

CLOUD-D RF: CLOUD-based Distributed Radio Frequency Spectrum Sensing

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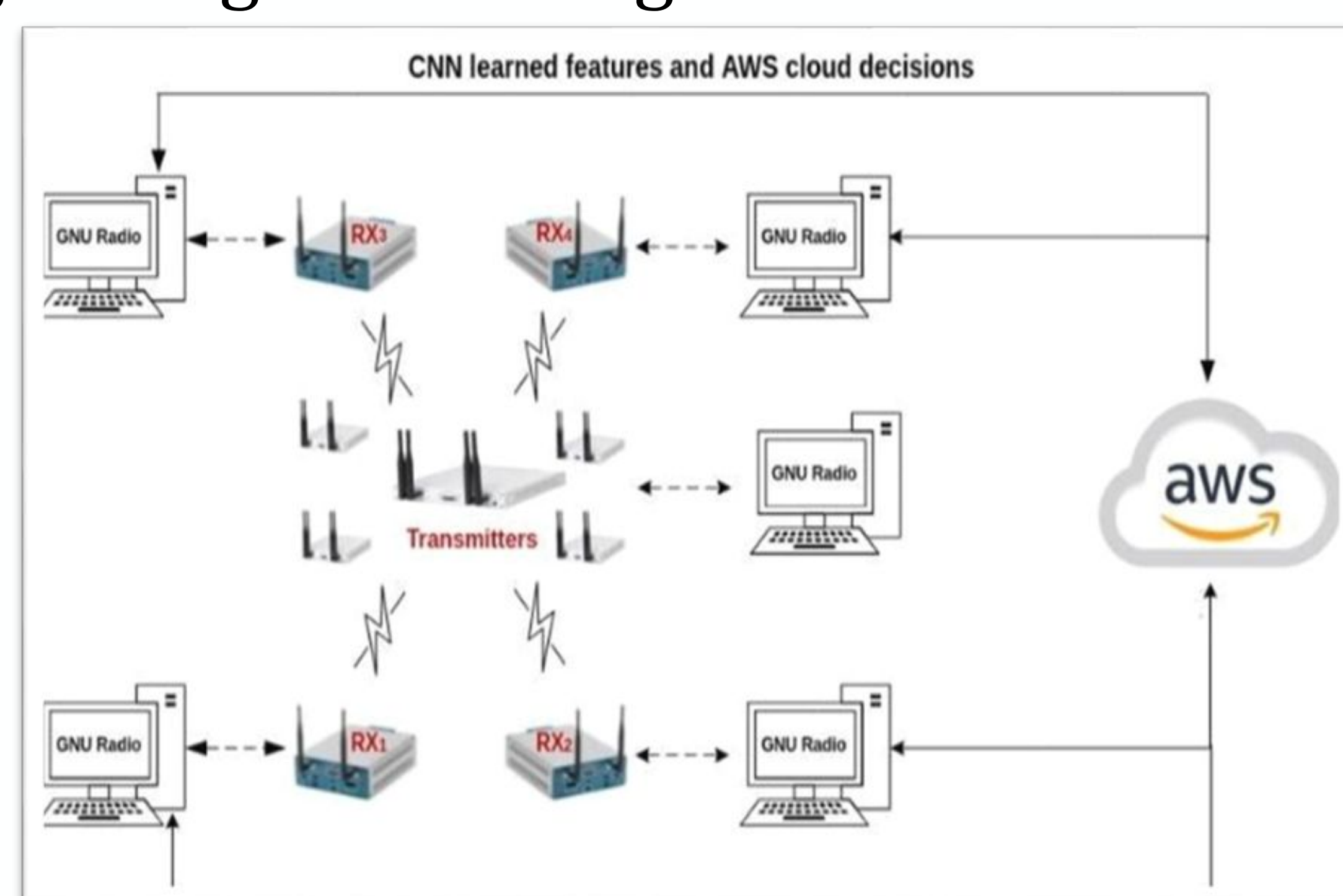
2025 Hume Center National Security Colloquium

Introduction & Motivations

- **Goals:** Research & develop radio frequency sensor fusion techniques for heterogeneous sensors at the edge leveraging the cloud.
- **Motivations:** Contribute to the limited research on heterogeneous RF sensor fusion & offload decision-making to the cloud to reduce edge sensor load

System Model

1. Generate datasets modeling RF edge sensors with different performance bounds and sensing models through the utilization of GNU Radio.
2. Train edge device models on the datasets to classify the type of the signal.
3. Extract learned features from the sensor models.
4. Transmit features to a centralized server for fusion
 - Currently done locally via ZMQ
 - AWS Cloud will be future fusion center
5. Aggregate features for collaborative decision making through clustering.



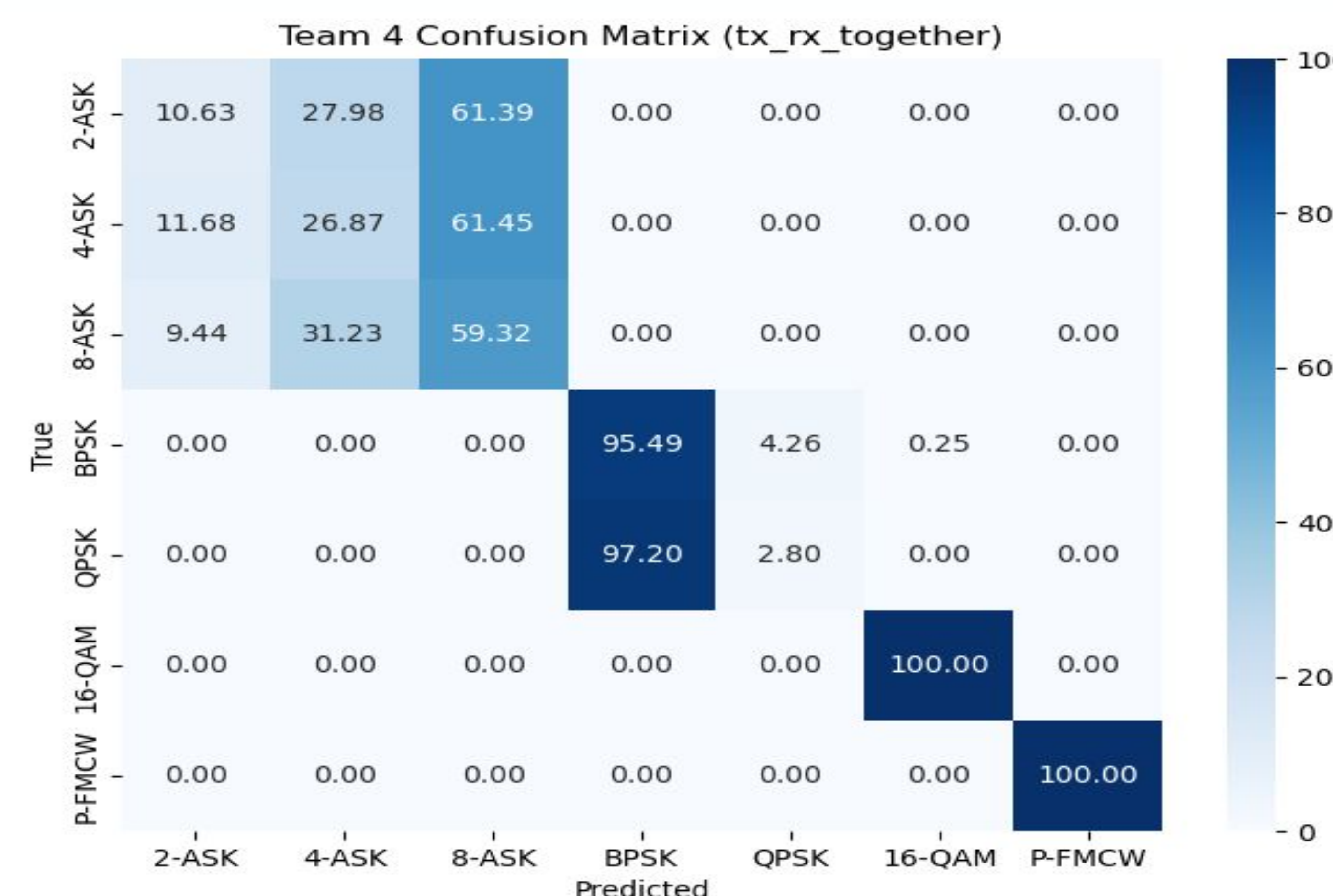
Signal Transmission & Reception

- Flowgraphs were built using GNU Radio to transmit and receive different modulations
- Constellation plots were visualized to validate flowgraphs

Edge Sensor Performance

- Each edge device has a unique and independently trained model to mimic different heterogeneous radios.
- Differentiates between different modulations well, but gets confused between modulation orders due to being trained on a smaller dataset

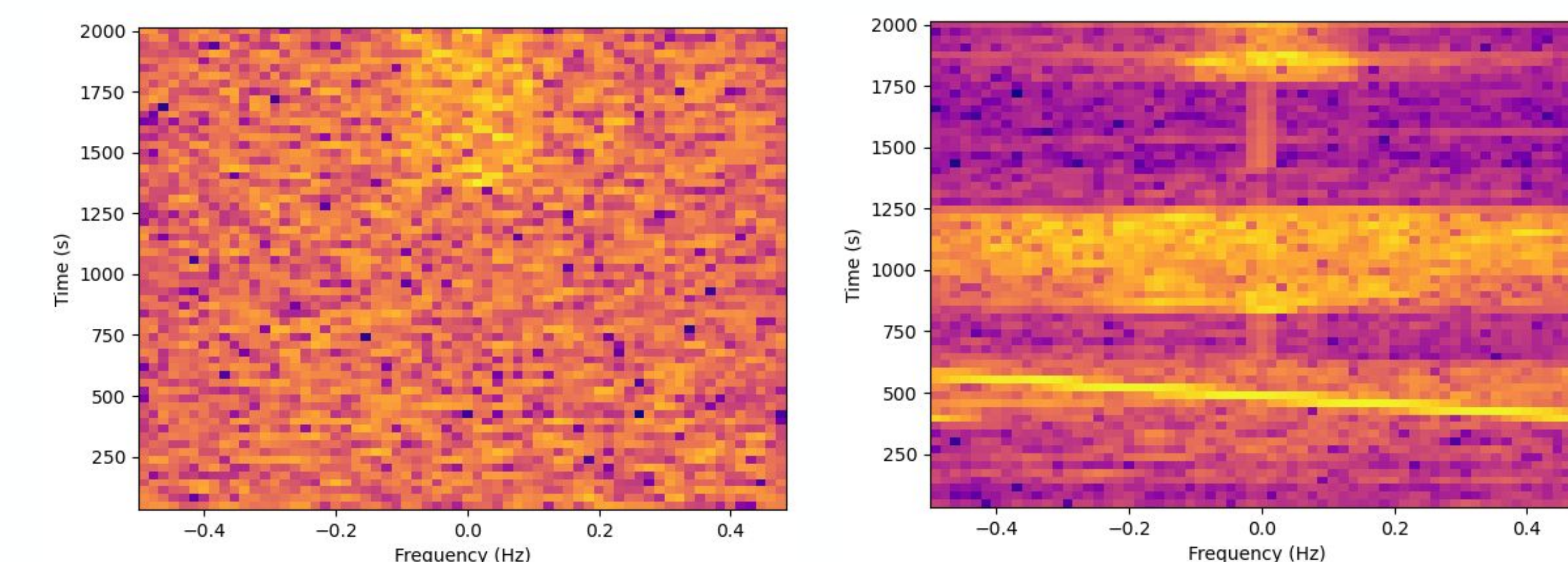
Model Performance on Flowgraph Dataset with Transmitter and Receiver



Split Trx/Rx Data Generation

- Transmitter & receiver gains need to be adjusted to capture signal
- Detection stage at receiver needed to properly process signal

IQ Data Spectrograms



trx gain: 50, rx gain: 50

trx gain: 80, rx gain: 90

Feature Transmission via ZMQ

- ZeroMQ packages extracted model features and reliably transmits them to the designated server
- Modulation Classification in GNU Radio using a Custom Python Classifier block

Example Flowgraph Transmitting Features Extracted from Hardware Radios

