DSA with Reinforcement Learning in the HF band

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Using the ionosphere as a passive reflector allows trans-horizon communications in the HF band, which covers the radiofrequency spectrum from 3 to 30 MHz. This band is mainly used for military communications, but also for aeronautical, maritime, and amateur communications. Besides its propagation changeability, the limitation of the HF band is the existence of multiple uncontrolled collisions between users. Even if HF stations use the Automatic Link Establishment protocol (MIL-STD-188-141B), they select their transmission channel according to its internal ranking based only on the channel propagation characteristics. Therefore, we propose to add some adaptability and cognition into the exploitation of the HF band as a good solution to diminish the inefficient use of the band.

In a cognitive radio context, Dynamic Spectrum Access (DSA) (Q. Zhao and B. Sadler, *IEEE Signal Processing Magazine*, vol.24, no.3, pp. 79-89, 2007) will allow HF users to access unoccupied channels by legacy users at a particular time and area. In this work, we propose the use of reinforcement learning based algorithms (R.S. Surto and A.G. Barto, Reinforcement Learning: An Introduction, 1998) to dynamically access the HF spectrum. These algorithms learn from previous rewards in case of success but without any a priori knowledge of the activity in the spectrum. They can be used for decision making in a set of channels to select the best channel to transmit.

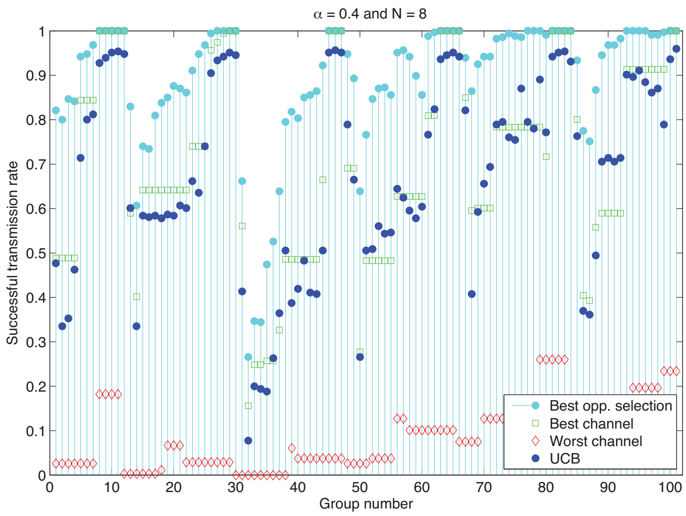

Figure 1: Comparative of the successful transmission rate.

In this work, we show the feasibility of reinforcement learning in the HF band by testing one of these algorithms with the HFSA_IDeTIC_F1_V01 database (L. Melián-Gutiérrez *et al.*, *Physical Communication*, vol.9, pp.199–211, 2013) of real measurements of the HF band. It is the Upper Confidence Bound (UCB) algorithm (P. Auer *et al.*, *Machine Learning*, vol.47, no.2-3, pp.235-256, 2002) (W. Jouini *et al.*, in 3rd International SCS Conference, 2009), which allows decision making in a set of channels finding a compromise between exploitation of the previous selected channels and exploration of new channels. To better depict its suitability for a cognitive radio application, we propose a new metric based on the successful transmission rate achievable in different approaches: best channel, worst channel and best opportunistic selection. The obtained results demonstrate the feasibility of the UCB algorithm even in the worst conditions in terms of channel availability. Hence, showing that reinforcement learning technique is suitable for dynamic HF spectrum access.