Erasure Correcting Codes for Opportunistic Spectrum Access

Mots clés :
- Directeur de thèse : JEAN-CLAUDIE BELFIORE
- Co-encadrant(s) :
- Unité de recherche : Laboratoire Traitement et Communication de l'Information
- Ecole doctorale : Ecole Doctorale Informatique, Télécommunications, Électronique de Paris
- Domaine scientifique principal : Divers

Résumé du projet de recherche (Langue 1)

There is a need of either more spectrum or to use existing spectrum more efficiently due to dramatic increase in the demand of limited spectrum. The emergence of new devices especially the smartphones and tablets having a lot of new applications have rocketed the wireless traffic in recent years and this is the cause of main surge in the demand of radio spectrum. Among the new dynamic access schemes designed to use the spectrum more efficiently opportunistic spectrum access (OSA) is currently addressed when one or more secondary users (SU) are allowed to access the channel when the PU is not transmitting. There is no coordination between PU and SU when dealing with OSA and SU needs sensing to detect PU's idle periods in the channel before starting the transmission, this is one of the main challenges that is addressed in this thesis. The sensing operation must be performed as quickly as possible in order to seize maximum opportunities as they appear but it suffers from two kinds of impairments: False alarms when there is no PU while the detection stage decides there is one; as a consequence the SU experiences a missed opportunity to use the channel. Conversely, it may happen that there is actually a PU but it is not detected by the SU. The result is a collision between PU and SU and a loss of data of both users. Due to the possible loss of packets during collisions the SU’s link can be modelled as an erasure channel. If retransmission of data is done the channel would even worsen the problem (the SU would have to find another opportunity to send a retransmission request). The erasure correcting codes are therefore envisioned to recover the lost data and we address the short erasure correcting codes for the recovery of erased data in opportunistic spectrum access (OSA). The main advantage of using short codes is their low decoding complexity. There is a need to define a parameter to estimate the secondary spectrum access. We define this parameter as efficiency of SU and optimize it in-terms of spectrum utilization keeping into account sensing impairments, code parameters and the activity of PU. Various decoding methods are compared and Tanner graph based approach is selected due to lower decoding complexity. The performance enhancement of short codes for better erasure recovery is also addressed and the concatenation of short codes is described to build more powerful product codes in case the collision rate is high. Finally, the spectrum access for multiple secondary users is addressed when there is no primary and each user has equal right to access the channel. The interesting scenarios are Cognitive radio networks and WiFi where 802.11 protocol gives the specification for MAC layer. With the increasing number of users in the network waiting time is increased and in order to avoid the long delays to access the channel the parameters of MAC protocol can be modified. When the waiting time is reduced the collisions among multiple users are increased and there is a need to envision erasure correcting codes to recover the lost data due to collisions. The analytical approximation for global collision rate is provided and it is compared with the simulation results, the effect of codes at various collision rates is analysed for multiple users. The expression for global throughput for multiple users is estimated and simulation curves are plotted by modifying the parameters of 802.11. The throughput curves achieved by retransmission and using various erasure correcting codes are compared. This modification in MAC layer will reduce the long waiting time to access the channel, as the number of users are increased, using erasure correcting codes at the expense of redundancy.