BANDWIDTH-ADAPTIVE WAVEFORMS FOR DYSPANS

Network Coordination Using Cyclostationary Signatures

THE ISSUE OF COORDINATION

Today's high-performance tunable radio front-ends and cheap, powerful signal processors mean that a wide range of communication waveforms may now be synthesized in real-time and tailored to achieve optimal performance. Such flexibility is a driving force behind innovative concepts such as dynamic spectrum access and cognitive networks. However, as systems become more flexible, the challenge of network coordination becomes more pressing. A transmitting node within a wireless network may be capable of adapting its waveform to suit the operating conditions but this optimization is pointless if receiving nodes cannot simultaneously adapt in order to receive and demodulate that waveform.

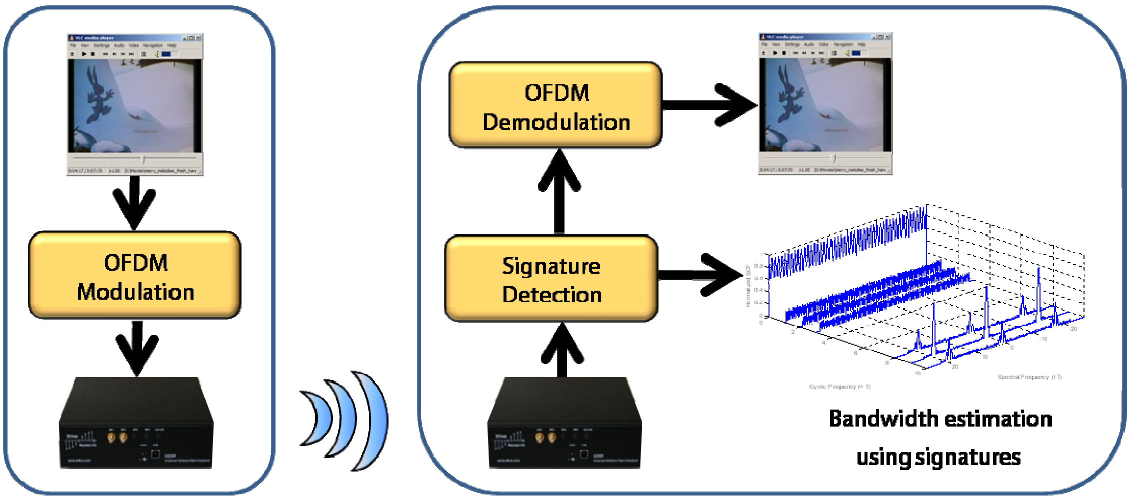

Figure 1: The Demonstration Layout

In a network where communications links are established, these links may be used to coordinate the choice of waveform parameters. Often however, coordination must be achieved before nodes may communicate. This is the case for example in Dynamic Spectrum Access Networks (DySPANs) where operating frequencies and waveform bandwidths must be agreed before network connectivity can be achieved.

This demonstration addresses the challenge of network coordination in DySPANs and illustrates a practical solution – the use of physical layer signaling through cyclostationary signatures. Specifically, we present a bandwidth-adaptive waveform for DySPANs featuring embedded signatures for network coordination.

CYCLOSTATIONARY SIGNATURES – A PRACTICAL SOLUTION

Among the proposed solutions for DySPAN coordination are fixed control channels, waveform analysis and bootstrapping over existing networks. Fixed control channels require dedicated frequency allocations and present both a bottleneck and single point of failure for a network while the bootstrapping approach requires the presence of an existing network. A number of techniques exist for waveform analysis and could be adopted for signal parameterization and thus coordination, however many of these techniques are computationally complex and are typically adopted only for off-line signal analysis. One such technique is cyclostationary signal analysis.

Cyclostationary signal analysis exploits the inherent periodicities which exist in communications signals and provides a powerful technique for signal detection, classification, synchronization and equalization. *Cyclostationary signatures* overcome the restriction of computational complexity by using artificial features which are intentionally embedded in data-carrying waveforms. These artificial features can be generated, detected and analyzed using low-complexity architectures and can be easily incorporated in existing transceiver designs to achieve network coordination.

A Bandwidth Adaptive Waveform Using Cyclostationary Signatures

In this demonstration, a video stream is transmitted between two nodes using a bandwidth-adaptive OFDM waveform. The waveform is composed of between 1 and 16 bandwidth units, each containing 64 subcarriers. Within each unit, a cyclostationary signature is embedded by mapping a subset of 4 subcarriers. At the receiver, a low-complexity analyzer is used to detect these signatures and determine the overall bandwidth of the waveform. The video data is extracted from the waveform using a reconfigurable OFDM demodulator.

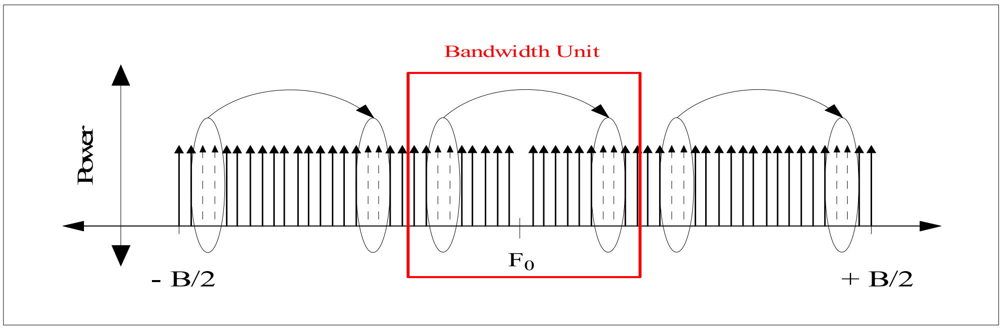

Figure 2: Generating a bandwidth-adaptive OFDM waveform with embedded cyclostationary signatures

The platform used for the demonstration is the CTVR IRIS software radio architecture, running upon Intel general purpose processors. IRIS provides run-time reconfigurability for the software radio, permitting our receiver to dynamically adapt to changes in waveform properties. When the bandwidth of the waveform transmitted is adjusted, this change is detected by the receiving cyclostationary analyzer and the ofdm demodulator is parametrically reconfigured to handle that change.

Bandwidth Unit Parameters	
Data-carrying subcarriers	56
Pilot subcarriers	2
Guard subcarriers (including DC)	2
Mapped subcarriers (signature generation)	4
Total subcarriers	64

Reference

Sutton P.D., Ozgul B., Nolan K.E., Doyle L.E., “Bandwidth-Adaptive Waveforms for Dynamic Spectrum Access”, in New Frontiers in Dynamic Spectrum Access Networks, DySPAN 2008, October 14-17, 2008.

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