Reinforcement Learning Applied to Reconfigurable Hardware in Contested Environment

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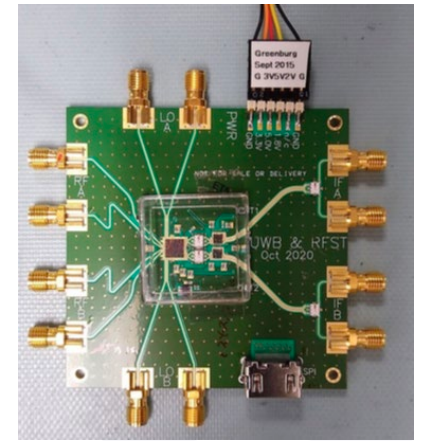Faculty: Dr. Waleed Khalil and Dr. Shane Smith

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Reconfigurable Hardware

| Traditional Radios	Reconfigurable Hardware
Fixed Internal Hardware Gains	Adjustable Hardware Gains
Fixed Bandwidth	Adjustable Instantaneous Bandwidth
Fixed Frequencies	Adjustable Frequencies
Inability to overcome interferer	Ability to overcome interferer
No driver necessary	Requires driver

Reinforcement Learning

- Ability to explore large action spaces to determine optimal solutions

- Action spaces are made up of the different controls that controls the location and the depth of the notch on the REMAR hardware

- Process of RL Algorithm
  - Interacts with an environment with a state (observation), an action space (policy), and reward function (action)
  - Learns the optimal action space (policy) that maximizes the reward
 - Tests the learned action space (policy) to make decisions
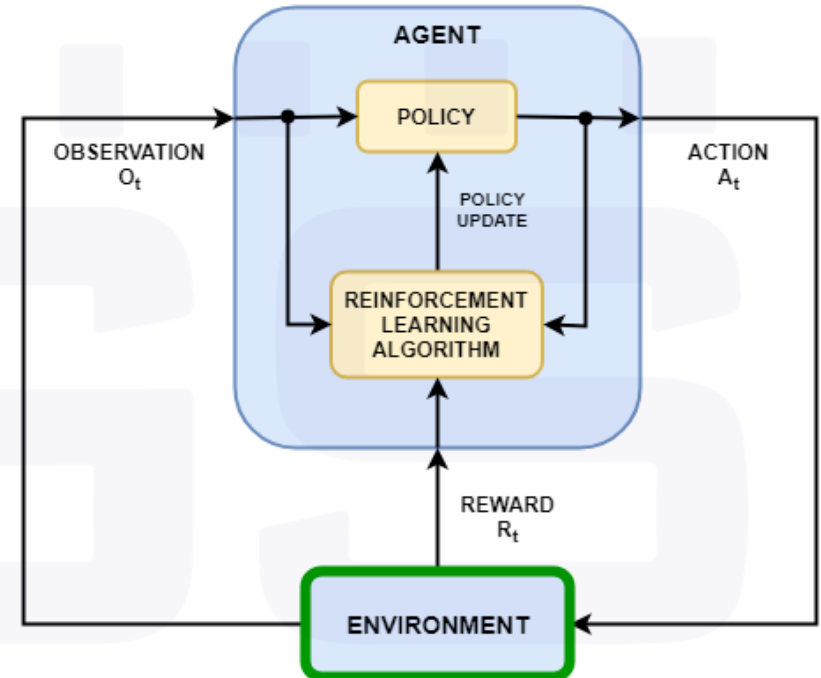
Reinforcement Learning with Reconfigurable Hardware

- Communicates with reconfigurable hardware through custom digital driver written in C

- Utilizes the reinforcement learning toolbox in MATLAB to build the neural network and reinforcement learning algorithm

- Trains the reconfigurable hardware with injected interferer in an attempt to find optimal solution to combat the interferer

- Tests the reconfigurable hardware with the interferer on and the expects the reconfigurable hardware to recover the parameter of interest
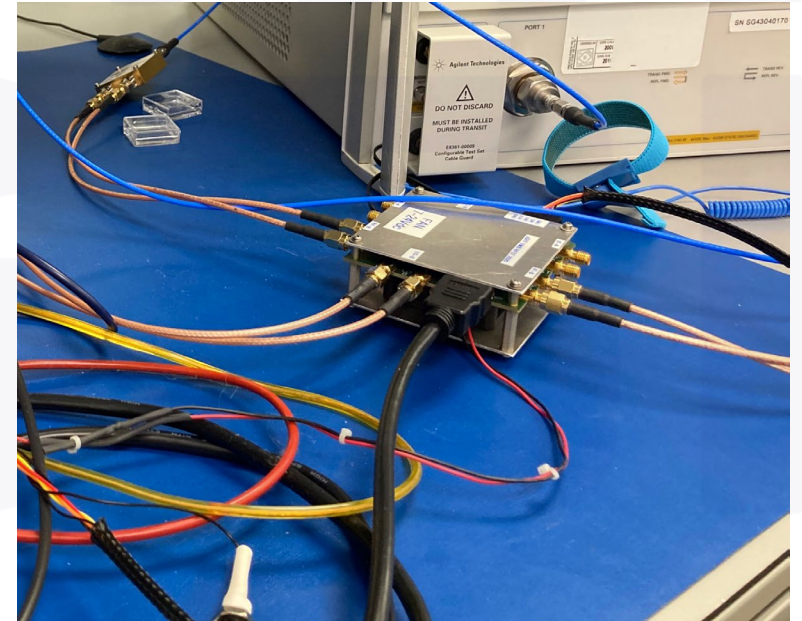
Possible Reinforcement Learning Scenarios

1. Out-of-band static interferer

2. In-band static interferer

3. Out-of-band dynamic interferer

4. In-band dynamic interferer

In band Static Interferer
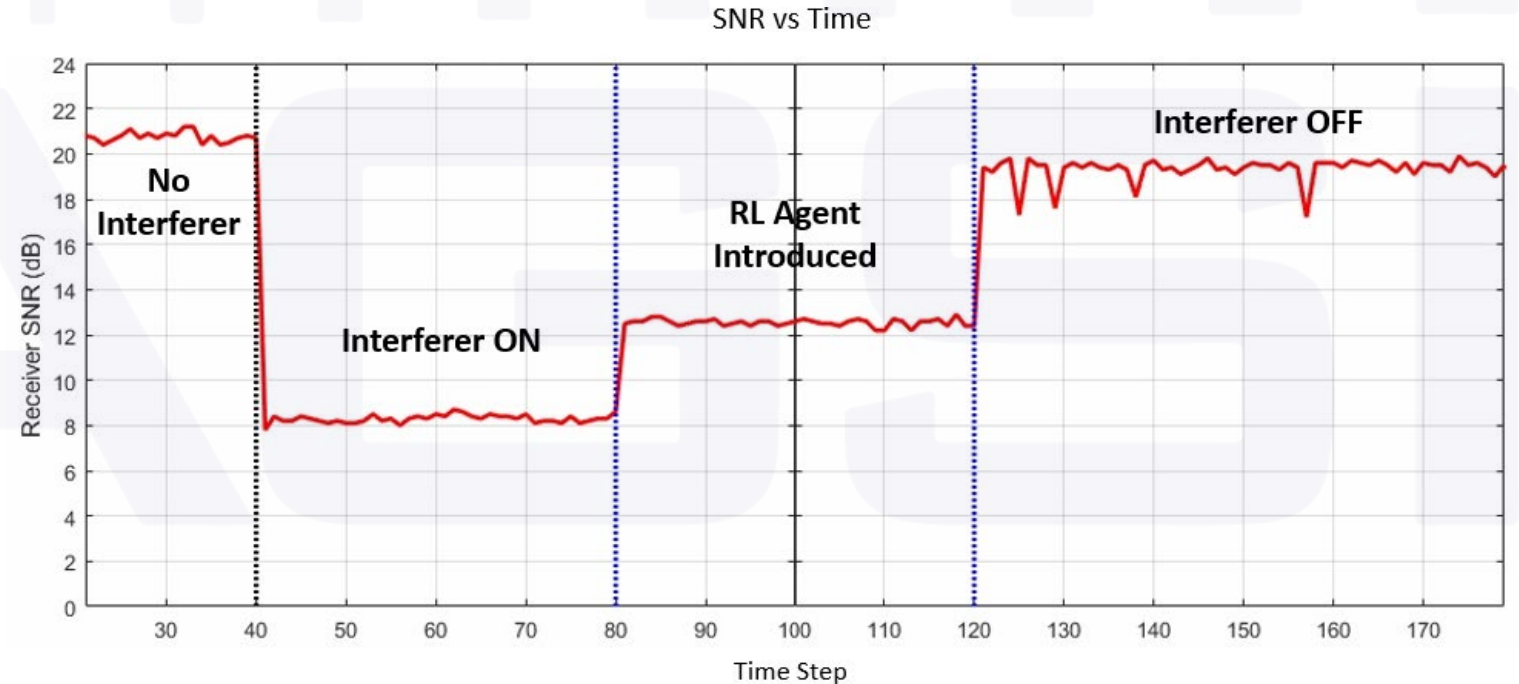
Out of band Static Interferer
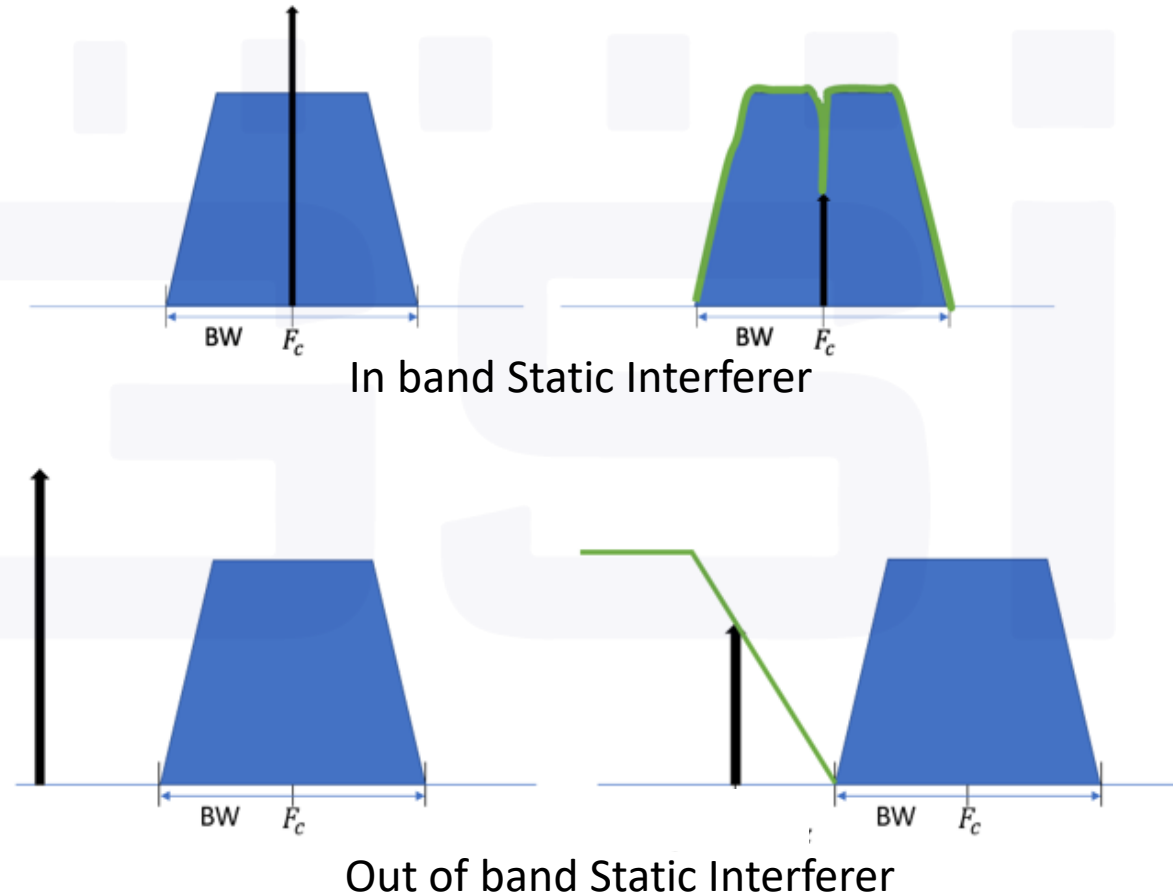
Previous Result with Reconfigurable Hardware

Attempt to achieve better recovery of SNR compared to result below against presence of interferer using current reconfigurable hardware.
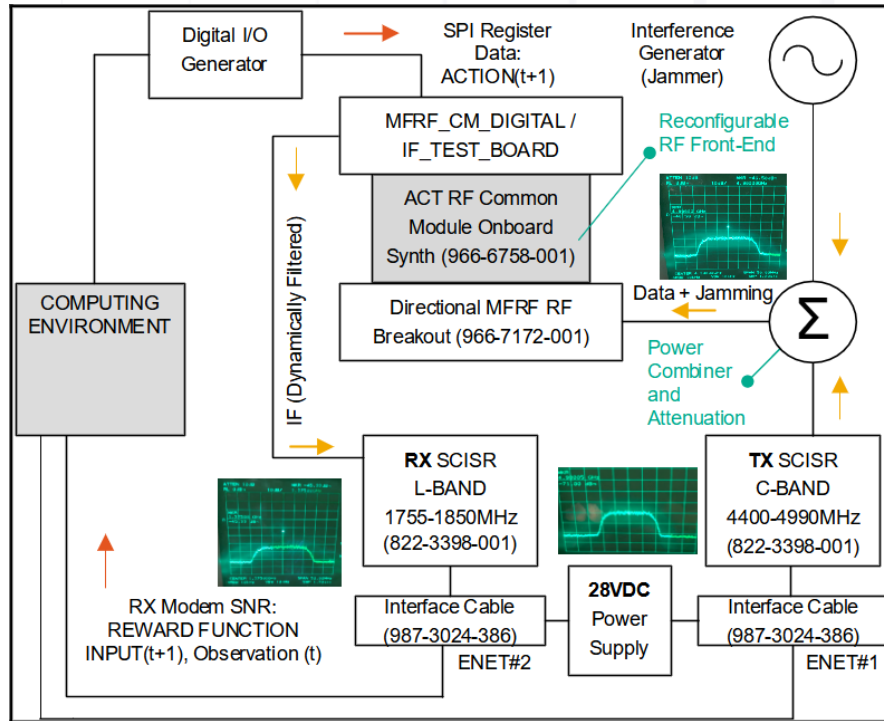
Demo Setup

Affects of Static In-band Interferer and RL Agents on Receiver SNR

Future Work and Acknowledgement

- Obtain the result for the four scenarios stated and compare it to results obtained with previous hardware

- Improve latency of the system

- Explore other parameter of interests

- Incorporation of commercial systems

- Special thanks to Collins Aerospace for technical support of their reconfigurable hardware