Mission-Critical Communications Planning Over Contested RF Spectrum with Deep Reinforcement Learning Aided Artificial Intelligence

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Mission-critical communications (MCC) refer to those that support operations involving high risk to human life and property. As RF spectrum becomes highly contested, ensuring mission success with MCC requires intelligent planning policies. This project develops a novel game-theoretic model for MCC and a Deep-Q-Network (DQN) implemented Deep Reinforcement Learning (DRL) based Mission-Critical Communications Protocol (MCCP) to learn to complete a mission within given resource-constraints against an adversary. An example critical mission is defined as two radios exchanging messages within a given time-constraint over two oppositely-directed communication links in the presence of a jammer. Mission-planning requires radios to learn when and how to switch directions vs. channels in response to the behavior of the adversarial jammer as well as wireless channel anomalies. Through extensive-form sequential-game modeling, the problem was shown to be too complex to solve analytically and beyond traditional reinforcement-learning due to uncountable state-space. Results on an actual wireless network showed that the DQN-implemented DRL could achieve mission success with 0.9 probability. A new DRL algioritthm called Deep Policy Hill Climbing was developed that outperformed Google DeepMind's original DQN-DRL algorithm. Beyond MCC, this framework can be applied in a wide-variety of fields such as disease control, troop distribution optimization and resource allocation in management.