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ROLE and SIMULATION

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Dedicated to

my dad and mum.

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Abstrak

Dalam sesebuah radio takrifan perisian, fungsi-fungsi yang asalnya diperoleh daripada perkakasan seperti penjanaan isyarat pemancaran dan pengesanan isyarat radio penerima, kini boleh dilaksanakan oleh perisian yang mengawal pemprosses isyarat berkelajuan tinggi. Atas sebab keupayaan mudah diaturcara-semula, radio takrifan perisian boleh diaturcara untuk beroperasi dalam julat frekuensi, lebar jalur dan standard pengantaran yang luas. Keupayaan aturcara-semula ini membolehkan suatu alat tunggal memancar antara beberapa perkhidmatan bersel dan penyiaran di seluruh dunia. Projek ini bermatlamat mengaji peranan teknologi radio takrifan perisian untuk masa depan sistem tanpa wayar dengan simulasi yang berkemungkinan.

Abstract

In a software defined radio, functions that were formerly carried out solely in hardware such as the generation of the transmitted signal and the tuning and detection of the received radio signal are performed by software that controls high-speed signal processors. Because of the ability to be easily reprogrammed, a SDR could be programmed easily to operate over a broad range of frequencies, bandwidth and transmission standard. This reprogramming capability could allow a single device to transmit in the various cellular and broadcast services, worldwide. This project is to study the role of SDR technologies for the future wireless system with some possible simulation.

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Chapter 1

Overview of Communication Systems

1.1 Basic Concepts of Communication Systems

1.1.1 Introduction

Communications, whether between humans, animals, or computers, involves the transfer of information. Considering that people developed computers, it should not be surprising that many of the problems that designers of communication systems face are, in many respects, similar to those encountered when people communicate on a day-to-day basis. For example:

- When two people want to talk, some agreement must be made to ensure that the person who begins talking eventually stops so that the other person has a chance to respond.

- When a person misses part of what is said in a conversation, mechanisms should exist that allow the lost information to be repeated.

- When a person finishes speaking, it is often considered polite (and some-times necessary) to ask whether what has been said has been heard and comprehended.

1.1.2 Entities

Communications, unless otherwise stated, are assumed to be between pairs of objects, often called entities. The transfer of information occurs across a channel (sometimes referred to as a line), of which there are two types:

- A simplex channel is one in which communication can occur in one direction only.
- A duplex channel is one in which a communication can occur in both directions simultaneously.

The channel can be any medium, including air, copper wire, or optical fibres. At any moment, an entity can be

- A transmitter - that is, it sends information.
- A receiver - that is, it receives information.
- Both a transmitter and a receiver - that is, it can transmit and receive information simultaneously.

Two broad categories describe the type of communication that can take place between entities. The first type of communication permits either entity to transmit, but not simultaneously, and is known as half-duplex. A typical half-duplex communication involves one entity transmitting its information while the other receives. The roles are then reversed, and the entity that was originally receiving now transmits (while the original transmitter receives).

In a communication involving humans, it is obvious who the entities are: the people involved in the communication. However, in a communication involving computers, it is not so easy to determine the entities, since one may be the application process (the software requiring the communication), the support software (the software supporting the communication requirements of the application processes, perhaps needing the communication facilities offered by the underlying hardware), or the processor (computer) itself.

1.1.3 Protocols

Other communicating entities require rules, or protocols, to ensure that the communication can proceed. Protocols are intended both to control the communication between the stations and to define certain characteristics about it. Broadly speaking, any communication protocol can be discussed in terms of the following:

- Coding of information: how the information is represented between the various entities.
- Control: how the communication is controlled by the entities involved in the communication.
- Error checking and recovery: how the entities ensure that the information is sent and received correctly.
- Channel utilization: how efficiently tile channel is used by tile communicating entities.
- Synchronization and timing: how the entities remain in step during the progress of a communication.
- Transparency: how the mechanisms supporting tile communication are hidden from the entities.

1.2 Telecommunications, Radio Communications, and Mobile Communications

1.2.1 Telecommunications

The term telecommunications covers a particularly large number of human activities relating to the transport of data. A generally accepted definition for Telecommunications, adopted by the International Telecommunication Union (ITU), is:

"Any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems."

Since the ITU adopted this definition in 1947, a large number of markets, industry, and technological developments have taken place in the field of telecommunications. The definition as given is still valid, however.

1.2.2 Radio Communications

The opposite of wireless telecommunications is wire-line telecommunications, in which an electrical conductor or glass fibre is used. Radio communications is the form of wireless telecommunications defined by the ITU as

"Telecommunication by means of radio waves."

The radio frequency spectrum or radio spectrum forms part of the electromagnetic spectrum. The latter comprises electromagnetic waves that are transmitted through space. The electromagnetic spectrum, and therefore the radio spectrum, is a naturally occurring resource in the physical environment.

Only part of the radio spectrum is technically available for telecommunications. Technological progress means that the part that can be used is increasing in size all the time. At present, telecommunications is considered to be technically feasible using frequencies up to 300 GHz (this frequency has been realized in the laboratory). Radio communications using frequencies up to 60 GHz are currently considered to be operationally feasible.

Various technical and economic aspects play an important role in determining the most suitable frequency for mobile communications systems. First, component costs increase as communications frequency rises. This is due to a market that was small and the strict criteria that are set for the technical components. Second, the free-space signal losses increase quadratically with the communications frequency used. This means the energy realized by the receiver diminishes as higher frequencies are used. These first two aspects therefore favour a low communications frequency. The third aspect, however, favours a high communications frequency: communications systems are namely disrupted by man-made noise. The most suitable frequency range for mobile telecommunications is one in which these three aspects maintain an equilibrium with each other. Current technical developments and the costs of technical components mean that this is in the range of approximately 0.5 to 2 GHz.

The exploitable part of the radio spectrum as an intrinsically scarce commodity since physical size in an absolute sense is limited with respect to its use for data transmission. The usable spectrum is divided into frequency bands. These frequency bands are ranges with upper and lower limits and are used for particular applications. Frequency bands are usually subdivided into channels. These channels are the frequency units at which communications stations transmit or receive. The size of these channels, expressed in MHz, varies depending on the application. The term channel was very satisfactory when a separate frequency was used for every communication. Following the advent of technology such as time multiplexing (TDMA, channel sharing by several users by allocating time slots) the term channel has become somewhat vague. The current ITU definition of channel is: "Channel: a means of unidirectional transmitting of signals between two points." In practice, the word channel is used both for frequencies (GSM channels, for example, each of which can be shared by eight users) and for a unidirectional capacity (the capacity in one direction intended for a particular user), depending on the context.

1.2.3 Mobile Communications

The term mobile communications refers to certain kinds of radio communications applications. This is why the definition below is of a primarily pragmatic character: other applications could, for example, also use the same technical systems. Unfortunately, there is no consensus about the content of this term: definitions and descriptions differ. This is because new systems and forms of use are being developed all the time, which system and form of use are difficult to classify. The following definition is proposed here:

"Mobile communications is a form of radio communications in which a radio connection exists between a communications station whose location is not restricted and a fixed communications station in which the communications stations may be transmission, reception and transmission/reception stations."

"Mobile" terminals are then normally installed in a fixed location, for example in the form of a telephone plus a rooftop antenna. Access to a public phone network depicted here is a called a wireless local loop (WLL): the wireless connection from the telephone wall socket to the (local) switch. A mobile communications system comprises both the entire infrastructure necessary for the connections and the entire fixed infrastructure. A communications network is a realization of a communications system.

Chapter 2

Mobile Communications Systems Development

2.1 Early History of Radio Communications

At the end of the 19th century, the young German scientist Heinrich Rudolf Hertz made an interesting discovery: An electrical spark with sufficient energy caused invisible waves to be received by a device constructed close by specifically for that purpose. He used his experiment, conducted in 1886, to confirm Maxwell's electromagnetic theory. Maxwell had predicted the existence of this kind of (transversal) waves in 1861. Communications between ships was one of the first valuable applications of wireless telegraphy (by Morse code). The 1912 Titanic disaster confirmed the usefulness of radio communications, and these systems were introduced rapidly from that time on. Initially it was only possible to transmit series of pulses and the system was limited using Morse-Code. Technology for radio communications was refined in subsequent years. In 1905, Reginald Fessenden succeeded in transmitting the first speech and music signals. The technique Fessenden used is now called amplitude modulation (AM).

The first practicable speech systems appeared during the 1920s. This was too late to have any influence on the outcome of World War I. The next technological breakthrough, frequency modulation (FM), took place in 1935 and was initially