

MATLAB EXPO

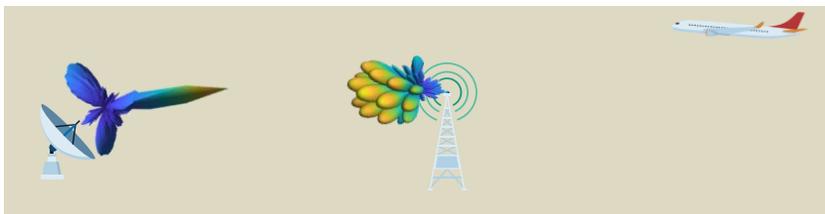
无线标准 + 人工智能: 实现未来无线连接



张茜
MathWorks



近期美国机场5G部署面临的挑战



Evaluating Interference from 5G New Radio (NR) Signals at an Airport...

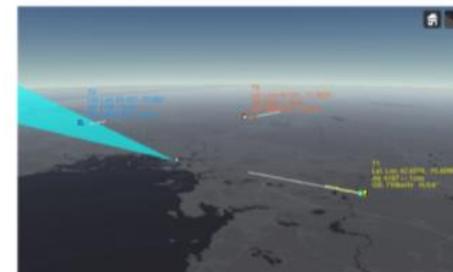
Model an air traffic control radar which operates in the vicinity of a 5G base station.

[Open Live Script](#)

机场监控雷达 & 5G 基站



Image Credit: Toronto Star



C-Band 5G Telecom Delays and Airline Frustration

The airlines made their case to the FAA earlier this week, warning that the rollout of 5G service near airports could cause catastrophic disruption...

Lisa Harvey on Jan 22, 2022
Behind the Headlines

雷达高度计 & 5G 基站

互联世界的未来

不同的
标准

不同的
频率

不同的
用例

不同的
技术



应对挑战-实现无处不在的连接

处理复杂性

提早协作



需要
标准

确保可靠性

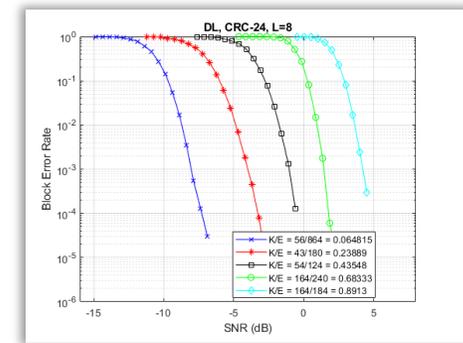
测试一切



需要
大量测试数据

推动性能

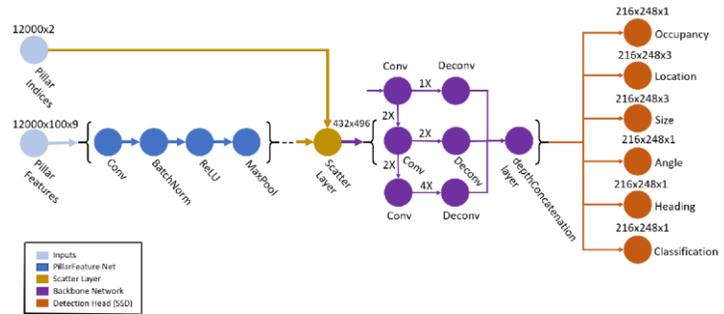
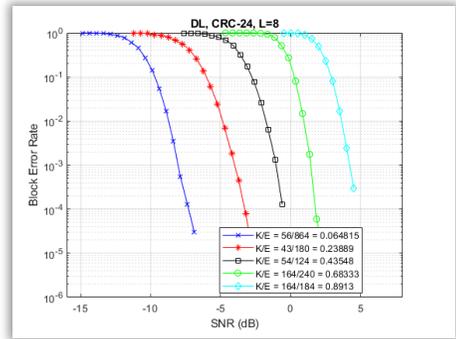
优化一切



需要
AI 部署

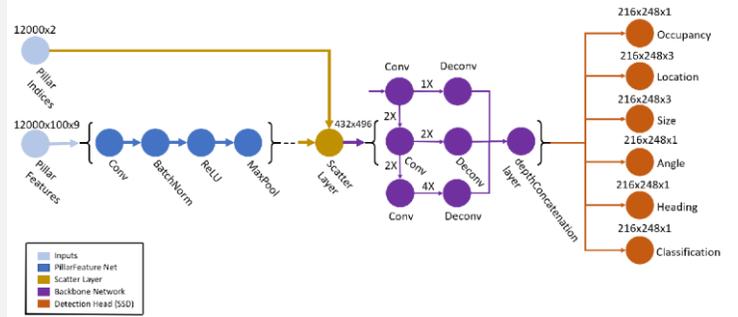
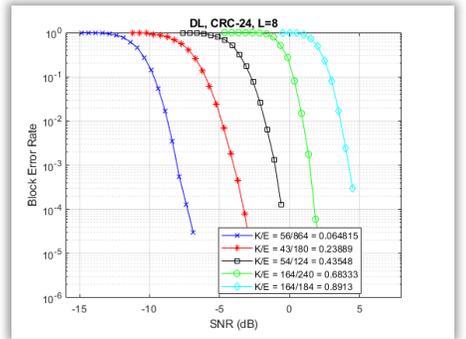
目录

- 1** 用标准处理复杂性
- 2** 用硬件连接测试一切
- 3** 用 AI 优化一切
- 4** 总结

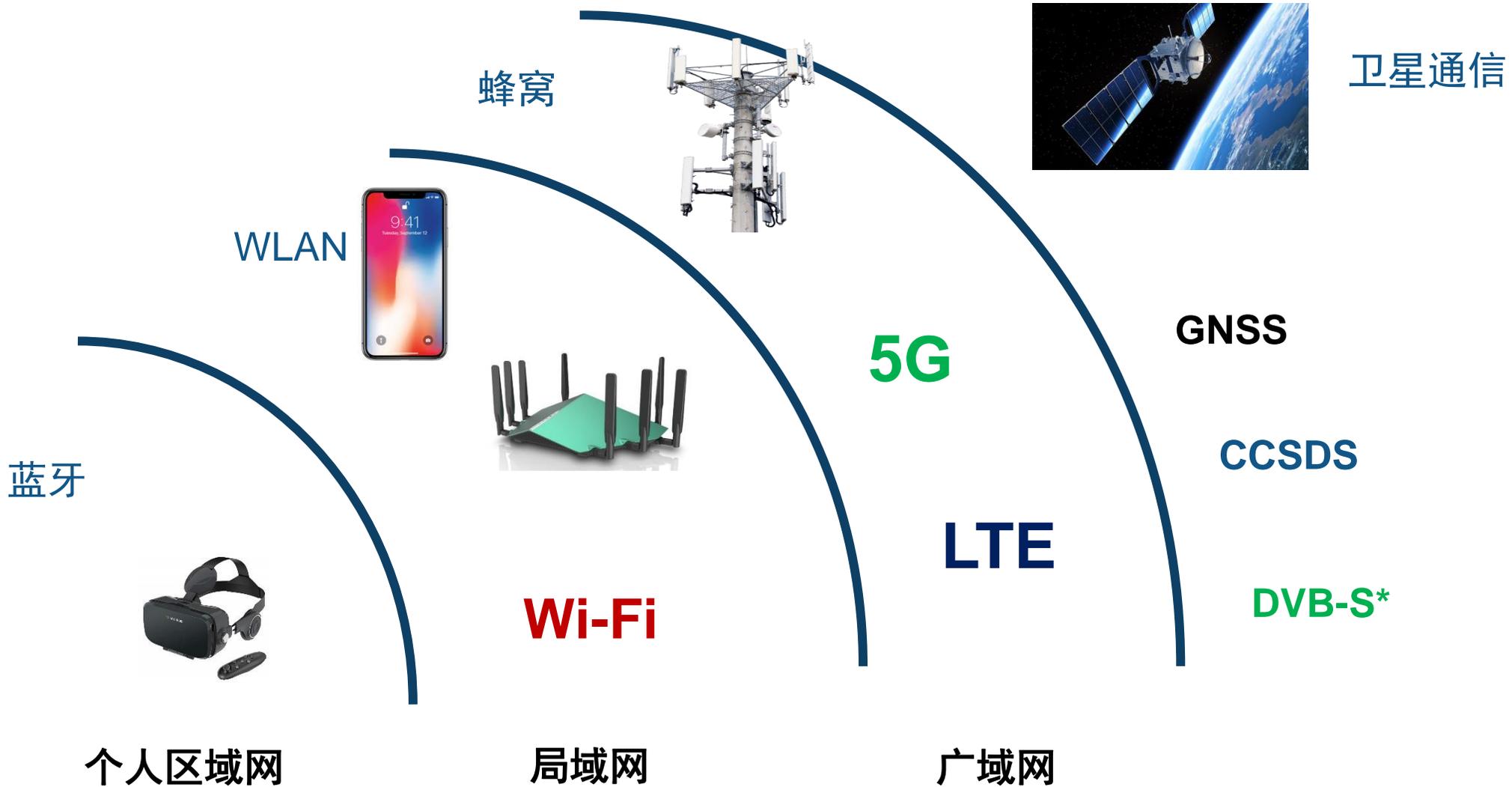


目录

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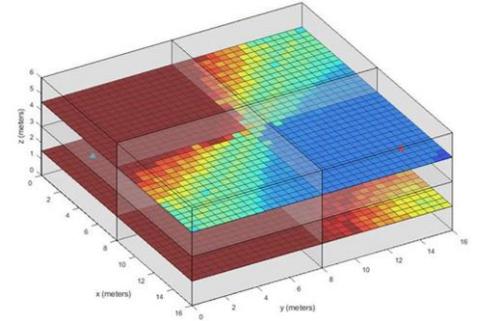
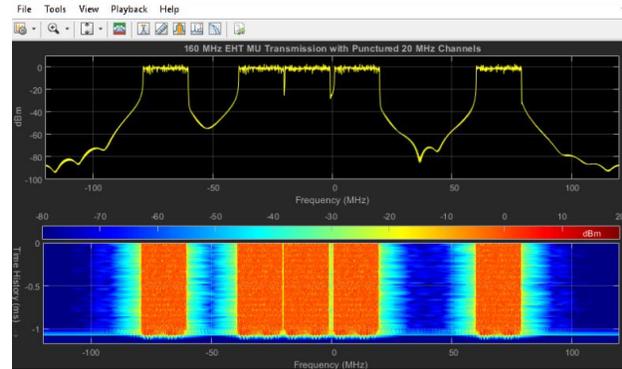
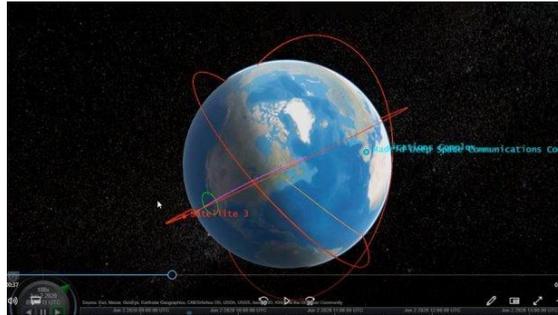
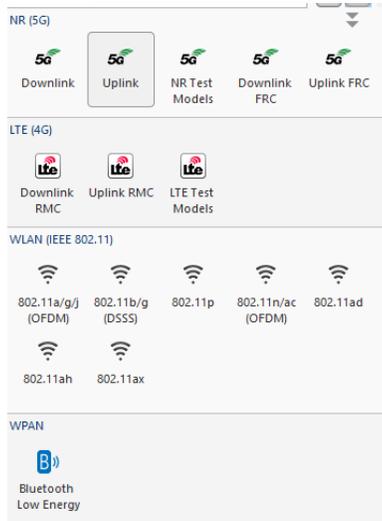
无处不在的连接 – 技术 & 标准



我们在无线标准方面的新进展



卫星通信



波形生成

非地面网络 (NTN)

Wi-Fi 7
IEEE 802.11be

new
Bluetooth
Toolbox

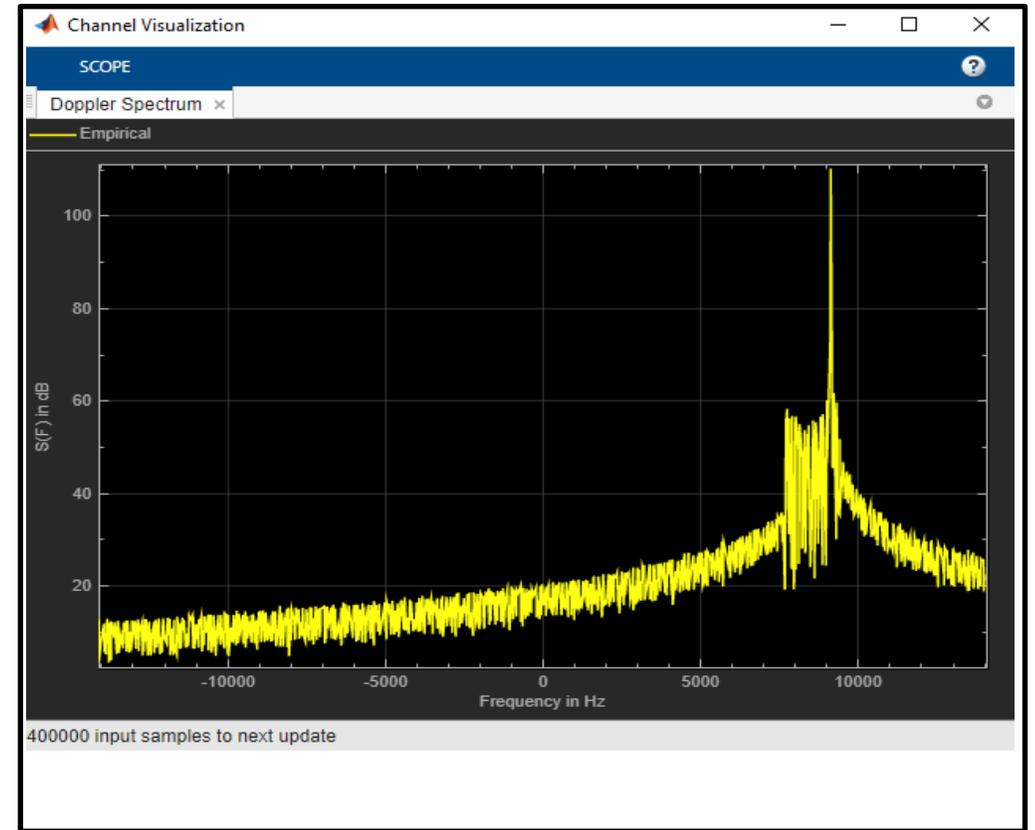
Wireless Waveform Generator App

The screenshot displays the MATLAB Wireless Waveform Generator - Spectrum Analyzer app interface. The window title is "Wireless Waveform Generator - Spectrum Analyzer". The interface is divided into several sections:

- Top Bar:** Contains tabs for "GENERATOR" and "TRANSMITTER". A toolbar includes icons for "New Session", "Open Session", "Save Session", "Impairments", "Visualize", "Default Layout", "Generate", and "Export".
- Waveform Type:** A dropdown menu is currently set to "OFDM". Other options include "QAM" and "PSK".
- Waveform Configuration (Left Panel):**
 - OFDM Waveform Configuration:**
 - FFT length: 64
 - Guard band subcarriers: [6;5]
 - Insert DC null
 - Cyclic prefix lengths: [16]
 - Windowing
 - OFDM symbols: 100
 - Transmit antennas: 1
 - Subcarrier spacing (Hz): 1000000
 - Pilot input
 - OFDM input type: QAM
 - QAM Waveform Configuration:**
 - Modulation order: 4
 - Symbol mapping: Gray
 - Bit source: User-defined
 - Size of input bits: [10600 1]
 - Input bits: randi([0 1], 10600, 1)
 - Filtering Configuration:**
 - Filtering: None
- Spectrum Analyzer (Right Panel):**
 - Y-axis: dBm (ranging from -80 to 20)
 - X-axis: Frequency
 - Current status: Stopped
 - Tab: OFDM Subcarrier Mapping

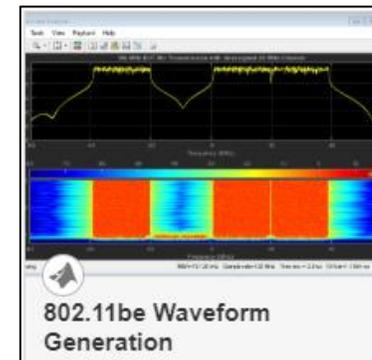
非地面网络 (NTN) 窄带信道

- 支持3GPP TR 38.811规定的平坦衰落窄带信道模型
- 支持ITU-R P681.11规定的不同频率范围和环境类型
- 支持多普勒频谱、脉冲和频率响应的可视化



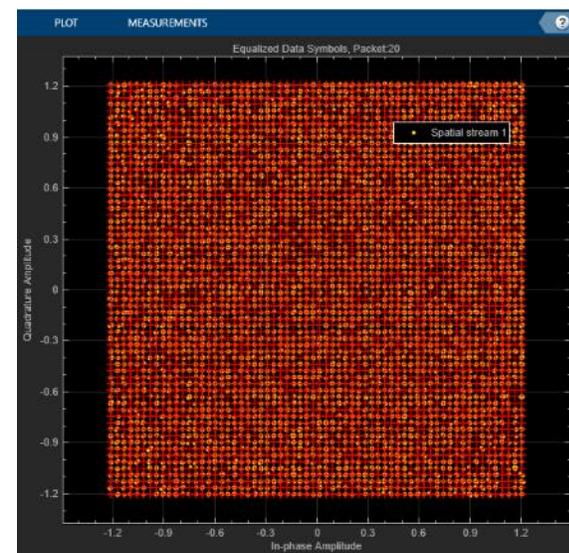
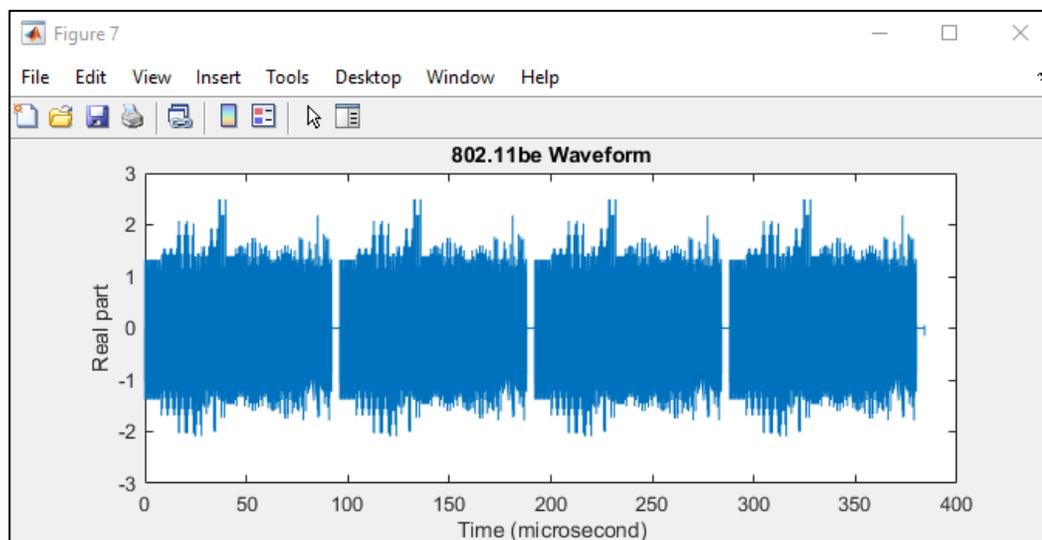
生成 802.11be (Wi-Fi 7) 波形

- 高达 320 MHz 信道带宽
- 最高 4096QAM

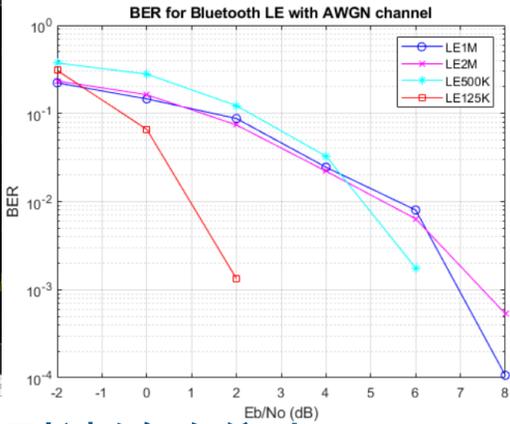
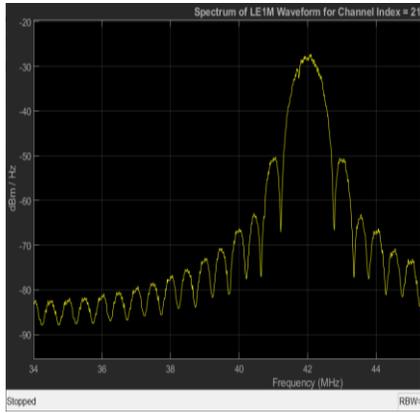


Command Window

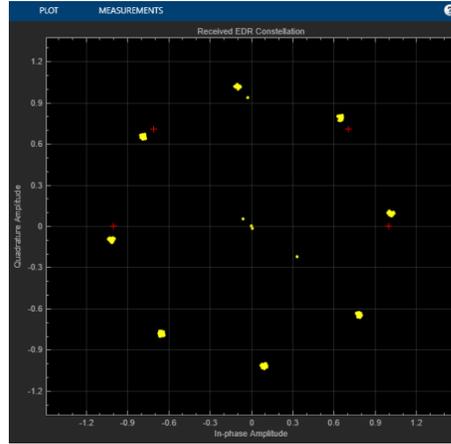
```
>> cfgEHT = ehtMUConfig('CBW320');  
>> txWaveform = ehtWaveformGenerator(data, cfgEHT, 'NumPackets', 4, 'IdleTime', 4*1e-6);  
fx >>
```



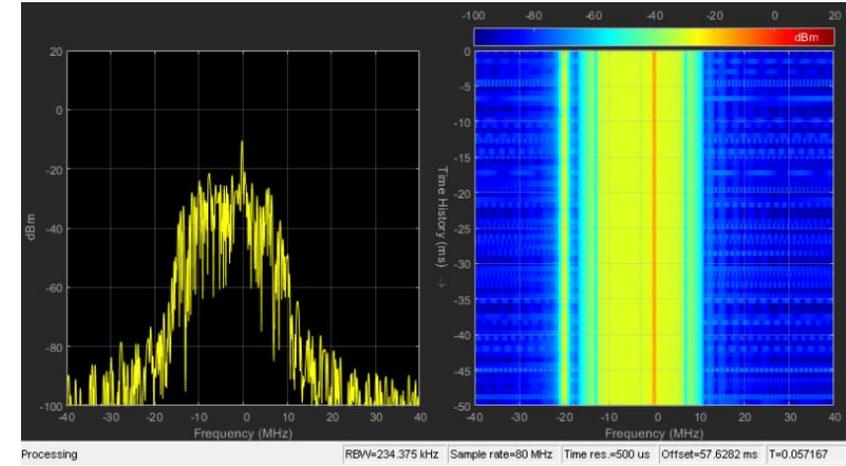
Bluetooth Toolbox



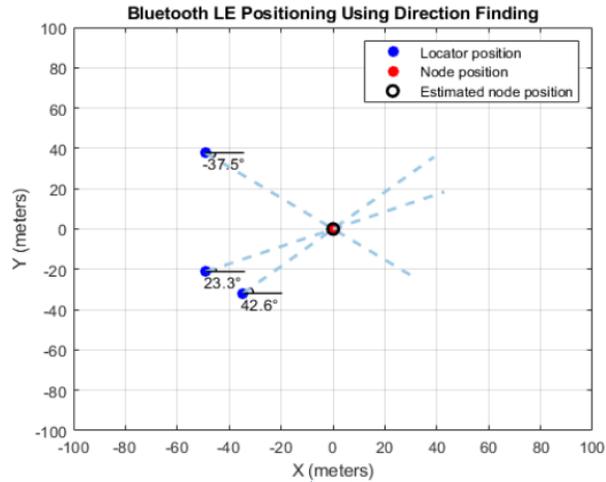
波形生成和端到端链路仿真



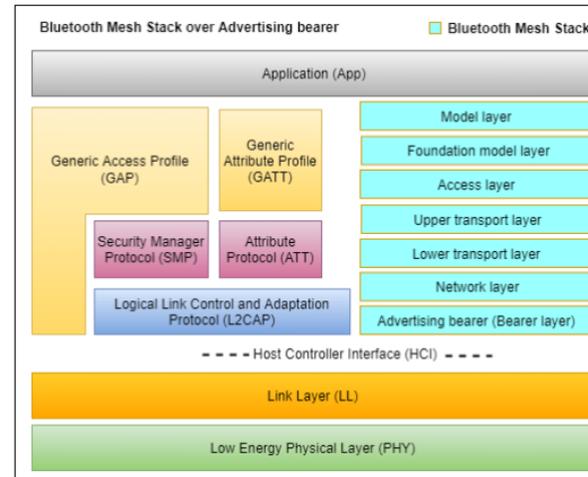
信号恢复和分析



Bluetooth/WLAN 共存



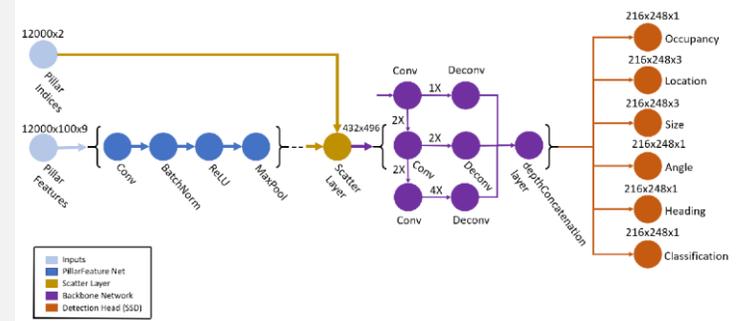
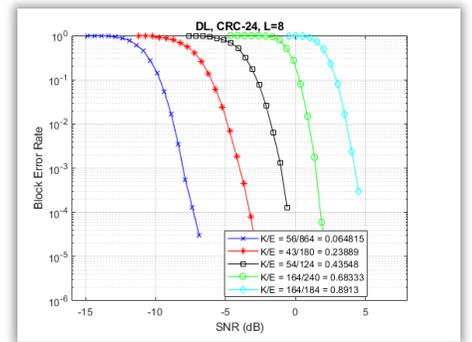
定位



网络建模

目录

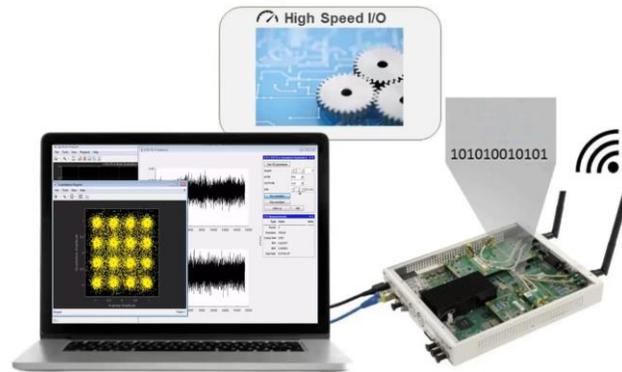
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- 4** 总结



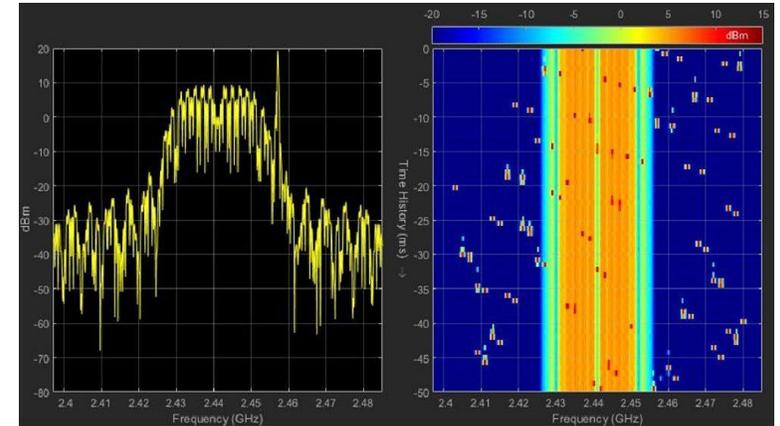
我们在无线测试方面的新进展



SDR 连接



Wireless
Testbench

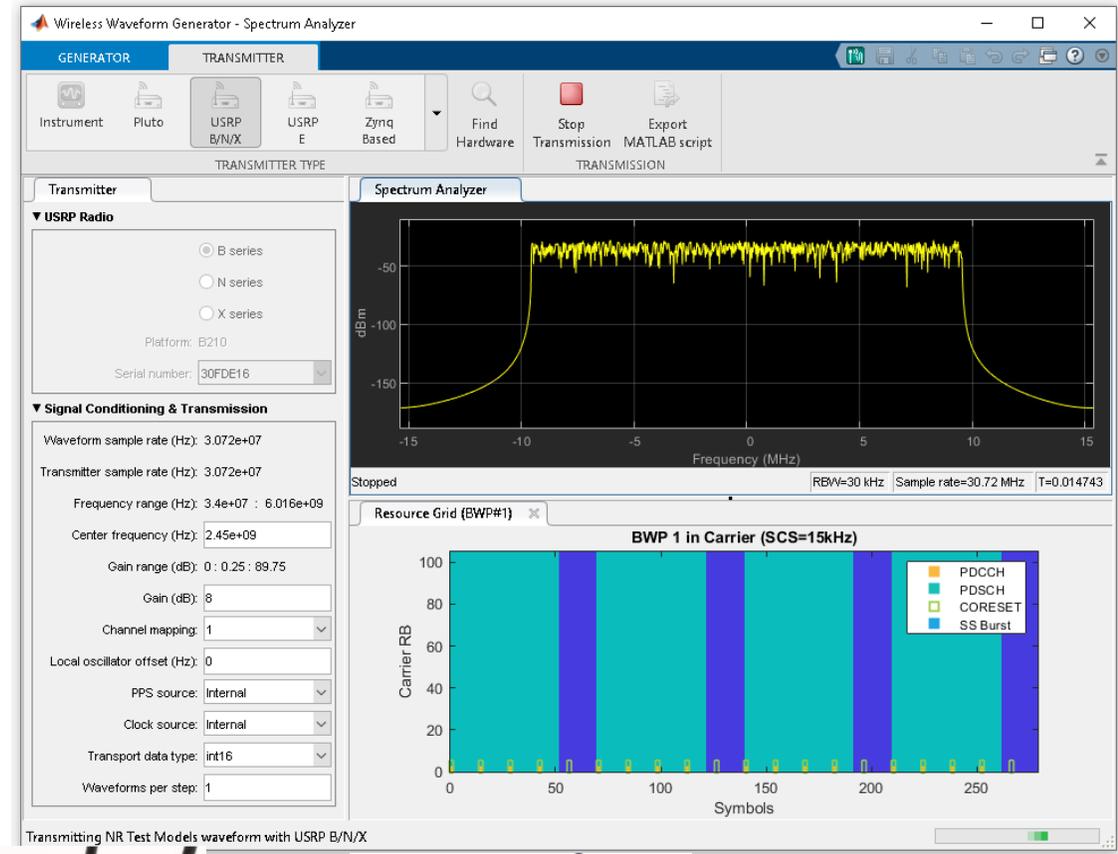


干扰 & 共存

在无线波形发生器应用程序中轻松连接到SDR

使用 Pluto, USRP B/N/X, USRP E, Zynq 软件定义无线电, 轻松、图形化地传输无线信号

- 支持所有波形类型 (5G, WLAN, LTE, Bluetooth, Comms)
- USRP B/N/X 的自动采样率选择和波形重采样
- 生成等效 MATLAB 代码

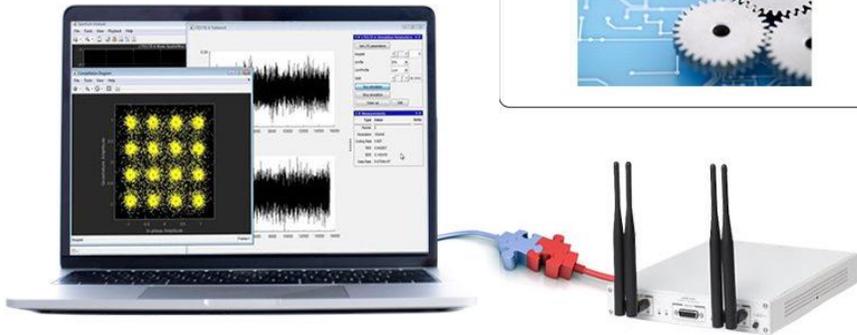
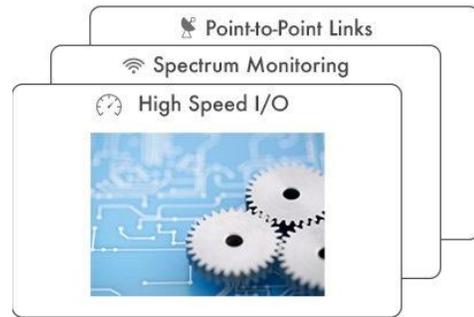


Wireless Testbench

探索并测试使用智能高速数据传输/捕获的无线设计

用例 / 应用

- 谱一致性
- 信号检测
- 频谱监测
- 信号分类
- 认知无线电



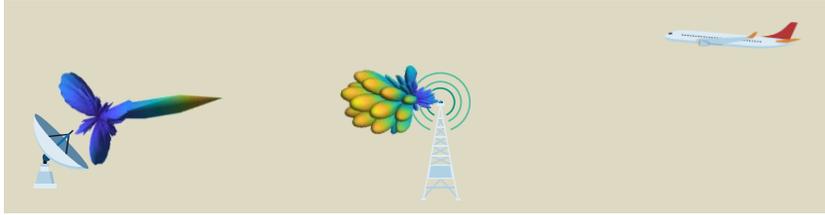
以高达 250 Msps 的速度传输和捕获宽带信号

端到端收发机设计，基于标准的和定制的信号发射器/接收器设计

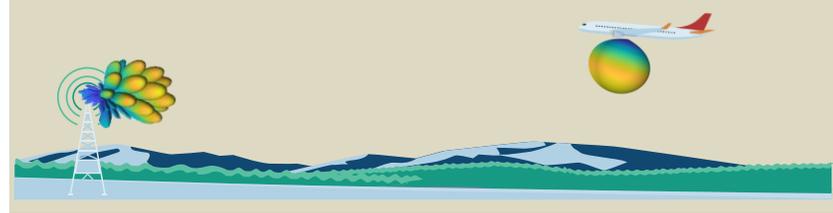
智能数据捕获

通过前导码监测仅捕获感兴趣的波形，减少发送到主机的数据

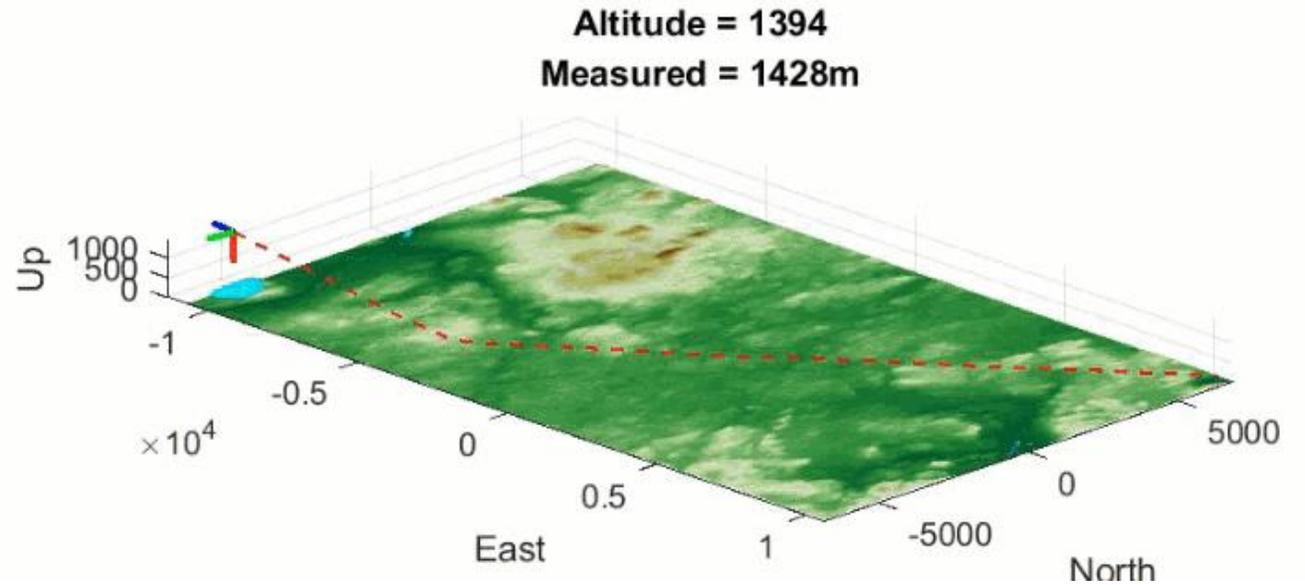
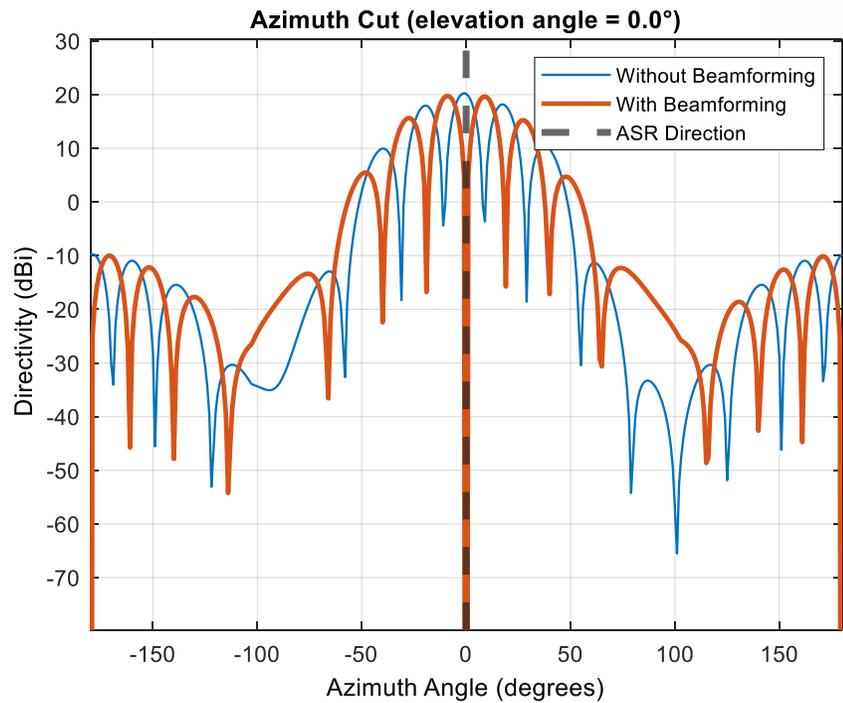
确保可靠性和通过干扰抑制共存



机场监控雷达 & 5G 基站



雷达高度计 & 5G 基站



目录

1

用标准处理复杂性

2

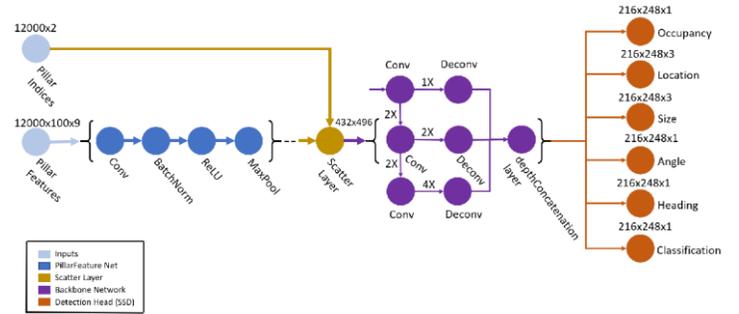
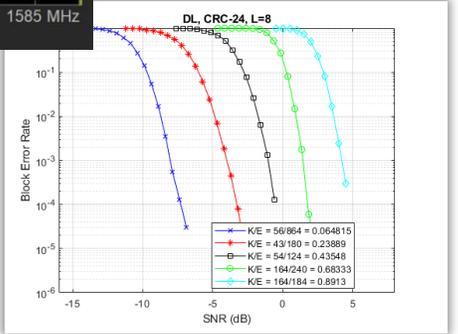
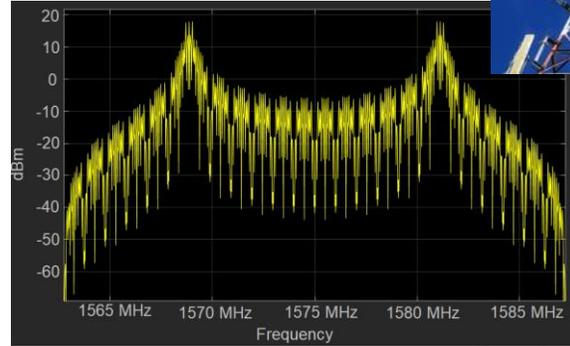
用硬件连接测试一切

3

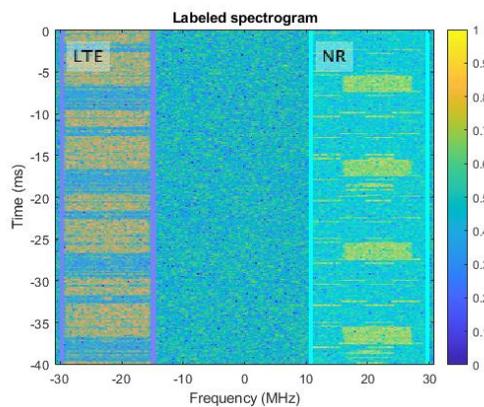
用 AI 优化一切

4

总结



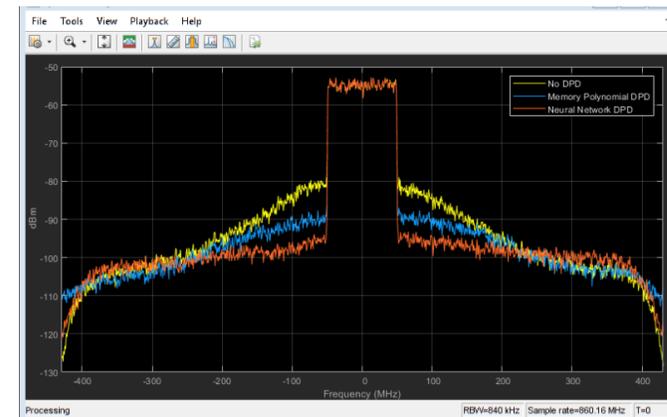
我们在无线通信AI方面的新进展



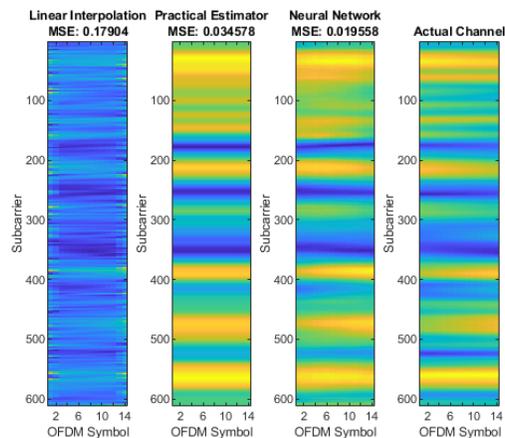
频谱感知 & 信号分类



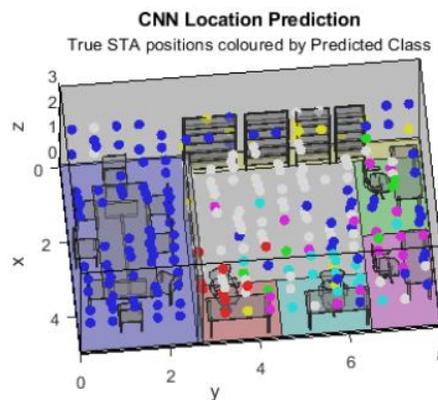
设备识别



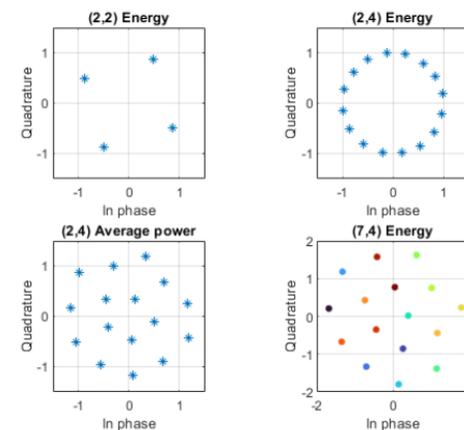
数字预失真



波束管理 & 信道估计



定位



收发机设计

AI 驱动的无线系统设计

数据准备

 数据清洗和准备

 人类洞察

 仿真生成数据

AI 模型

 模型设计和调整

 硬件加速训练

 互操作性

仿真 & 测试

 与复杂系统集成

 系统仿真

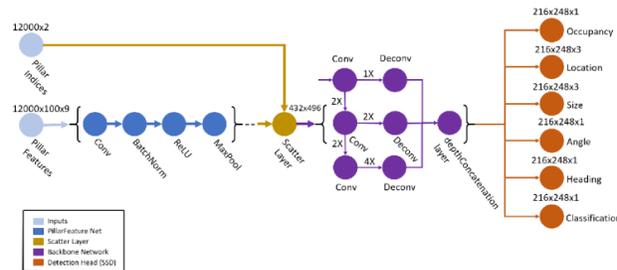
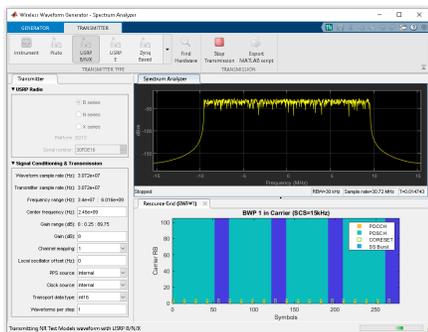
 系统验证和确认

部署

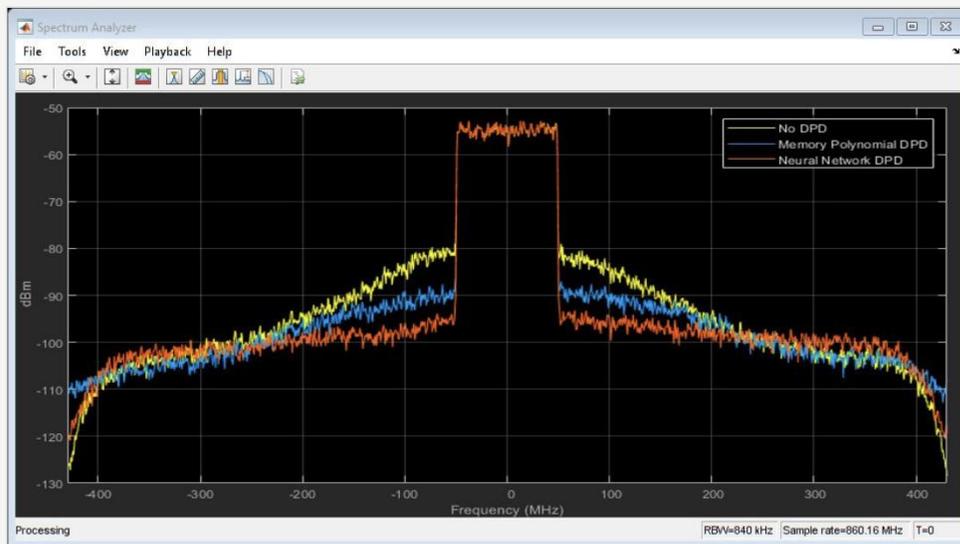
 嵌入式设备

 企业系统

 边缘, 云, 桌面



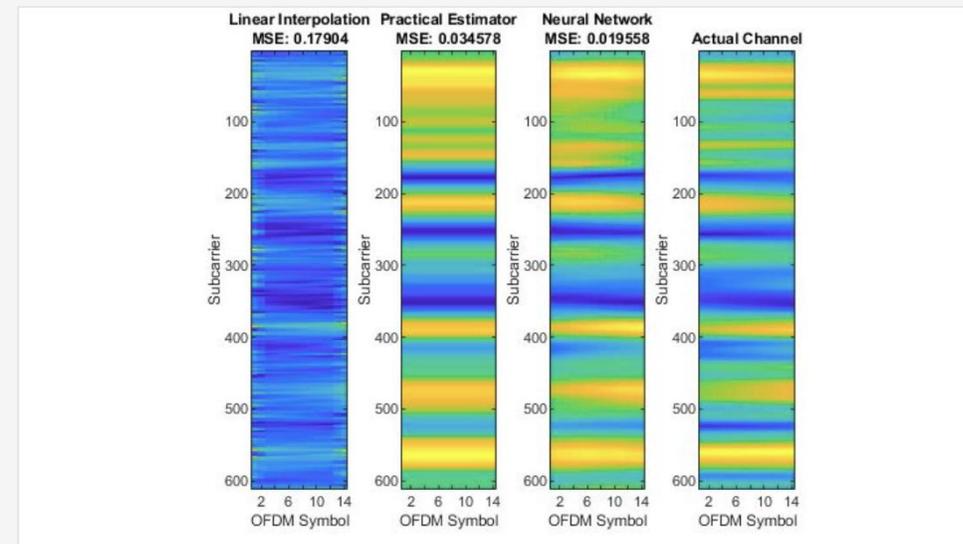
示例: 如何在MATLAB中使用无线AI



Digital Pre-Distortion

Apply neural network-based digital predistortion (DPD) to offset the effects of nonlinearities in a power amplifier (PA).

💡 [Neural Network for Digital Predistortion Design - Offline Training](#)



Beam Management and Channel Estimation

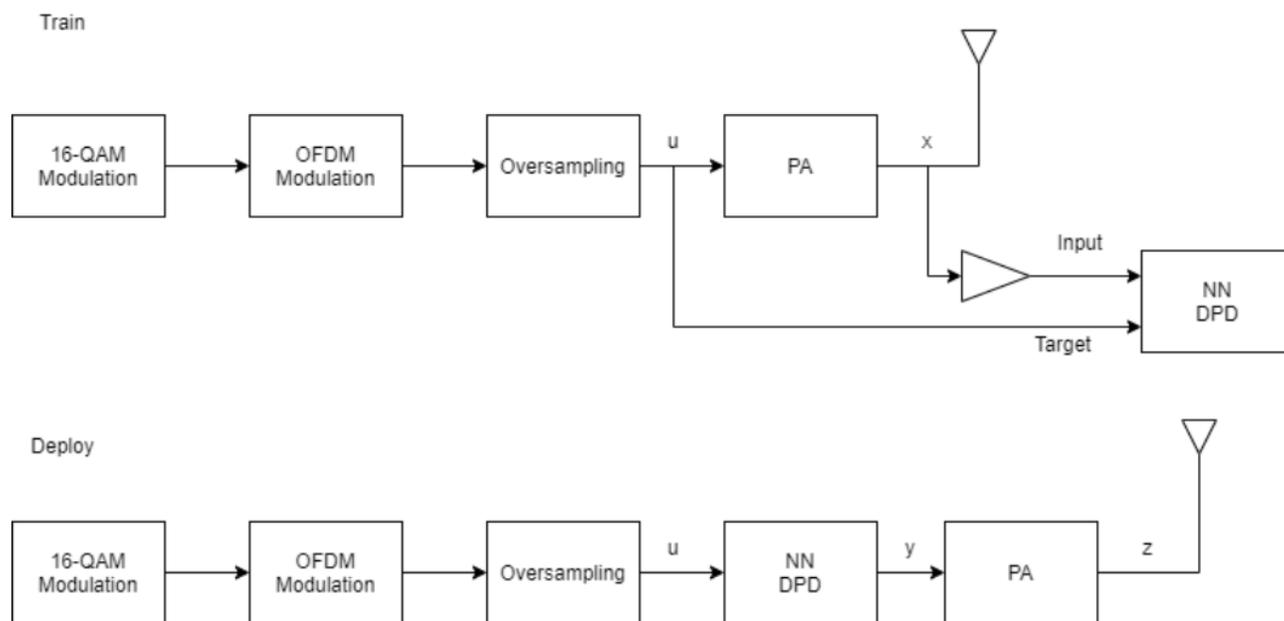
Use a neural network to reduce the computational complexity in the 5G NR beam selection task. Train a CNN for 5G NR channel estimation.

💡 [Neural Network for Beam Selection](#)

💡 [Deep Learning Data Synthesis for 5G Channel Estimation](#)

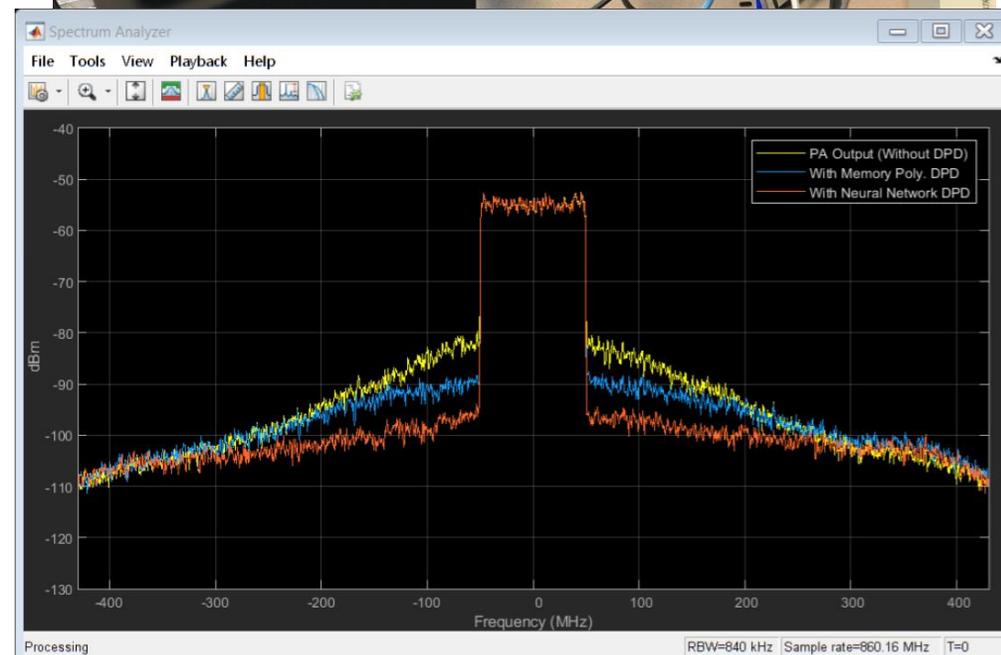
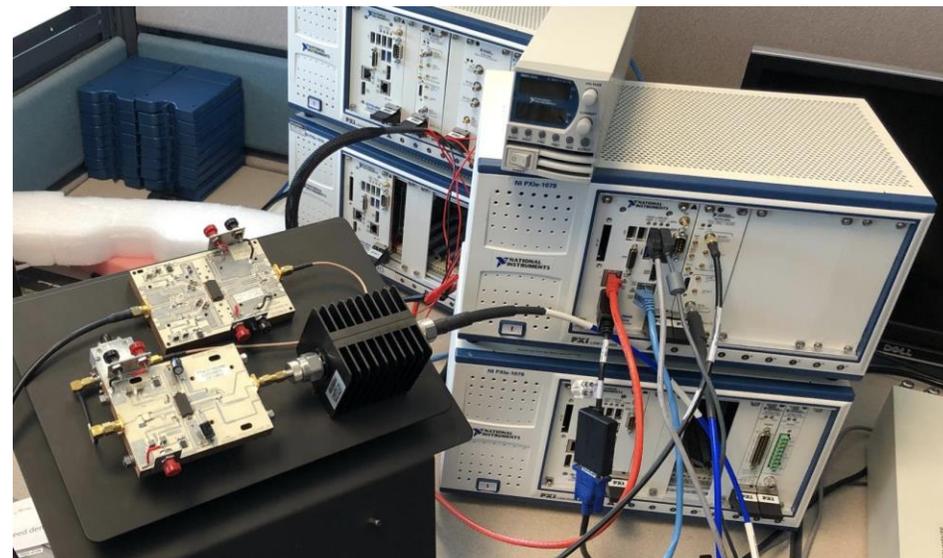
<https://www.mathworks.com/solutions/wireless-communications/ai.html>

AI 用于数字预失真 — 训练和部署



workflow

- 使用测试仪器硬件从真实PA收集数据，或表征PA并使用模型进行仿真
- 使用真实 PA 数据或仿真数据训练神经网络
- 使用硬件真实数据测试网络
- 一旦满足要求，对网络进行修剪和量化
- 以FPGA为目标，使用HDL部署算法



AI 用于信道估计

Data Preparation

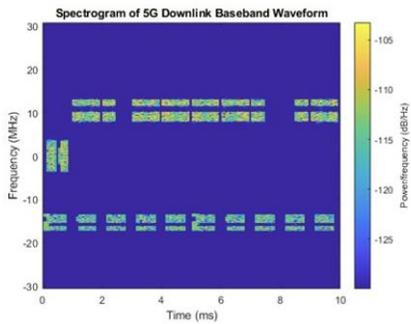
AI Modeling

Simulation & Test

Deployment

Data Synthesis

Generate 5G Standard-compliant Waveforms



Algorithm Design

Deep Learning Design & Training

Simulate 5G Transmission

Visualization and Performance Comparison

Hardware Deployment

Generate and Deploy FPGA HDL Code



Automate

以最佳性能部署到任意处理器

MATLAB 和 Simulink 中的 AI 模型可以部署到嵌入式设备，边缘设备，企业系统，云和桌面

部署



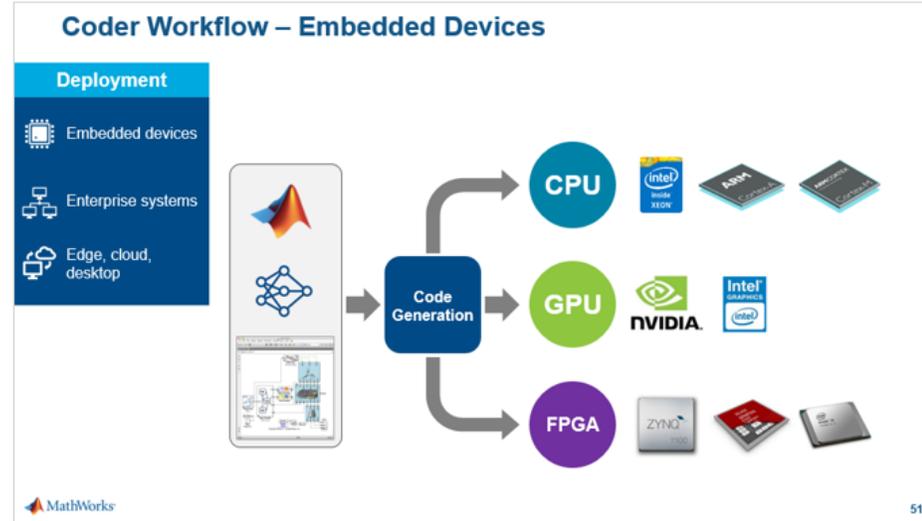
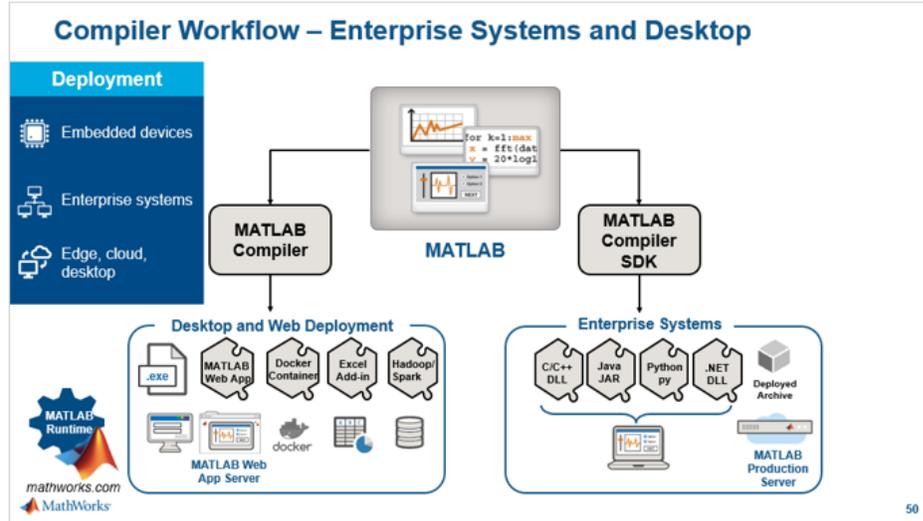
嵌入式设备



企业系统



边缘，云，桌面



目录

1

用标准处理复杂性

2

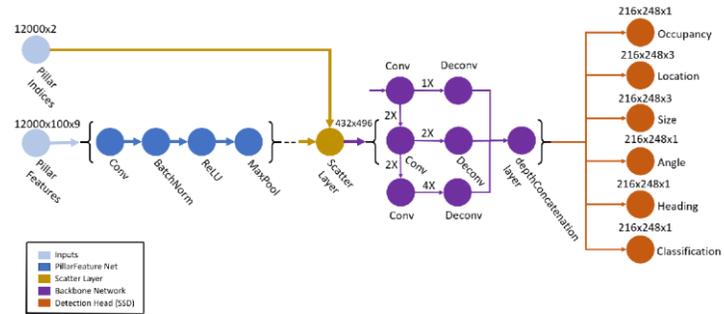
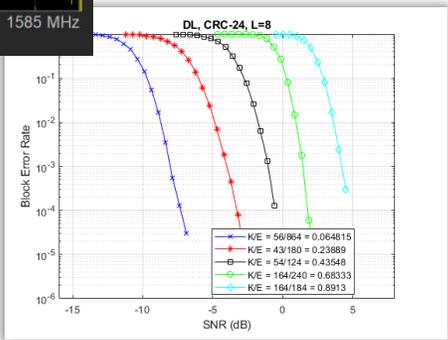
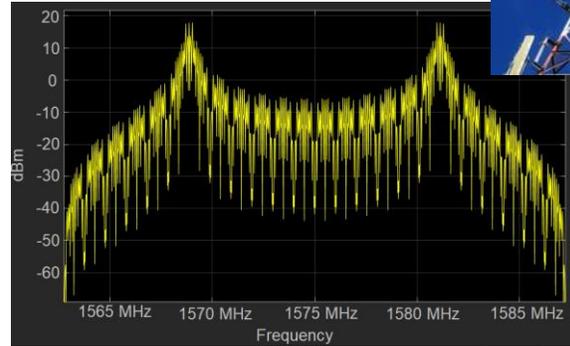
用硬件连接测试一切

3

用 AI 优化一切

4

总结



如何了解更多信息

无线通信产品页面

5G

LTE

WLAN

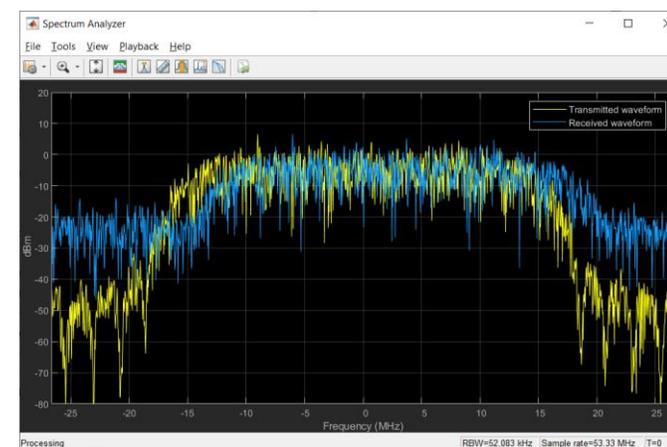
Satellite-communications

Bluetooth

Wireless Testbench

无线通信解决方案页面

mathworks.com/solutions/wireless-communications.html



总结

MATLAB 和 Simulink 支持端到端无线通信系统的高效设计，使您能够使用基于标准的工具处理无线设计的复杂性，使用增强的测试和验证工具确保可靠性，并使用 AI 模型和工具优化设计

这些功能包括:

- 基于标准的 5G, Wi-Fi, Satellite Communications 和 Bluetooth 工具
- 使用硬件连接测试和验证您的设计，评估性能和存在干扰信号下的共存
- AI 在无线设计中的新应用

MATLAB EXPO

Thank you



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