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Digital signal processors (DSP) and 3G Mobile Communication System

Abstract - Digital signal processing is performed by mathematical operations. Digital Signal Processors are microprocessors specifically made for digital signal processing tasks. These devices have an enormous growth during the last decade, are used in everything from mobile phones to advanced scientific instruments. In fact, hardware engineers use "DSP" to mean Digital Signal Processor, just as algorithm developers use to mean "DSP" Digital Signal Processing. DSP has become a key component in many consumers, communications, medical and industrial products. This paper illustrates the role of the Digital Signal Processors (DSP) for mobile radio systems of the third generation. The currently used wireless infrastructure supports the third generation of mobile communications of many significantly different standards together. As a result, the interoperability of these standards with respect to the cellular base station is nearly impossible. Many solutions for the base station or mobile station over the years has been carried out, and each solution is required, a combination of two components, ASICs (Application Specific Integrated Circuits) and DSPs (Digital Signal Processors). This two-chip solution divides the processing tasks between the ASIC and DSP are. Although this solution is functionally acceptable to its system cost and flexibility not fully optimized. Global goals and attributes that belong roaming, universal connectivity, high data transfer rates, site service capabilities and support for high-quality multimedia services are now required worldwide.

Key terms: Digital Signal Processors, 3G Mobile Communications Systems

1. Introduction

The significance of the digital signal processors (DSPs) for the communication, especially mobile communications, has increased. Today DSPs provide a key technology for the design of baseband modem and lower layer protocol functions. Factually, DSPs were designed around multiplier as independent integrated circuits (ICs). With the VLSI technology, the computing power and complexity of DSPs has been increasing to the current levels. Therefore, embedded DSPs have been widely accepted today and are becoming mainstream. However, in the future, developing of the market will occur furthermore. Major customers of embedded DSP ICs, such as "tiers one" mobile device terminals manufacturers, today must have ASIC design expertise, to adopt the custom logic to the embedded DSP. So there can be an exclusive solution to secure a competitive advantage. This paper is a brief understanding of the DSP technology.

2. Motivation

2.1. Achieving a competitive advantage

The communications market is very dynamic and has a high development rate. Therefore DSPs [2] for the communication need to evolve further as a platform for achieving and maintaining a competitive position. How can this be attained?

The performance of the DSPs is developed by advances in semiconductor technology. This leads for example to higher clock frequencies and lower power consumption per MIPS. Extra performance developments can be obtained by developing new DSP architectures, in which the performance can be measured by a reduced need for MIPS per algorithm (improved efficiency), reducing power consumption or allowed higher clock frequency. Riding on advances in semiconductor technology to achieve a competitive advantage can be extremely dangerous. Therefore Architecture technology is a important.

2.2. How to get a hold of DSP technology?

Usual money maker ICs have obtained a reasonable advantage by ensuring a technical and / or marketing advantage. A technical benefit as:

(i) Power
(ii) The size / cost
(iii) Performance
(iv) Package, I/O, chip integration

is attained by combined architecture applications optimization.

2.3. What type of DSPs is required?

There have been discussions about DSPs against microprocessors. This was generally based on general-purpose floating-point DSPs. Essentially; DSPs cover a very broad spectrum of architecture for customizing applications.

We can divide DSPs into three general classes,

(i) Application specific DSP (AS-DSP)
(ii) Domain specific DSP (DS-DSP)
(iii) General purpose DSP (GP-DSP).

Following we refer to a circuit of DSP only, when it is software programmable by an assembly language. DSPs defined as, [1] we call data path processors AS-DSPs are

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usually on an application to serve high-end application performance requirements, or adapted to minimize costs. In general, the market volume should allow for a customized solution to be developed and customizing performed to gain market advantage. But, the time to market constraints must permit for a long design cycle. Examples of AS-DSPs may found, for speech coding [2, 3]. Application Customizing will found in the data path, address generation, memory bus architecture, and I / O.

DS-DSPs are targeted for broader applications, such as cellular modems (TI C540, TCSI Lode). They can be used in a variety of applications, but they have been developed "with a target application in the mind". With the special instructions and additional hardware, one can domain-specific algorithms run efficiently.

A DS-DSP is high enough to allow specialized solutions designed for a market with a volume. Its main advantage over an AS-DSP is the rapid availability and access to a small software base library. GP-DSPs are developed from the classic FFT / filtering multiply-accumulate design paradigm. Examples include C50 TI, Lucent 16xx, Motorola 563xx, 21xxx and ADI DSP Semi Oak / Pine. GP-DSPs are readily available and are broadly applicable, and have a large software base. However, they lack the performance compared to more customized solutions for specific applications.

3. The Third Generation of Mobile System Requirements

As more as applications require audio, video and communications processing functions, demands placed on the processors in the base station and mobile stations (portable devices and edge-client devices) became as computationally and bandwidth intensive. Both RISC microcontroller (MCU) and DSPs have assisted these applications.

While RISC processors have traditionally been designed to allow efficient asynchronous control flow, DSPs are designed to perform well for synchronous, constant rate data stream (for example, audio or voice band applications).

Because so many embedded applications have intensive demands for control and media processing, the engineers usually used DSPs and MCUs together, either at board level or in system-on-chip (SoC) integration. Together, the relevant functional aspects of RISC processors and DSPs unite as perfect processing machine for a variety of multimedia applications and products, such as mobile phones, digital cameras, portable networked audio / video devices, and so on. Key base station areas that require high-performance DSPs include:

(I) Antenna array with adaptive digital beamforming (in BS Base Station)

(Ii) Power Control (in both BS and MS - base and mobile stations)

(Iii) Voice Processing (in BSC: Base Station Control)

(Iv) Baseband modem (in BTS: Transceiver Base Station)

Digital Signal Processors are required in both BS and MS, as we observe in Fig. 1, 2. Today, there are some new technologies such as:

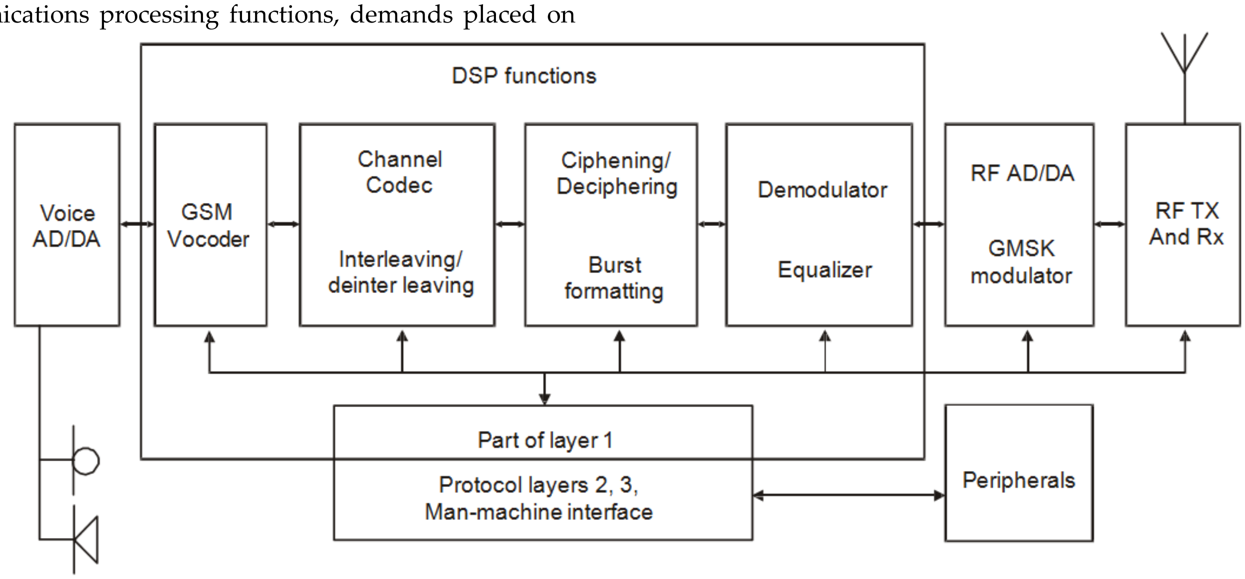

Fig.1. The GSM mobile station.

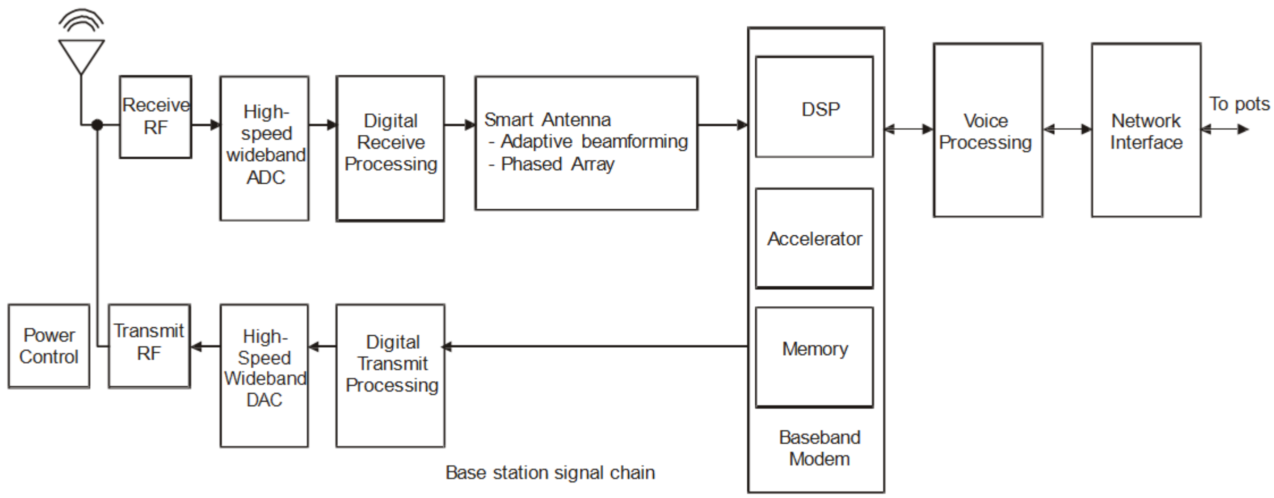

Fig.2. the base station.

(i) DSP - based Internet telephony, which becomes the bridge between PSTN and packet-switched network (VoIP gateway); the DSP advances in computing power, smaller footprint and reduce power dissipation have expanded number of channels carried on VoIP gateways.
(ii) ADSL market
(iii) Software Radio
(iv) Space-time processing

3.1. Smart Antennas

Digital beam-forming algorithms are aimed to target the source positions in a noisy environment. They quickly compare responses from several antennas used in space; the result of calculation is a signal that probably comes from the target direction. In principle, calculates a correlation function which compares the signals and a measure that how close to the desired and received signals. Due to the several factors involved in the algorithm, and their wide dynamic range, floating point perform multiplication accumulate operations, which are used almost completely to reduce rounding error. The objective is movable and can be moved to a significant velocity, adds another dimension of complexity of calculation.

3.2. Power control

In code division multiple access (CDMA) systems initiated for 3G, base station power control of remote unit transmitter (uplink) is proposed critical to compensate for fast fading, peaks in the transmission of power, and to avoid near-far problems. This is required to reduce interference between cells. The calculations required for power control and are multiply-accumulate intensive which requires the high performance digital signal processing to meet requirements of time delay in 3G systems.

3.3. Language Processing

DSPs [3] are the traditional choice for speech processing in the cellular system. Opinion on the quality of the system of the phone user's is straightly dependent on the performance of the speech coder, and this has a solid impact on the channel density. Numerous speech codes are used today in the current 2G systems and must be supported in 3G systems. Although lower codec bit rates to raise equipment capacity, they degrade voice quality. The critical DSP features for high-quality voice processing combine large on-chip RAM and a high processing capacity to support fast context switching and high channel density.

3.4. Baseband modem

The 3G standard is expected to be a major factor, the applications that are made possible the transmission of broadband signals. Accordingly, the baseband modem (BTS) has developed and with the possibility of applications with high bandwidth and low bandwidth voice and paging mix to be implemented. In downlink packets to the base station in parallel transport block streams in physical channels; and in the uplink, it creates the transport blocks from the baseband signal. 3 shows a typical baseband modem portion of the 3G base station for both uplink and downlink configurations. During the downlink error coding schemes are applied first to the transport block. Then the blocks are rearranged and before it from, sent with other channels recombined to the radio. For the uplink, the rake receiver is used for the first time to sort and optionally to combine multipath effects to the data of a plurality of antennas. The blocks are then restored to their original order and channels are applied before forward error correction. The next section shows a breakdown of the baseband modem insight as to where a designer can choose to use a DSP. An optimum must be between minimizing the power cost and maximizing the flexibility of the system to future design iterations are sought to deal with. Rake, channel coding / decoding hardware-software trade-offs: an overview of the functions shown in the figure 3 is needed to see exactly where DSP is better than other alternatives. The interleaving, channel segmentation and rate matching are I / O-intensive operations to combine the data from different sources and to reorganize the data in order to minimize the effects of errors. Due to the variability of the parameters, data rates and the memory reference, these functions are ideally suited for the manipulation DSP; it would be difficult to implement cost-effective in an ASIC. The error coding and correction algorithms include bit manipulations implemented correctly - can be implemented in the DSP. The error correction algorithms provide an area of the modem manufacturer that can provide differentiation.

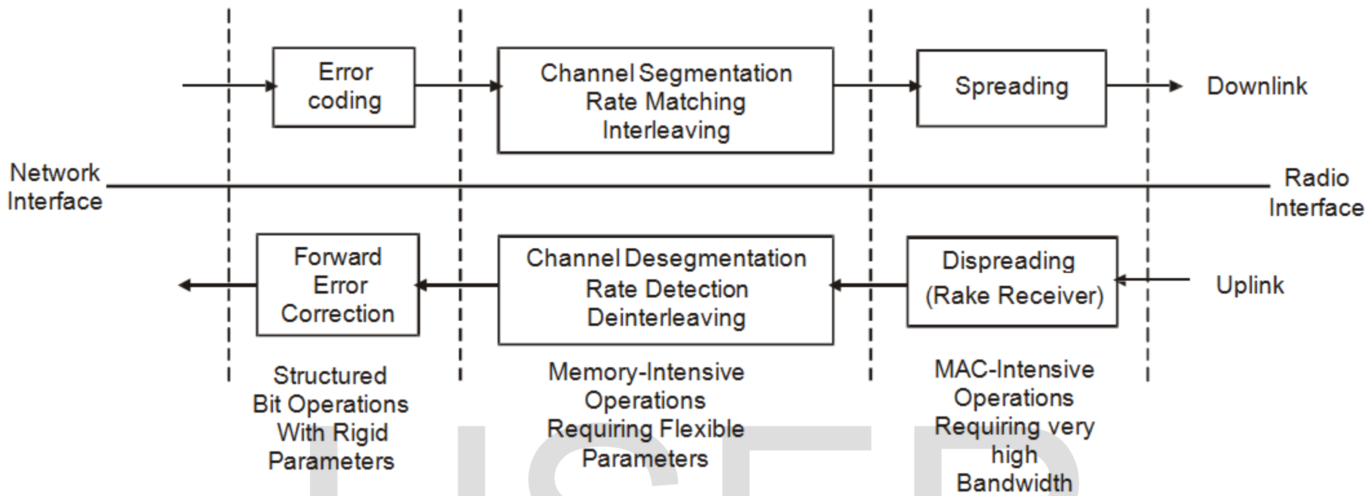

Fig.3. Block diagram showing the baseband processor's signal chain.

3.5. Advance technologies

The advanced technologies consider the extensions of multiple antennas (MIMO) processing in the physical layer provided. Traditionally, the speed of a wireless connection through the radio resources (power, bandwidth) is limited. If the transmitter antennas and the receiver antennas, the connection speed linearly with the same power and bandwidth budget. More antennas provide spatial dimension in the radio resource set. Some technologies are briefly explained below. These techniques are suitable for the use of DSP -BLAST (Bell Labs Layered Space-Time Architecture): At the transmitter N independent data streams from the n antennas are transmitted in the same bandwidth. At the receiver, each receiving antenna "sees" all the transmitted streams superimposed, not separately. If multipath scattering is sufficient these n data streams different spatial signatures for each of the n reception antennas are separable.

4. Conclusion

Designer of 3G base stations is the use of DSPs in order to attain the required high performance and flexibility for tomorrow's voice and data applications. Speech encoding is an important application of digital signal processing in modern mobile communications, which use high data compression ratios. Effective execution of these design principles is the promise of 3G to fulfill the foundations for the kind of wireless infrastructure, the offer for applications of tomorrow.

5. References

[1] G. Fettweis, S. Wang, "Strategies in a cost-effective implementation of the PDC half-ratecodec for wireless communications," IEEE 46th

[2] Gerhard Fettweis, "DSP Cores for Mobile Communications: Where are we going?"

[3] Gatherer, E. Auslander, editors, "The application of programmable DSPs in Mobile Communication", Ed.Wiley, (2002),

[4] Y. Okumura, T. Ohya, Y. Miki, T. Miki, "A study of DSP circuits applied to speech codec for digital mobile communications," Proc. of the Fall Meeting of the IEICE, B-294, p.2-294(1993).