

# Hierarchical Thompson Sampling for Multi-band Radio Channel Selection

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**Abstract**—We consider the multi-band channel selection problem, where the best channel is to be selected from  $n$  distinct frequency bands, each containing  $m$  wireless channels. The objective is to select the channel with the best average signal-to-interference-plus-noise ratio (SiNR), where the SiNR for each channel follows a parametric distribution, generated from a band-dependent prior distribution. We introduce a Bayesian Hierarchical Bandit (BHB) model that captures the correlation induced by the hierarchical relationship between channels and band, and develop a Hierarchical Thompson sampling (HTS) algorithm which leverages the underlying Bayesian Hierarchical structure to efficiently determine which channel is optimal. We demonstrate that the HTS algorithm outperforms traditional bandit algorithms by a factor of  $n$  when the bands are sufficiently dissimilar. Through extensive simulation, we characterize the Bayesian regret of the HTS algorithm under varying degrees of band similarity and demonstrate that the Bayesian regret of HTS does not increase linearly with  $n$ , in contrast to traditional

In the single-band DCS problem, all channels share the same frequency band and are subject to the same propagation conditions. In the Multi-band DCS problem, channels are grouped into separate frequency bands as shown in Figure 1. Channels in the same band share the same propagation path and experience similar environmental conditions, however, there may still be variation in channel quality due to small-scale fading and interference. On the other hand, channels in different frequency bands may experience vastly different large-scale fading effects such as free-space path loss and shadowing, resulting in a bigger difference in channel quality between channels in different bands compared to channels within the same band. This correlation provides additional structure, and the information this structure provides can be exploited to improve the channel selection process. Addition-