

Enhancement of Digital Radio Features-An Approach towards Generation of Waveforms for SDR

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Abstract-- A Software defined radio (SDR) defines the transmitted waveforms and demodulates the received waveforms. SDR is an interdisciplinary technology involving a combination of hardware and software technologies where some or all of the physical layer functionality are programmable. Re-configurable platform of SDR device hosts several software components to provide users with functional services. A user can load number of "Software Defined Personalities" on to an SDR. A personality includes RF band, channel set, air interface waveform and related functions that are completely software defined. This paper aims towards the Study of existing Digital Radio features and implementation of various stages of the Digital radio in terms of Software platform by generation of waveforms for SDR.

Keywords- fm3tr, software defined radio ,software communication architecture

I. INTRODUCTION

Software defined radio is promising and emerging technology that can improve interoperability facilitate new technology insertion and reduce development cost. It has been an active research topic for over a decade. The concept of SDR was firstly proposed by Joseph Mitola in 1992. In a SDR, same

hardware platform can be used to perform different functions through loading different software. In order to achieve the goal of SDR, the SDR must be built upon a well-defined, standardized and open architecture. Defining such architecture also enhance scalability and provide plug and play behavior for the components of radio. The famous architecture in SDR is Software Communication Architecture(SCA). The SCA imposes some limitations on the development process of hardware and software of SDR.

This paper discusses the digital radio, SDR, Software Communication Architecture(SCA) and fm3tr waveform generation.

II. DIGITAL RADIO

Digital radio is capable of broadcasting specific stations without following the continuous airwaves. Digital radios work by picking up a processed signal which turns sound into patterns of digits (numbers) rather than the radio waves which are used for analogue transmissions. It is more flexible than Analog Radio in terms of hardware architecture. In the Digital Radio the received signal is digitized at the IF stage

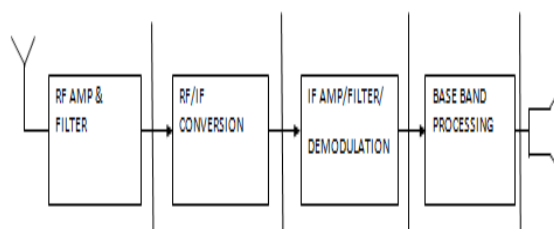


Fig 1 Radio Receiver

Digital radio was developed relatively recently by a group of manufacturers and broadcasters. While analogue radio was

first used commercially during the 1920s, engineers began researching digital radio in the early 1980s. According to independent electrical retailer Home vision UK, the development of digital radio was headed by the British Broadcasting Corporation. They made their first digital broadcast in 1995. The service has been growing steadily in popularity and, in August 2010, a total of 12 million digital radio receivers have been sold.

Digital radio offers many benefits over analogue radio. It provides a better sound quality and is not affected by interference from buildings or bad weather. Digital radio receivers also display relevant information for listeners, such as the station being listened to and the title of the song playing. As the information packets used to transmit digital stations take up less space than analogue radio signals, broadcasters can send out multiple signals on the same frequency. This reduces costs for service providers and gives consumers a wider choice of stations. Results of digital Radio for various modulations as shown in figure 1 The following results shown the transmission and reception of 90 MHz IF signals for different frequencies of message signals in the Digital Radio.

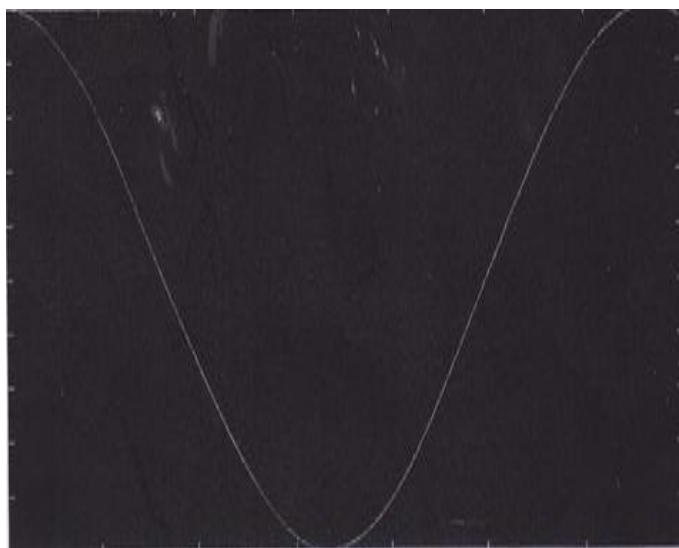


Fig 1. 300 HZ Message Signal

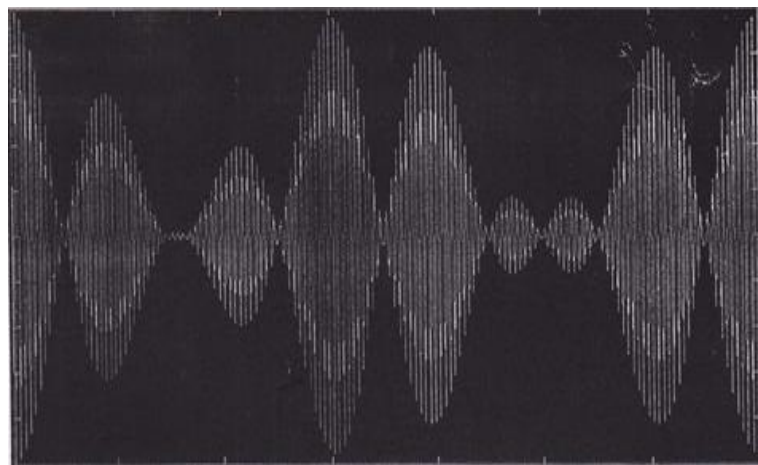


Fig 2. 90M HZ IF Output from Processor

III. SOFTWARE DEFINED RADIO

SDR defines a collection of hardware and software technologies where some or all of the radio's operating functions (also referred to as physical layer processing) are implemented through modifiable software or firmware operating on programmable processing technologies. These devices include field programmable gate arrays (FPGA), digital signal processors (DSP), general purpose processors (GPP), programmable System on Chip (SoC) or other application specific programmable processors. The use of these technologies allows new wireless features and capabilities to be added to existing radio systems without requiring new hardware.

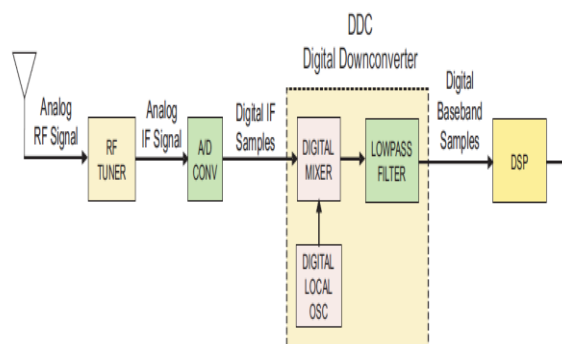


Fig 5.SDR receiver

The above shows a block diagram of a software defined radio receiver. The RF tuner converts analog RF signals to analog IF frequencies, the same as the first three stages of the analog receiver. The A/D converter that follows digitizes the IF signal thereby converting it into digital samples. These samples are fed to the next stage which is the digital downconverter (DDC) shown within the dotted lines. The digital downconverter is typically a single monolithic chip or FPGA IP, and it is a key part of the SDR system.

technology advances which are expected to greatly enhance interoperability of communication systems and reduce development and deployment costs.

The SCA has been structured to Leverage commercial standards to reduce development cost. Reduce software development time through the ability to reuse design modules. Build on evolving commercial frameworks and architectures

The figure below shows a very simplified version of the main layers of a JTRS radio set

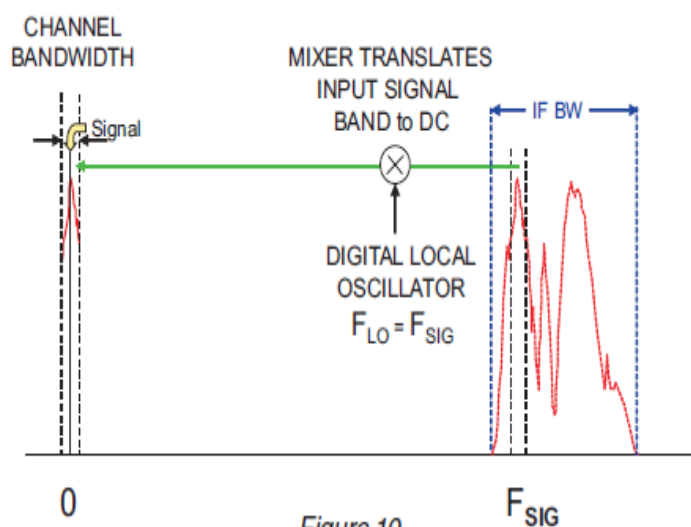


Figure 10

Fig 6.SDR

Receiver mixer

At the output of the mixer, the high frequency wideband signals from the A/D input (shown in Figure above) have been translated down to DC as complex I and Q components with a frequency shift equal to the local oscillator frequency.

IV. SOFTWARE COMMUNICATIONS ARCHITECTURE (SCA)

The Software Communication Architecture (SCA) is published by the Joint Program Executive Office (JPEO) of the Joint Tactical Radio System (JTRS). This architecture was developed to assist in the development of software defined radio communication systems, capturing the benefits of recent

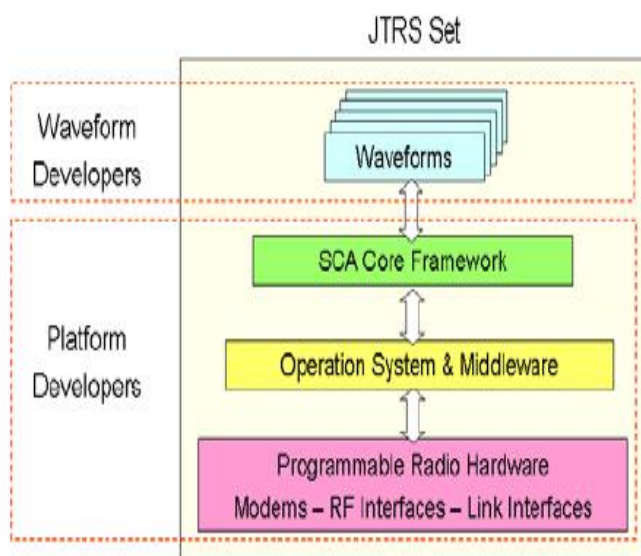


Fig 7. Simplified version of JTRS Radio set

The actual radio hardware that provides all the analog and digital interfaces to the outside world. The operating system and middleware. The SCA core framework which is the software that interfaces to the hardware. The waveforms that are actually what gives the radio its specific characteristics needed to satisfy the application requirement.

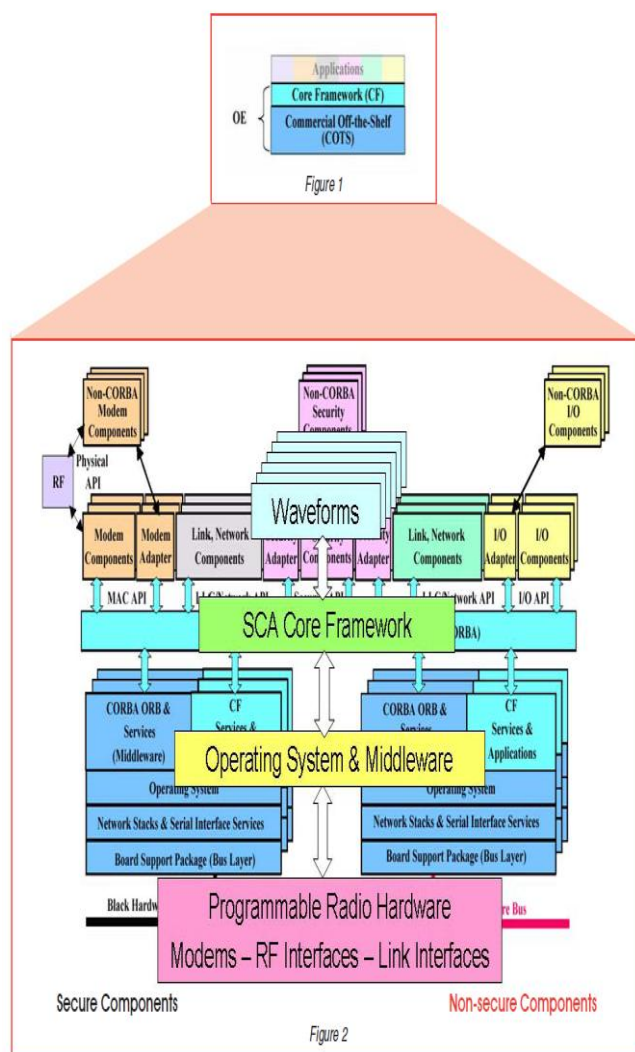


Fig 8. SCA Operating Environment

The SCA Operating Environment, sometimes called the OE. It basically depicts all the layers of the software and how they interact. These components consist of the Core Framework, the Operating System, the Board Support Package, CORBA (Common Object Request Broker Architecture) ORB (Object Request Broker), and the Network Services

V.EXAMPLE WAVEFORM FOR SDR IMPLEMENTING USING SCA : FUTURE MULTIBAND MULTIWAVEFORM MODULAR TACTICAL RADIO (FM3TR) :

The Future Multiband Multiwaveform Modular Tactical Radio (FM3TR) is a multi-national collaboration to create a modern unclassified communication waveform, that can be used to test interoperability between two different Programmable Digital Radio platforms. The waveform addresses the issues of :1.hop rate programmability 2.extended frequency band coverage over 30-400 MHz. The FM3TR waveform has been used extensively throughout the Phase 1 work as it provides a good example of a modern waveform, which has exercised the language currently under development. As the final WDL is expected to be issued as an open standard, a tutorial example of a waveform parameterisation is required. FM3TR will fill this role. WDL combines principles from a number of increasingly mature research areas to produce a practical specification language

The first task in parameterisation of FM3TR is to identify the main specification structure. The top level entity shows all external interfaces identified by the specification.

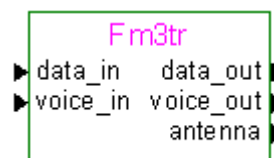


Fig 9. FM3TR Interface

The next layer of decomposition identifies the FM3TR protocol layers and, hence, the main structure of the specification. The FM3TR radio specifies a realisation of the lower three layers of an OSI protocol stack using four layers: Network (Nwk), Data Link Control (Dlc), Medium Access Control (Mac) and Physical (Phl). The FM3TR specification identifies a variety of configuration and operation parameters, but does not specify their interface Mercury tool describes the steps for installing and running the FM3TR

waveform application in audio or data mode. The audio and data modes are implemented as separate waveforms but they share some of the components. Each waveform implements the full receive and transmit chain (in loopback mode), therefore the waveforms can be run and tested on a single computer. Results of SDR by using fm3tr waveform as shown in fig 10. In this we take cpsk signal

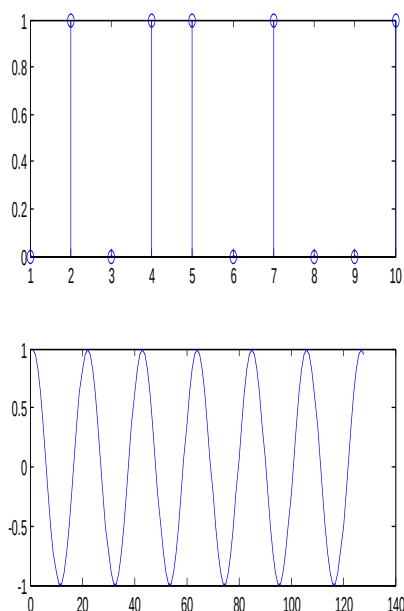


Fig 10 CPFSK signal

VI. CONCLUSION

In the SDR the main tool used for achieving the waveform portability is Software Communication Architecture (SCA) which is developed by Joint Tactical Radio system (JTRS) in USA. The function of each layer in the SCA Operating Environment (OE) was studied. Then for showing the waveform portability in the SDR compare to Digital Radio integrated complex source code, the waveform for SDR was developed using SCA OE, the new version waveform called **Future Multiband Multiwaveform Modular Tactical**

Radio (FM3TR) waveform was developed by using the MERCURY tool in the SCA operating environment.

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