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REVIEW ON RECEIVER ARCHITECTURE FOR MULTI-STANDARD (WLAN & WIMAX)

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Abstract: ***One of the biggest challenges in wireless communication systems consists in achieving flexible dual-band receivers with maximum hardware share and minimum power consumption. The key for surpassing this challenge is the feasibility and performance evaluation for the different receiver topologies at system level stage. This task has its degree of complexity, by the fact that the receiver blocks can have different implementations leading to different performances.***

This paper presents the receiver architecture and the corresponding design supporting WLAN and WIMAX standards with small form factor, low cost, and low power consumption. To maximize the level of component share in the receiver, the corresponding standards is analyzed and applied to the proposed multi-standard receiver architecture.

Keywords: Direct conversion receiver, WLAN, WiMAX, 802.11g, 802.16e

I. INTRODUCTION

The evolution of telecommunication technologies has been going through three different three generations of mobile networking. At the same time, the new Internet-based wireless technologies, such as WLAN and WiMAX, are increasingly seen deployed in our everyday life. One of the biggest challenges in wireless communication systems consists in achieving flexible multi-standard receivers with maximum hardware share and minimum power consumption.

Institute of Electrical and Electronics Engineers (IEEE) 802.11 Wireless Local Area Network (WLAN), also known as Wi-Fi, is most certainly the wireless technology with the highest acceptance worldwide, becoming nowadays the default interface in almost every electronic device.

Meanwhile, Mobile Worldwide Interoperability for Microwave Access (WIMAX) continues to attract a lot of attention in the telecommunication world, especially by manufacturers and Internet Service Providers (ISP) [1].

II. WLAN & WIMAX STANDARD

A. WLAN

The IEEE standard 802.11 development on WLAN began in 1991 by the IEEE 802.11 Working group. IEEE 802.11a was presented in 1999 and is based on OFDM at the 5 GHz

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band, while IEEE 802.11b, also presented in 1999, is based on the Complementary Code Keying (CCK) at the 2.4 GHz band. The 802.11b products arrived at the market around the same time with great success due its backward compatibility and fast transmission rates. IEEE 802.11a was later introduced to the market in 2002 with great difficulties. It was not backward compatible and the devices were more expensive, its higher transmission rates weren't enough to overcome those two downsides.

Nowadays, IEEE 802.11g remains the most popular 802.11 PHY in the market at a global scale. Mainly due to its fast transmission rates, lower cost devices and backward compatibility. Table 1 compares the various PHYs of the 802.11.

Standard	Modulation	Frequency Band	Transmission rate(Mbps)
802.11a	OFDM	5GHz	Upto54
802.11b	DSSS	2.4GHz	Upto 11
802.11g	OFDM	2.4GHz	Upto 54

Table 1: IEEE 802.11 Standard [2].

B. WIMAX

The development of the IEEE 802.16 standard on Broadband Wireless Access (BWA) started in 1999, by IEEE 802.16 Working Group. The initial goal was only to provide fixed wireless services, but it was expanded to offer mobility in IEEE 802.16e. WIMAX Forum is responsible for the commercial profile of IEEE 802.16 standard since 2001.

The fixed BWA service in Line of Sight (LOS) environment of 10-66 GHz band was approved in 2001 (IEEE 802.16-2001). In 2003, IEEE 802.16a standard was developed in the Non Line of Sight (NLOS) environment of 2-11 GHz band including three types of Physical Layer (PHY) layers, Single Carrier (SC), Orthogonal Frequency Division Multiplexing (OFDM), and Orthogonal Frequency Division Multiple Access (OFDMA). Later, these standards were revised by IEEE 802.16d and its final version, IEEE 802.16-2004, was approved.

	802.16	802.16a	802.16d	802.16e
Frequency band	10-66GHz (LOS)	2-11GHz (NLOS) 10-66GHz (LOS)	2-11GHz (NLOS) 10-66GHz (LOS)	2-11GHz (NLOS)
PHY layer	SC	SC,OFDM, OFDMA	SC,OFDM, OFDMA	SC,OFDM, OFDMA
Mobility	Fixed	Fixed	Fixed	Mobile
Data rate	32-134.4 Mbps	1-75 Mbps	1-75 Mbps	**III-75** bps

Table: 2 IEEE 802.16 Standard [2].

III. RECEIVER ARCHITECTURES

A. Heterodyne Receiver

It is an architecture that uses one or more Ifs. The super heterodyne receiver was invented by Armstrong in 1918, this architecture is also referred as heterodyne. Channel filtering is proven to be very difficult at high frequencies. So, it was created a method of translating the desired signal to a much lower frequency allowing channel filtering with a reasonable Q.

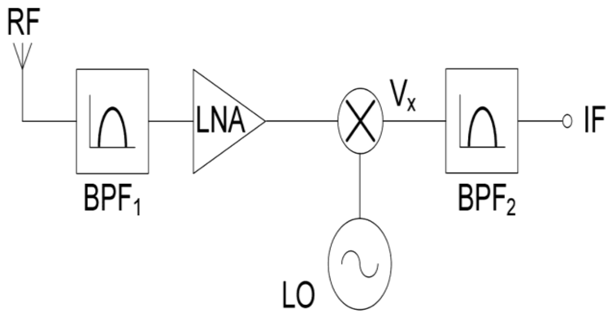

Figure 1 Heterodyne Architecture [3].

Heterodyne receiver have a problem called the image frequency. Supposing that one interferer exist at $W_{IM} = 2\ W_{LO} – W_{RF.}$

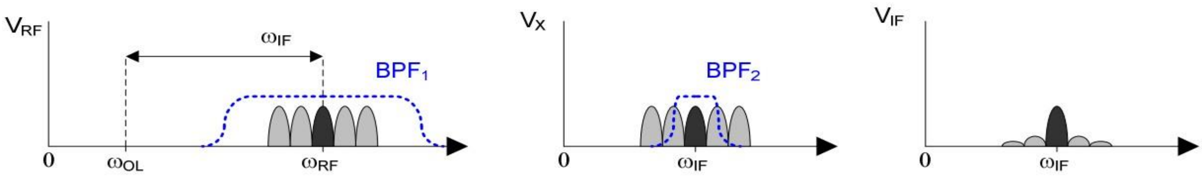

Figure 2: Band Selecting and Channel Filtering [3].

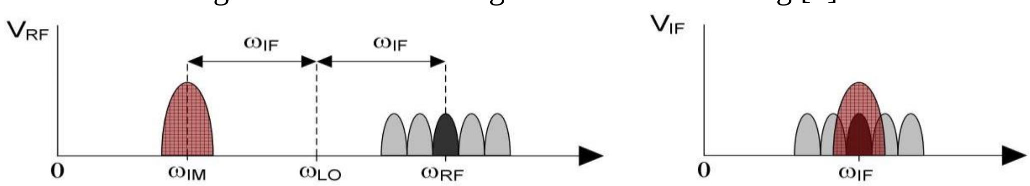

Figure 3: Image Frequency Problem [3].

B. **Homodyne Receiver**

A direct-conversion receiver (DCR), also known as homodyne, or zero-IF receiver, is a radio receiver design that demodulates the incoming radio signal using synchronous detection driven by a local oscillator whose frequency is identical to, or very close to the carrier frequency of the intended signal. This is in contrast to the standard super heterodyne receiver where this is accomplished only after an initial conversion to an intermediate frequency.

It is an architecture that down converts the RF signal directly to BB. This means that $W_{RF} = W_{LO}$ &$W_{IF} = 0$.

The major advantage of the homodyne receiver is that IT DOESN'T suffer from the image frequency problem, so no image-reject filter is needed. IF filters are not necessary because there is no IF. Channel select LPF is usually active. A good trade-off noise-linearity-power must exist between this filter, the ADC and a possible amplifier between them.

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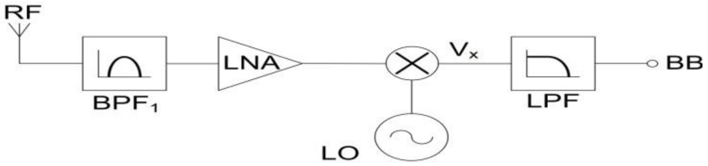

Figure 4: Homodyne Architecture [3]

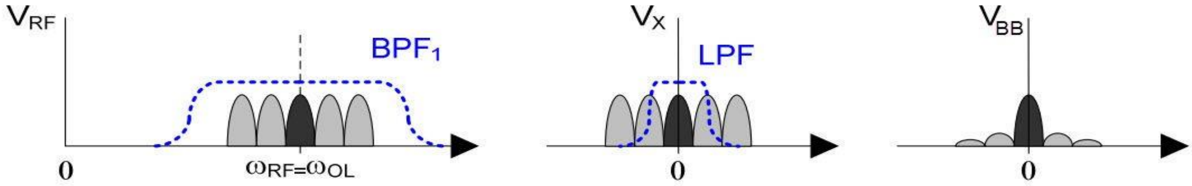

Figure 5: Downconversion to BB [3].

IV. MOST SUITABLE RECEIVERR ARCHITECTURE

Concerning the design of IEEE 802.11g standard WLAN receivers, the Direct Conversion Receiver (DCR) has been chosen for highly integrated systems and low power consumption. For mobile receivers, the level of integration, flexibility, and power dissipation are crucial factors. DCR is less complex than a heterodyne receiver, since it does not require an external image-reject filter and the receiver baseband (BB) stage includes only low-pass filters (LPF) and programmable gain amplifiers (PGA). However, it has disadvantages such as DC offset that can only be canceled with digital signal processor (DSP) help, quadrature demodulator impairments must be minimized with proper layout design combined with DSP aid, and flicker noise that became important due to signal with relatively low level at baseband circuits.

In the design of WIMAX receivers for the IEEE 802.16e standard, DCR architecture is mainly chosen for the same reasons as Wi-Fi receivers. It requires less and simpler filters than the heterodyne receiver. Band-pass filters (BPF) are not used because the intermediate frequency (IF) is at DC, so the image rejection does not apply [1].

In the design of Mobile WIMAX/Wi-Fi dual-band receivers, DCR architecture is used for the same reasons referred above for the individual standard receivers. Also, 802.11g the 802.16e signals do not have a subcarrier at DC, which relaxes the requirements of carrier suppression and 2nd order intermodulation, making the DCR the ideal choice.

If the designer is willing to invest in the DSP level, then the zero-IF architecture should be chosen since its problems can be corrected in the digital domain lowering the analog to digital converter (ADC) requirements.

V. CONCLUSION

In this paper, various receiver architectures have been examined and analyzed for the multi-standard receiver supporting WLAN (IEEE 802.11) and WIMAX (IEEE 802.16) applications. Concerning the design of IEEE 802.11g standard Wi-Fi and IEEE 802.16e receivers, the Direct Conversion Receiver (DCR) has been chosen for highly integrated systems, compact and low power consumption. For mobile receivers, the level of integration, flexibility, and power dissipation are crucial factors.

DCR is less complex than a heterodyne receiver, since it does not require an external image-reject filter and the receiver baseband (BB) stage includes only low-pass filters (LPF)

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and programmable gain amplifiers (PGA). To maximize the level of component share in the proposed multi-standard receiver, the corresponding standards have been analyzed.

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