

California Title 24 Programmable Communicating Thermostat
Wide Area Network One-Way Interface Recommendation
UC Berkeley PCT Research Team
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Introduction

Several technologies have been discussed as possibilities for enabling electronic communication functionality in thermostats. The resulting *programmable communicating thermostats* (PCT's) could be used for dispatching load curtailment messages necessary to balance the electrical grid during peak events. These technologies include wired & wireless and one-way & two-way solutions. A list of discussed options will be available in the Technology Survey section of the UC Berkeley PCT report. The CEC recognizes that two-way communications from the thermostat to a utility communication infrastructure (UCI) will be an ideal solution for implementing demand response in the long term. Such implementations however have not yet been proved out on a large scale. Until these solutions have proven themselves in the marketplace, the CEC, through Title 24 code, is proposing the standardization of a 1-way communications technology to be embedded in PCT's.

Two particular technologies have been proposed for a standard, statewide one-way solution: RBDS (alternatively referred to as "RDS"¹) over broadcast FM radio, and FLEX one-way paging (will be referred to as "paging"). Both technologies have been proposed because of their maturity, practicality, and the existence of a well-developed infrastructure. Demonstrations for the general feasibility of these technologies for this application already exist in the marketplace: RBDS is used by GPS devices which receive realtime traffic information from FM broadcasts², and paging is used in an Ambient Devices product which receives local 5-day weather forecasts over the paging network³. This document contains the recommendation by the UC Berkeley PCT Research Team between these two technologies and a discussion of the evaluation used to make the recommendation. Listed in the final section of this document are known players in various industries which have expressed interest in working with the State and other stakeholders on this project. The appendix to this document contains an in-depth evaluation of each technology for use in the PCT application.

Key Evaluation Criteria

The following criteria were identified as the most critical in evaluating each one-way technology for use in the PCT:

- Longevity: Will it be around for 10 Years?
- Reliability: Is the reliability of the infrastructure and the medium sufficient for this application?

¹ Radio Data System (RDS) has been a standard in Europe for over 20 years. The United States version of the standard, Radio Broadcast Data System (RBDS) is technically compatible with the European standard but adds some technical functionality.

² Cobra Nav One 4500 with TMC, <http://www.cobra.com/navone/4500page.htm>

³ Ambient Devices 5-day Weather Watcher, <http://www.ambientdevices.com/cat/index.html>

- Ubiquity: Is the technology ubiquitous enough that there are a large number of vendors available to provide equipment and support the interface?
- Infrastructure: What is the cost to set it up?
- Operational Costs: What is the annual cost to maintain the system on a statewide level?
- Costs to the Manufacturer/Vendor: What is the additional cost to the bill-of-materials (BOM) for the communications subsystem?

Summary

Both technologies will likely work for this application. However, it is recommended that further investigation efforts be focused on RDS over paging for several reasons: RDS is more attractive in terms of longevity (can practically be guaranteed), ubiquity (open standards and technology) and costs to the manufacturer/vendors. There are remaining questions about the reliability (in terms of expected performance), infrastructure, and operational costs for both technologies.

Longevity

The RBDS system is pretty much guaranteed to be around as a communication technology for the next 10 years since it is being widely installed in automobile radios and utilizes commercial FM radio. While there is a commonly held conception that the paging industry is “dead” since consumer uses have been replaced by cell phone technology, paging continues to support areas of the professional services industry, such as medical care, public safety responders, and field service technicians. Paging services are still widely supported and will be expected to be for a number of years. Paging, however, does not have nearly the same promise of longevity of broadcast FM radio.

Reliability

Both technologies have existing commercial applications which suggest that high reliability will be possible in PCT's. Detailed reliability studies of the factors that will likely influence in-home performance and general statistical models are not generally publicly available for either technology. The UCB Team is proposing a field-study experiment which could assist with the system design of an RDS solution. In addition, E-Radio USA has been testing performance of in-home display prototypes using RDS over commercial radio stations. The paging carriers are well-experienced in designing the transmission infrastructure to achieve reliable, in-home performance and as part of the RFP/PFQ process would be able to leverage this experience into the system design of a FLEX paging solution.

While the transmission infrastructures of both media are highly reliable under normal operation, the FM infrastructure is believed to be more robust and fault-tolerant. FM radio stations tend to employ redundant communications methods between the station and the transmitter (paging uses a single satellite link), utilize power redundancy as a de-facto standard for transmitters (power redundancy is based on what is available at the transmitter's host site), and have auxiliary backup transmitters in place.

Ubiquity

RDS technology is growing in the United States in ubiquity after becoming standardized in Europe roughly two decades ago. In this criterion, the technology has a clear advantage over FLEX paging because it is an open (non-proprietary) standard and more players are involved with the technology. FM radio already reaches more residents than paging, is supported by more broadcasters than paging carriers, and going forward, markets for chip makers and device manufacturers are much larger with RDS than with FLEX paging. A general summary of market ubiquity issues is presented in the following four subsections.

FM Radio Operators

The commercial and educational FM broadcast industry is fairly segmented, with very large networks such as ClearChannel, CBS Radio (Infinity Broadcasting), and Cumulus Media, smaller private networks, individual private broadcasters, and non-commercial operators such as NPR member stations and college and community radio stations. In addition to the broadcasters, there exist third-party data network operators which partner with independently-owned or network-owned stations to create a data network for distributing information. One such company is E-Radio USA. In California, there are 594 licensed FM stations (including commercial and educational), 217 of which have Class B (largest protected service territory in CA) licenses. 22 of ClearChannel's 30 California stations have dynamic RDS capability which is used to broadcast automotive traffic information.

FM RDS Chip Vendors

Due to the large scale inclusion of mobile FM receivers into portable music players and car radios, a number of companies manufacture chips which serve as both integrated FM receivers and RDS decoders. One company, NXP (formerly Philips Semiconductor) offers a variety of chips using the technology. Other known vendors offering integrated solutions include Silicon Laboratories, RDA, and Comlent.

Paging Carriers

In the last ten years the paging industry has undergone a considerable amount of consolidation. There are now only two known national paging carriers, though local regional carriers continue to exist. The two national paging carriers are American Messaging and USA Mobility.

Paging Chip Vendors

Motorola, the company which owns the intellectual property for the FLEX protocol, no longer makes any device hardware. Instead, a company choosing to implement the FLEX stack, in software or in hardware, must pay licensing fees to Motorola. Many companies which previously offered FLEX decoder chips have discontinued the products, meaning that a device manufacturer must implement the FLEX stack in the device processor if an external decoder cannot be used. One company, Renesas, a joint-venture between Hitachi and Mitsubishi, continues to manufacture integrated FLEX decoding chips.

Infrastructure

The infrastructure costs for both technologies are unclear. The term “infrastructure” includes both the physical, transmitting infrastructure, and the data network which connects the system operator to the broadcast and transmission nodes. With RDS, the currently existing physical infrastructure may not need substantial investment, but the data network will need to be set up and managed. Large radio networks or RDS data operators are capable of developing this infrastructure (some of it is already existing today) and may include the costs into their rates or quotes. With paging, the data network is built into the carrier’s system design, but the physical infrastructure is currently deficient to several residential areas of the state. It is unclear whether the paging companies will be willing to include the necessary investments as part of their long-term market strategy, or fold the costs into the statewide RFP requirements. The potential infrastructure investments for either the RDS or paging systems should not exceed millions of dollars in order-of-magnitude. More detailed discussion of the infrastructure issues is presented in the appended Communication Interface document.

Operational Costs

Accurate cost figures for business at this scale is subject to negotiation and difficult to obtain prior to the RFP/RFQ process. The RDS system has been estimated by E-Radio USA to cost roughly \$5-million per year on a statewide level. Paging vendors were unable to provide general estimates, and cost figures derived from their general one-way telemetry rates were in discrepancy with utility experiences with paging technology.

Costs to the Manufacturer/Vendor

The BOM cost (vendor cost per unit) of an RDS subsystem is expected to be anywhere from \$2 to \$8 less than that of a FLEX subsystem. Estimates for FLEX systems were difficult to obtain, due to the limited availability of integrated hardware solutions and proprietary nature (licensing is required to implement the stack in hardware or software) of the technology. Anecdotal estimates by experienced device manufacturers included “\$5 to \$10” and “five times more than with FM.” The BOM estimate of an RDS subsystem, according to the UCB team, ranges from \$2 to \$3.

Cost Comparison Summary

Assuming that the statewide system will eventually support approximately 10-million PCT’s, the estimated costs are summarized in the table below as summaries *per thermostat*.

	Estimated Cost <i>per PCT</i>	
	FM/RDS	FLEX Paging
Infrastructure and Setup	< \$1	< \$1
Annual Operational Costs	~\$0.50	?
BOM Costs	\$2 - \$3	\$5 - \$10

Contact Information for Known Players

Listed here are contacts that the UCB team has established a relationship with at companies operating in various industry areas. Many of these companies have expressed interest in participating in DR demonstrations and long-term solutions for the State.

Commercial FM Radio Stations

Clear Channel

www.clearchannel.com

Contact: Rob Speicher, VP of Operations for Clear Channel Distribution Development
They have 22 stations in California, out about 30, hosting RDS traffic data.

Entercom

www.entercom.com

Contact: Marty Hadfield, VP of Engineering and one of the chairs of the US RBDS Committee (National Association of Broadcasters)

They have 5 stations in Sacramento and 3 in San Francisco with dynamic RDS and have expressed interest in partnering for a demo.

RDS / Data Network Operators

E-Radio USA

Contacts are Jackson Wang, from E-Radio Inc (Canada) and Rick Boland, from E-Radio USA
<http://www.e-radiousa.com>

E-Radio has been working with RDS technology for some time and has experience managing data networks to send secure, dynamic data such as TMC (traffic message channel) information through partner radio stations.

Jump2Go

www.jump2go.com

Contact: Allen Hartle, CTO and Founder, and one of the chairs of the US RBDS Committee (National Association of Broadcasters)

Jump2Go is a very recently-founded company which installs hardware/software to enable radio stations to send interactive data through RDS and HD Radio technology.

FM RDS Chip makers

NXP

www.nxp.com

Contact: Ken Wong, Marketing Manager for Portable Audio

NXP offers a low-cost, fully integrated FM receiver/RDS decoder chip and is very supportive in technical support and documentation, and have also expressed interest in partnering for a demonstration.

National Paging Carriers

American Messaging

www.americanmessaging.net

Contact: Cindy White, Sales Director

American Messaging has offices in Hayward and Fresno and has been working with PG&E on paging load control devices.

USA Mobility

www.usamobility.com

Contact: Nancy Green, Vice President, New Business & Product Development

Paging Device Manufacturers

Unication

Contact: Vic Jensen, one of the authors of the FLEX specification

Unications manufactures pagers and electronic devices with paging-embedded capability.

DavisComms

<http://www.daviscomms.com.sg>

Contact: Bob Popow, Director of Operations

DavisComms is the spinoff of the pager manufacturing arm of Motorola.