WipAir Series

Mitigating Interference in License-exempt Bands

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1. Introduction

As use of wireless communication is at a constant rise, wireless solutions designers are facing increasing radio frequency (RF) interference in the unlicensed spectrum, damaging performance and downgrading link quality. This white paper will introduce the causes to these problems, their effect and the technology introduced by WaveIP used for eliminating and mitigating these issues.

2. License-exempt wireless deployment challenges

With service providers spreading their reach, the license-exempt spectrum is getting increasingly crowded. The consumers of wireless technology enjoy the benefits of license-exempt bands, as installing links in these frequencies is fast, easy and affordable. However, as more and more wireless links are deployed, interference level rises and affects link quality, in some cases to the point of unacceptable level.

RF interference can sometimes be mitigated during initial deployment, like selecting the optimal band, but with new links installed so often, the interference must be handled dynamically. Carriers must ensure high performance at all times by using equipment that is capable of handling interference by implementing sophisticated mechanisms.

WaveIP's WipAir series has been designed to overcome RF interference, offering ultimate link quality by implementing advanced mechanisms and proprietary breakthrough technologies for interference elimination and mitigation. With years of experience and field proven success, WipAir series is **the only wireless link that provides true carrier-grade performance**.

3. Carrier grade stability in the license-exempt spectrum

WaveIP's products combine several sophisticated mechanisms and cutting edge proprietary technology designed for interference mitigation in order to deliver true carrier class wireless link:

1. Automatic Interference Sensibility (AIS)
2. Hitless Adaptive coding & modulation (ACM)
3. Automatic Channel Selection (ACS)
4. Fastest Automatic Retransmit reQuest (ARQ)
5. Time Division Multiple Access (TDMA) protocol
6. Real time synchronization
7. Antenna Diversity (2x2 MIMO)
8. Configurable channel bandwidth
9. Forward Error Correction (FEC)
10. Advanced Orthogonal Frequency Division Multiplexing (OFDM)
11. Directional antenna

3.1 Mechanism #1: Automatic Interference Sensibility (AIS)

The AIS is a cutting edge proprietary and unique technology that makes WipAir the **only stable solution in throughput and latency with real RF robustness.**

On any WiFi based solutions, the 802.11n PHY may receive (though S/N is OK), a legal 802.11 preambles from a different source. The Physical Layer and the MAC layer will actually spend time on decoding packets that do not belong to the system (transmissions of other devices = noise). This causes loss of time/data since the PHY is busy decoding others preambles "noise" instead of its own data, and will also create jitter in latency (due to retransmissions) and lower throughput.

WipAir AIS technology avoids those false receptions, thus maintaining constant latency and throughput - This is an extremely important and unique feature, especially in congested licensed-exempt spectrums.

Though other vendors are all claiming “Carrier Class” radios, WaveIP’s WipAir products with this innovative solution surpass all other wireless links, as this breakthrough feature allows outstanding performance in highly interfered environments.

Deployments in congested areas show 10-50 times better performance in throughput and latency compared to competition.

In some cases, WipAir is the only working solution.

3.2 Mechanism #2: Hitless Adaptive Coding & Modulation (ACM)

WipAir is the only solution in its class that implements **hitless** ACM, guaranteeing error-free operation.

By changing signal coding and modulation, data rate can be adapted according to current interference conditions. The use of adaptive rates provides stable service quality and optimized throughput in interfered environments. The hitless ACM mechanism probes the channel using different variations of coding and modulations when interference is detected, and calculates preferred combination. By changing coding and modulation and calculating current packet error rate (PER), the ACM mechanism will choose if switching to a higher rate while receiving higher PER will be more efficient than switching to a lower rate and receiving lower PER, which will reduce automatic retransmit request % (ARQ). Since the answer to this query is not pre-determined and will change according to channel interference conditions, the Hitless Adaptive coding and modulation (ACM) mechanism will probe through different coding and modulations at all times, ensuring best possible link quality and throughput at all times.

WaveIP’s distinction in using this mechanism is **absolute hitless ACM**. On other solutions, switching between different modulations may create data loss while trying to transmit in higher rates (generating errors due to insufficient Signal-to-Noise ratio). WaveIP’s proprietary algorithms combined with superb hardware performance overcome this obstacle, making WipAir the only stable and error-free hitless solution in the market.

Mechanism #3: Automatic Channel Selection (ACS)

The Automatic Channel Selection (ACS) feature is an essential one, enabling the installer to automatically perform radio frequency (RF) site survey.

WipAir ACS mechanism monitors and analyzes the active bands in the area and chooses the least interrupted one of all. This operation is performed in the initial installation and also during the system operation, to maximize link's performance according to changes in wireless deployments in the proximate perimeter.

3.3 Mechanism #4: Fastest Automatic Retransmit reQuest (ARQ)

The Automatic Retransmit reQuest (ARQ) mechanism is an imperative feature in wireless communication systems. When RF interference causes data corruption or loss, the ARQ will manage retransmission of lost or corrupted packets, ensuring reception the data and no packet loss.

WipAir solution introduces lowest latency in the market of 1ms. With ARQ implementation at the physical layer, the process of resending the missing/corrupted data is ultra-fast, better then any other solution it the class.

This fast retransmission of data ensures that link's quality, throughput and latency remain at peak performance, with no degradation in link grade for end users.

3.4 Mechanism #5: Time Division Multiple Access (TDMA) protocol

WipAir introduces a **TDMA based protocol** that schedules link's transmission and reception time.

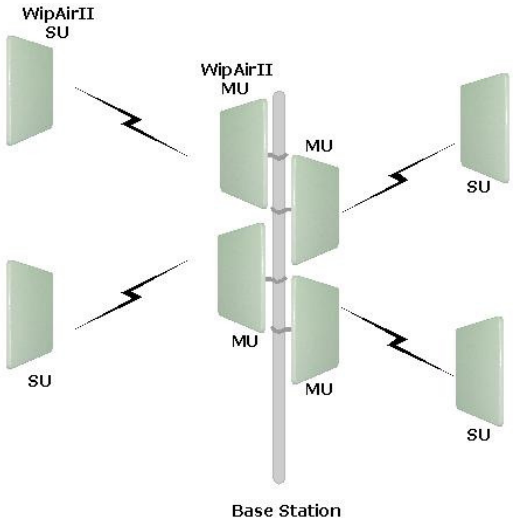
Unlike 802.11 CSMA/CA based solutions, interference and congested environment does not halt or delay WipAir transmissions thus allowing WipAir to maintain and guarantee constant latency and throughput and true carrier grade performance.

3.5 Mechanism #6: Real time synchronization

WipAir's built in time synchronization technology, allows collocation of unlimited number of wireless units on the same mast and on collocated masts while reusing frequencies and eliminating self-interference between them**.**

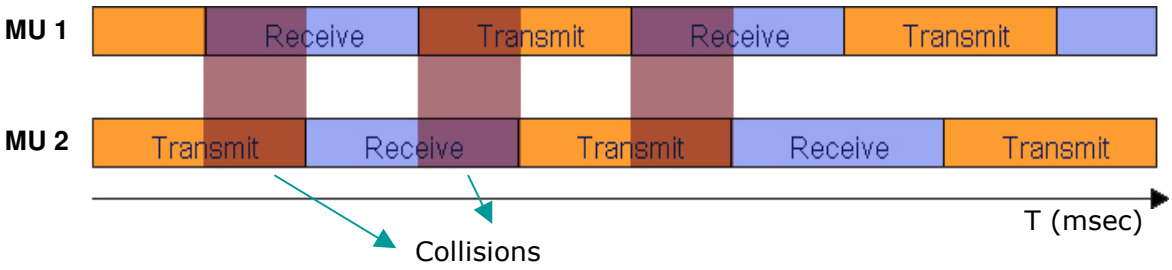
WipAir supports full time synchronization capabilities:

- Internal – synchronizing units collocated on the same tower via a configurable master unit (no additional hardware requirement).
- External – synchronizing towers located at the same area via GPS.
- Unlimited – practically no limit of synchronized units using any method (internal or external).



Multiple WipAir MUs on one tower

Failing to synchronize collocated wireless units will result in data loss due to collision between them, as one will transmit while the other is receiving. This phenomenon might happen even if the units use different frequencies.



Self-interference without time synchronization

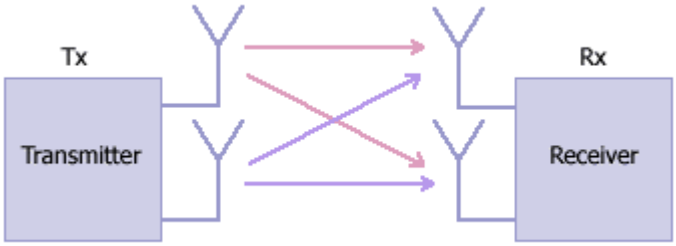
The mechanism synchronizes the transmission and reception of all units, thus eliminating self-interference between them and allowing better frequency reuse.

Time synchronization eliminates self-interference

3.6 Mechanism #7: Antenna Diversity (2x2 MIMO)

Dual polarization MIMO (Multiple Input Multiple Output) allows connecting two antennas with opposite polarization to the same wireless unit, enabling transmission and reception of two simultaneous data streams.

WipAir MIMO capability allows configuration of antenna diversity that sends redundant data over both antennas. In case of interference that causes signal disruption in a path, the receiver is still able to recover all data from the second path, without any packet loss.



3.7 Mechanism #8: Configurable channel bandwidth

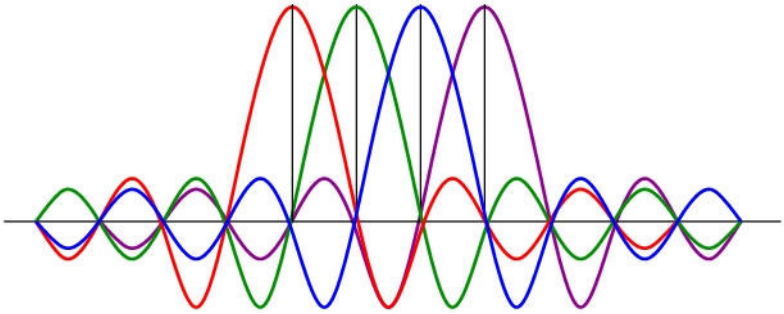
By changing the channel bandwidth, users can choose whether to use higher channel bandwidth with high spectrum footprint or lower channel bandwidth with small spectrum footprint. Enabling users to choose between desired channel bandwidth of 5 MHz, 10 MHz, 20 MHz, and 40 MHz boosts the performance by optimizing the link's throughput and availability according to the actual condition.

3.8 Mechanism #9: Forward Error Correction (FEC)

Forward Error Correction (FEC) is a mechanism of error control for data transmission, implemented to reduce retransmissions triggered by corrupted packet reception. The mechanism adds redundant data to each packet, which upon reception at the receiver, will be analyzed for errors. When errors are detected, the mechanism is able to recover the original data from the redundant data added, without having to request for message retransmission. As this mechanism results in higher bandwidth requirements, the percentage of redundant data added is modified according to channel interference conditions, as a part of the Adaptive coding and modulation (ACM) mechanism.

3.9 Mechanism #10: Advanced Orthogonal Frequency Division Multiplexing (OFDM)

WaveIP's WipAir series uses Orthogonal Frequency Division Multiplexing waveform, optimized for high bandwidth efficient radio links over challenging environments. The basic principle of this technique is splitting the data into several, smaller different sub-signals and transmitting them simultaneously at different frequencies. The receiver collects the signals, and recovers lost data from duplicate carriers in case of RF interference.



Characterized by low overhead, high interference resiliency and low latency, OFDM is designed to overcome signal fading and multipath interference, making it the best suited technology for wireless links in the sub-7Ghz license exempt spectrum.

3.10 Mechanism #11: Directional antenna

Choosing the suitable antenna type holds great importance when designing and deploying a wireless link, especially in the license exempt spectrum. The selection of the antenna design will affect budget and performance in conditions of RF interference. By using directional antennas, RF signals will travel in a narrow beam that radiates greater power in one direction, allowing improved performance on transmit and receive, and reduces RF interference from unwanted sources.

4. Summary

In order to achieve carrier grade performance in the license exempt bands, WaveIP implements a variety of mechanisms and solutions ensuring high quality wireless links. It is WaveIP's primary goal to ensure a stable and robust operation, using top-of-the-line hardware and innovative algorithms and mechanisms for ultimate, best-in-class performance.

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