SOFTWARE DEFINED RADIO IN WIRELESS AD-HOC NETWORK

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ABSTRACT

The parameters of communication in ad-hoc network such as the distance between nodes and channel characteristics changes frequently with the position of the user. For efficient use of such a communication systems, we can change software specification rather than changing any hardware (such as chip), because change of hardware is difficult and cost effective as compared to that of software. On such way software defined radio (SDR) is simple and economically beneficial. In this paper, we are using concept of M-ary phase shift keying (MPSK) technique for adaptive detection. Implementation of MPSK adaptive detection is performed by using software programming of MPSK modulation and it can be reprogrammed according to the requirement. Use of radio signal makes this network more reliable and flexible because of its property.

1. INTRODUCTION

Software Defined Radio (SDR) reduces the burden of changing the hardware so frequently. A radio is used in wireless communications device in which the physical and link layer functions are implemented in software. This enables a single wireless device to be reprogrammed to use different modulation, coding, and access protocols. The main advantage of software is its flexibility such that in can be programmed for emerging standards. It also can be dynamically updated with new software without any change in hardware and infrastructure. Rapid deployment is another important feature of the software radio. In wireless applications where different standards might be deployed, user's roaming can be a big issue in existing platform. Most software radio research to date has been driven by the interoperability problems present in commercial and military wireless systems [1, 2]. In commercial systems, the multitude of different cellular standards inhibits universal roaming and new standards are deployed slowly since it requires installing new base station hardware and distributing new handsets to users. Similarly, the varying operational requirements of the different branches of the military require different radios and hinders the coordination of joint operations. Software radio also provides the flexibility to adapt dynamically.

The ideal software radio interoperates with any communications service in its RF preselector band and A/D bandwidth. By running a different algorithm, the software radio instantly reconfigures itself to the appropriate signal format. This opens interesting possibilities for expanded radio services. A future software radio might autonomously select the best transmission mode (Personal Communication Network, Mobile Cellular Network, etc), send probing signals to establish a link, explore communications protocols with the remote end and adapt to the remote signal format. It could select the mode for lowest cost, service availability or best signal quality. The software radio reconfigures itself on the fly to support the required services [3].

2. ARCHITECTURE OF SDR

This signal traveling from transmitting antenna will be collected at receiving antenna then to radio frequency (RF) from RF to down converter.

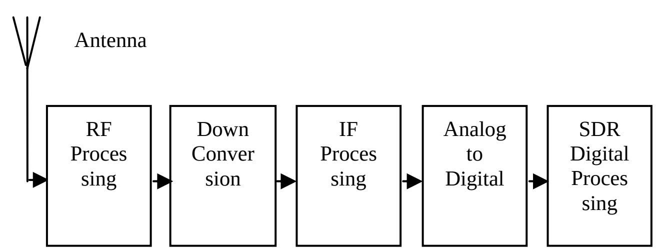

Fig. 1.Commonly used SDR receiver.

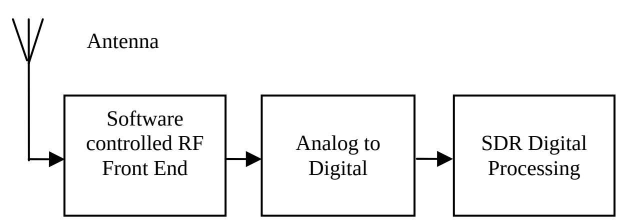

Fig. 2. Advance SDR receiver with software-controlled front end.

After that passes through analog to digital converter (ADC) in order to get digital signal which is to be fed in digital signal processing (DSP) and ultimately the signal passes to computer CPU's front end for further processing as shown in Figure 1. Signal coming from antenna is passed in software controlled RF Front end then to ADC ultimately the signal passes to computer CPU for further processing as shown in Figure 2.

3. APPLICATION AREA OF SDR

SDR can be used as a part of cognitive radio [4] and in wireless communication system in which either network or wireless node changes its transmission or reception parameters to communicate efficiently avoiding interference with licensed or unlicensed users. This alteration of parameters is based on the active monitoring of several factors in the external and internal radio environment, such as radio frequency spectrum, user behavior and network state.

3.1 FPGA

Field-Programmable Gate Arrays (FPGA) have formed the basis for high-performance and affordable computing systems. FPGA- based logic simulators can emulate complex logic designs at clock speeds of several orders of magnitude faster than even accelerated software simulators, while FPGA-based prototyping systems provide great flexibility in rapid prototyping and system verification. However, besides FPGA pin limitation, existing FPGA-based systems [5] also meet the problem of improving the routability of interconnect networks in the architecture design. FPGA related systems and products have drawn great attentions from engineers and designers. FPGA based systems can provide novel, high-performance, and affordable approaches to rapid prototyping, logic emulators, and dynamically reconfigurable subsystems, because FPGA approach allows flexibility, fast time-to-market, customizability and just-in-time production. These systems can run several orders of magnitude faster than software even with.

3.2 JTRS

Joint Tactical Radio System (JTRS) often pronounced "jitters" is planned as the next-generation voice-and-data radio for use by the U.S. military in field operations. Launched with a Mission Needs Statement and a subsequent requirements document (which has been revised several times), JTRS [6] is a software-defined radio that will work with many existing military and civilian radios. It includes integrated encryption and Wideband Networking Software to create mobile ad hoc networks. The functionality and expandability of the Joint Tactical Radio System are built upon the Software Communications Architecture (SCA), an open-architecture framework that tells designers how hardware and software are to operate in harmony. It governs the structure and operation of the JTRS, enabling programmable radios to load waveforms, run applications, and be networked into an integrated system. A Core Framework, providing a standard operating environment, must be implemented on every hardware set. Interoperability among radio sets is increased because the same waveform software can be easily ported to all radios.

3.3 GPP

General purpose processor (GPP) [7] is a macro-processor that is not tied to, or integrated with, a particular language or piece of software. In its simplest form, a macro processor is a program that copies a stream of text from one place to another, making some kind of systematic set of replacements as it does so. Macro processors are often embedded in other programs (for example, many assembler programs incorporate a macro processor and the C-language mandate the presence of a preprocessor which incorporates some crude macro processing facilities). However, macro processors may also be stand alone programs, which mean that it is easy to use them for processing any kind of text at all. General purpose macro processors can be used for many tasks; they have been used for language expansion (defining new language constructs that can be expressed in terms of existing language components), for systematic textual replacements that require some kind of decision making (where a global edit would be insufficient), and for textual reformatting (e.g. conditional extraction of material from an HTML file).

3.4 ASIC

An application-specific integrated circuit (ASIC) It is an integrated circuit (IC) customized for a particular use, rather than intended for general-purpose use. For example, a chip designed solely to run a cell phone is an ASIC. In contrast, the 7400 series and 4000 series integrated circuits are logic building blocks that can be wired together for use in many different applications. Intermediate between ASICs [8] and standard products are application specific standard products (ASSPs). As feature sizes have shrunk and design tools improved over the years, the maximum complexity (and hence functionality) possible in an ASIC has grown from 5,000 gates to over 100 million. Modern ASICs often include entire 32-bit processors, memory blocks including ROM, RAM, EEPROM, Flash and other large building blocks. Such an ASIC is often termed a SoC (system-on-a-chip). Designers of digital ASICs use a hardware description language (HDL), such as Verilog or VHDL, to describe the functionality of ASICs.

4. M-ARY PSK DIGITAL MODULATION

In the digital communication systems M-ary [9] phase shift keying (MPSK) the characteristics of MPSK and detection are described as follows. MPSK carrier phase have M values, usually it chooses $M = 2^n$ where n is positive integer, the phase value often are at same interval

$$\theta_i = \frac{2\Pi i}{M} + \varphi \quad (1)$$

where i = 0,1,2,…, M -1, $M = 2^n$ And φ is the initial phase. Here we are going to consider rectangle envelops MPSK, modulated signal in time-domain is expressed as:-

$$Z_{MPSK}(t) = \left[\sum_n \sqrt{\frac{2E_s}{T_s}} rect(t - nT_s)\right] \cos[\omega c t + \theta(n)] \quad (2)$$

where T_s is the symbol duration, E_s is the unit symbol's signal energy, $\theta(n)$ is the carrier phase at $t = nT_s$ and $rect$ is rectangle function. Value is given as:-

$$rect(t) = \begin{cases} 1, & 0 \le t \le Ts \\ 0, & \text{Others} \end{cases} \quad (3)$$

$\theta(n) \in \{\theta_i\}$ Where i = 0,1,2,…, M -1 Derived from formula (1). If initial phase φ =0, then

$$Z_{MPSK}(t) = \left[\sum_n a_n \, rect(t - nT_s)\right] \cos \omega c t - \left[\sum_n b_n \, rect(t - nT_s)\right] \sin \omega c t \quad (4)$$

where

$$a_n = \sqrt{\frac{2E_s}{T_s}} \cos \theta(n)$$

$$b_n = \sqrt{\frac{2E_s}{T_s}} \sin \theta(n)$$

From (4), we can say that MPSK signal may be orthogonal. The above equation reveals that the MPSK signal may use two orthogonal carrier signals to realize the coherent detection. When T_s equals to 10 and (no of iteration) N equals to 100 our graph have greater time interval, where N is the number of terms, as shown in Figure 3. When we increase T_s to 60 and N to 300 our graph compresses and tends to orthogonal. We will get close to ideal (orthogonal) if we will increase T_s and N as shown in Figure 4.

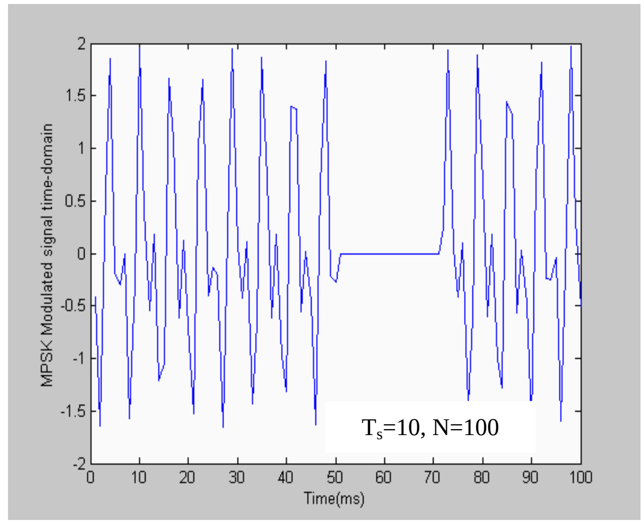

Fig. 3. MPSK modulation.

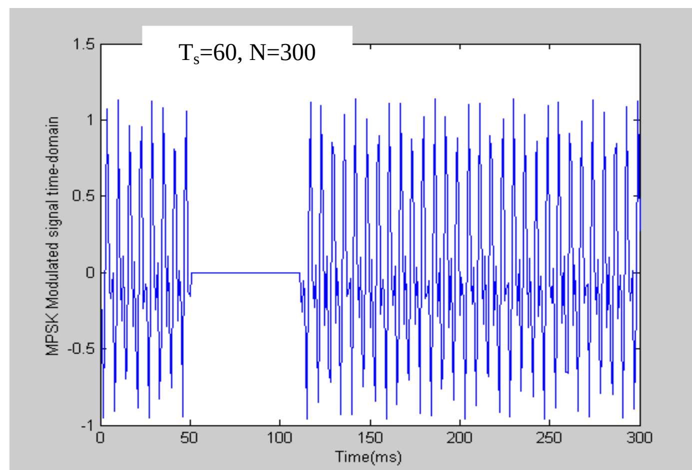

Fig. 4. Left shifting of gap and compression of signal.

5. CONCLUSION

With the use of SDR, we can change the parameter of Ad-hoc network by using M-ary PSK modulation technique. Just by changing software, we achieve the desired output. Hence it reduces the task to a great extent. In continuous phase rate modulation, we can identify them for each phase rate properties. These can be implemented by software radio. These are involved in many specific problems such as differential encoding MPSK and filter before modulation. We need to differentiate them according to their new properties as phase. These concepts will be used to develop adaptive software using various applications.

6. REFERENCES

[1] J. Mitola, “Globalization of the Software Radio”, *IEEE Comm. Mag.*, Vol 37, No. 2, pp. 82-83, 1999.

[2] R. J. Lackey and D. W. Upmal, “Speakeasy: the Military Software Radio”, *IEEE Comm. Mag.*, Vol. 33, No. 5, pp. 56-61, May 1995.

[3] J. Mitola, “Software Radios Survey, Critical Evaluation and Future Directions”, *IEEE AES Systems Mag.*, Vol. 8, No. 4, pp. 25-36, April 1993.

[4] L. N. Singh and G. R. Dattatreya, “Channel and Data Estimation for Ad Hoc Networks and Cognitive Radio ”, *Int. J. Wireless Information Networks*, Vol. 14, No. 1, pp. 17-31, March 2007.

[5] J. Li and C. K. Cheng, “Routability improvement using dynamic interconnect architecture”, *IEEE Symposium*, pp. 61-67, April 19-21 1995.

[6] C. D. Young, “The mobile data link (MDL) of the joint tactical radio system wideband networking waveform”, *Military Communications Conference*, pp. 1-6, Oct. 23-25 2006.

[7] S. Wong, S. Cotofana and S. Vassiliadis, “Multimedia Enhanced General-Purpose Processors”, *IEEE International Conf. on Multimedia and Expo.*, Vol. 3, pp. 1493-1496 , 30 July-2 Aug. 2000.

[8] J. F. Christian, et al, “An Application-Specific Integrated Circuit for Positron Emission Tomography”, *IEEE Nuclear Science Symposium Conf.*, Vol. 5, pp. 2963-2966, 23-29 Oct. 2005.

[9] Wu Hao, Li Xu and Li Cheng-shu, “Software Radios Applying in Ad Hoc Network Nodes Adaptive Detection”, *IEEE Int. Symposium on Microwave, Antenna, Propagation and EMC Technologies for Wireless Comm. Proc.*, pp. 1214-1217, 2005.