Physical Communication 19 (2016) 18–29

Contents lists available at ScienceDirect

Physical Communication

journal homepage: www.elsevier.com/locate/phycom

Full length article

From conceptual to operational: Over-the-air-programming of land mobile radios

Jeremy Carter [a,*], Eric Grommon [b,1], Phil Harris [c,2]

[a] School of Public and Environmental Affairs, Indiana University-Purdue University Indianapolis, 801 W. Michigan Street, BS 4081, Indianapolis, IN 46202, United States

[b] School of Public and Environmental Affairs, Indiana University-Purdue University Indianapolis, 801 W. Michigan Street, BS 4067, Indianapolis, IN 46202, United States

[c] Engility Corporation, Engineering & Program Management Group, Rome, NY, United States

ARTICLE INFO

Article history:
Received 15 October 2015
Received in revised form 17 January 2016
Accepted 20 January 2016
Available online 24 February 2016

Keywords:
Public safety
Over-the-air-programming
Land mobile radios
Wireless
Interoperability

ABSTRACT

Programming, management, and interoperability of land mobile radios within the public safety sector have long been salient issues for policymakers, practitioners, service vendors, and scholars. Despite receiving substantial attention in the form of government expenditure and agency task forces, there has only been moderate advancement in this concerning area. Recently, as part of a US Department of Justice-funded effort, an innovative technology known as wireless broadband over-the-air-programming (OTAP) has been translated from a conceptual model to an operational deployment. OTAP technology holds significant promise to enhance the management of public safety communications via land mobile radios. This research presents the concept of OTAP, the engineering behind the recently developed broadband enabled OTAP prototype, and conceptualizes how this technology can impact the processes used to facilitate public safety interoperability within the context of portable radio programming.

1. Introduction

To say the issue of public safety interoperability is vast and highly complicated is a significant understatement. Recent directives from the leading interoperability program of the US Department of Homeland Security [1] outline investment areas to target solutions for improved interoperability. These areas include governance, standard operating procedures, technology, training and exercises, and usage. The focus of the current research is on the technology investment area; more specifically a recently developed technology to improve land mobile radio (LMR) programming tasks. This technology is known as "over-the-air-programming" (OTAP).[3]

Interoperability, for purposes of the present research, is focused on enabling different portable radio end-users to remotely access new talk group configuration files that allow users to directly communicate with one another. OTAP is compared to, and considered in context of, legacy

* Corresponding author. Tel.: +1 317 274 4170.
E-mail addresses: carterjg@iupui.edu (J. Carter), egrommon@iupui.edu (E. Grommon), philip.harris@engilitycorp.com (P. Harris).
1 Tel.: +1 317 278 9481.
2 Tel.: +1 315 339 6184.

http://dx.doi.org/10.1016/j.phycom.2016.01.007
1874-4907/

[3] The OTAP acronym is also sometimes used to describe over-the-air-provisioning. Cellular device support uses an analogous process often referred to as firmware-over-the-air (FOTA). These are each valid and analogous processes that describe a method of updating software (radio firmware and/or configuration data) over a wireless medium. Over-the-air-provisioning is adopted here because it is the descriptive term commonly used within the LMR industry.

provisioning tools that usually rely on a physical cable connection between a computer and an end-user device to accomplish configuration tasks.[4] The adoption of OTAP must be considered by the public safety community. A standardized OTAP capability demonstrates a range of potential programming and practice benefits. Public safety agencies stand to improve day-to-day operations and maintenance, reduce the logistical and financial burdens associated with managing radios, and promote multi-system and large-scale interoperability. These potential gains must be communicated to policymakers and decision-makers responsible for technology acquisition. Though OTAP-enabled land mobile radios are of limited availability, public safety agencies should consider this function as a requirement in new purchases. The potential cost savings are likely to be significant for any public safety or emergency management organization with several hundred radios in use. Moreover, if OTAP-enabled radios are acquired and made operational, agencies arriving at an emergency response scene from disparate geographies and organizations could receive the necessary operating profile, channel plan, and other necessary features remotely and succinctly that could aid interoperability, command, and control. Such benefits, especially in the context of long-term sustainability and short-term interoperability, are difficult to deny.

This research discusses the concept of OTAP and how this technology has recently been deployed to support public safety and criminal justice tasks through the management of LMRs.[5] It is important to note the present research is neither an outcome evaluation of OTAP technology nor an output of detailed technical specifications regarding its engineering as currently operationalized. Given the state of the science regarding OTAP, such an outcome evaluation would be premature and requires a fundamental understanding of the technology and its application to practice; hence the focus of the present research.

As part of a federally-funded project by the US Department of Justice, National Institute of Justice[6] to examine the operational impact of OTAP within a public safety environment, this research partnered with the North Carolina State Highway Patrol (NCSHP). The information presented here was obtained during three site visits to the NCSHP headquarters in Raleigh, North Carolina between November 2012 and September 2014. During these site visits the research team observed a proof of concept deployment demonstration and interviewed key personnel. The focus of the research presented here is to describe the OTAP process and how OTAP technology can be harnessed to improve operational efficiency. The success of technology adoption within criminal justice organizations relies heavily on a clearly articulated technology concept [2]. More specifically, organizations must understand what the technology is and the means through which it can have an impact on their operations. This research seeks to articulate the concept of OTAP and how it can impact land mobile radio programming for public safety.

2. Context: public safety radios, programming, and interoperability

Prior to a discussion of the potential benefits of OTAP to improve radio programming for public safety, and thus interoperability, some context is required. The basic premise of public safety interoperability is the ability for personnel from different agencies – such as law enforcement, fire, and emergency medical – to directly communicate with one another. This communication demand may occur within a chaotic environment during a response to an emergency situation (e.g., earthquake or terrorist attack) or during a more routine event that was planned for months (e.g., large convention or sporting event). Each of these aforementioned scenarios requires the same steps. Radio programming personnel must physically touch and program – or upload – an appropriate software file that includes designated talk groups; essentially a contact list of predetermined communication channels for the varying agency types. Without this programming effort, first responders would not have the ability to directly communicate with one another. This programming issue of interoperability is perhaps less concerning when considered in the context of a planned event. However, when considered as a necessary step in the process of responding to an emergency, time is of the essence and any gain in efficiency could be prominent. Despite the scenario, OTAP demonstrates the potential to greatly improve this necessary process.

3. Over-the-air-programming: OTAP

The concept of remotely managing radio equipment is not new. This process is analogous to cellular service providers that "push" software updates into customer cell phones as a routine component of ongoing network maintenance and to add new features over time [3]. Commercial use of OTAP is critical for the implementation of voice over long term evolution (LTE) functionality to cellular handsets as commercial carriers enable this service in their networks [4]. This commercial application provides a positive example of the benefits provided by the use of OTAP and related technologies to improve public safety interoperability [5].

Non-broadband OTAP is available in a range of forms and applications [6], but has limited use for the management of land mobile radio technology. Unlike the land mobile radio industry, commercial cellular telephone operators have adopted over-the-air software and firmware delivery as a mission critical tool for everyday management of commercial cellular radio technology. Over-the-air-programming, or analogous processes in a number of

[4] OTAP should not be confused with over-the-air-re-keying (OTAR). These two terms describe analogous processes but the latter only deals with establishing secure keys for access to encrypted channels or talk groups, not with general radio channel configuration. OTAR technology is beyond the scope of this document.

[5] The authors acknowledge, but do not address, the possibility of using a similar OTAP process in context of remote network infrastructure provisioning and maintenance. This application lies outside the scope of this paper.

[6] Award Number: 2010-IJ-CX-K023.