Path towards a Fairness (QoS) control within the DSA Project

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I. Introduction: The DSA approach

The Dynamic Spectrum Access is a novel method to improve the performance of radio wave based communication systems, such as wireless local area network (WLAN) and Bluetooth. This approach works in the 2.4[GHz] band (2400∼2484 [MHz]), using methods such as the Fast Fourier transform (FFT), the power spectrum of the radio waves can be calculated. DSA should be able to identify the different types of radio frequencies that may be present in the 2.4[GHz] band. In this band, WLAN, Bluetooth, microwave ovens and other devices may operate creating interference between each other's signal. DSA will address the interference that these devices induce into each other by identifying what type of device is transmitting over the above mentioned band, restricting the access of a given device to a selected frequency and therefore controlling and improving the throughput of the overall network.

This document shows a summary of the steps towards designing a "fairness control" or quality of service (QoS) that defines the DSA approach. The fairness control is composed of three main components:

1) Sensing Strategy
2) Communication Simulator to test our DSA approach (Design Traffic Model for General Radio Systems)
3) Fairness Control

In the following sections each of these components are further explained and the expected time to complete each of them is proposed.

II. Sensing Strategy

This sensing strategy is focused on determining if there is an available interval within other wireless system's signals. One can determine that if in a given frequency the value of its signal power spectrum is lower than a known threshold this frequency will not be used. There are various problems with this approach. One of them is that the power spectrum of a signal has a directly proportional relationship with the distance from its closest access point (AP). Thus, a user may be sending/receiving data at a lower power level and this level may be "sensed" as below of the established threshold.

Another problem is that a WLAN may have transmitted a data frame will wait for to receive an acknowledgement (ACK) from its receiving party. As part of the WLAN communication standard, the interval the transmitter (AP) waits after sending the data frame and the ACK is always 10[μsec], this is called the "short interframe space" or S-IFS. If the transmitter does not prepare to listen to the ACK it may miss it. In addition, if during the S-IFS interval period another WLAN signal is introduced or is present, it may cause an interference in the original signal.

It should be noticed that a simple approach as not using a given frequency because of its low power spectrum should be avoided since the S-IFS will not be able to be used.

A number of steps to accomplish this sensing strategy are shown as follows:

1) Is it WLAN/BT/Microwave oven? [__ weeks]
   a) What method should be used for this? [__ weeks]
   b) Type of packet [__ weeks]
2) Is this an interval? [__ weeks]
   a) What type of interval? [__ weeks]
   b) Output: Use or don't use this frequency's channel [__ weeks]

III. Fairness Control

In a given location, a network may consist of WLAN and/or BT connections. A typical example may be that of a WLAN connection being interfered due to the introduction of a BT connection and viceversa. However in such case, if we can open an interval between a WLAN connection's packet and packet both the WLAN and the BT connection would be possible. The problem is administering these intervals such that the WLAN allows the BT connection's packet to be present without causing interference to the original WLAN connection.

DSA aims to administer these intervals through a number of policies that consider the constraints of the WLAN, BT and other devices' connections within the same location. Some of these constraints and the proposed policies are listed below.

1) Policy definition [__ weeks]
1) Communication System's Constraints [__ weeks]
   a) Signal's power [__ weeks]
   b) Signal's packet interval [__ weeks]
   c) BT automatically moves from one channel to the other fast and randomly [__ weeks]
   d) WLAN has fixed channels [__ weeks]

IV. Communication's Simulator

In order to test the components presented in Sections II and III, a simulator is required. This simulator will be able to give a realistic representation of the communication between AP and wireless users. The most important issue here is the design of a "human behavior" model that accurately represents people's usage of the network.

1) Simulate one WLAN connection [__ weeks]
   a) Define AP (Server) [__ weeks]

    i) IP's protocol [__ weeks]
    ii) TCP/UDP's protocol [__ weeks]
    iii) Application protocol [__ weeks]
    iv) Server behavior based on a human's connection model [__ weeks]
  b) Define Wireless User [__ weeks]
    i) IP's protocol [__ weeks]
    ii) TCP/UDP's protocol [__ weeks]
    iii) Application protocol [__ weeks]
    iv) Human behavior model (How can this be defined? It is a "non-stationary deterministic process") [__ weeks]
2) Simulate multiple WLAN connections [__ weeks]
3) Integration of the sensing strategy presented in Section II.[__ weeks]