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SPECIFIC TARGETTED RESEARCH PROJECT
Project Deliverable

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Abstract:
To test the performance of Cognitive Radios, the needed features of an emulator will be investigated and eventually be build within workpackage 9. In order to make the emulator usable for a wide audience, meaning emulating radio scenes that resemble a real world environment, it must be highly flexible and adaptable by the user. This deliverable describes the first investigation results into the needs for such an emulator. Naturally, as the project still continues, the emulator will be further developed. Later deliverables will include those developments.

Contents

1 Introduction

The objective of PHYDYAS is to propose a physical layer for future radio systems that is more efficient than present OFDM based solutions and better suited to the new concepts of DASM (Dynamic Access Spectrum Management) and cognitive radio.

One of the basic ideas is to concentrate the signal power in a single subcarrier that transmits stronger within its frequency. With OFDM parts of the signal power leaks into neighboring subcarriers (a single subcarrier follows a sinc function), leading to a higher sensitivity to frequency offsets and to the need of capacity reducing band guards. In reverse the new physical layer proposed in PHYDYAS ought to be less sensitive to carrier offsets and smaller guard bands should be affordable, leading to a more efficient use of the spectrum. Additionally spectrum sensing in cognitive radio is more reliable due to lesser interference.

To reach these goals a filter bank is introduced into the transmission chain. This filter bank is the heart of the project. A basic solution was provided at the beginning, which was and will be further developed within the project. Many aspects of the transmission chain, such as synchronization and initialization, channel estimation and tracking, equalization and demodulation, MIMO (multiple input multiple output) processing, need to be addressed. This is done within other work packages and thus this deliverable will not go into detail with respect to these algorithms.

In this deliverable we will report the investigation results concerning the development of a Radio Scene Emulator for Cognitive Radios.

Cognitive Radios (CR) can be split into two different types. First, there’s the “Mitola” Radio, a CR that takes all observable parameters into account to make decisions on its own. And secondly, there’s the Spectrum Sensing CR that only uses a scanning technique to obtain information about the radio spectrum. In the Phydyas project we will focus on a test solution for these sensing abilities, a technique used in both CR and thus covering the 2 types with one test solution.

To test the spectrum sensing capabilities of a CR, a new kind of test environment is needed. The equipment must be capable of emulating a dynamic and altering radio spectrum, meaning that frequency allocations should change over time. Holes in the spectrum should appear and disappear, or occupied bands have to fade or to be amplified.

2 Control Software

For testing purposes, the emulated spectrum mustn't change at random but in a controlled way. The user must be able to control frequency occupation and power at each given point in time. Another interesting feature would be the ability to use different waveforms to fill the selected spectrum. An AWGN source is the minimum, but other formats like WiMAX or LTE could deliver an added value to the tool.
The steps one should take into account to configure the tool are:

1. Bandwidth Selection
2. Waveform Loading
3. Individual Power Adjustment
4. Waveform Placement
5. Radio Scene Generation

2.1 Bandwidth Selection

The user will select the width of the radio scene. This will be the part of the spectrum in which the CR will use its scanning capability. It will dictate the number of samples that are needed per second, the wider the band, the more sample are needed per time unit.

2.2 Waveform Loading

If the software is extended with the possibility to use externally generated waveforms, then the user can load them into memory. For each waveform, the sampling rate is needed as it can differ from waveform to waveform. With size and rate, the software can calculate the duration of the waveform and can resample it if needed. And burst of signals that are shorter than the total time can be used several times (see Fig.1).
For internally generated AWGN, the user must set the duration manually.

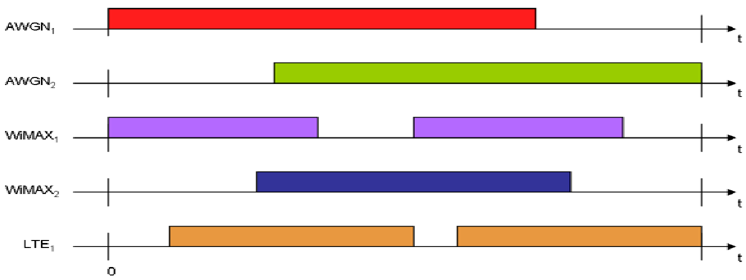

Figure 1: Loaded Waveforms

2.3 Individual Power Adjustment

Fading or amplifying the loaded signals separately in time.

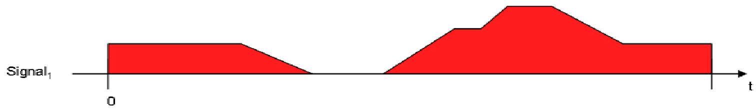

Figure 2: Power Adjustment

2.4 Waveform Placement

Now the user can decide which frequencies the waveforms should occupy within the previously selected band of the radio scene.

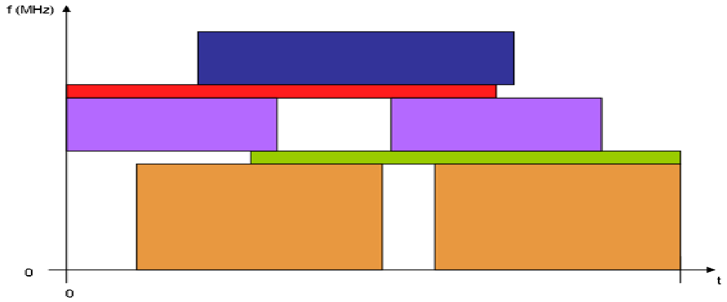

Figure 3: Waveform Placement

2.5 Radio Scene Generation

The final step is to generate a new waveform that comprises all the loaded ones with their specific parameter settings.

3 Emulator Hardware

The hardware must be able to up convert the digitally generated baseband signal to a certain frequency and to transmit the signal at a pre-defined power level.
For this purpose we've selected the E4438C ESG from Agilent. It's a signal generator for RF and baseband test applications in e.g. wireless communication. It features low phase noise, high output power and advanced baseband capabilities. Other interesting signal generating capabilities are: 80MHz RF BW, 64MSa waveform memory and digital I/O for waveform streaming. It has also a LAN communication interface to connect it to a PC. All this makes it suitable as up converting equipment for the digitally generated baseband signal. Fig.4 shows the test set-up with signal generator and a Cognitive Device Under Test.

Figure 4: Emulator Set-up