Faculty of Engineering

FRONT - END FREQUENCY SELECTION FOR SOFTWARE RADIO

Liyana Binti Abdul Rashid

Bachelor of Engineering with Honours
(Electronics and Telecommunication Engineering)
2004

R13a

BORANG PENGESAHAN STATUS TESIS

Judul: FRONT-END FREQUENCY SELECTION FOR SOFTWARE RADIO

SESI PENGAJIAN: 2003/2004

Saya LIYANA BINTI ABDUL RASHID
(HURUF BESAR)

mengaku membenarkan tesis * ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sarawak.
2. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Membuat pendigitan untuk membangunkan Pangkalan Data Kandungan Tempatan.
4. Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
5. ** Sila tandakan (✓) di kotak yang berkenaan

[ ]	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
[ ]	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan).
[✓]	TIDAK TERHAD	

Disahkan oleh

(TANDATANGAN PENULIS)	(TANDATANGAN PENYELIA)
Alamat tetap: NO. 1580, LORONG E8,	
TAMAN SATRIA JAYA, BDC STAMPIN	MOHD SAUFEE BIN MUHAMMAD
93350 KUCHING,	Nama Penyelia
SARAWAK	
Tarikh: 19 MAC 2004	Tarikh: 19 MAC 2004

CATATAN
* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah, Sarjana dan Sarjana Muda.
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

This final year project attached here:

Title	:	Front-End Frequency Selection for Software Radio
Student Name	:	Liyana binti Abdul Rashid
Matric No	:	5279

has been read and approved by:

_______________________ 19 MAC 2004

Mr. Mohd Saufee Muhammad Date

(Supervisor)

FRONT-END FREQUENCY SELECTION FOR SOFTWARE RADIO

LIYANA BINTI ABDUL RASHID

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Engineering with Honours
(Electronics and Telecommunication Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2004

Dedicated to my papa and mama

Acknowledgement

Firstly, thanks to Allah, Al-Rahman, Al-Rahim the almighty whose blessing I always seek.

Thanks also to my beloved family, and my beloved friends who always support and gave me courage in time of needs.

And foremost I would like to extend a very special thank you to my supervisors, Mr. Mohd Saufee Muhammad and Ms. Sharifah Masniah Wan Masra, for their guidance and unending support.

Last but not least, thank to my entire colleague and those who had either directly or indirectly assist me in making this thesis a success.

Abstrak

Generasi ketiga sistem tanpa wayar merangkumi perancangan dan strategi yang dapat meningkatkan kemajuan yang diingini serta rangkaian data. Dalam masa yang sama, ia menjana keanjalan dan mampu dimiliki. Radio perisian menjanjikan keanjalan yang diperlukan di peringkat pemprosesan isyarat frekuensi radio, frekeunsi perantaraan dan isyarat jalur dasar. Kemajuan teknologi ini juga membolehkan peranti tunggal ini memancarkan beberapa perkhidmatan bersel dan perkhidmatan pernyiaran di seluruh dunia. Projek ini bermatlamat mengkaji penapisan frekuensi radio di mana memfokuskan pengkajian dalam perbezaan jenis penapisan dan simulasi untuk sesebuah radio perisian.

Abstract

Third-generation wireless system call for strategies that can improve achievable performance and data rates while providing flexibility and affordability. Software Radio (SR) technology is promising to provide the required flexibility in Radio Frequency (RF), Intermediate Frequency (IF), and baseband signal processing stages. This technology could allow a single device to transmit in the various cellular and broadcast services all out the world. This project investigates the front end RF filtering, which focuses on the different types of filtering and simulation for SR.

Table of Contents

APPENDICES

List of Figures

List of Table

List of Abbreviations

ADC	Analog–Digital Conversion
AWGN	Add White Gaussion Noise
BB	Baseband
BER	Bit Error Rates
B-FFT	Buffer-Fast Fourier Transform
COBRA	Common Object Resource Broker
DAC	Digital-Analog Conversion
DCS	Digital Cellular System
DSP	Digital Signal Processing
FDD	Frequency Duplex Mode
FEC	Forward Error Control
FFT	Fast Fourier Transform
FIR	Finite Impulse Response
GSM	Global System for Mobile
GUI	Graphic User Interface
IF	Intermediate Frequency
IIR	Infinite Impulse Response
IO	Input/Output
ISI	Intersymbol Interface
ITU-T	International Telecommunications Union-Telecommunications
LNA	Low Noise Amplifier
LO	Local Oscillator
LPF	Low Pass Filter
MFLOPS	Millions of floating-point operations per second
MIMD	Multiple instruction multiple data stream
MIPS	Millions of instructions per second
NCO	Numerical Controlled Oscillator
PA	Power Amplifier
PCS	Personal Communications System
QAM	Quadrature Amplitude Modulator
RF	Radio Frequency
SNR	Signal to Noise Ratio
SR	Software Radio
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
UMTS	Universal Mobile Telecommunications System
VCO	Voltage Control Oscillator
VHDL	VHSIC Hardware Description Language
W-CDMA	Wideband-Code Division Multiple Access

CHAPTER 1

INTRODUCTION

1.1 Software Radio (SR) Definitions

Software Radio (SR) technology is increasingly used in wide range of communications. A software radio is a radio whose channel modulation waveforms are defined in software. That is, the waveforms are converted from digital to analog via a wideband Digital-to-Analog Conversion (DAC) for transmission and then possibly upconverted from Intermediate Frequency (IF) to Radio Frequency (RF). The receiver, similarly, employs a wideband Analog to Digital Converter (ADC) that captures all of the channels of the software radio node [1]. The receiver then extracts, downconverted and demodulates the channel waveform.

The design of Software Radio terminals presents challenges due to the existing of various mobile communication standards which are situated within a radio frequency range from 800 (GSM) up to 2200 MHz (UMTS/W-CDMA) with channel bandwidth from 200 KHz up to 5 MHz. Strong requirements such as dynamic range is needed while making the terminal more wideband.

1.2 Project Background

SR technology is promising to provide the required flexibility in radio frequency, intermediate frequency, and baseband signal processing stages. In a standard receiver design, the frequency selection and rejection of unwanted signal is perform by the a pre-selection filter, which in conjunction with a circulator or duplexer (FDD standards).

There are number of problems that the filtering/interface cancellation techniques are occurred in a SR design. There are the varying channel bandwidth, the duplex spacing between transmit and receive frequencies varies over the different standard and the large of frequency involved.

This project will be investigate some possible solutions for frequency selection and rejection of unwanted signal in the front-end receiver design.

1.3 Project Objectives

The objectives of this project are to :

- Investigate the filtering or rejection requirements of a SR
- Look at possible switching, tuning, or cancellation techniques that could be employed in SR
- To implement the usage of MATLAB Programming for simulation of the designed SR

CHAPTER 2

LITERATURE REVIEW

2.1 Software Radio Overview

The SR architecture is widely applicable to trunk radios, peer networks, air and sea traffic management, mobile military communications and satellite mobile systems. For simplicity, this overview describes the SR architecture in a mobile cellular or Personal Communications System (PCS) setting [2].

In an advanced application, a software radio does not just transmit: it characterizes the available transmission channels, probes the propagation path, construct an appropriate channel modulation, electronically, steers, its transmit, beam in the right direction, select the appropriate power level, then transmits. Again, in an advanced application, a SR does not just receive : it characterizes the energy distribution in the channel, and in adjacent channels, recognizes the mode of the incoming transmission, adaptively nulls interferers, estimates the dynamic properties of desired-signal multipath, coherently combines desired signal mutipath, adaptively equalizes this ensemble, trellis decodes the channel modulation and then corrects residual errors via Forward Error Control (FEC) decoding to receive the signal with the lowest possible Bit Error Rates (BER).

Lastly, the SR supports incremental service enhancements through a wide range of software tools. These tools assist in analyzing the radio environment, defining the required enhancement, prototyping incremental enhancements via software, testing the enhancement in the radio environment and finally delivering the service enhancements via software or hardware.

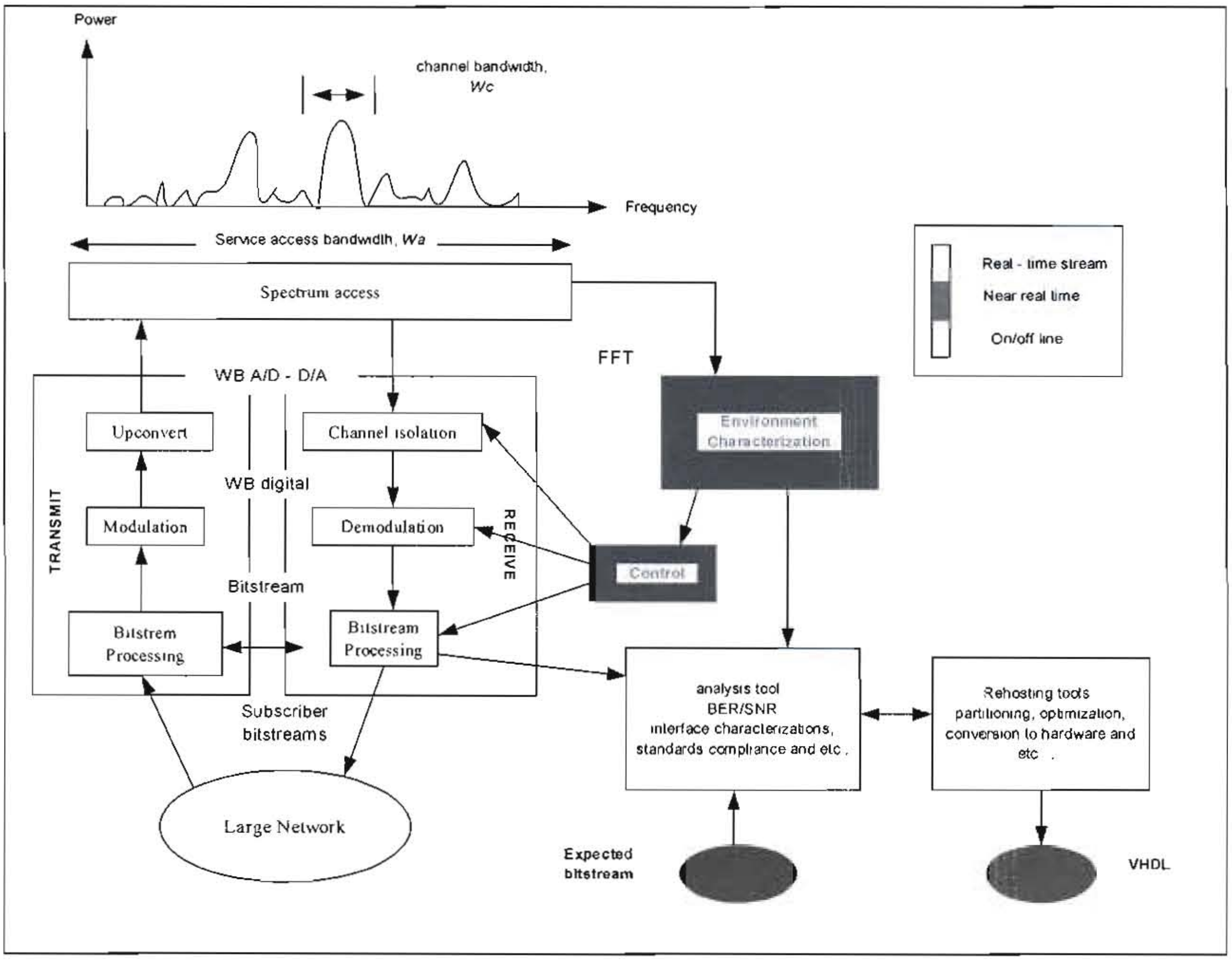

Figure 2.1 : SR functional architecture in a mobile cellular base station application[2]

2.1.1 The Real–Time Channel Processing Stream

The canonical SR architecture includes the channel processing stream, the environment management stream and associated software tools illustrated in Figure 2.1. The real-time channel processing stream incorporated channel coding and radio access protocols. Channel processing is characterized by discrete time point-operations such as the translation of a baseband signal to an intermediate frequency by multiplying a discrete time-domain baseband waveform by a discrete reference carrier to yield a sample IF signal.

The time between samples in on the order of tens of microseconds to hundreds of nanoseconds. Such point-operations require hundreds of millions of instructions per second (MIPS) and /or millions of floating-point operations per second (MFLOPS) to Giga-FLOPS with strictly isochronous performance. This is sampled data values must be computationally produced and consumed within timing windows on the order of time between samples in order to maintain the integrity of the signals represented there in. Input/Output (IO) data rates of this stream approach a gigabit per second per A/D converter.

Although these data rates are decimated through processing, it is challenging to sustain isochronisms through I/O interfaces and hard real-time embedded software in this stream. Multiprocessing is therefore be organized as a pipeline with sequential functions of the stream assigned to serially interconnected processors i.e., a multiple instruction multiple data-stream (MIMD) multiprocessing architecture.

2.1.2 The Environment Management Stream

The near-real-time environment management stream continuously characterizes radio environment usage in frequency, time and space. This characterization includes channel identifications and the estimation of other parameters such as channel interference levels which is depending on the specific signaling and multiple access scheme. The environment management stream employs block operations such as fast Fourier transforms (FFTs), wavelet transforms and matrix multiplies for beam forming.

Channel identification results are needed in times on the order of hundreds of microseconds to hundreds of milliseconds, while power levels may be updated in milliseconds and subscriber locations maybe updated less frequently. A MIMD parallel processor readily accommodates the block structure of such operations. The interface between this highly parallel environment management stream and the pipelined channel processing streams must synchronize the environment management parameters to the channel processing streams.

2.1.3 On-Line and Off-Line Software Tools

On-line and off-line systems analysis, signal processing and rehosting tools illustrated in Figure 2.1 allow one to define incremental service enhancements. For example, an enhanced beamformer, equalizer and trellis decoder may be needed to increase subscriber density. These enhancements may be prototyped and linked into the channel processing stream, allowing one to debug the algorithm, to experiment with parameter settings and to determine the service value and resources impact.

Software-based enhancements may be organized around managed objects, collections of data and associated executable procedures that work with object resource brokers and conform to related open architecture software interface standards such as the Common Object Resource Broker (COBRA). Enhancement may then be deliverd over the air to other software radio modes, as contemplated in the future software-defined telecommunications architectures being considered by ITU-T.

A well-integrated set of analysis and rehosting tools leads to the creation of incremental software enhancements relatively quickly, with service upgrades provided over the air as software defined network proliferate. Technology limitations that require hardware-based delivery are overcome by mapping critical elements of the service enhancement to hardware via VHDL.

2.2 Software Radio Basic Configurations

The SR consists of major basic components as illustrated in Figure 2.2. There are the antenna units, Analog-to-Digital Conversion (ADC) and Digital-to-Analog Conversion (DAC) Unit, Power Amplifier (PA), Circulator and Digital Signal Processing (DSP) Baseband.

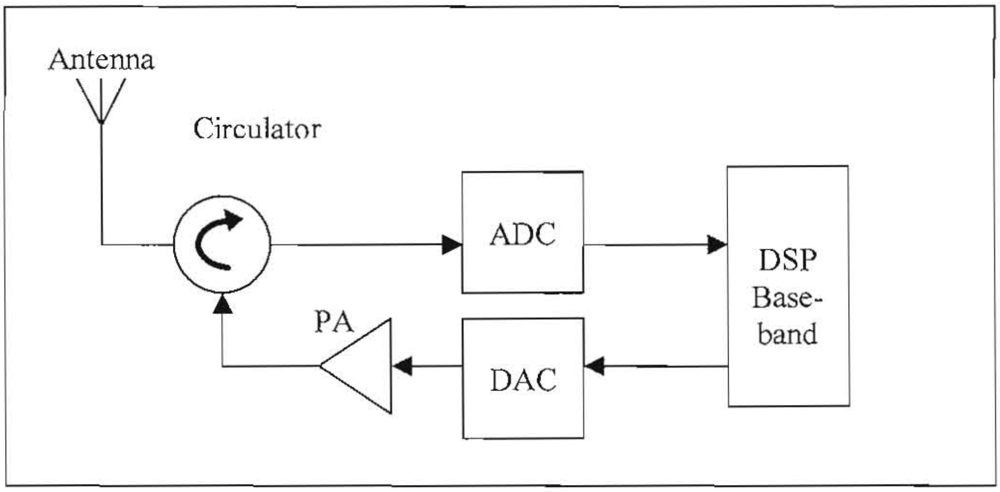

Figure 2.2 : The concept of SR architecture

The description of each component is as follows [3]:

- The modulation scheme, protocols, equalization etc. for transmit and receive are all determined in software within the Digital Signal Processing (DSP)
- The 'ideal' circulator, in conjunction with ideal (perfect) matching between it and the antenna and power amplifier impedances results in the elimination of the requirement for a diplexer in the radio. Since the diplexer is very much a fixed-frequency component within a radio, its eliminations is a key elements in a multiband or even multistandard radio.
- The Power Amplifier (PA) ensures an ideal transfer of RF modulation from DAC to a high power signal suitable for transmission, with low adjacent channel emissions.