Spectrum Sensing Using USRP

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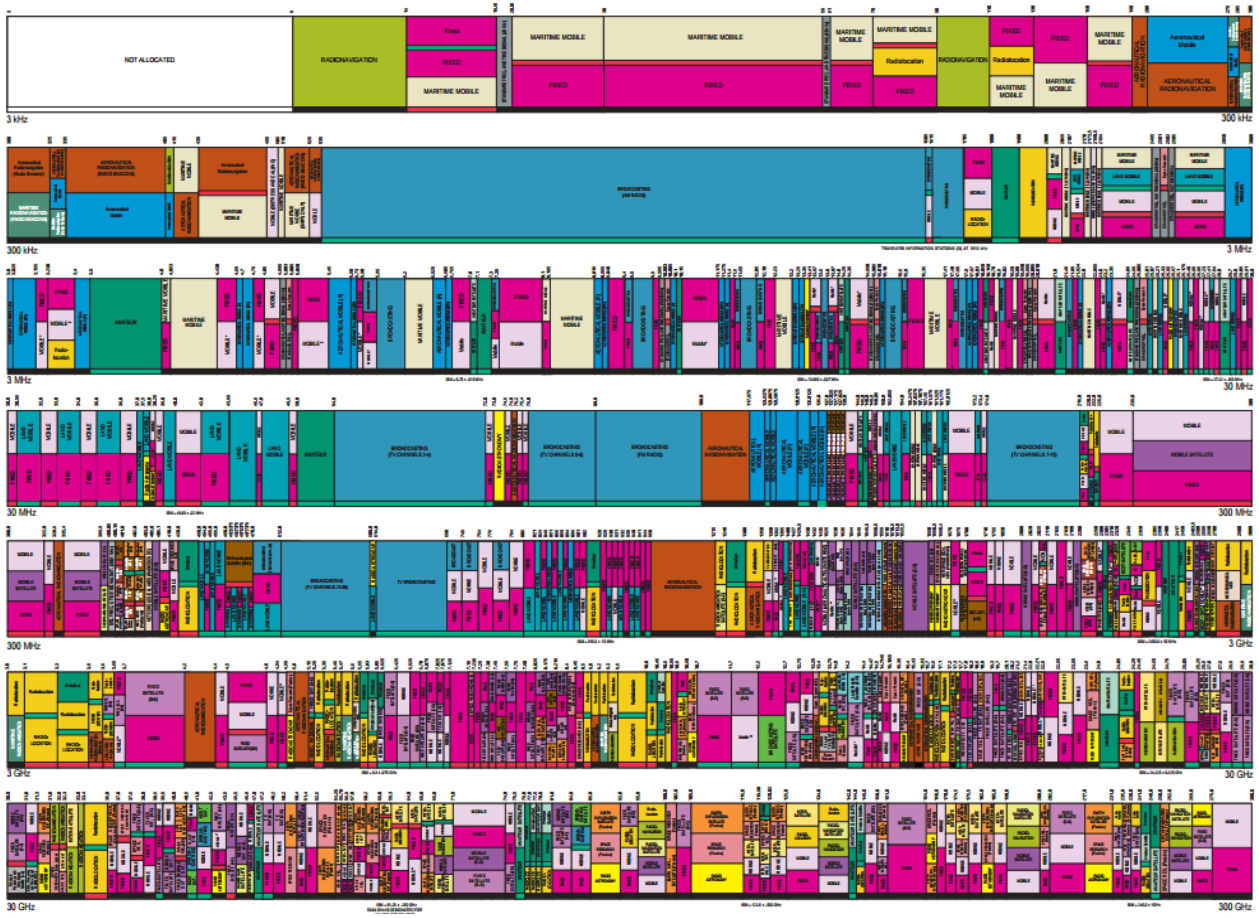
Outline

- Background
- Identified Need
- Proposed Solution
- Considerations and Responsibilities
- Decompositions
- Implementations

Background

- RF spectrum (1 Hz - 300 GHz) utilization has increased exponentially in the past decades.
- Using the Software Defined Radios, there is a less need for specialized hardware.
- One module can address a wide range of uses and reduce high overhead costs.
- Wireless communications pose an increasing threat to deployed military personnel
- There is a push in the military towards utilizing Software Defined Radios



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Identified Need

- Current spectrum analyzers are heavy, expensive and another system to put on a vehicle
- SDRs provide the opportunity for hardware convergence
- The MITRE Corporation (sponsor) has identified a need of the Army (potential customer) for a spectrum analyzer that automatically identifies modulation of observed signals
- If successful, the solution would be expand RF situational awareness Army personnel deployed around the world

Mitre.org

peoc3t.army.mil

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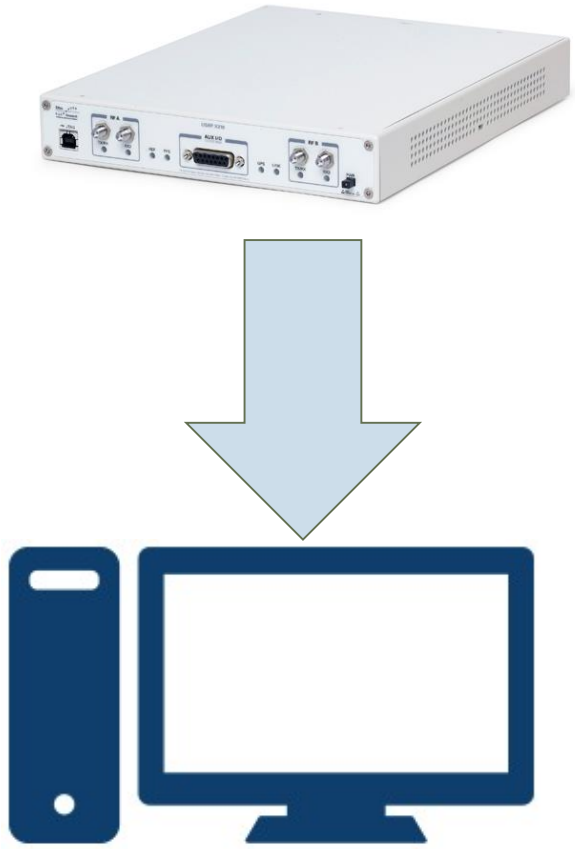
Proposed Solution

- Solution suggested by the Sponsor includes 3 parts:
  - SDR
    - Many options from different companies, including Ettus Research
- Computer
  - Implements processing of samples provided by the SDR
- Application
  - Takes control information from the user, and displays data containing spectrum and signal information



```
11:32:38am: FM signal detected at 103.7 MHz
11:32:39am: AM signal detected at 1050 MHz
11:32:42am: OFDM signal detected at 756 MHz
11:32:47am: QPSK signal detected at 752 MHz - ANOMALY
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www.ettus.com

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Considerations and Responsibilities

- RF Spectrum – do not disrupt during testing, operation etc.
- Economic – we have a sponsor, but still not unlimited resources
- Environmental – RoHS (Restriction of Use of Hazardous Substances)
- Health and Safety
  - Normal risk with electronics
  - Use of RF bands
- Reliability – this would be a critical system for military or law enforcement applications

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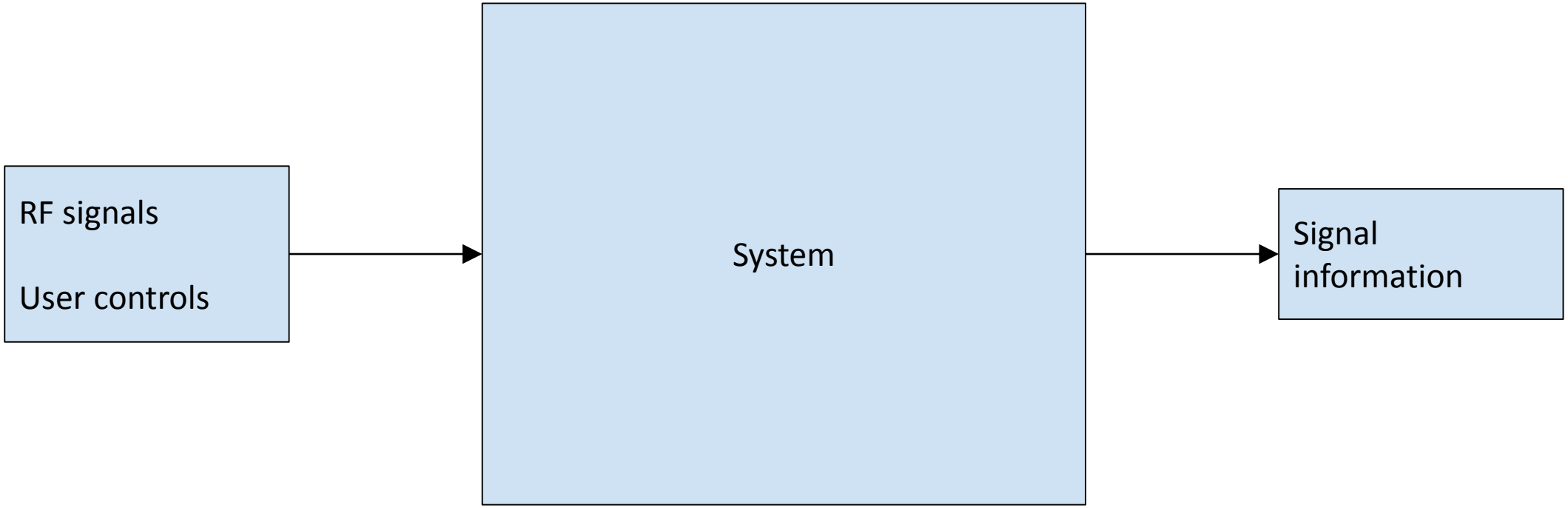
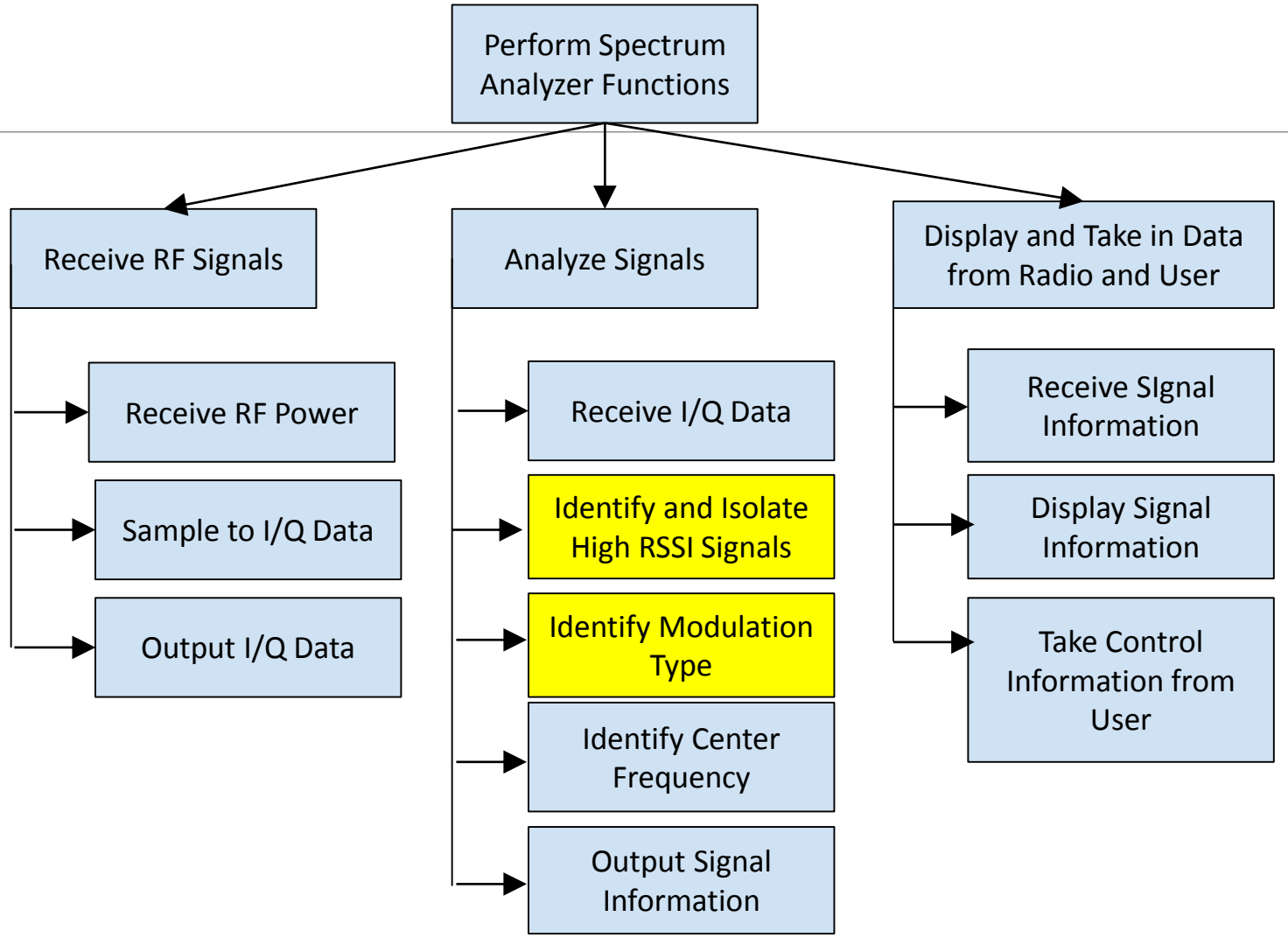
Black Box Decomposition



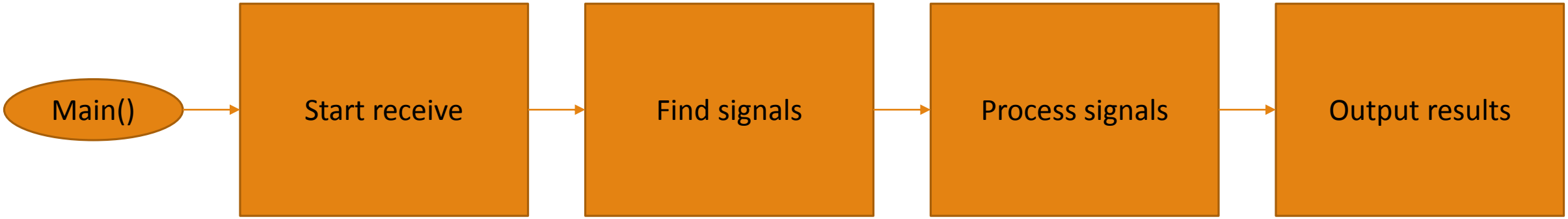
Functional Decomposition



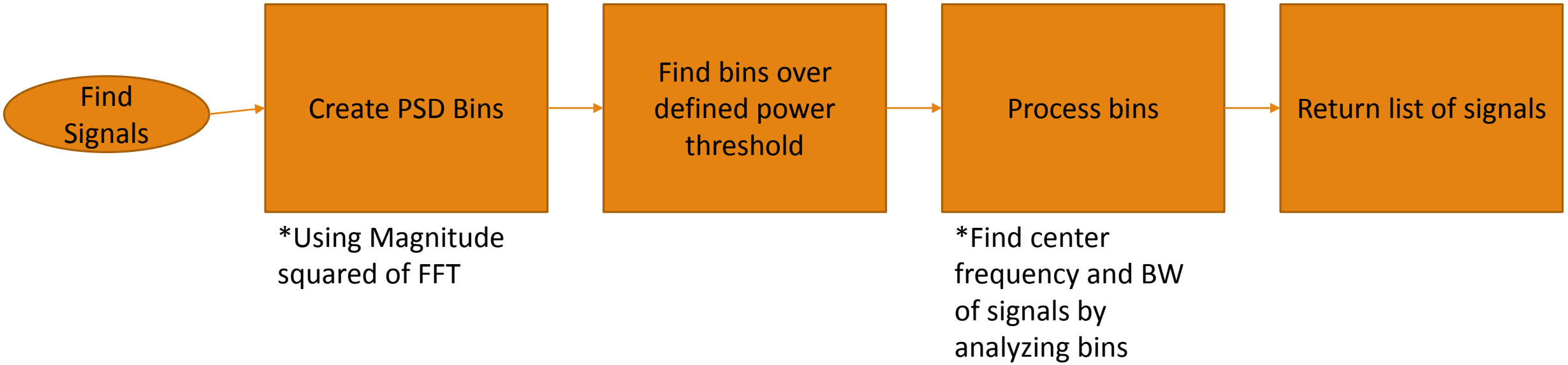
Identify and Isolate Signals

- Energy detection using Power Spectral Density (PSD)
- Divide window (user given BW) up into bins
- Find target bins using some algorithm (above certain power number for now)
- Process bins
- Return list of signals.

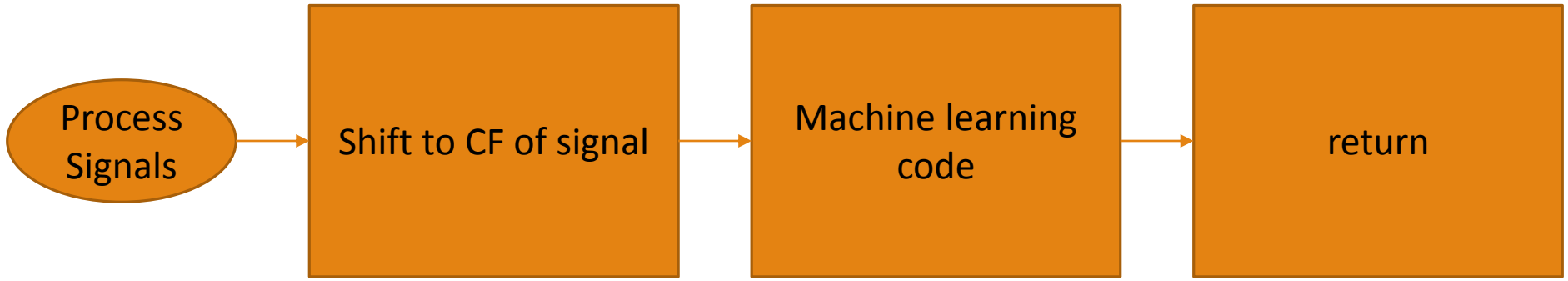
Identify and Isolate Signals



Identify and Isolate Signals



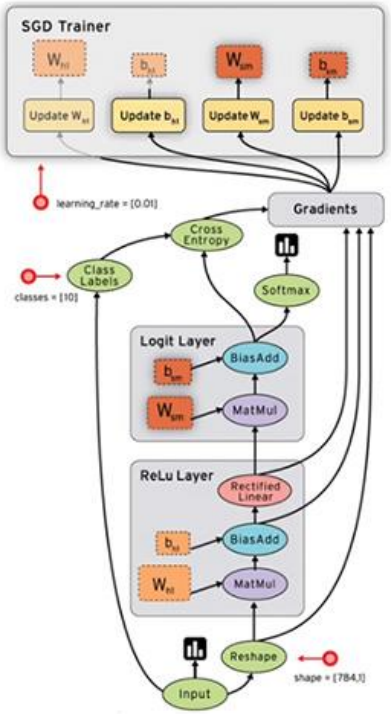
Identify and Isolate Signals



*For each signal

Machine and Deep learning approach

The advantage of implementing the concepts of deep learning to signal processing is to recognize modulation in signals of unknown origins.



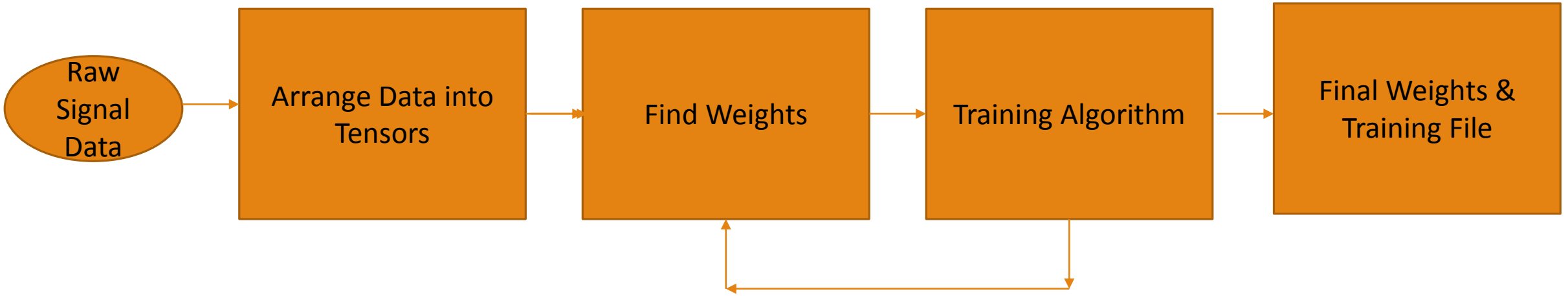
The GNU Radio platform makes it easy to write blocks through the use of Python.

Easy to make use of the TensorFlow API (open source software library for machine learning) within the python package.

To analyze and distinguish the signals by modulation of unknown origin, the approach of convolution neural networks was applied using this TensorFlow API.

Identify Modulation
(Using Machine Learning)

Training Overview:



Training Results

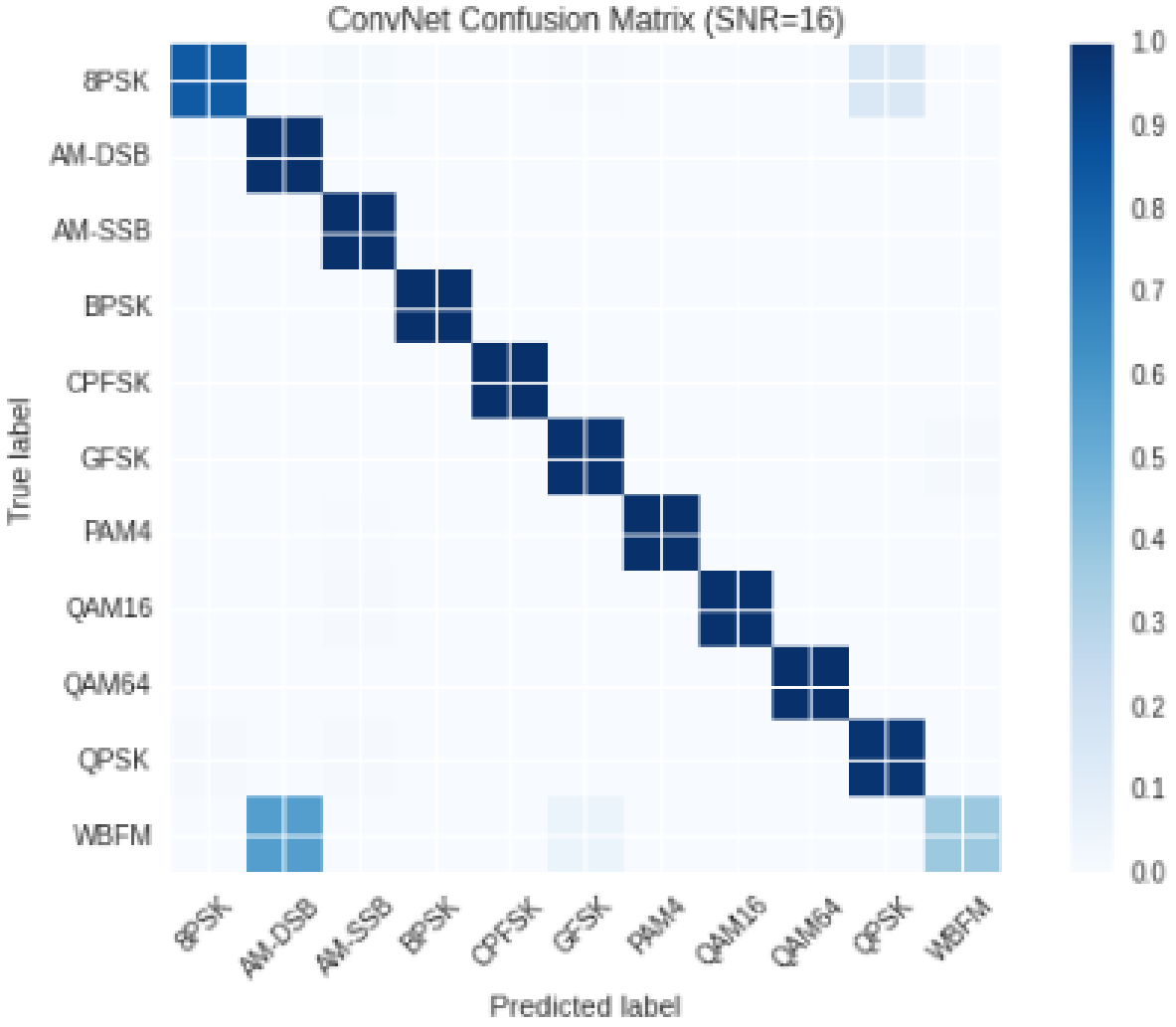
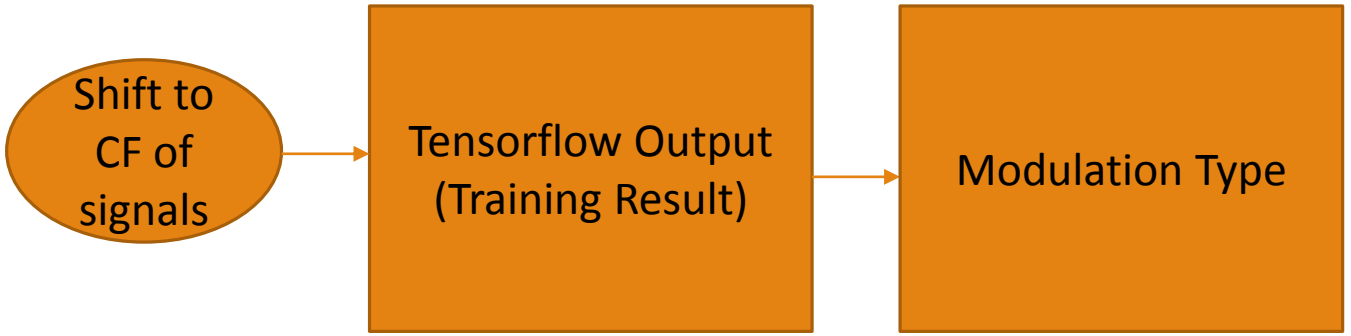


Figure 8. Conv Net Confusion Matrix at +18dB SNR

Using Results



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Implementations

GNU RADIO AND PYTHON

- Advantages
  - Low development time and cost.
  - Large library and knowledge base already available and accessible.
  - High-level abstraction tools available.
- Disadvantages
  - Processor has to handle many intensive tasks.
  - Lowest performance

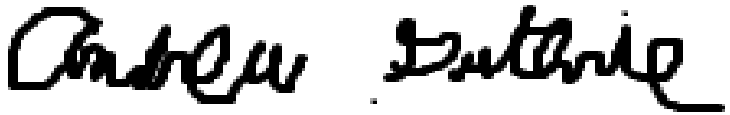
C++ AND VHDL

- Advantages
  - Extremely fast and efficient once implemented.
- Disadvantages
  - Few specific resources available.
  - VHDL implementation for FPGAs.
  - Longer development time and cost.

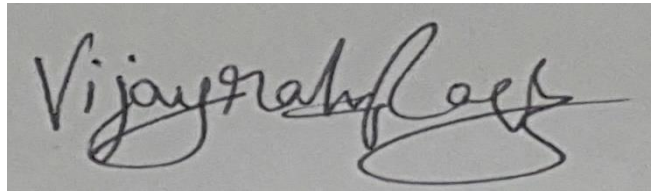
Pledge : “I pledge my honor that I have abided by the Stevens Honor System”

Joseph Pang

Andrew Gutherie



Vijayrahul Raja



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