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# Multi-Armed bandit Learning in Iot Networks (MALIN)

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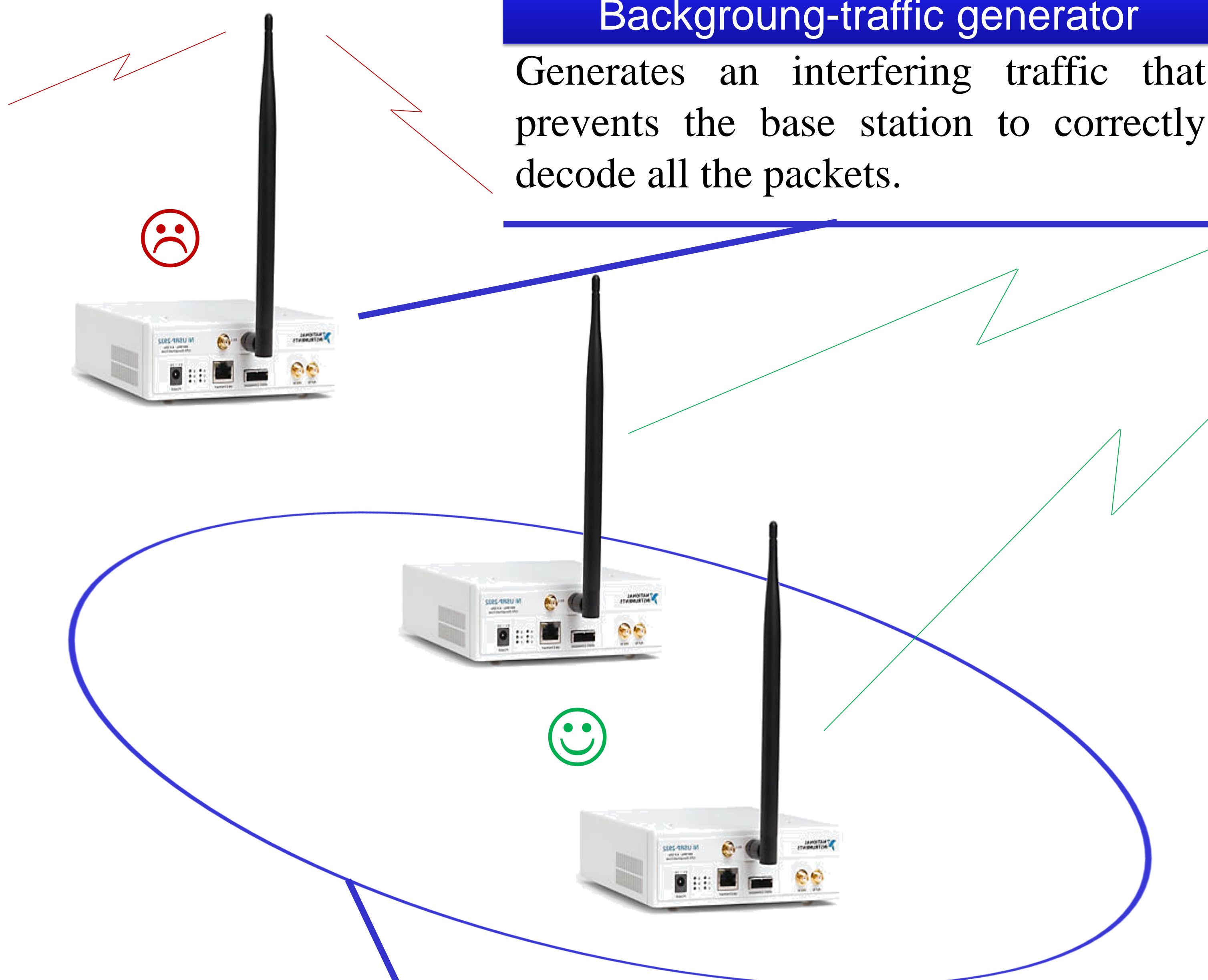
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## Goal

- With the advent of the Internet of Things (IoT), unlicensed band are going to be shared by a large number of devices with dissimilar characteristics. In such context, solutions are required to allow the coexistence of devices and to avoid performance drop due to interference.
- In this demonstration, we show that reinforcement learning algorithms and in particular Multi-Armed Bandit algorithms can be used as a means of improving the performance of IoT communications.

## Background-traffic generator

Generates an interfering traffic that prevents the base station to correctly decode all the packets.



## Gateway

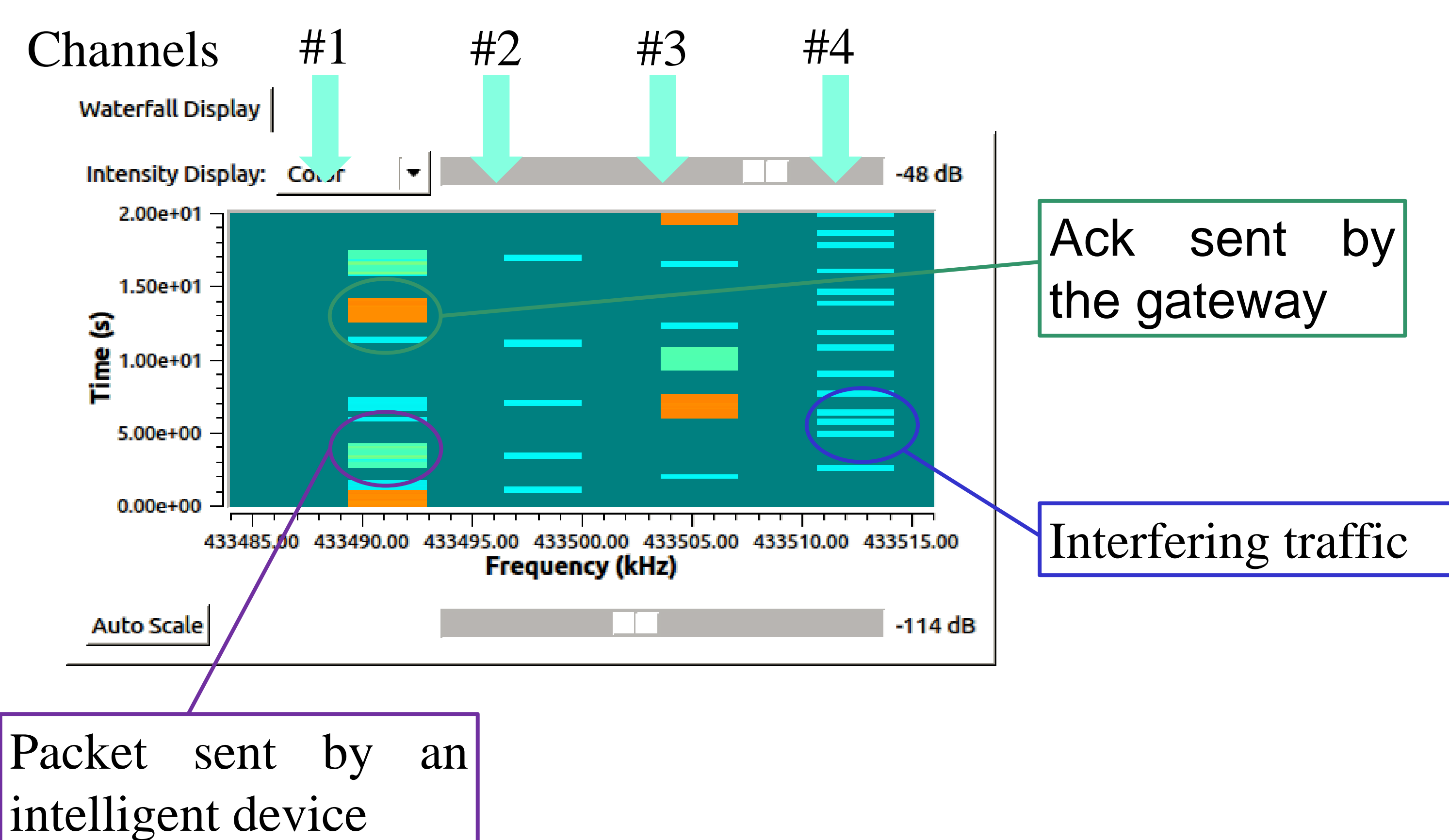
Receives and decodes the packets sent by our intelligent devices in different channels. Once a packet is successfully received, the gateway sends an acknowledgement in the channel used for the uplink packet

## Intelligent devices

They want to send packets to the gateway. For that purpose, they can use the different channels available. The selection of the channel is done using a MAB learning algorithm in order to avoid collisions with other objects transmissions.

Each objet makes its own decision. They do not share any information. The decision is decentralized and uncoordinated.

## Traffic observed by the gateway



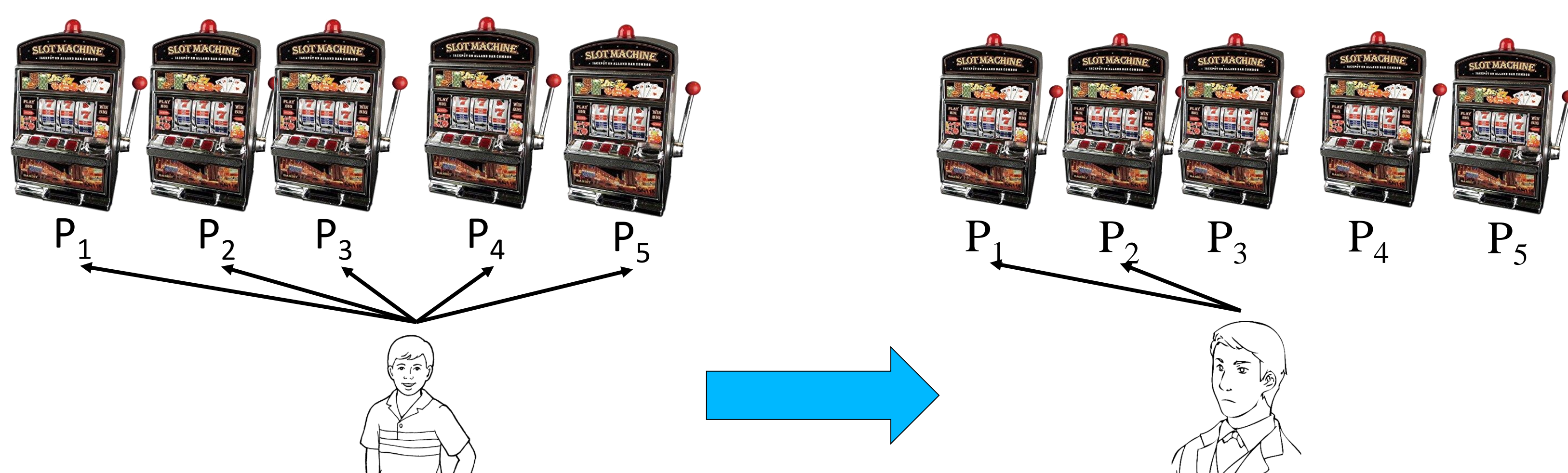
## MAB learning

- A user faces N choices (e.g. N channels)
- The channels provide him a reward with a given probability

### How to identify the best channel?

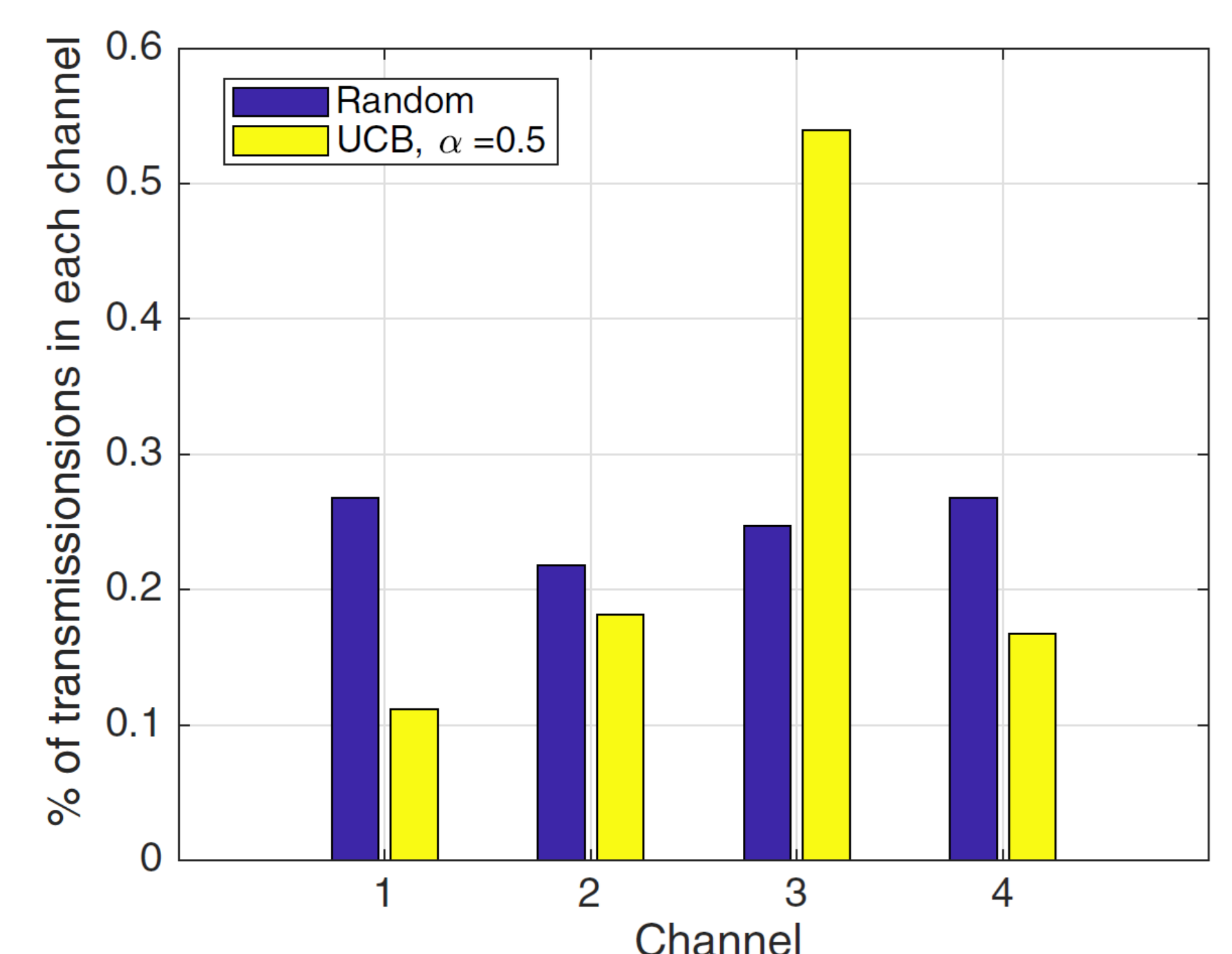
- MAB learning algorithms are proved to be optimal to solve this problem.
- Any MAB algorithm can be used for channel selection (UCB, Thompson Sampling or others)
- With the UCB algorithm, the channel with the highest index is chosen for each transmission

$$B_j(t) = \frac{\sum_{l=0}^{t-1} r_l(t) \mathbb{1}(a_l = j)}{T_j(t)} + \sqrt{\frac{\alpha \ln(t)}{T_j(t)}}$$



## Results

Channels occupancy rate [20%, 10%, 5%, 25%]



## Acknowledgement

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[2] S. Bubeck and N. Cesa-Bianchi, "Regret analysis of stochastic and nonstochastic multiarmed bandit problems," *Foundations and Trends® in Machine Learning*, vol. 5, no. 1, pp. 1–122, 2012.