NONCONVENTIONAL APPLICATIONS OF THE RADIO DATA SYSTEM

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ABSTRACT:
The widespread use of radio broadcasting has enabled the development of new technologies and standards that enable additional information to be transmitted together with conventional radio programmes based on the audio signal. One of them is the Radio Data System (RDS) that allows sending digital information over the regular FM (Frequency Modulation) radio broadcasting networks. The information can be used either by specific features of the RDS or by an open-data application. The paper reveals some new applications based on transmitting data using the RDS protocol.

KEYWORDS: Digital information, data application, radio broadcast, receiver, alerting system.

1. INTRODUCTION

Radio Data System was first developed in 1974 by IRT (Institut für Rundfunktechnik, the German Institute for Broadcasters) and standardized by the EBU (European Broadcasting Union) after 10 years, when it started to be introduced, at first in Europe and, at the beginning of 90s in North America.

Nowadays, it is frequently applied in sending traffic messages for motorists, which also, are able to listen to the same radio programme without changing the channel frequency. Receivers having RDS compatibility are found also in portable devices such as mobile phones and multimedia players or in household entertainment appliances like home cinema or HiFi systems.

RDS devices are able to receive information about date and time, programme name or the song's title and author.

2. SENDING DATA

The information represents serial data transmitted as a time frame with a standard structure. Data are organized in groups of 104 bits. Each group consists of 4 blocks, the transmission time for a group is around 87.5 ms, so that 11.4 groups per second can be transmitted. Each block contains 16 bits which encodes an information word and a check word. An information word is comprised of 16 bits and a check word is comprised of 10 bits.

The structure is shown in Figure 1.

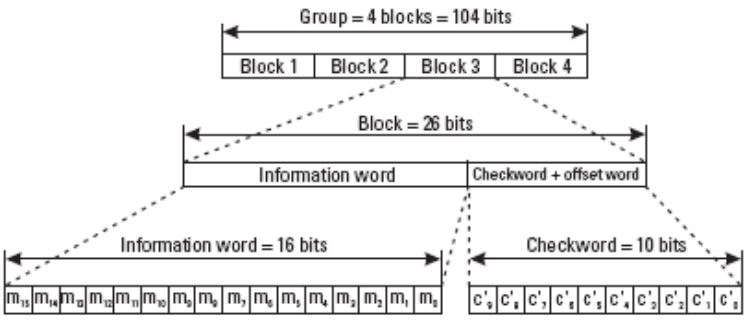

Fig. 1. The structure of information transmitted within the RDS

Data transmission is synchronous and continuous. Thus, there are not any intervals between consecutive groups or blocks. Data (the information word and the check word) are transmitted in a binary way starting with the most significant bit. Thus, the first bit of useful information is m_{15} and the last bit transmitted is m_0, followed by the bits from corresponding control word starting with c_9 and ending with bit c_0.

Those 10 control bits are required for proper reception of data signal. Through these control bits of the check word, the information can be synchronized for proper decoding. At the same time, the receiver can detect and correct errors occurred during transmission.

In terms of error detection and correction, the encoding structure has the following characteristics:

- Detection of all single and double errors in a block;
- Detection of any single error burst spanning maximum 10 bits;
- Detection of about 99.8% of bursts spanning 11 bits and about 99.9% of all longer bursts;
- Correction of any packet that contains maximum 5 wrong bits.

3. SPECTRUM ALLOCATION

Implementation of any Radio Data System is based on the following functional requirements:

- Radio data signals must be compatible, they must not cause interference to the reception of sound programme signals on existing receivers;
- Data signals must be capable of being reliably received within a coverage area as great as that of the monophonic main programme signal;
- Usable data rate provided by the data channel should support the basic requirements of station and Programme Identification, and provide scope for future developments;
- Message format should be flexible to allow the message content to be tailored to meet the needs of individual broadcasters at any given time;
- System should be capable of being reliably received on low-cost receivers.

Those requirements had conducted to the spectral configuration presented in figure 2.

FM transmission has two major spectral components: the component of the stereo multiplex signal and a data component corresponding to the RDS data format.

The stereo multiplex signal is comprised of:

- The “M” component which represents the frequency band of the mono signal. (20 Hz – 15 KHz);
- A pilot carrier frequency at 19 kHz;
- The “S” component that is the resulting frequency band from AM-SC (Amplitude Modulation Suppressed Carrier) with a 38 KHz subcarrier frequency (the second component of the stereo signal between 23-53 kHz).

RDS data channel is allocated outside the stereo multiplex signal's frequency band. Transmission is achieved by amplitude modulation of a subcarrier with frequency of 57 kHz ± 6 Hz (multiple of the pilot frequency). This value was chosen to reduce channel interference. RDS data channel occupies a bandwidth of 2.4 kHz.

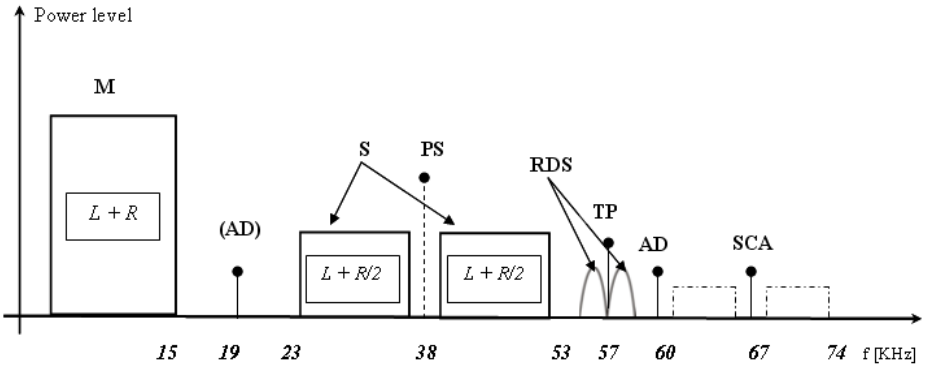

Fig. 2. RDS signal spectrum

RDS signal spectrum may include other signals outside the multiplex stereo channel and data channel. It is possible to transmit an auxiliary audio channel (SCA) resulting from an amplitude modulation suppressed carrier on a carrier frequency of 67 kHz or an auxiliary data channel (AD) providing data speed rates of 25 bit per second (when using a 19 KHz frequency carrier) or 200 bit per second (when using a 60 KHz frequency carrier).

4. INTEGRATED FEATURES

Data transmitted through RDS are used to achieve some applications that consist of:
- Automatic tuning of radio receivers;
- Applications for automatic transmission of road traffic information.
- Displaying additional information about the programme received (name of the channel, together with the name and type of current programme);
- Broadcasting alarm messages;
- remote-controlling of devices;
- Applications that enable radio paging services.

There are 3 basic functions of the RDS: Programme *Identification (PI)*, Programme *Service name (PS)* and *Alternative Frequency (AF.).* PI is a 16-bit code that is comprised of a country code, a regional code and a number which allows the identification of the broadcaster and the particular programme. Besides the PI code, the broadcaster sends the Programme Service which consists of 8 alphanumeric characters used to inform the listener about the name of the programme received. Function AF enables the broadcaster to transmit one or more list with alternative frequencies of the programme (maximum 25 frequencies per list). Those 3 functions together are needed for automatic tuning of receivers. Thus, on its movement, the listener can receive the same programme without changing the radio frequency because the receiver identifies the programme identification code and is continuously checking the Alternative Frequency list, displaying the Programme Service to the listener. The user may listen to the same programme and may read the programme's name every moment.

Features for traffic announcements are offered to motorists. There are 2 specific functions. One of them is *Traffic Programme code (TP),* which is used to identify those programmes that send traffic messages for motorists. The other one is the *Traffic Announcement signal (TA)*, a signal which automatically switches the receiver to the programme that currently transmit traffic messages, even if the user is listening to another radio programme or CD.

Additional functions are used for sending more information to users.
- *Programme Type (PTY)* allows identification of a news channel, music, sports, etc. There are 32 distinct types; all this types are listed in table 1.

0	No PTY	11	Rock music	22	Travel
1	News	12	Easy listening music	23	Leisure
2	Current affairs	13	Light classical	24	Jazz music
3	Information	14	Serious classical	25	Country music
4	Sport	15	Other music	26	National music
5	Education	16	Weather	27	Oldies music
6	Drama	17	Finance	28	Folk music
7	Culture	18	Children's programmes	29	Documentary
8	Science	19	Social affairs	30	Alarm test
9	Varied	20	Religion	31	Alarm
10	Pop music	21	Phone in		

Table 1. PTY codes within RDS

- *Clock Time and date (CT)* is a function which avoids time zone problems. It is a code, usually originated from standard time transmissions, to enable receivers to display the current time and date. This is also used in synchronizing various receivers.
- *Music / Speech (M/S)* enables the receiver to distinguish whether music or speech is transmitted. This can provide two different playback sound levels for both categories.
- *Radio Text (RT)* provides information (maximum 64 characters) about radio show's name, the song name, the author's name and song's releasing year.
- *Enhanced Other Networks (EON*) creates a list of all available radio networks. The list contains information for the PI, AF, TP, TA and PTY functions.
- *Radio Paging (RP)* Offers the possibility of mobile pocket pagers with alphanumeric display of messages and alerting beeps.

- *In-House (IH)* is a dedicated channel to broadcasters which can monitor the transmission network (transmission quality parameters, appropriate operation, etc.) Transmitted signals can be decoded only within the network**.**
- *Emergency Warning System (EWS)* is a function that uses a very small amount of data for emergency warning services such as national disasters and hazardous chemical spills.

5. USER-DEFINED FEATURES

The Radio Data System allows users to develop new applications. There are 2 ways of implanting the features.

One of them is the *Transparent Data Channel (TDC)*. This channel can be used to transmit data streams for remote controlling and displaying functions of some electronic devices such as computers and peripherals. Data sent through TDC is identified by the receivers following a standard time frame structure of the RDS

Another way consists of using Open Data Application (ODA), a feature for sending data within a customized application. Due to its own data structuring, the information is received and processed only by the devices involved in the system, standard devices can not recognize the data encoded.

6. NONCONVENTIONAL DATA APPLICATIONS

Developers have found great advantages in RDS, and nowadays they integrate it into new application that requires data communications at low speed rates. Thus, different technologies were brought together to operate an advanced system. Some of them are overviewed further.

6.1. AUTOMATION PROCESSES

New special thermostats are developed for increasing the efficiency power electricity consumption. These devices, called Programmable Communicating Thermostats (PCT), have a built-in FM receiver with RDS decoder. A PCT can be installed in a heating central unit or air-conditioning to increase or decrease the temperature setpoint. The electricity supplier sends via RDS information about the user's bill. The user is also announced if a growth of energy consumption within the power electricity network appears, so, PCT device should manually or automatically change the air temperature in order to save energy and also, to avoid damages on the power electrical grid. On this way, the user can decrease its electricity consumption with great financial benefits of billing.

A programmable communicating thermostat is shown in figure 3 and a diagram of the PCT system is presented in figure 4.

Fig. 3. A Programmable Communicating Thermostat

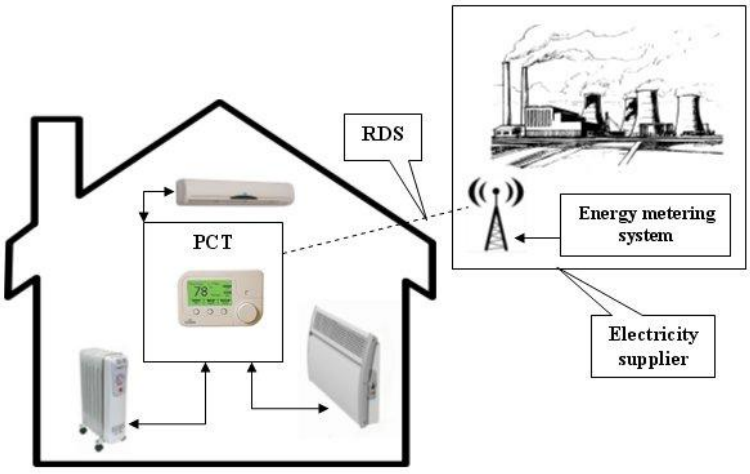

Fig. 4. PCT system

6.2. ALERTING SYSTEMS

An alerting system based on RDS was implemented in North America. The National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA) and the United States Department of Homeland Security are permanently connected to a FM broadcaster called Alert FM by an internet connection. Authorities send the alert messages to Alert FM which further broadcasts them over its radio broadcasting network. The system delivers messages either to all the users, either to a certain area, if it is local interest information.

Figure 5 shows the system's diagram.

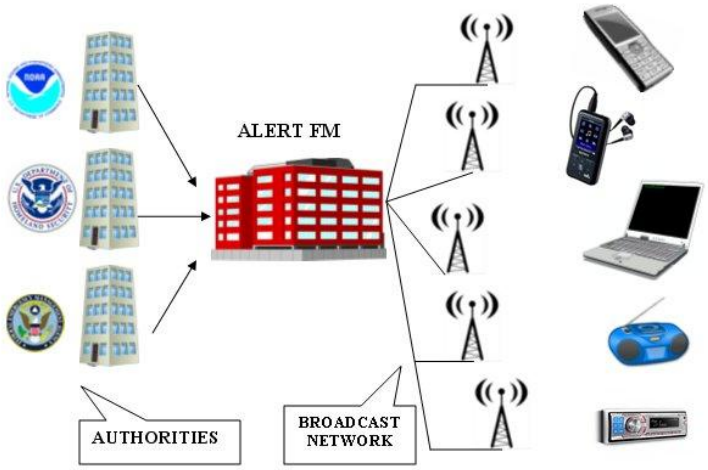

Fig. 5. Alerting system

There are 2 types of special designed receivers, shown in figure 6:

- a standard programmable receiver with LCD display;
- a USB receiver which runs without Internet connection. The device is plugged in a computer, receives the message via RDS and displays it within the software application installed.

Fig. 6. Alerting receivers

Fig. 7. Notification displays

Companies may introduce their own alerting system for sending information inside buildings. Information is displayed on large screens (figure 7) with built-in RDS decoder. The solution eliminates the needs of building a wiring data network.

6.3. REMOTE CONTROLLING SYSTEMS

The installation of large-scale displays at stations, airports, harbours e. g. for commercial or informative purpose, is very expensive. The largest part of the expenditure is needed for the laying of the interface cable to the computer to run the display. Very often it is not possible to install a display at a specific place because streets, channels/rivers or houses have to be passed.

The alternative is to run the display via RDS and to decode the RDS signal. Another advantage of this technique is the ability to control several displays within the service area of the transmitter without the need to lay cables. Electronic signs may also be controlled using RDS. Their installation is very expensive and difficult. The laying of cables to supply the hardware is extremely difficult or simply not possible. Installing a transmitting set is too expensive considering the short range provided by such a set. Therefore, RDS is a good solution to control the transmission.

Large parking areas having many access points are equipped with an integrated system for displaying information about available parking spaces, fees, actual time or currently closed exits. Drivers read these information from several screens spread along significant distances from hundreds of meters to kilometres. Displays should have a built-in RDS decoder to receive data. Thus, data are sent from a unique location to all remote screens via FM RDS radio signal without the need of installing wires on large areas.

A similar solution could be integrated on local transport system for displaying data in stations. Screens inform the travellers about the currently timetable of trams, busses or metros and remaining time until the next vehicle arrives. The sending process uses real-time information transmitted from a central location to all remote screens via RDS, covering metropolitan areas. Additional displays could also be installed on the public means of transport to inform the travellers or to announce the vehicle's driver when routes are changed or some traffic events are taking place. This solution is also efficient and easy to implement because it doesn't use a metropolitan cabling network.

6.4. NEWS DELIVERING APPLICATIONS

A data receiver (in the form of a PC extension board or peripheral) could be connected to a computer using an interface (e.g. USB). The device receives the information via RDS, data are sent as radiotext streams. The broadcast text files provided by press agencies would be organized in articles and pages, just like a classical newspaper, to be stored in the computer for reading later. This system brings updating news by using radio signals instead of web based connectivity, which represents an advantage when an Internet connection is not available. In the case of visually impaired people, the received information could be transformed into vocal messages via a blind person's dedicated user interface. Users can select the information they want to listen.

7. CONCLUSIONS

Radio Data System is a technology which enables specific features with significant utility. It also brings relevant technical resources in developing advanced solutions. Those non conventional systems are cost efficient and offer comfort functions needed in every day life. It may be drawn the following conclusion: RDS creates a link between different technologies from electronics, mechanics, power electricity, IT and communications in order to achieve advanced functions within non conventional systems.

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