Description and implementation of some aspects of UMTS terminals

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Abstract: *In this paper, the main parts of an UMTS terminal are described. First, a radio-frequency receiver using a super-heterodyne architecture is presented. Then, the functionality and implementation of the baseband physical layer is discussed. Finally, optimization of the transmission of multimedia applications is addressed.*

1. Introduction.

The sustain growth of mobile phone users is emphasized by the current success of second generation systems. However, second generation systems can only deliver voice, messaging and low bit rate data services because of their limited bandwidth capacities. Third generation systems, as described in ITU's IMT-2000 standards, are specified to deliver multimedia services and wideband applications available at any location. UMTS is one of the major third generation systems.
This paper proposes a description and an implementation of some aspects of UMTS terminals. An implementation of operations carried out by the radio-frequency receiver and in the physical layer are shown in the first and the second sections, respectively. The integration of multimedia applications in UMTS terminals for an optimized transmission over an UMTS network is pointed out and discussed in the last section.

2. Analog receiver.

Figure 1 shows a block diagram of the W-CDMA mobile station receiver. The receiver uses conventional super-heterodyne architecture. The received frequencies 2110-2170 MHz are down converted to the first intermediate frequency (IF) of 270 MHz. The desired 5 MHz channel is then selected by an IF band-pass filter. An AGC amplifier provides variable gain control to IF signal with 90dB of dynamic range, from –45 dB to 45 dB. The IF signal is fed to the demodulator circuits where it is mixed with fixed local oscillator frequency to produce zero IF baseband quadrature I and Q signals. To avoid the unwanted DC and low frequency signals simple DC blocks are used. The differential I and Q signals emerging after DC blocking are filtered by low pass filters and sent to the 10-bit A/D converters.

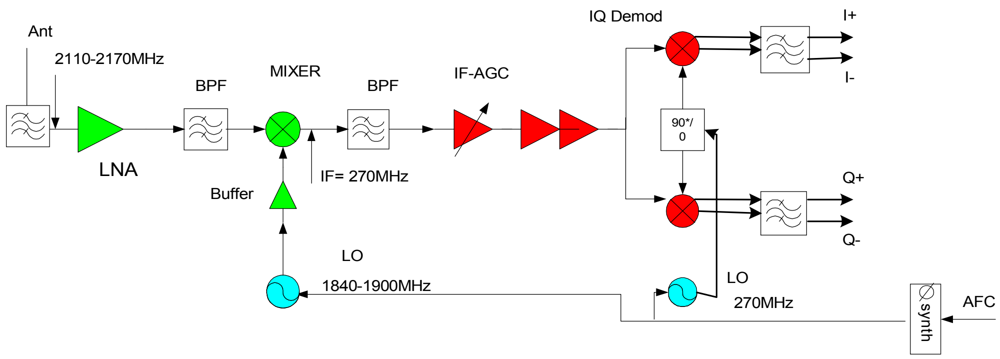

Figure 1 : A block diagram of the W-CDMA mobile station receiver

The component specifications are reported in Table1. The system performance analysis was carried out. It shows a noise figure of about 5 dB which is adequate considering the sensitivity specification by 3GPP, namely an input power of –117dBm [1]. The cascaded 3rd order intercept point value is – 6.2 dBm. This value is higher than the 3rd order intermodulation requirement of the standard. The I to Q path amplitude imbalance caused by mainly the IQ demodulator and local oscillator phase noise, results in error value of less than 1dB. The IQ path mismatch yields a negligible phase error value. That means the two signal paths have a good matching.

	BPF-1	LNA	BPF-2	Mixer	BPF-3	AGC	Amp-1	Amp-2	Demod	BPF-4
Gain (dB)	-2	20	-2.5	-7	-3	-40/38	19	19	0	-1
NF (dB)	2	1.5	2.5	7	3	50/5	3.8	3.8	24	1
OIP3		22		10	-42/-4	30	30	5		

Table 1 : Component specifications

For the receiver characterization, a W-CDMA signal with 9 code channels is used: two sub-channels for synchronization (primary and secondary SCH), three common channels (pilot channel CPICH, primary and secondary CCPCH), and four dedicated physical channels (DPCH). The receiver signal measurements were made using a vector signal analyzer. As an example, the output received power spectrum are shown in Figure 2. The measurement results are closed to predicted ones. The measurements were limited to positive signal to noise ratio (SNR).

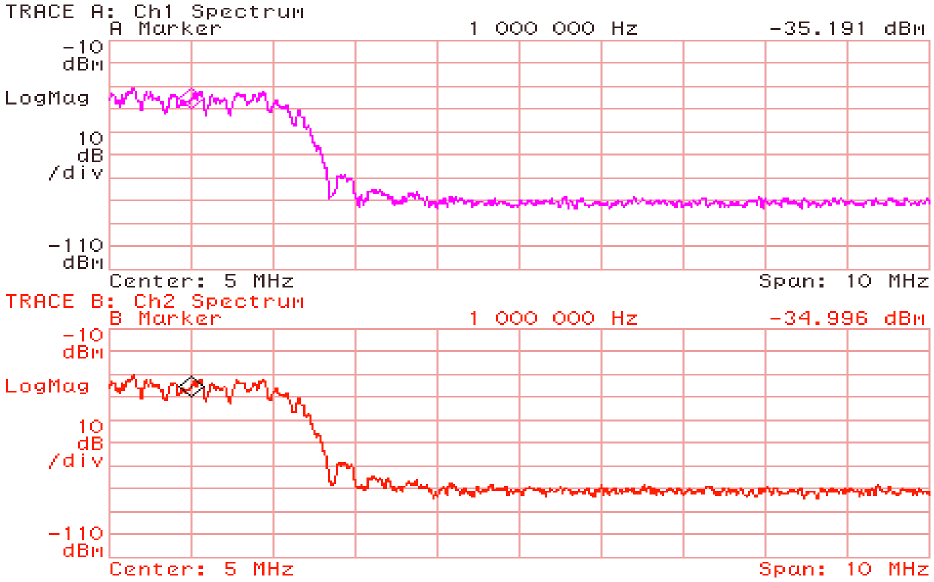

Figure 2 : Received baseband spectrum : I & Q signal

3. Baseband receiver.

The system model is based on a baseband functionality of a mobile station receiver. The functions reverse-link receiver is given in Figure3.

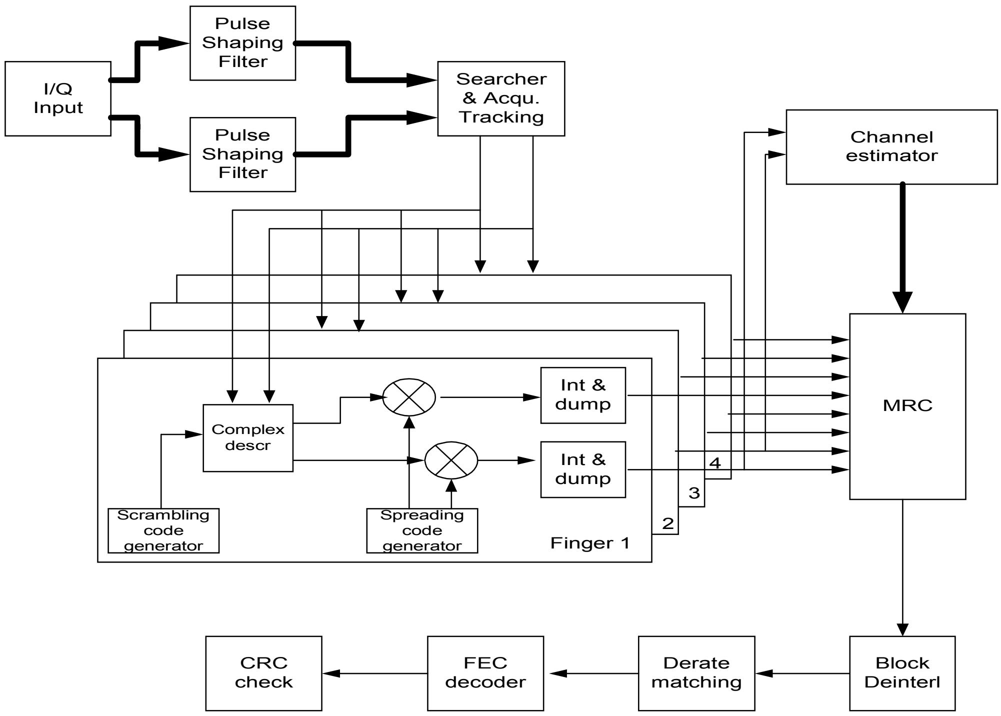

Figure 3 : Reverse link receiver

The most typical choice in implementing baseband processing especially at the chip rate in 3G mobile station has been the ASIC, with its high-speed and low-cost processing power. However, the mandatory requirement for future flexibility opens the debate to include DSP-based solutions including those where the DSP is complemented or supported by a coprocessor. There are two basic baseband signal-processing categories to consider: processing at the chip (spreading) rate and processing at the symbol rate. The attributes of DSPs and ASICs clearly define their availability for these tasks [2].

4. Transmission of multimedia applications over UMTS network.

The main differentiating factor between 2G (GSM, IS95) 2.5 G (EDGE, GPRS and HCSD) and 3G (UMTS, CDMA2000) is the achievable throughput. When most of Internet applications can be accessed with a 52.6 kbps modem, video telephony or video streaming require higher data rate in order to meet user requirement in terms of quality. Hence, multimedia applications with rich video content , should benefit the deployment of 3G wireless networks. Following this assumption, the question is how to integrate such application in an UMTS terminal and what are the consequences on the architecture of tomorrow's network and terminal?

Three topics to be studied are identified : applications, transport, and economic aspects. To each topic corresponds a set of characteristic parameters given in Figure 4. As a first conclusion, an objective that depends on these characteristics must be minimized to produce multimedia capable terminals that could be deployed in an UMTS network.

Application aspects are tackled in three subjects. First concerns the adaptation of existing video telephony application, H323, to UMTS. This action results from a call for contribution made by ITU in 1999. Second, the development of a simple demonstration application is considered to evaluate what are the parameters to be tuned in order to adapt the bit rate at the output of the application layer to the available transport capacities of the network. Third an action is to define a set of transport channel parameters fitting to the requirement imposed by application

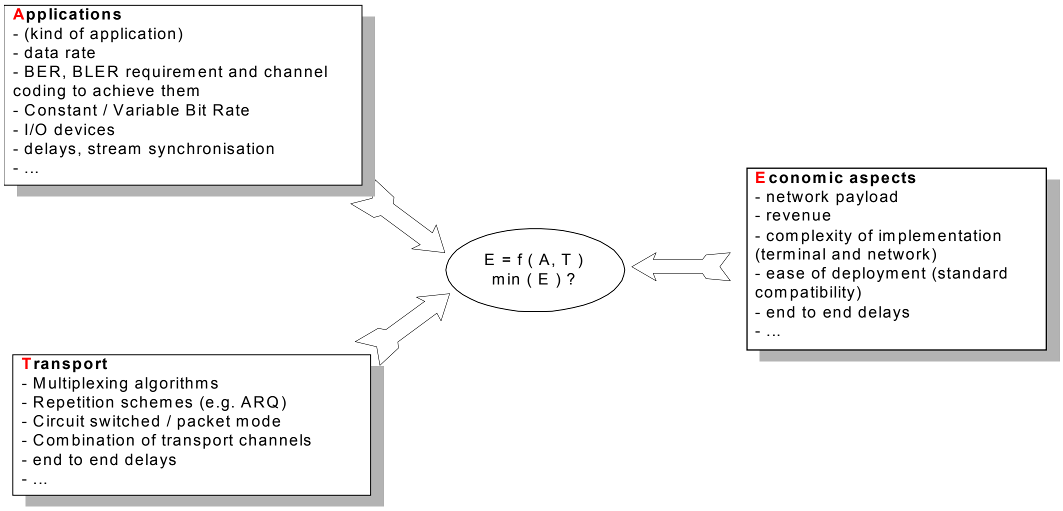

Figure 4 : Characteristics to be optimized

4. Summary.

Main parts of an UMTS terminal have been described in this paper. First, a super-heterodyne architecture for the radio-frequency receiver has been analyzed. Experimental measurements have confirmed that the implemented architecture meets the requirements specified in the UMTS norms. Operations carried out in the physical layer have been implemented on an ASIC. Finally, a cost function which depends on a set of application, transport and economic characteristics has been established. This cost function should be minimized to efficiently integrate multimedia applications in an UMTS terminal.

References.

[1] 3GPP Technical Specification 3G TS 25.101: " UE Radio transmission and Reception (FDD)."

[2] S. Morris, " Signal-Processing Demands Shape 3G Base Stations." Wireless Systems Design, Nov. 1999, pp.12-18.