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Smart Radio for Police

Police departments will soon be able to take advantage of better radios that will help officers in various ways. The new radios can even be programmed to recognize when a particular radio frequency is overloaded with traffic, automatically switching to an alternative frequency when needed.

Software Defined Radio (SDR) and Cognitive Radio (CR) are two related developments in radio technology. Radios were once built from analog electronic parts and circuits that handled signal processing. With the advances in digital electronics over the past few decades, however, radios have more digital parts, making them more like computers. This switch to digital is important because digital parts and circuits are usually much less expensive than analog and because an analog system can usually do only a few tasks, while a digital system can do many, depending on the software it uses.

Advantages of Software Defined Radio

A software defined radio can send and receive analog voice, digital voice, data, or all three. Its software determines this, which is why it is called "software defined."

In most modern radios, signal-processing functions near the antenna take place in analog and those near the speaker or microphone take place digitally. Manufacturing cost, battery life, and needed performance all influence where the boundary between analog and digital is. However, this boundary has been moving ever closer to the antenna, expanding digital functions while minimizing analog functions. All modern public safety and cell phone radios are at least partly software defined, meaning they use software-controlled digital electronic circuits to do most of their internal signal processing. Moreover, they do it with better performance and at a lower cost than their analog predecessors did. These developments are already familiar to people who have experienced the technological improvements in present-day cell phones compared to the early models.

Software defined radios offer advantages to the public safety community. For example, they do not require the expert tuning and adjustment that analog does. Engineers believe this will lower costs.

Some military SDR programs have created the impression that the technology is inherently complex or expensive. This is due in part to the costs and complexity associated with the early days of any technology (think of the first computers) and because of the technical approach the military took. For example, the Software Communications Architecture (SCA) is viewed by some as unnecessarily restrictive, cumbersome, and too expensive for public safety applications. Most civilian software defined radios do not use SCA.

A software defined radio does most of its signal processing with digital electronics. To its operator, it works just as radios always have, but is better and less expensive. A cognitive radio is "aware" of its environment, its own powers, and its operator's needs and privileges. If it can change its performance in useful ways, according to the rules within which it operates, it is adaptive. If it can "learn" about circumstances that its designer never anticipated, it is cognitive. The boundary between adaptive and cognitive is hazy. Most cell

phones are adaptive. Your phone, for example, will first try to find a cell site belonging to your service provider and connect with that cell site. If that fails, it will find a cell site that it can use under a roaming agreement.

Cognitive Radio Mimics an Intelligent Human

A cognitive radio is essentially a software defined radio running under the control of an intelligent software package called a "cognitive engine." The cognitive engine does many things an intelligent human operator would do, freeing real operators to do their primary jobs.

One application for cognitive radio is dynamic frequency sharing. This is a technique by which radios find and use open frequencies ("white space" in the radio spectrum) or in which radios share channels on the basis of a priority system. In principle, this would give police access to more spectrum when needed and allow sharing of public safety channels with others during idle times.

Other potential applications for cognitive radio in public safety are in improving interoperability or in automatic adjustment of radio performance. A cognitive radio can recognize various signals and configure itself to interoperate with them. It can recognize difficult situations and take action to counter them. For example, if a police officer is inside a building that has no public safety radio coverage, the radio may automatically switch to a Voice over Internet Protocol (VoIP) mode and reach the dispatcher through a WiFi access point and a telephone line. These ideas are research topics now; however, some of them will soon reach the market.

For more information about NIJ's work in communications technology, visit http://www.ojp.usdoj.gov/nij/topics/technology/communication/welcome.htm.

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