DMB channel. The DMB receiver catches the DMB signal from the transmitter, decodes the TPEG frame, and finally plays the content to the in-vehicle monitor device according to the content type. It takes less than 10 seconds from the time the advertisement content is uploaded or modified until the modification is displayed in the DMB receiver monitor. It mainly includes the content upload delay via the Internet and the waiting time for the content to meet its turn in the local DMB carousel.

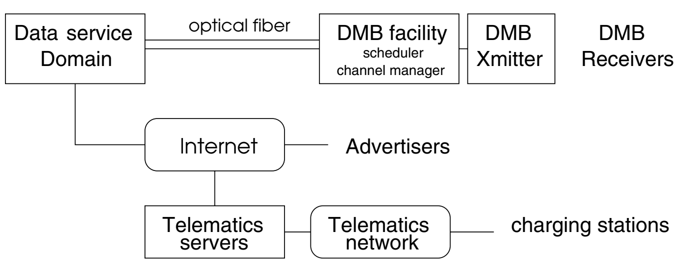

Fig. 2. Advertisement system

In addition to this basic advertisement scenario, charging stations want to announce their current queue status automatically. It's not possible for a human manager to keep uploading the waiting queue status every time a new customer arrives, a charging service is completed, or a new reservation is made. Hence, charging stations send this status message to the telematics server via the telematics network, which can be the Internet, cellular networks, WiFi, or sometimes vehicular ad-hoc networks [7]. The telematics server can either autonomously publish this status to the vehicles in vicinity or upload to the DMB data service. To this end, the telematics server and DMB advertisement manager must have agreement on the content upload fee and the right. The remaining procedure is identical to the ordinary advertisement content case. In addition, to estimate the waiting time, each charging station can schedule the requests having their own requirement [8].

3 Implementation Details

For more efficient management, each advertisement item has a common fixed field set by which most contents can be specified. Our authoring tool implementation provides a user interface for the advertisers to input title, contact phone number, address, latitude, longitude, detailed description, representative service menu, operation hour, and optionally a group of images and coupons. This interface easily converts the user input data to XML documents and stores in the data service domain. In our pilot implementation, the MS SQL server now contains now 41 restaurants, 44 tourist places, and 9 shopping areas.

TPEG can support frames on road traffic message, public transport information, and location referencing, while it is going to further include parking information, congestion and travel-time, traffic event compact, and weather information for travelers. As shown in Figure 2, we can extend a TPEG message to define an ADI (Advertisement Information) message. As an instance of the TPEG frame, the ADI frame must specify MID (Message Identifier) and VER (Version), along with encoding message management, event, and location containers. TPEG POI (Point Of Interest) for location containers consists of a variety of components. Basically, it includes components on classification, description, bi-directional service, time information, and parking information. Moreover, it can further have feature information, product information, relation information, and guide position components optionally. At last, the ADI table includes the ADI application primitives. The encoder converts the XML document created in the authoring tool to corresponding TPEG images and binary files.

The encoded contents are sent to the DMB transmitter system owned by YTN DMB, one of the major domestic broadcasting companies in the Republic of Korea. Broadcasting companies generally lease optical fiber line from the telecommunication companies or institutions. In the provincial DMB domain, the TPEG ADI caster module, implemented using Factum DBS100 5.2 API on the Microsoft .net framework, sends the encoded file to DBS100, which is the data broadcasting equipment. It also provides the monitoring interface through

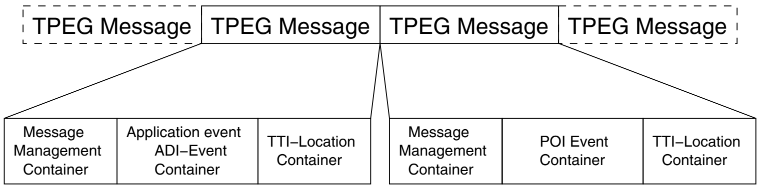

Fig. 3. Advertisement information TPEG frame

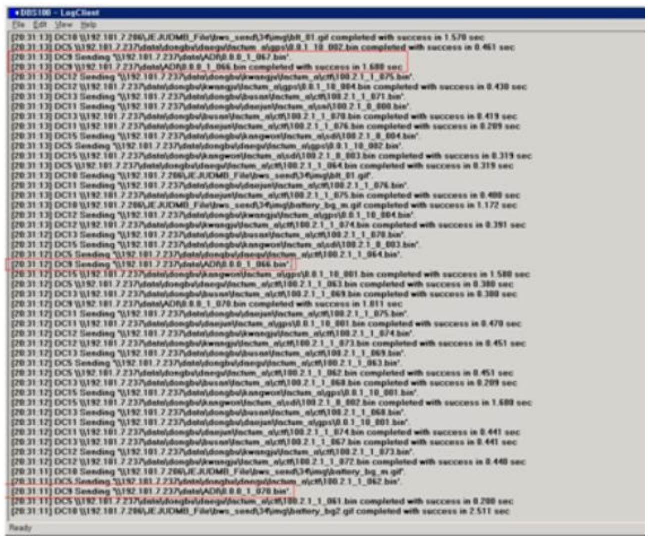

Fig. 4. DBS100 monitoring interface

which we can check the current operation status of the equipment as shown in Figure 4. In addition, Figure 5 also demonstrates the ADIcast interface implemented in our work. For sample data recording, our system employs the indoor transmitters such as DVU5000 DMB modulator radio frequency and DABAir-Multi recorders. In the receiver device, the decoder converts the TPEG-ADI signal into the text message. Here, it doesn't have to be XML format. In our experiment, the decoding time is less than 15 ms in the receiver module.

For the receiver side, the decoded content is displayed on the monitor. The receiver device stores the advertisement and displays one by one. Due to the carousel-style presentation, the update time depends on the number of contents. Here, we can optionally build a terminal side carousel [9]. For example, just the route-related information will be filtered. Receiving the DMB transmission, the receiver device decodes the message as usual. Then, the route match module analyzes the location tag to decide whether the content lies in the route of the vehicle. The A* algorithm can retrieve all the road segments along the path from the digital map, while the segment information includes the boundary box of the segment. Comparing the location tag and the boundary boxes, the route match

Fig. 5. ADI caster interface

module can decide the content is of interest or not. When the destination is not known, the route match module calculates the angular difference between the moving direction of the vehicle and the line segment consisting of the current position of the vehicle and the location tag of the contents. If it lies within the tolerance bound, the content is considered to be of interest.

4 Concluding Remarks

This paper has designed and implemented an advertisement management framework based on digital multimedia broadcasting facilities, defining the roles of advertisers connected to the Internet, data service managers in data service domain, and broadcasting facilities in the provincial area. The advertiser interface creates advertisement contents as XML documents in the data service manager. Then, the high-speed optical fiber network carries the TPEG frames converted from the XML files to the local broadcasting facility. In our system implementation, the content update latency is remained below 10 seconds, including the content upload time via the Internet, waiting time in the local carousel. In addition, test decoder device can decode the TPEG frame and display it within 15 ms.

Based on this framework, the charging station information on the queue length, waiting time estimation will be automatically sent to the telematics server via telematics networks to complement the absence of upload path in digital broadcasting. With the prearrangement on the purchase of right for content upload and the selection of the broadcast period between the data service manager and the telematics server, this posting can distribute electric vehicles over multiple charging stations, reducing the average waiting time as well as helping electric vehicle to permeate into our daily lives.

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