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Additional Band width Design with Adaptive Orthogonal Frequency Division multiplexing

Prof Ch.Venkata Ratnam , Mallineni Lakshamiah Engineering college,

S. prabhu Sri Lakshmi Ammal Engg College

Abstract :

With the advent of new high data rate wireless applications, as well as growth of existing wireless services, demand for additional band width is rapidly increasing. A cognitive radio (CR) node is a radio device capable of operating over multiple channels. As a result, a network consisting of one or more CR nodes can adapt to varying channel availability in its geographical region by dynamically changing the channel (or channels) that nodes use for communication. We investigate the problem of neighbor discovery in a network consisting of one or more CR nodes when nodes have multiple receivers but only single transmitter. Neighbor discovery, in turn can be used to solve other important communication problems such as broadcasting and gossiping in an efficient manner . we present an OFDMA – based deterministic distributed algorithm for neighbor discovery. An OFDMA system is considered to be suitable for the cognitive Radio base band processing . The individual carrier frequency can be switched off for an occupied user. We propose an ARM processor architecture which can be dynamically configured for the baseband for an adaptive OFDMA baseband for cognitive radio using ARM processor.

Key words: ARM processor, CR, OFDMA,

1. Introduction :

Cognitive radio will lead to a revolution in wireless communication with significant impacts on technology as well as regulation of spectrum usage to overcome existing barriers. Cognitive radio, including SDR as enabling technology, is suggested for the first time in to realize a flexible and efficient usage of spectrum. Cognitive radio is an enhancement of SR which again emerged from SDR. Thus, cognitive radio is the consequent step from a flexible physical layer to a flexible system as a whole similar to reconfigurable radio. The term cognitive radio is derived from “cognition”, Description of the emergent development of knowledge and concepts within a group. Resulting from this definition, the cognitive radio is a self-aware communication system that efficiently use spectrum in an intelligent way. It autonomously coordinates the usage of spectrum in identifying unused radio spectrum on the basis of observing spectrum usage. The classification of spectrum as being unused and the way it is used involves regulation,as this spectrum might be originally assigned to a licensed communication system. This secondary usage of spectrum is referred to as vertical spectrum sharing. To enable transparency to the consumer, cognitive radios provide besides cognition in radio resource management also cognition in services and applications. Cognition is illustrated at the example of flexible radio spectrum usage and the consideration of user preferences In observing the environment, the cognitive radio decides about its action. An initial switching on may lead to an immediate action, while usual operation implies a decision making based on learning from observation history and the consideration of the actual state of the environment. The Federal Communications Commission (FCC) has identified in the following (lessrevolutionary) features that cognitive radios can incorporate to enable a more efficientand flexible usage of spectrum:

• **Frequency Agility** – The radio is able to change its operating frequency to optimize its use in adapting to the environment.

• **Dynamic Frequency Selection (DFS**) – The radio senses signals from nearby transmitters to choose an optimal operation environment.

. **Adaptive modulation** – The transmission characteristics and waveforms can be reconfigure to exploit or opportunities for the usage of spectrum.

• **Transmit Power Control (TPC)** – The transmission power is adapted to full power limits when necessary on the one hand and to lower level on the other hand to allow greater sharing of spectrum.

• **Location Awareness** – The radio is able to determine its location and the location of other devices operating in the same spectrum to optimize transmission parameters for increasing spectrum re-use.

. **Negotiated Use** – The cognitive radio may have algorithms enabling the sharing of spectrum in terms of prearranged agreements between a licensee and a third party or on an ad-hoc/real-time basis. Cognitive radio will lead to a revolution in wireless communication with significant impacts on technology.

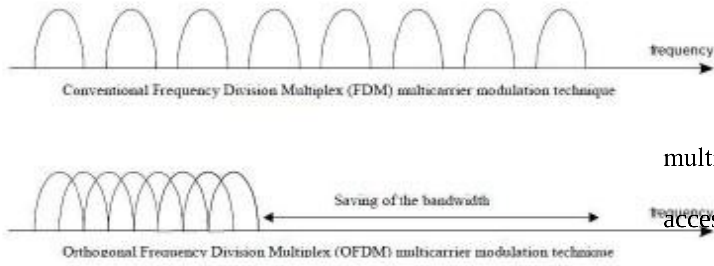
Intelligent antenna (IA) is antenna technology which exploits electronic intelligence to enhance the performance of radio communication systems, as well as being used to enhance the performance of free band systems. For instance, IA-based multiple antenna terminals enable to communicate multiple radio links simultaneously up to the number of embedded multiple antennas.

2.Current Treands and Research:

With the advance of the semiconductor technology, future wireless baseband processorsmove toward Multiprocessor System-on-Chips (MPSoCs) which integrate heterogeneous processing elements tailored for different processing tasks. MPSoCs offer high performance, re-configurability and energy efficiency. The SoC are interconnected by a Network-on-Chilp (NoC). Both the SoC and NoC are dynamically reconfigurable, which means that the programs (running on the reconfigurable processing elements) as well as the communication links between the processing elements are configured at run-time.However, it is a challenging task to map applications onto such MPSoCs. First, the applications to be mapped become more complex and may change their behavior dynamically. Second, applications have to be partitioned into tasks which are to be mapped on different components on an MPSoC.Therefore, designers have to deal with the low level interfaces for the inter-component communication and synchronization which may become a bottleneck from a performance and an energy point of view.Further, opportunities for reuse of hardware and software modules are limited and a method for exploring their trade-offs is missing. Therefore, there is a gap between the application models used for specification and the optimized implementation of the application on an MPSoC. So in this paper we propose an ARM processor for developing the adaptive OFDMA application for cognitive radio as ARM processor is itself a System on Chip. This proposed system design has all OFDMA and Baseband units present with in the ARM itself so it’s a single processor with reduced area and power.

3 OFDMA:

The Orthogonal Frequency Division Multiplexing (OFDM), a multiple carrier modulation technique. The idea was to use parallel data streams and FDM with overlapping sub channels to avoid the use of high speed equalization and to combat impulsive noise, and multipath distortion as well as to fully use the available bandwidth. The initial applications were in the military communications. In the telecommunications field, the terms of discrete multi-tone (DMT), multichannel modulation and multicarrier modulation (MCM) are widely used and sometimes they are interchangeable with OFDM. In OFDM, each carrier is orthogonal to all other carriers. However, this condition is not always Maintained in MCM. OFDM is an optimal version of Multicarrier transmission schemes.



For a large number of sub channels, the arrays of sinusoidal generators and coherent demodulators required in a parallel system become unreasonably expensive and complex The receiver needs precise phasing of the demodulating carriers and sampling times in order to keep crosstalk between sub channels acceptable. Addition to eliminating the banks of subcarrier oscillators and coherent demodulators required by FDM, a completely digital implementation could be built around special-purpose hardware performing the fast Fourier transform (FFT). Recent advances in VLSI technology enable making of high-speed chips that can perform large size FFT at affordable price. In a conventional serial data system, the symbols are transmitted sequentially, with the frequency spectrum of each data symbol allowed to occupy the entire available bandwidth. In a parallel data transmission system several symbols are transmitted at the same time, what offers possibilities for alleviating many of the problems encountered with serial systems. In OFDM, the data is divided among large number of closely spaced carriers. This accounts for the “frequency division multiplex” part of the name. This is not a multiple access technique, since there is no common Medium to be shared. The entire bandwidth is filled from a single source of data. Instead of transmitting in serial way, data is transferred in a parallel way . only a small amount of the data is carried on each carrier, and by this lowering of the bit rate per carrier (not the total bit rate), the influence of inter symbol interference is significantly reduced. In principle, many modulation schemes could be used to modulate the data at a low bit rate on to each carrier.

OFDM can be simply defined as a form of multicarrier modulation where its carrier spacing is carefully selected so that each sub carrier is orthogonal to the other sub carriers. As is well known, orthogonal signals can be separated at the receiver by correlation techniques; hence ,inter symbol interference among channels can be eliminated. Orthogonality can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. In order to occupy sufficient bandwidth to gain advantages of the OFDM system, it would be good to group a number of users together to form a wideband system, in order to interleave data in time and frequency (depends how broad one user signal is).

4 ARM:

A microprocessor's architecture defines the instruction set and programmer's model for any processor that will be based on that architecture. Different processor implementations may be built to comply with the architecture. Each processor may vary in performance and features, and be optimized to target different applications. Future processors, based on the new ARM architecture will provide developers of embedded systems with higher levels of system performance, whilst maintaining excellent power and area efficiency. Next generation architectures have been driven by the needs of emerging products and evolving markets. The key design constraints are predictable. The function, performance, speed, power, area and cost parameters must be balanced to meet the requirements of each application. ARM offers better ways of optimizing these constraints. At each major revision of the ARM architecture, significant features have been added. Between major architecture revisions, new features have been included as variants on the architectures.

modulation schemes could be used to modulate the data at a low bit rate onto each carrier.

The key letters appended to the core names indicate specific architecture enhancements within each implementation.

Key Improvements:

Memory Management

System design and performance is heavily affected by the way that memory is managed. The memory management architectural enhancements improve the overall processor performance significantly – especially for platform-type applications where operating systems need to manage frequent task changes. With the changes in ARM, average instruction fetch and data latency is greatly reduced; the processor has to spend less timewaiting for instructions or data cache misses to be loaded. The memory management improvements will provide a boost in overall system performance by as much as 30%. In addition, the memory management enhancements will enable more efficient bus usage. Less bus activity will yield significant power savings as a result of reduced memory access

Multiprocessing

Application convergence is driving system implementations towards the need for multiprocessor systems. Wireless platforms, especially for 2.5G and 3G, are typical applications that demand integration between ARM processors, ARM and DSPs, or other application accelerators.

Multiprocessor systems share data efficiently by Sharing memory. New ARM capabilities in data sharing and synchronization will make it easier to implement multiprocessor systems, as well as improving their performance. New instructions enable more complex synchronization schemes, greatly improving system efficiency.

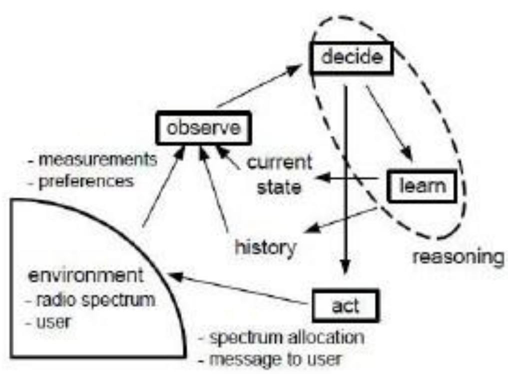
Data Handling

A system's endianism refers to the way data is referenced and stored in a processor's memory. With increasing system on chip (SOC) integration, a single chip is more likelyto contain little-endian OS environments and interfaces (such as USB, PCI), but with big-endian data (TCP/IP packets, MPEG streams). With ARMv6, support for mixed-Endean systems has been improved. As a result, handling data in mixed- endean systems under ARM is far more efficient. Exceptions and Interrupts for implementations targeted at real-time systems, efficient handling of interrupts can be critical. Examples include system such as hard disk controllers , and engine management applications where the consequences can be severe if a critical interrupt does not get serviced in time. More efficient handling of exception and interrupt conditions also improve overall system performance. This is especially important in reducing system latency. The introduction of the ARM architecture brings a new set of features and a performance leap that will meet the needs as they design next generation products across a range of target markets.

5 Our Proposed System Design:

The OFDM based cognitive radio is mainly used for dynamic allocation of the spectrum.

The present system is based on MPSoc where we have multiprocessors embedded inside a single chip. Since we use multi processors we have to overcome problems like network congestion, area, power and many other issues. As ARM processor is itself a System on Chip we can configure the ARM processor for the dynamic allocation of the spectrum.This can be explained with the help of cell phone example which is being explained in detail below.



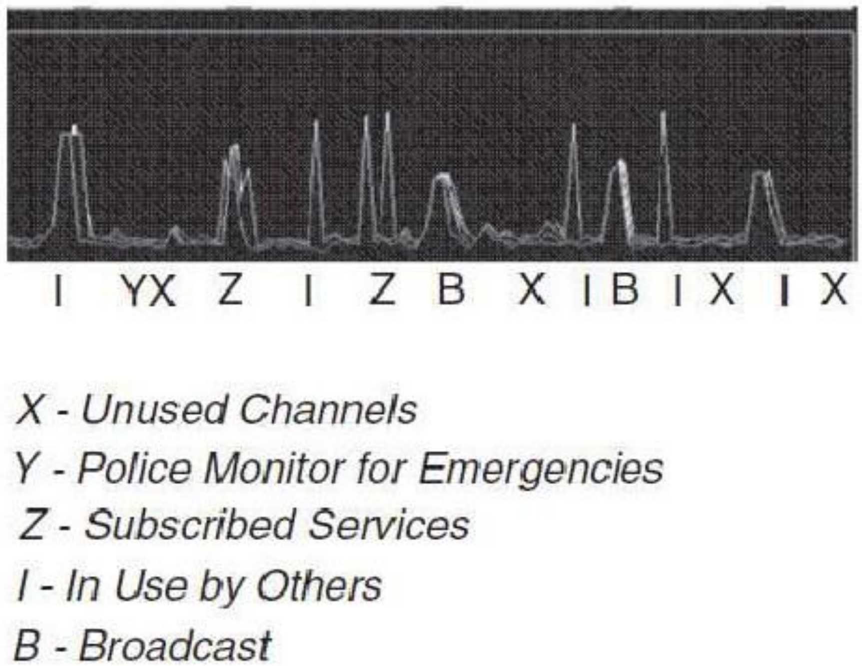


Fig 1:FSM for Cognitive Radio

The above figure shows the FSM of a Cognitive radio system. In the above system the user or the environment is giving the preferences and being observed the control systemand then the spectrum allocation is being decided and the whole system acts accordingly.The history of previous spectrum allocation has been learnt and updated periodically from which the spectrum allocation is done faster. We propose to bring this entire control system inside an ARM processor. Cognitive radios as radio systems that continuously perform spectrum sensing, dynamically identify unused ("white") spectrum, and then operate in this spectrum at times when it is not used by incumbent radio systems. Modern wireless LAN IEEE 802 .11 devices operate with a listen-before-talk spectrum acess and with dynamically changing frequencies and transmission power. However, such existing standards provide only a subset of the required techniques for cognitive radio, and do not cover the full range of objectives for efficiently re-using the licensed spectrum. We propose a framework for machine-understandable policies that would enable cognitive radio devices to make intelligent decisions.

The above diagram shows the different spectrum available while transmitting . in an ARM processor based cell phone there is a GPS monitoring system which senses the incoming spectrum and checks the data coming whether it's for the specified number or not and makes the processor act accordingly. With this we can also add a base band sensing circuit, OFDM and a MIMO to the ARM processor which identifies the spectrum to be dynamically allocated and makes the processor act accordingly. Hence a single processor is only required for the dynamic allocation of the spectrum rather than using MPSoC where the inter connection of the processor is a complex one. As shown in the above figure the in built components in a ARM processor detects the unused channels , in use by others and broadcast spectrum with the help of the control diagram shown in figure 1.

The OFDM has to be taken into consideration while we allocate spectrum dynamically.The data rate can be increased based on the formula given below,

$$Max \;\; R = \sum_{k=1}^{K} \frac{F_k}{K} \log_2(1 + \frac{h_k^2 p_k}{N_0 \frac{B}{K}})$$

$$Subject\ to: \sum_{k=1}^{K} p_k \le P_{total}$$

$$F_k \in \{0, 1\} \text{ for all } k$$

$$p_k = 0 \text{ for all } k \text{ which satisfies } F_k = 0$$

Where R is the data rate; K is the number of sub carriers; No is noise power density, B is the band of interest for Cognitive radio,hk is the subcarrier gain and Pk is the power allocated to the corresponding sub carrier.Fk is the factor indicating the availability of sub carrier k to cognitive radio,where Fk =1 means the kth carrier can be used by Cognitive radio . The bit allocation vector is determined by the spectrum occupancy information from spectrum sensing . The bit allocation vector is disseminated via a signaling channel, so that both transmitter and receiver have the same information . we assume the bit allocation vector does not change frequently for instance during several frames. The basic idea is to load more bits on good sub carriers and load zeroes on to carriers which cause interference to the licensed user or lead to poor transmissions.

6 Conclusions and Future Work:

This paper presents a proposed system design methodology for implementing an adaptive OFDM system, which is a part of Cognitive Radio baseband on an ARM processor. ARM processor reduces network congestion as it's not a multi-processor. The component interconnection is made easy in ARM therefore data communication and spectrum allocation is very faster when compared to MPSoc. It also consumes less area and power because of its tiny size. In the above paper we have not discussed about the analysis of data being transmitted. The data being transmitted through the dynamic spectrum must be verified whether it's an original data or message which will be very useful in military related applications. We propose to verify the data being sent in our future work.

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Authors Biography

Prof.Ch venkata Ratnam working as a professor in CSE Department at Malineni Lakshmaiah Engg College From June 2011 to till date . He has 17 years of teaching experience and his areas of research interested in Wireless and Mobile communications, Telecommunications, Microprocessors and microcontrollers communication Systems.

S.prabhu working as Assistant professor in CSE Department at sri Lakskmi Ammal Engg college. He has interested in communication Systems, Digital signal processing , Embedded Systems, VLSI Design.