

Intelligent Routing and Notification System for Emergency Services Vehicles

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ABSTRACT

An innovative program is described to improve emergency vehicle deployment by automatically alerting all other nearby vehicles on the road as to the presence and intention of the emergency vehicle. Since the use of audible sirens has somewhat marked effectiveness nowadays, in selecting the most practical automated method to notify most drivers a review is given of the various data-links that are available today, including plans for new standards. The research presented concludes that use of today's newer vehicle data-links is currently ineffective due to the fragmentation and, in many cases, low adoption rates, including satellite radio, HD and conventional radio, automatic cruise control radar, and vehicle telematics. None of the newer digital data-links in use today are each capable of reaching more than a few percent of all users on the road, so a notification system that relies on breaking through or working on these channels will have very limited effectiveness, practical implementation issues aside. The new IEEE vehicle data-link standards offer the potential, but, based on the research presented, any reasonable amount of adoption is 15 years or more into the future. Therefore, the system under development and deployment described in this paper focuses on the ubiquitous cellular telephone and techniques are described to relay an emergency vehicle's siren through these devices to help clear the road ahead for emergency services vehicles.

INTRODUCTION

Lt. Chapman of the DC Fire and Emergency Medical Services Department wrote about the difficulties encountered in getting appropriate driver and vehicle reaction to emergency sirens [1]. He stated that he would like to see the decibel level of audible warning devices reduced on emergency vehicles, but as a former driver in the D.C. Fire and Emergency Medical Services Department he advocates turning them up even louder instead. He described the frustration for emergency services when they are trying to get to someone in need and are blocked by a driver with his or her windows up, music blaring, perhaps a cell phone conversation in progress and what seems to be a complete disconnection from the world. He pointed out that the evolution of emergency vehicles once used only a bell rung by hand to clear the way. He went on to ask if science will provide an answer, such as a simple visual system that could alert drivers to the approach of an emergency vehicle.

Driver distractions are generally related to loud music, audio from movies or television (assuming the driver is not viewing the video source) and cell phone conversations. Music sources include CD, MP3, and radio including AM, FM, HD, or satellite transmission (XM/Sirius). The system under development, described in this paper, uses intelligent techniques to determine which cell users are in the path of the vehicle and targets only those cell devices to relay the siren. The relaying is virtual as it is intended to use siren or similar ring-tones that respond to the emergency notification to the user's cell phone number. The system makes use of calls, broadcasts, SMS messaging, text messaging, Push to Talk (PTT), e mails, and other means of cell phone communication.

CURRENT VEHICLE SYSTEMS

A summary of the various onboard systems and the types of data-links available to vehicles is summarized in Table I. While there are many different ways to broadcast or message the driver of a vehicle the overall adoption rate of any one system is low; i.e., some users have HD radio, some have conventional radio, others have satellite radio, but there is no practical way to tap into or effectively use these existing systems in a small region that would communicate with a meaningful number of vehicles. Therefore, it is more practical as discussed below to make use of personal mobile devices to have any reasonable impact over the next 15 – 20 years. A discussion of each data-link and the adoption rate is presented.

HD RADIO - HD Radio technology allows stations to simulcast compressed digital audio and traditional analog audio, without changing to new frequency bands. As of 2007, over 1200 AM and FM stations are broadcasting with HD Radio technology, with over 500 FM stations offering more than one digital channel per FM frequency, thus doubling or tripling the number of programs available to listeners. Most of the stations that have adopted the technology are FM, while AM stations have been slower to upgrade. As with traditional AM, FM and TV broadcasting, HD Radio programming is free and supported either by commercial advertising or public broadcasting. As for new digital TV standards, consumers must upgrade to a new receiver in order to receive digital broadcasts.

HD uses Orthogonal Frequency-Division Multiplexing (OFDM), a digital multi-carrier modulation scheme, which uses a large number of closely-spaced orthogonal sub-carriers to carry data. These sub-carriers typically overlap in frequency, but are designed not to interfere with each other as would be the case with traditional frequency division multiplexing and may be efficiently separated using a Fast Fourier Transform (FFT) algorithm.

TABLE I. CURRENT VEHICLE EQUIPAGE

Link	Frequency	BW/Data Rate	U.S. Equipage
IEEE 1609	5.9 GHz	75 MHz	New trial standards, so very low current adoption.
Telematics	2G – 3G	144kbps – 3 Mbps	4M
HD Radio	AM FM Bands	Video @ 255kbps, music @ 44 kbps; voice, 20 kbps; 16 kbps for low quality audio.	4.2M
FM AM Radio	88-108 MHz FM 520-1610 kHz AM	15kHz FM 5kHz AM	Unknown, but considered to be very high > 90% due to technology maturity.
ACC Radar	76.5 GHz	250 MHz	Unknown, but considered very low as technology is new.
Satellite Radio	2.3 or 1.4 GHz	≤ 44 kbps	20.5M

Each sub-carrier is modulated with a conventional modulation scheme maintaining data rates similar to conventional single-carrier modulation schemes in the same bandwidth. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over land lines, used in applications such as digital television and audio broadcasting, wireless networking and broadband internet access. HD has a low adoption at this time in the United States compared to conventional analog radio.

SATELLITE RADIO - The two major satellite radio companies continue to invest in their technology, infrastructure, and services. Recently, Sirius filed an application to launch and operate a new non geostationary orbit satellite (FM-6) to replace two existing non-geostationary satellites (FM-1 and FM-2) that are currently in operation. FM-6 would be placed half way between where FM-1 and FM-2 operate today. The launch is expected to take place in 2010. Sirius had already been granted authority to launch a geostationary satellite (FM-5) which will significantly alter its existing satellite constellation, resulting in the eventual constellation of three satellites; two non geostationary satellites (FM-3, FM-6) and one geostationary satellite (FM-5). FM-6 will have twice the transmit power of FM-1 and FM-2. The digital throughput is 1.35 Mbps and the additional capacity will be used to provide more audio channel programming and data; but is currently providing three compressed video channels primarily for vehicle back