# Optimal control of wireless sensor networks: a mean-field approach

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**Abstract**

Wireless sensor networks (WSN) consist of a large number of sensor nodes that monitor the real-world environments and have wide-ranging applications such as military surveillance, forest fire monitoring etc. One of the key objectives in these WSNs is to deliver the information with higher quality (accuracy, timeliness, importance) defined by the nature of application. Such WSNs with a large number of nodes often present important computational challenges which makes it more difficult to analyse the network.

We consider a WSN with a large number of nodes $N$, and model it as a very large Markov chain. Each node can take on $J$ different states which denote the value of information present at the node. We aim to find optimal strategies which keep the value of information as high as possible with regard to minimal information exchange. As the number of nodes in the network increases, the number of states increases as $J^N$, and as such, solving such system with dynamic programming becomes practically impossible due to the curse of dimensionality. Applying some existing limit results, we therefore formulate the equivalent mean-field model which heavily reduces the computational effort needed to find the optimal control. We discuss the computational efforts that are needed and present the two-state model in full detail. Finally, we present numerical results for system under consideration and discuss the nature of optimal control in the transient and steady state.

**Keywords:** Mean field limit, Value of Information, Wireless Sensor Network.