Performance of Interference Rejection Combining Receiver Employing Minimum Mean Square Error Filter for Licensed-Assisted Access

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***Abstract** – To support the rapid increase of mobile traffic, the LTE-based air interface is expected to be employed in the unlicensed spectrum known as "Licensed-Assisted Access (LAA)." The LAA terminal, which employs an LTE-based air interface, suffers from interference from WiFi access points as well as the LAA base station. The interference rejection combining (IRC) receiver, which employs a linear minimum mean square error (MMSE) filter, can suppress this interference from WiFi access points in addition to that of the LAA base station. The IRC receiver is effective, since it requires no knowledge of the interference, which is generally difficult to obtain for different systems. In this paper, we use a link-level simulation to evaluate the performance of the IRC receiver in suppressing the interference from WiFi access points, and show that the IRC receiver can effectively cancel the interference from WiFi systems as well as LTE systems, although we observed a slight performance degradation due to the covariance matrix estimation error caused by the WiFi interference fluctuation in the frequency-domain.*

1. Introduction

The volume of data traffic over mobile networks increases rapidly. One solution to the rapid traffic increase is the LTE-based air interface in the unlicensed spectrum, which cooperates with LTE in the licensed spectrum, and which is called "Licensed-Assisted Access (LAA)." In the unlicensed spectrum, WiFi systems are widely employed. Therefore, the LAA terminal may suffer from interference from the WiFi access points (APs). We apply the simple solution called the interference rejection combining receiver. The IRC receiver employs a linear minimum mean square error (MMSE) filter, which has been shown to cancel intercell interference. In this paper, the performance improvement level needs to be assessed in the complex link-level simulation, which generates the different transmission signals with different sampling rate, subcarrier spacing, and symbol duration, and received signal with the LAA terminal with LTE-based radio interface.

2. Performance evaluation

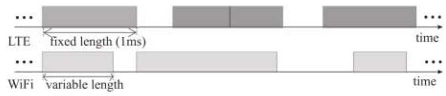
Table 1 shows radio parameters for LTE and WiFi system and Figure 1 shows the frame structure. In order to evaluate the performance improvement employing the IRC receiver, the block error rate (BLER) performance of the LAA with the IRC receiver with interference from the WiFi signal is evaluated. Figure 2 shows the BLER performance as a function of the signal-to-interference power ratio (SIR). As shown in the figure, We evaluated both IRC and simplified MMSE receivers. Furthermore, we investigated both types of interference, i.e., WiFi and LTE. We set the signal-to-noise power ratio (SNR) to be 20dB. When using the simplified MMSE receiver, we observed no clear difference between the interference properties of the WiFi and LTE. This is because the average bit error rate (BER) performance levels for two interferences bef ore the channel decoding are similar, although the BER fluctuation assuming the LTE interference is larger than that assuming the WiFi interference. However, by applying the IRC receiver, we see a clear difference between the interference properties, since the BER performance levels for two interferences before channel decoding differ. As a result, the performance improves by approximately 12dB (14dB) with respect to the interference from the WiFi (LTE) system. This result indicates that the IRC receiver can effectively cancel the interference from the WiFi system as well as the LTE system.

More details are presented in the following paper.

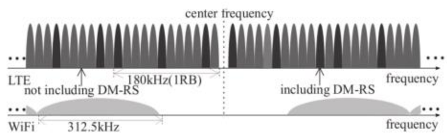
[1] J. Yamamoto, S. Bushisue, N. Miki, "Performance of Interference Rejection Combining Receiver Employing Minimum Mean Square Error Filter for Licensed-Assisted Access," IEICE Trans. on Communications, vol. E101, no.1, pp.137-145, Jan. 2018.

Table 1 radio parameters for LTE and WiFi system

	LTE	WiFi
System bandwidth	20 MHz	
Sampling rate	f_l = 30.72 MHz	f_w = 20 MHz
Subcarrier spacing	15 kHz	312.5 kHz
Number of subcarrier	1200	52
Frame length	1 ms	Variable
Symbol duration	71.4 μs	4 μs
Sample duration	T_l = 32.55 ns	T_w = 50 ns
Cyclic prefix length	66.7 μs	3.2>μs



(a) Time-domain.



(b) Frequency-domain.

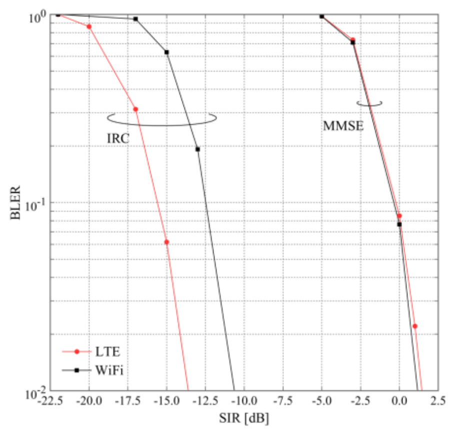


Fig. 10 Average BLER as a function of SIR.