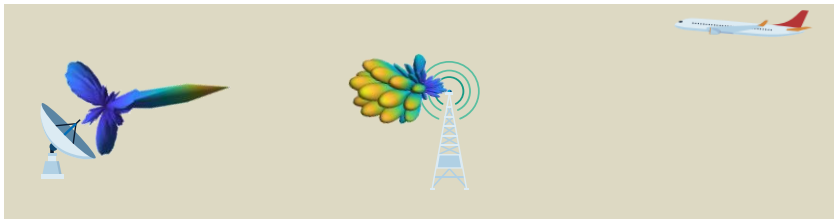
MATLAB EXPO

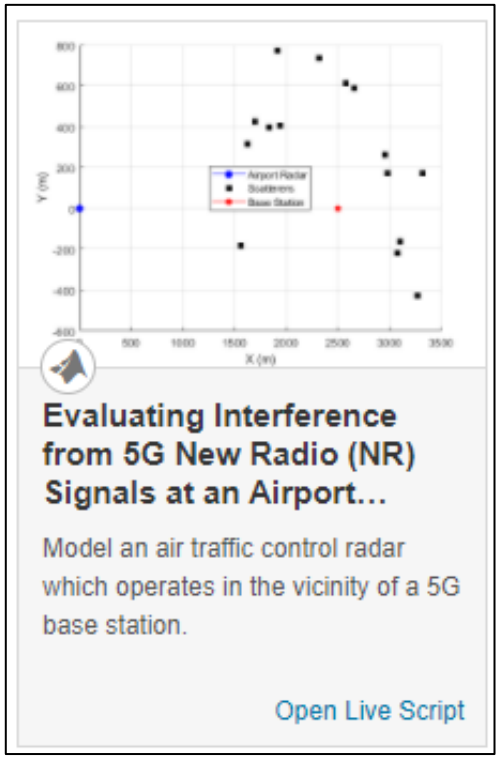
# 无线标准 + 人工智能: 实现未来无线连接

张 茜
*MathWorks*

MathWorks®

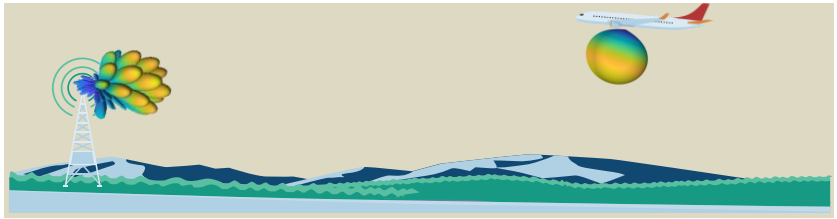
# 近期美国机场5G部署面临的挑战

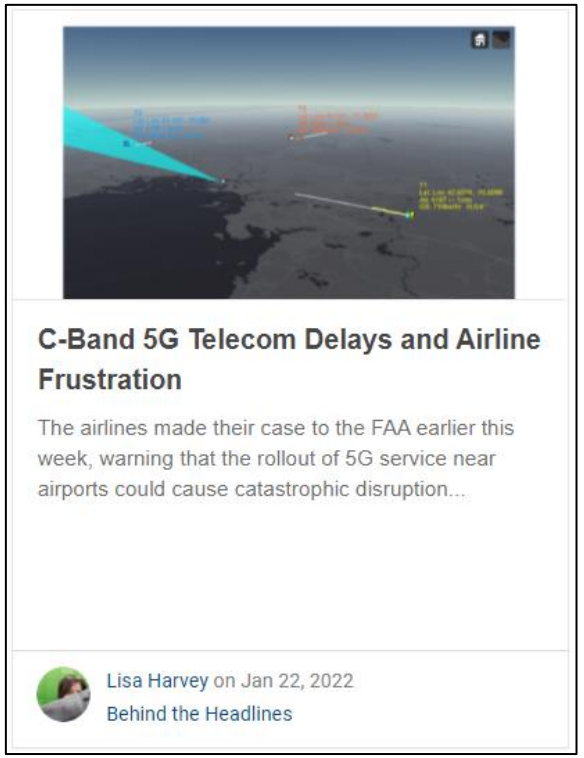





机场监控雷达 & 5G 基站

Image Credit: Toronto Star






雷达高度计 & 5G 基站

[C-Band 5G Telecom Delays and Airline Frustration]

# 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**

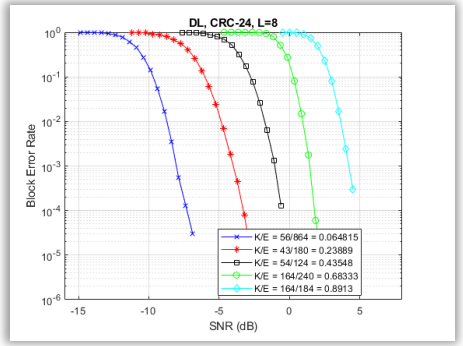
**确保可靠性**

*测试一切*

需要
**大量测试数据**

**推动性能**

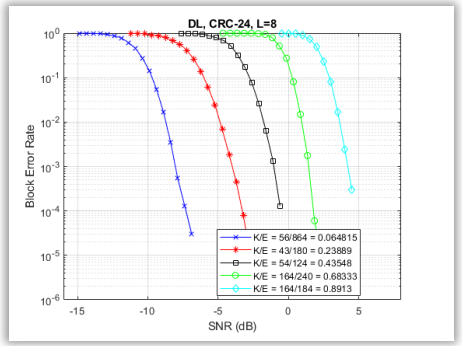
*优化一切*

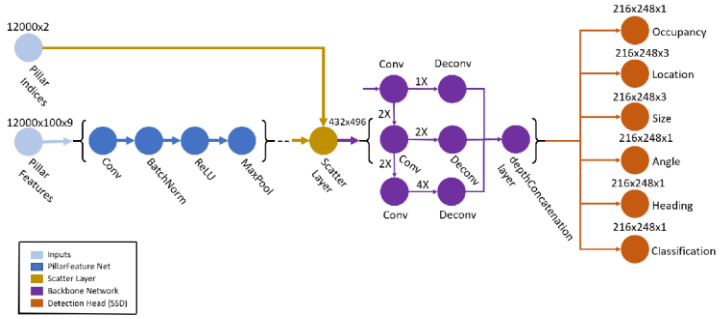



需要
**AI 部署**

# 目录





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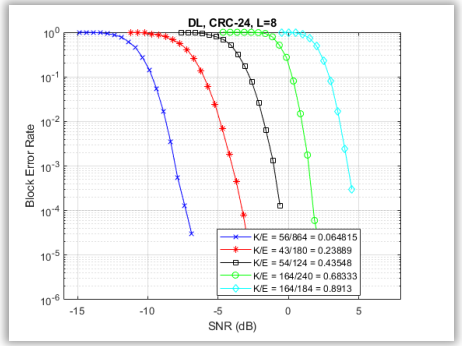
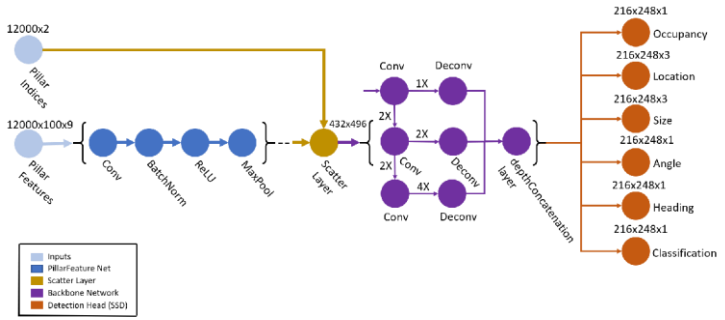
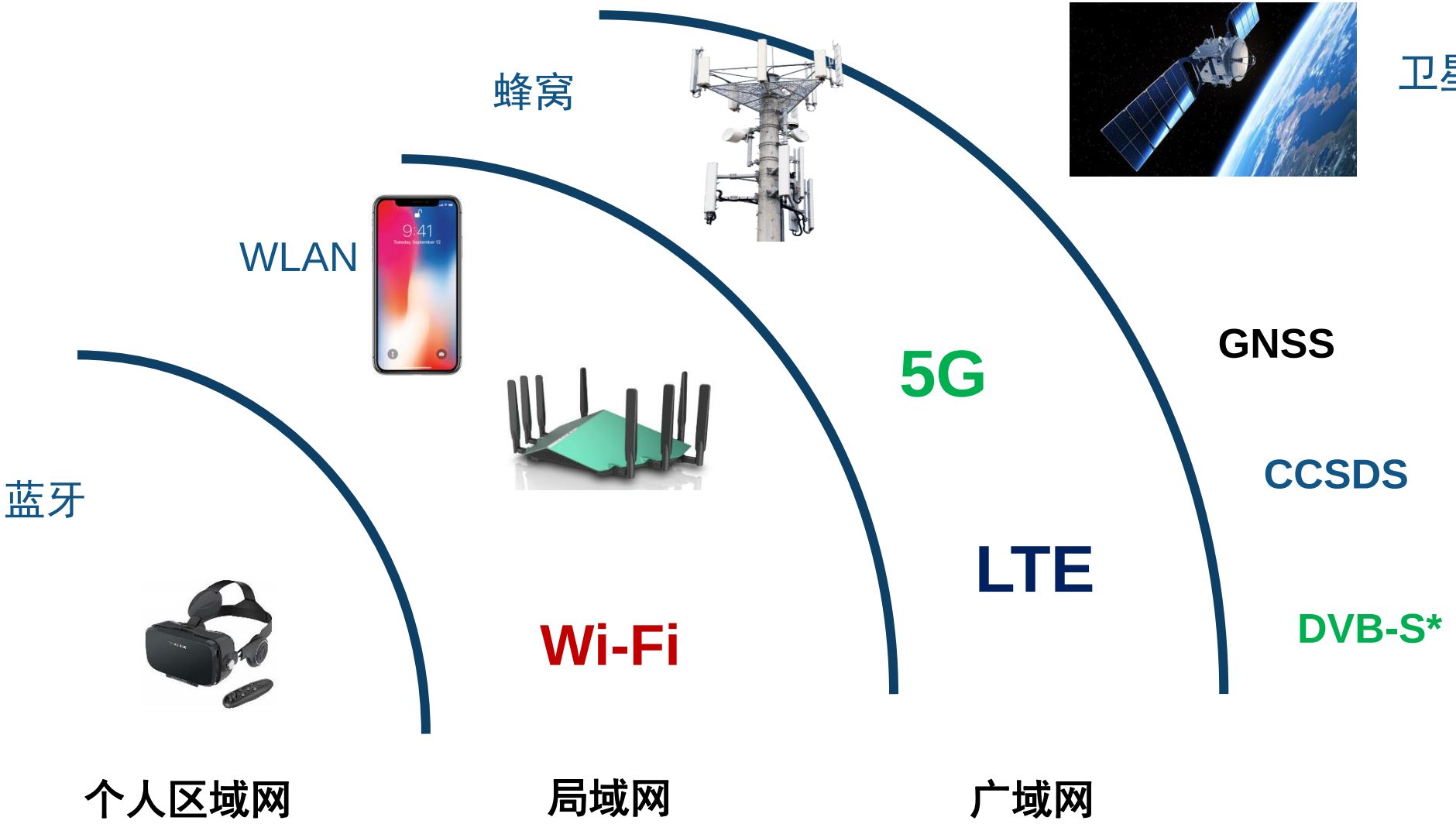


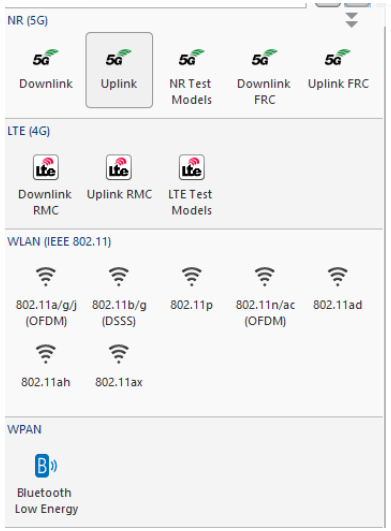
# 无处不在的连接 – 技术 & 标准

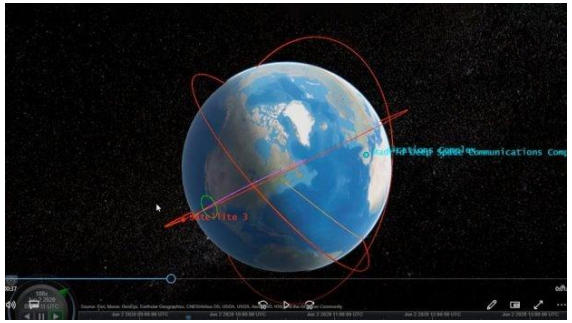


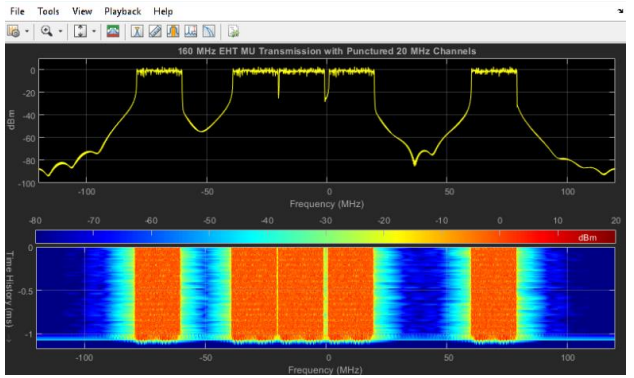
# 我们在无线标准方面的新进展

5G

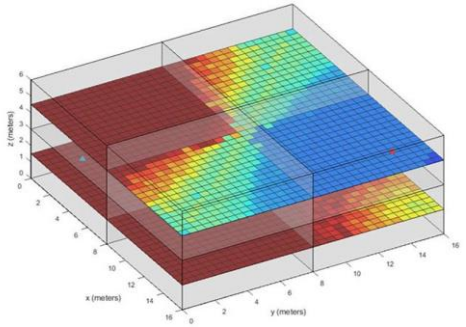
卫星通信






Bluetooth™




**波形生成**

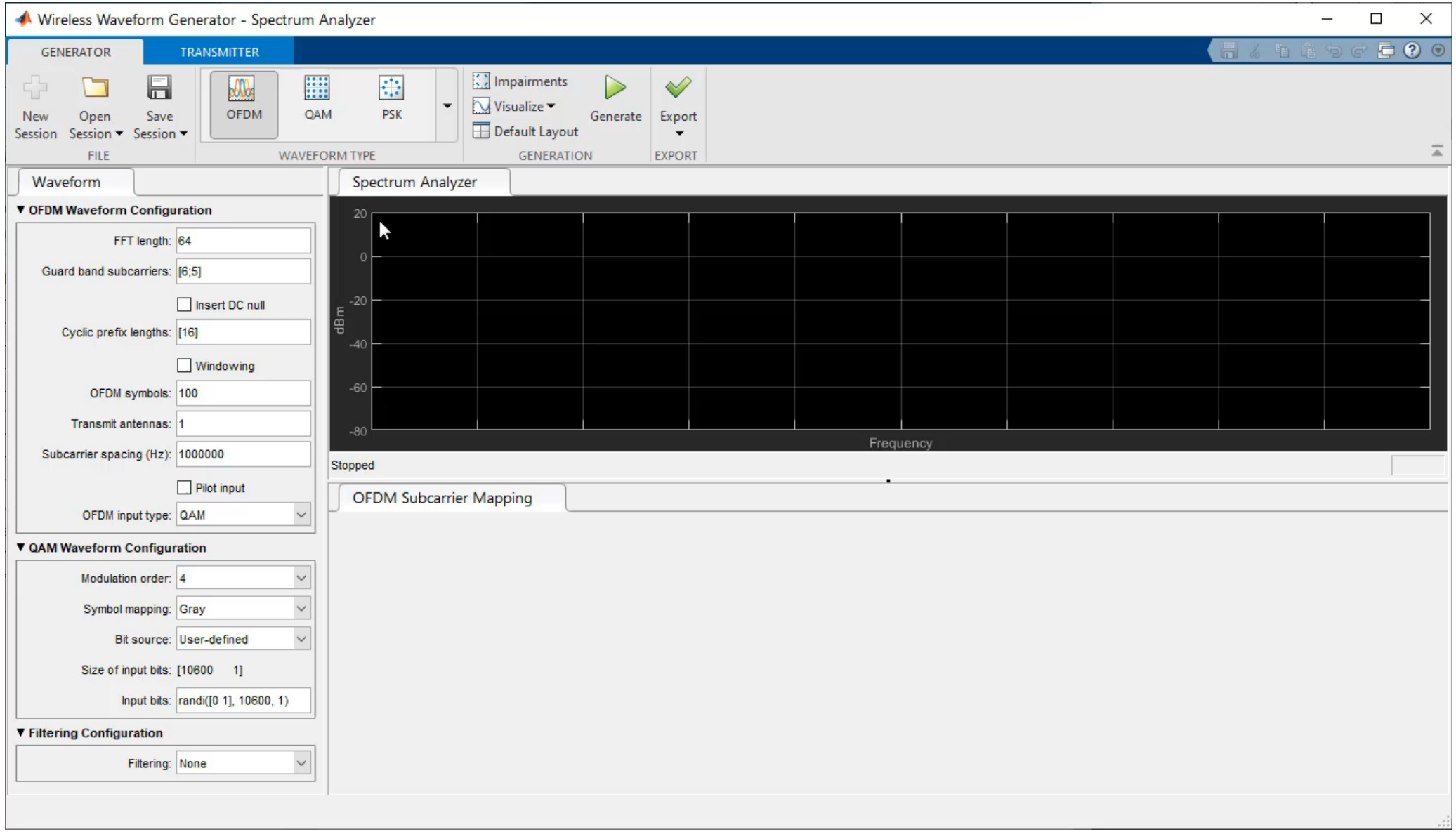
**非地面网络 (NTN)**

**Wi-Fi 7 IEEE 802.11be**

new

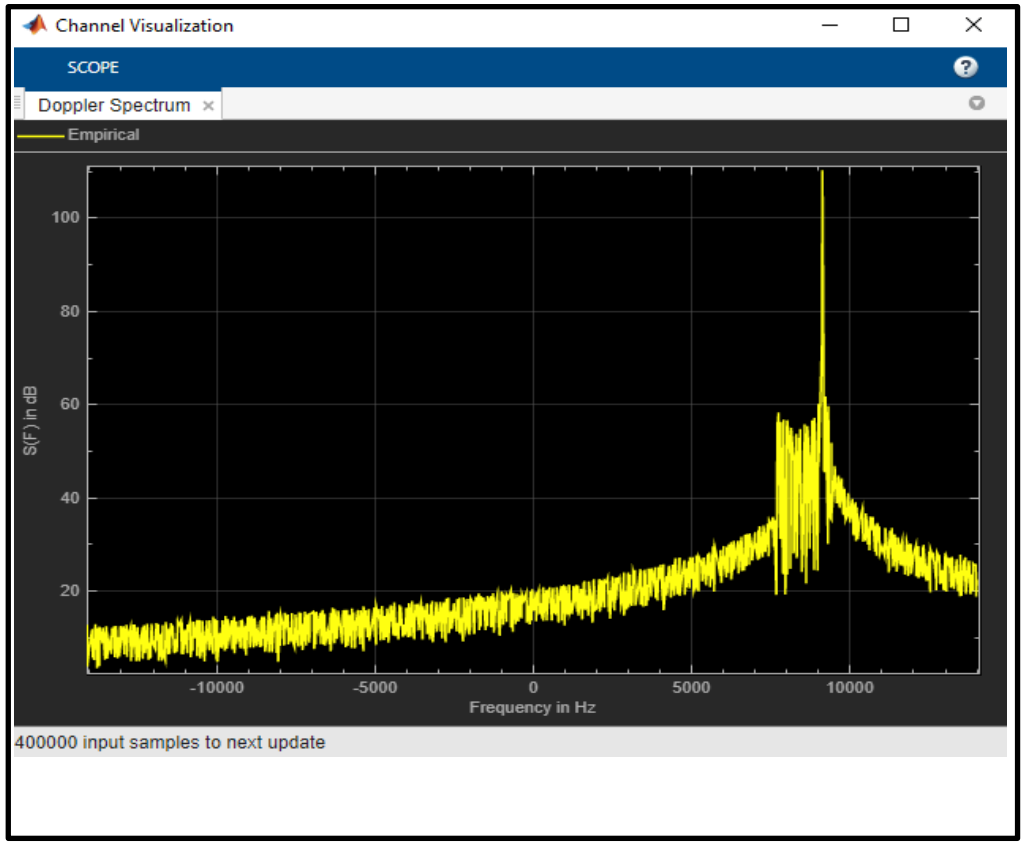
**Bluetooth Toolbox**

# Wireless Waveform Generator App



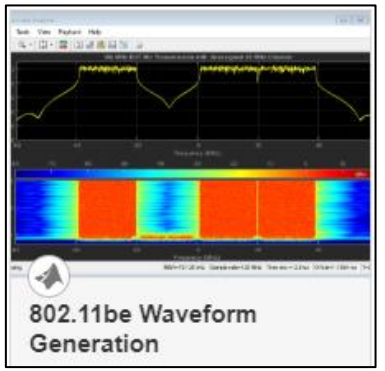
# 非地面网络 (NTN) 窄带信道

- 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

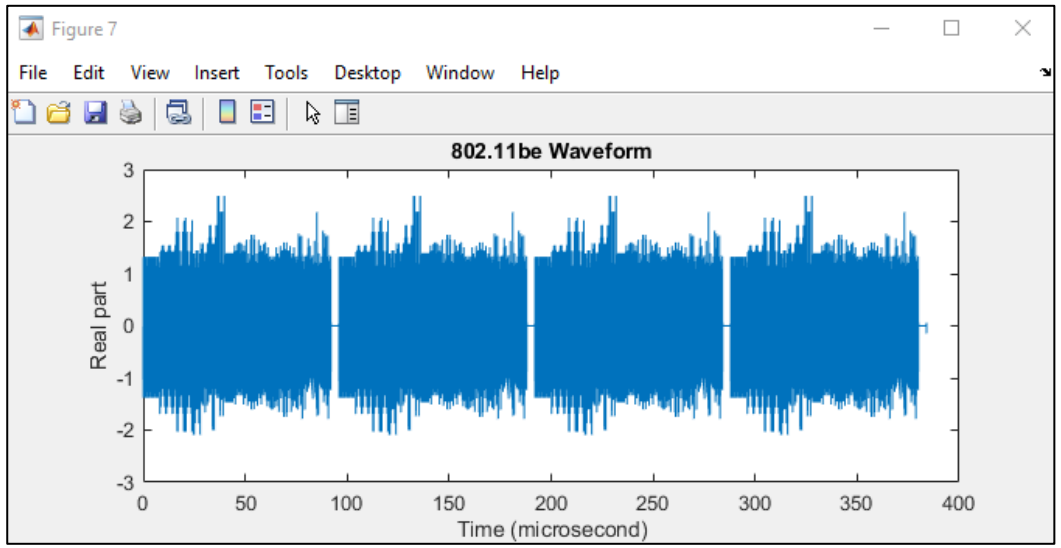


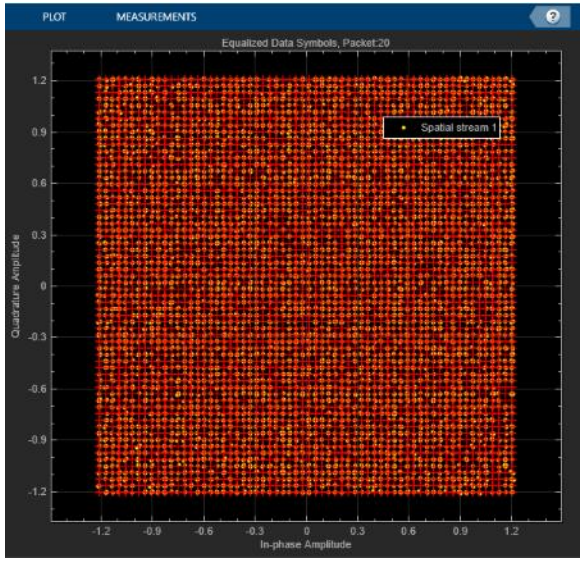
# 生成 802.11be (Wi-Fi 7) 波形

- 高达 320 MHz 信道带宽
- 最高 4096QAM

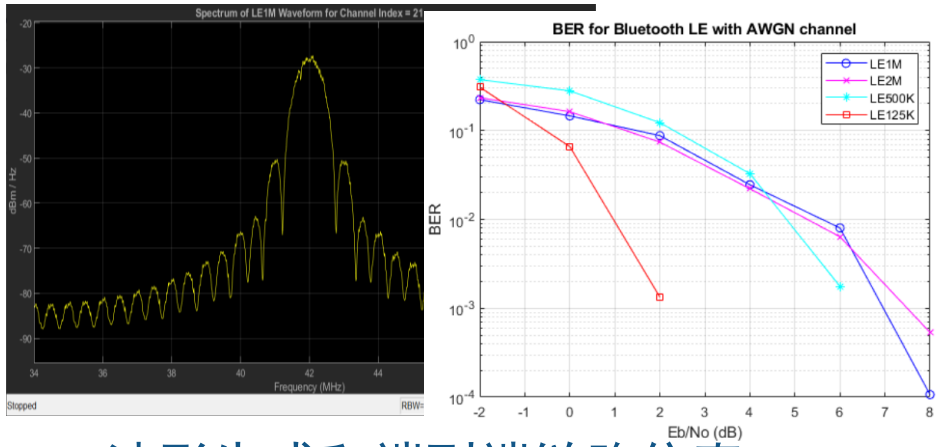



```
Command Window
>> cfgEHT = ehtMUConfig('CBW320');
>> txWaveform = ehtWaveformGenerator(data,cfgEHT,'NumPackets',4,'IdleTime',4*1e-6);
>>
```

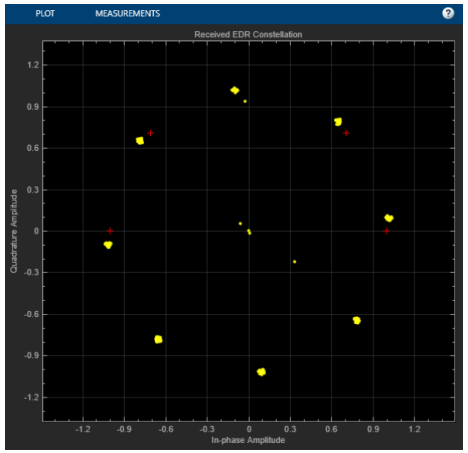


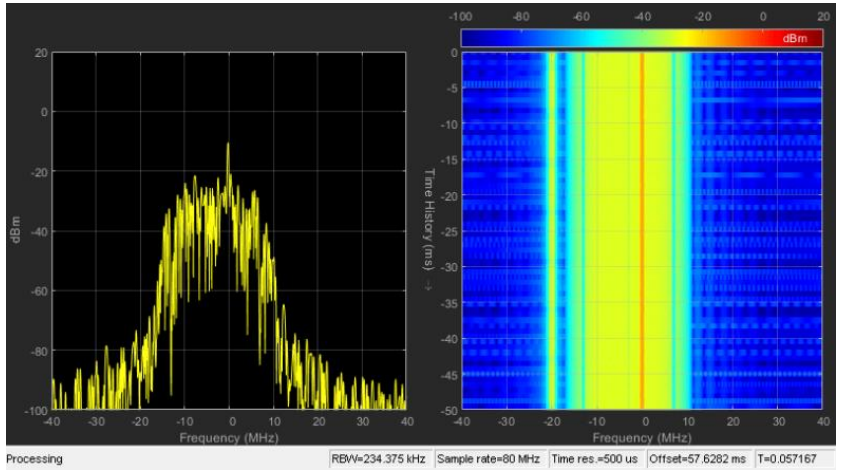
# Bluetooth Toolbox



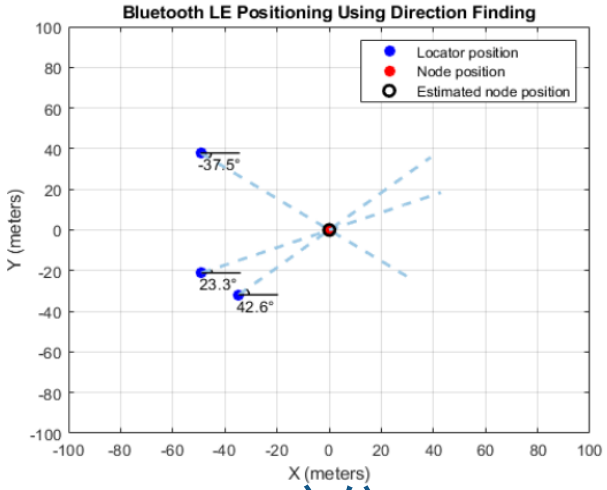

波形生成和端到端链路仿真



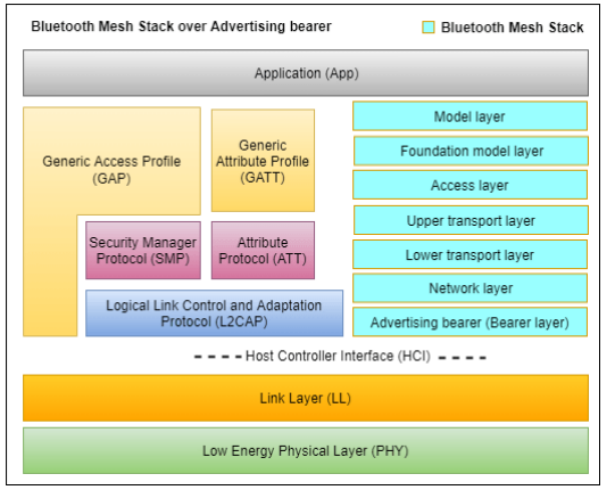

信号恢复和分析




Bluetooth/WLAN 共存



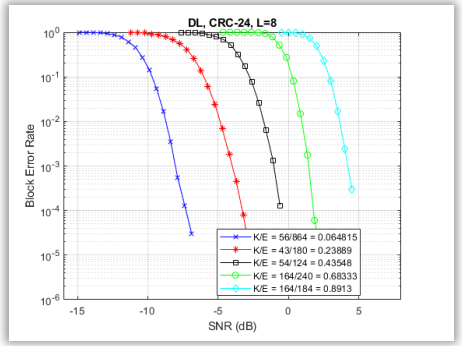

定位

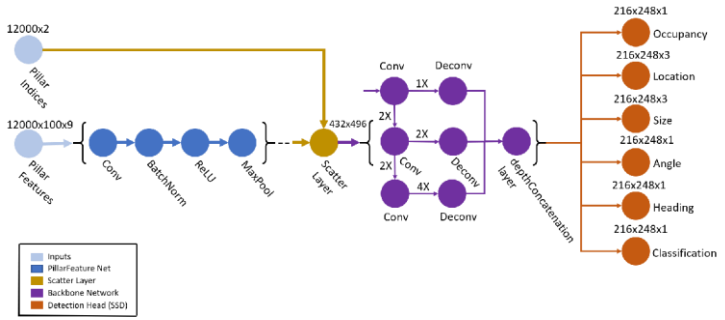



网络建模

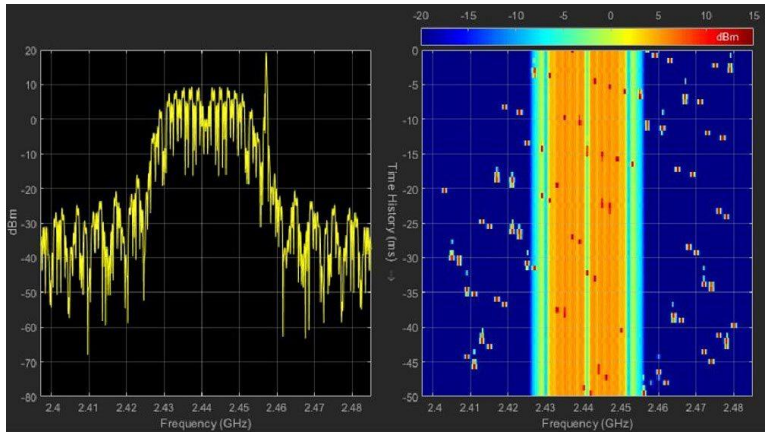
# 目录





# 我们在无线测试方面的新进展


**SDR 连接**

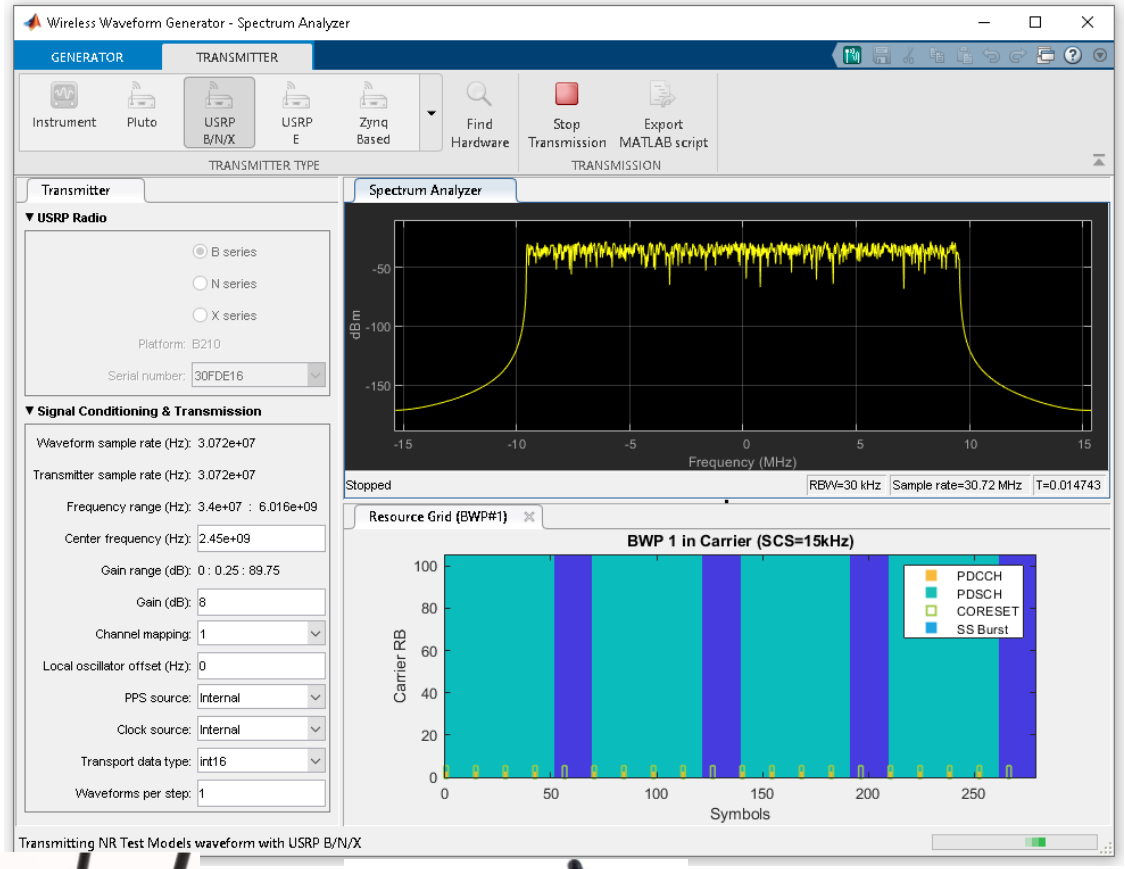
**Wireless Testbench**

**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



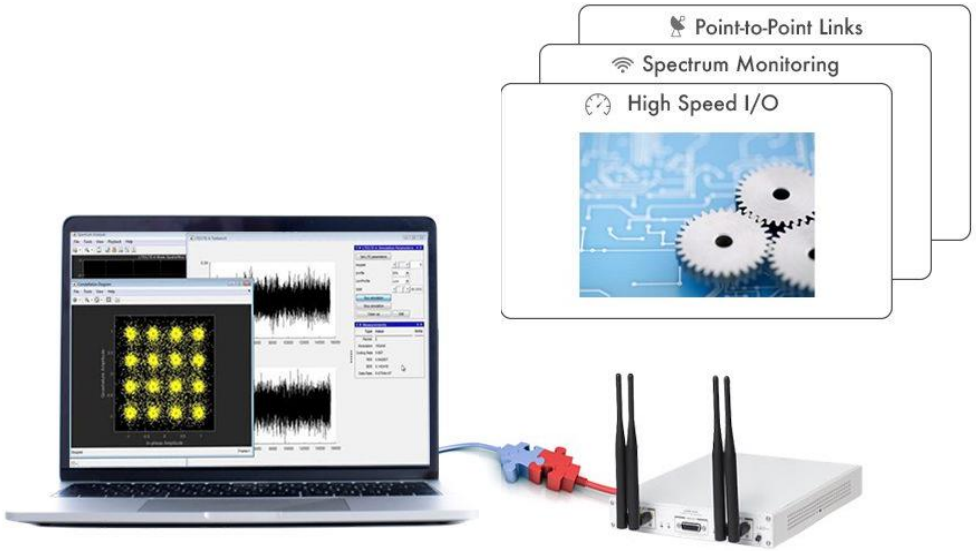


# Wireless Testbench

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



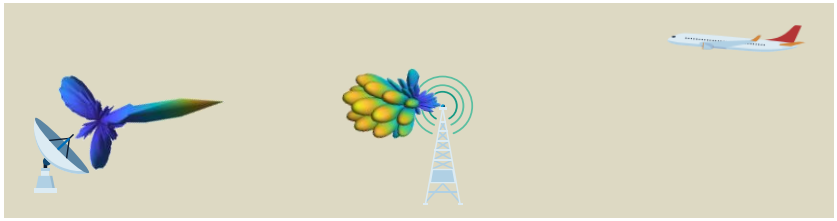

**以高达 250 Msps 的速度传输和捕获宽带信号**

*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*

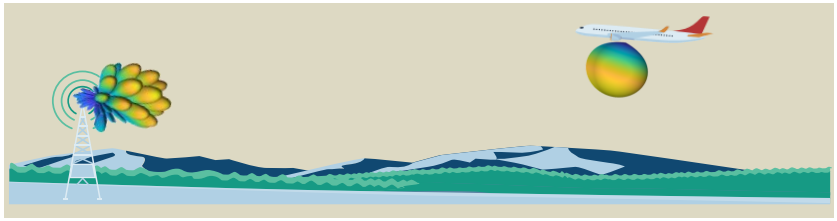
**智能数据捕获**

*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*

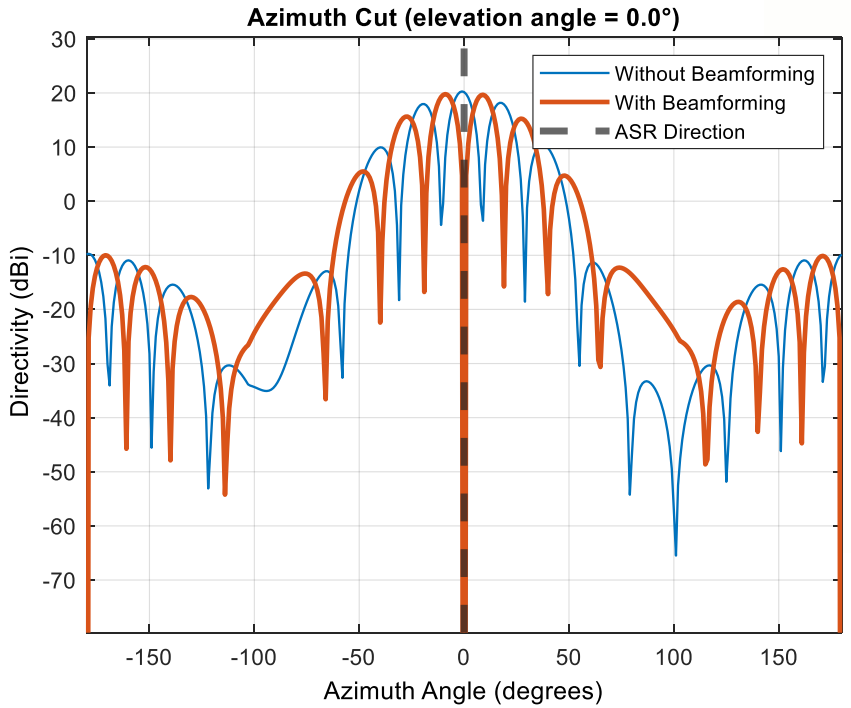
# 确保可靠性和通过干扰抑制共存

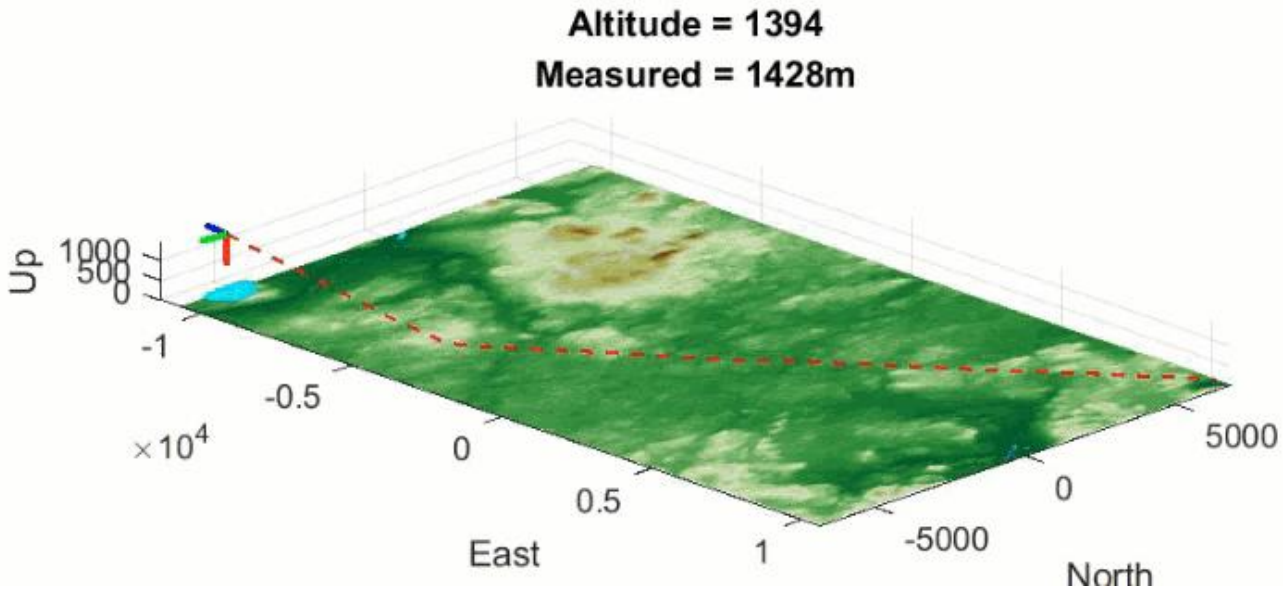


机场监控雷达 &
5G 基站



雷达高度计 & 5G 基站



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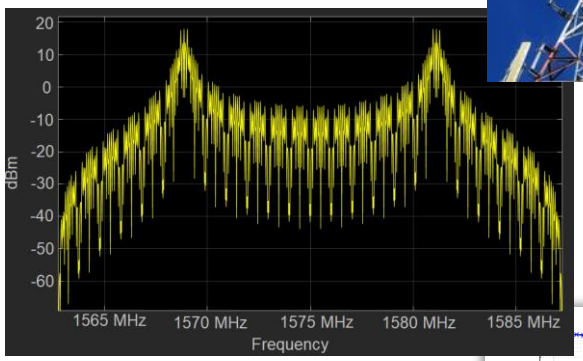
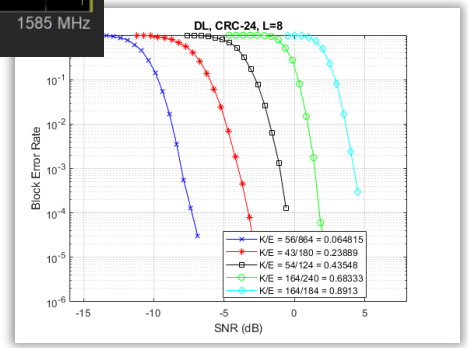
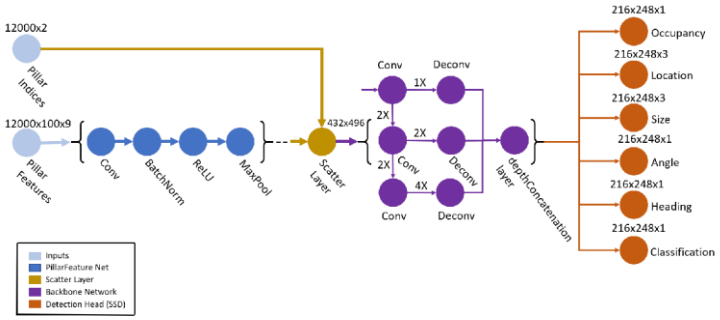
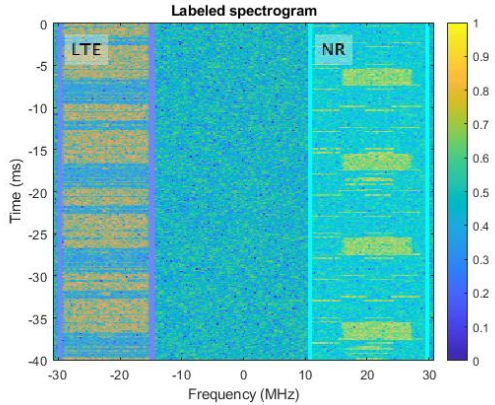


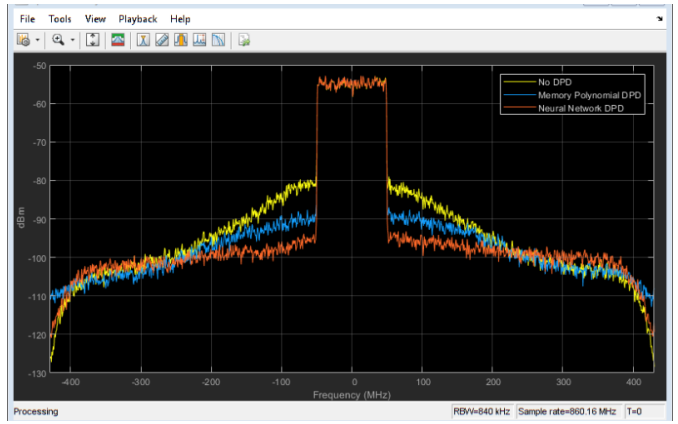



# 我们在无线通信AI方面的新进展

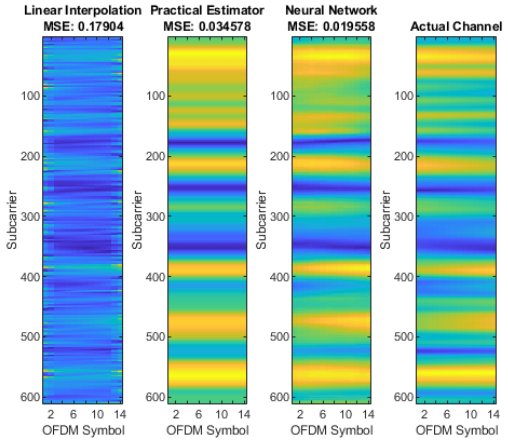



频谱感知 & 信号分类

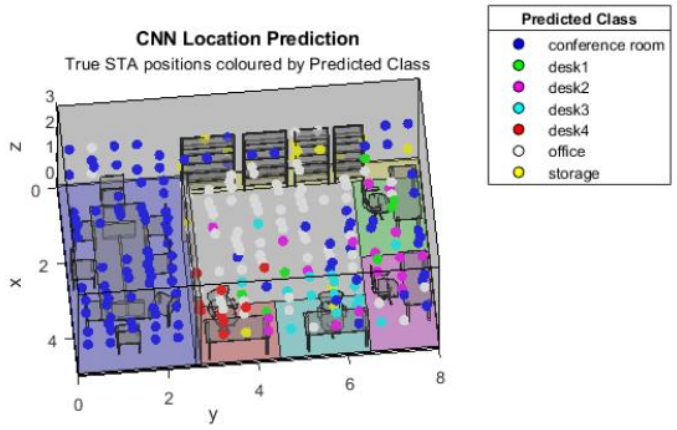
设备识别




数字预失真




波束管理 & 信道估计

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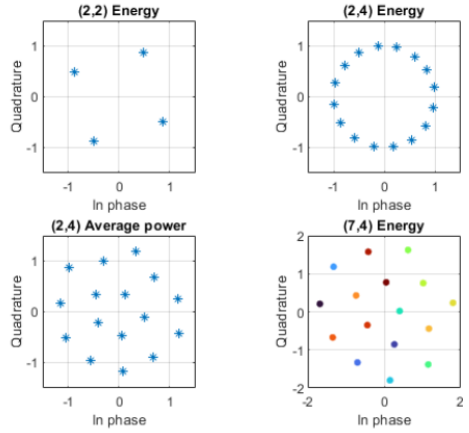



收发机设计

# 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

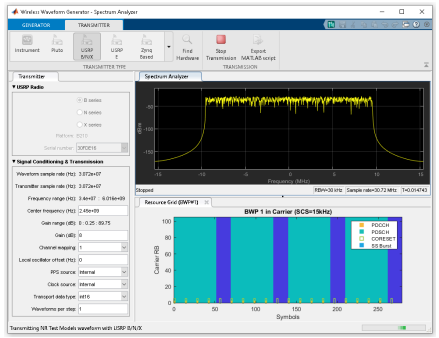
- 模型设计和调整
- 硬件加速训练
- 互操作性

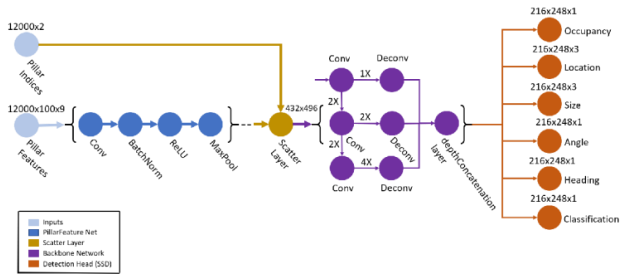
## 仿真 & 测试

- 与复杂系统集成
- 系统仿真
- 系统验证和确认

## 部署

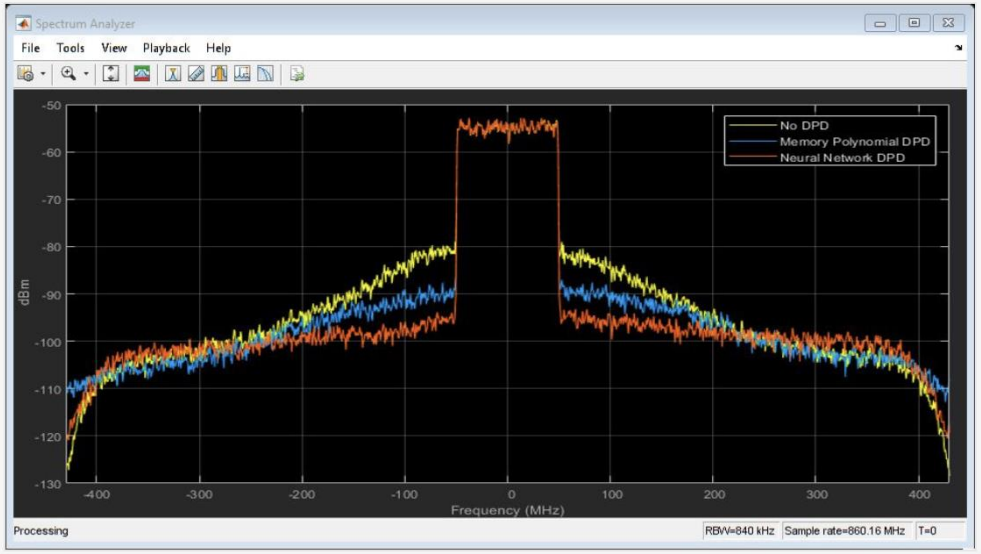
- 嵌入式设备
- 企业系统
- 边缘，云，桌面







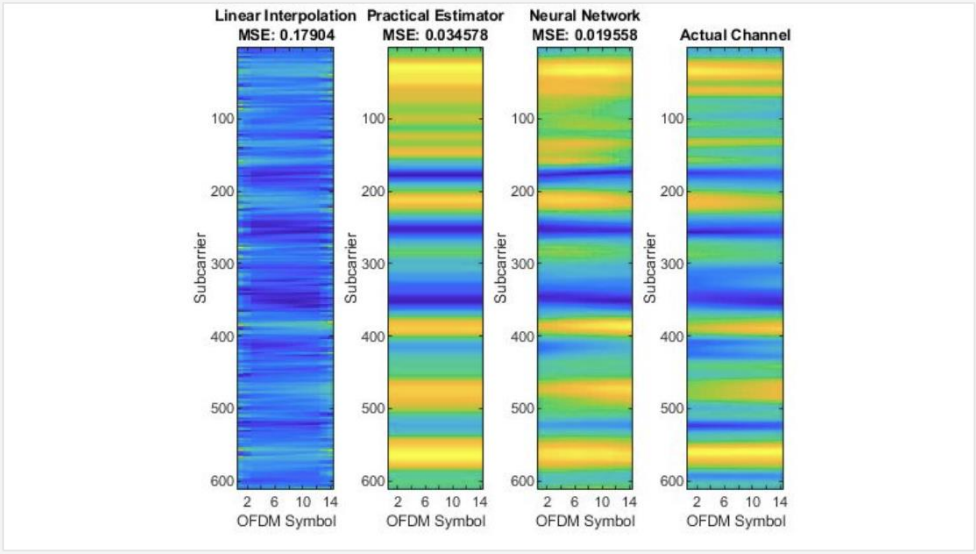
# 示例: 如何在MATLAB中使用无线AI




## 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



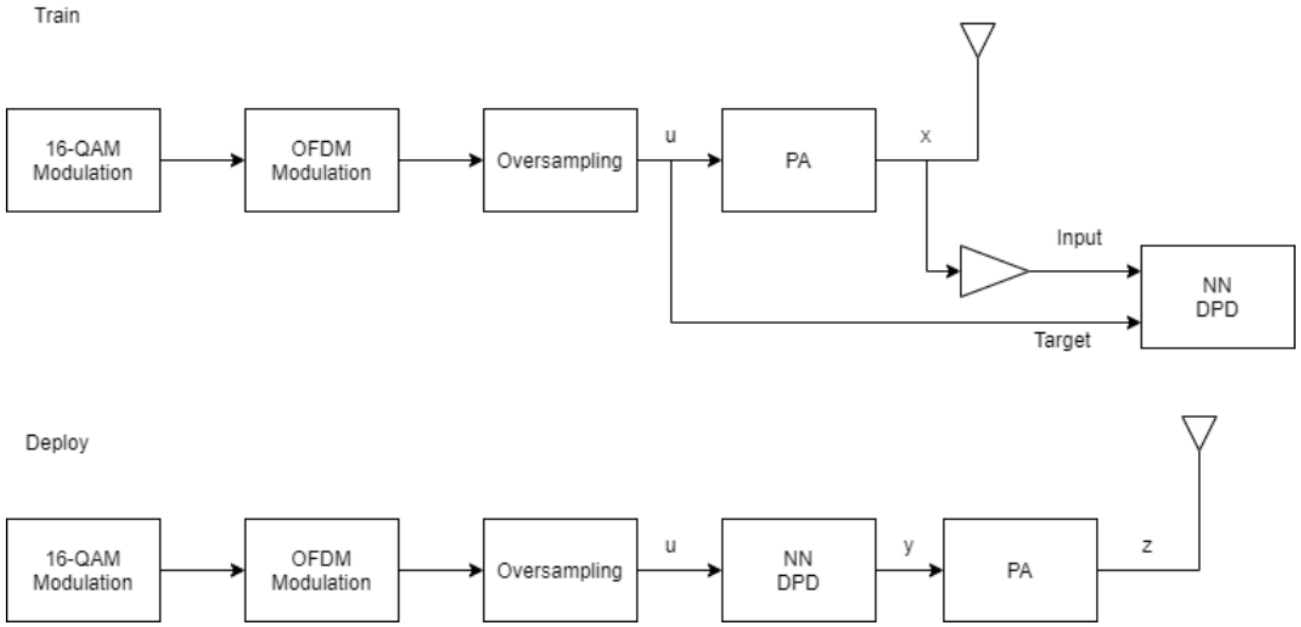

## Beam Management and Channel Estimation

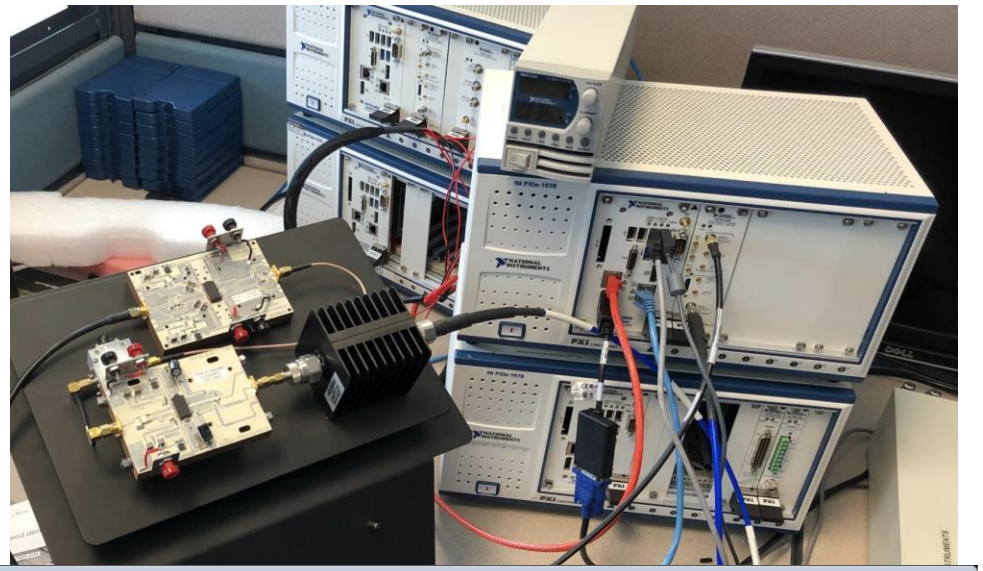
Use a neural network to reduce the computational complexity in the 5G NR beam selection task. Train a CNN for 5G NR channel estimation.

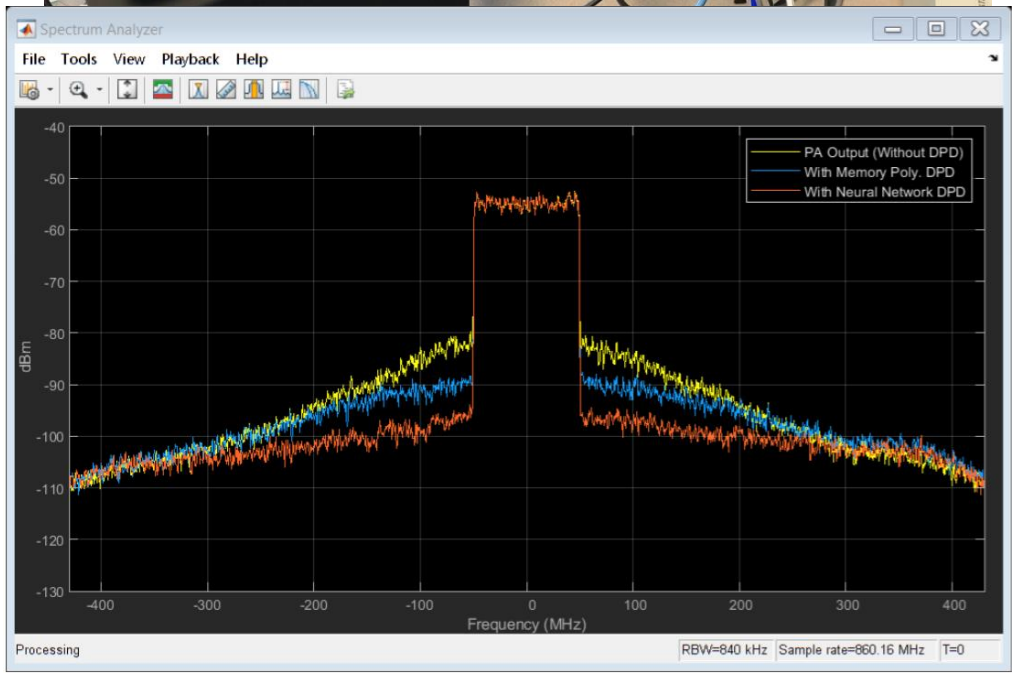
- Neural Network for Beam Selection
- Deep Learning Data Synthesis for 5G Channel Estimation

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

# AI 用于数字预失真 — 训练和部署






## 工作流

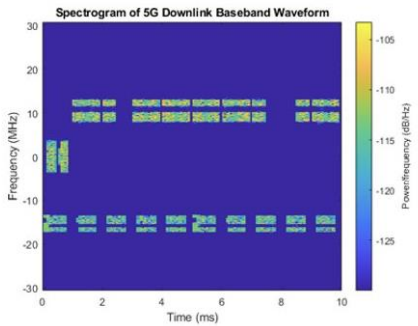
- 使用测试仪器硬件从真实PA收集数据，或表征PA并使用模型进行仿真
- 使用真实 PA 数据或仿真数据训练神经网络
- 使用硬件真实数据测试网络
- 一旦满足要求，对网络进行修剪和量化
- 以FPGA为目标，使用HDL部署算法

# 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

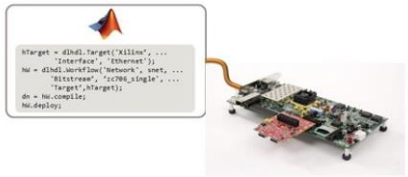
Simulate 5G Transmission

Visualization and Performance Comparison

Automate

## Hardware Deployment

Generate and Deploy FPGA HDL Code

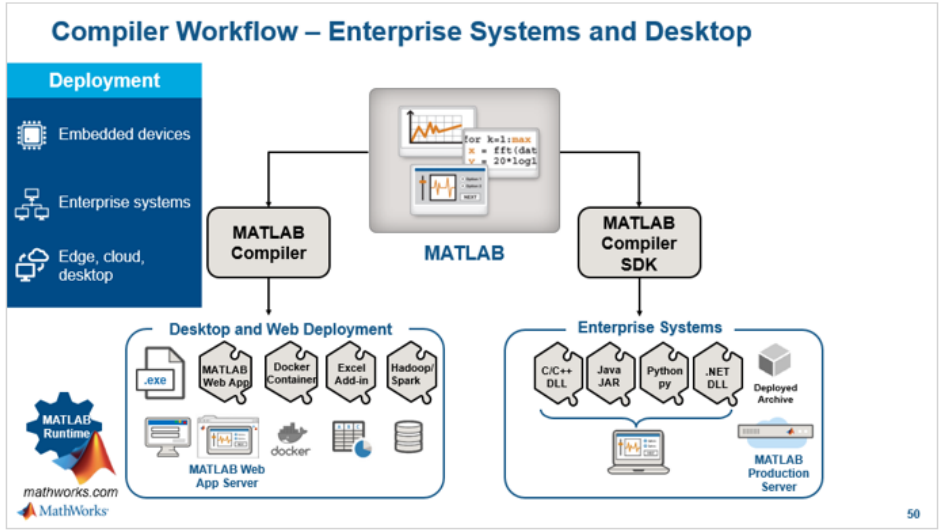


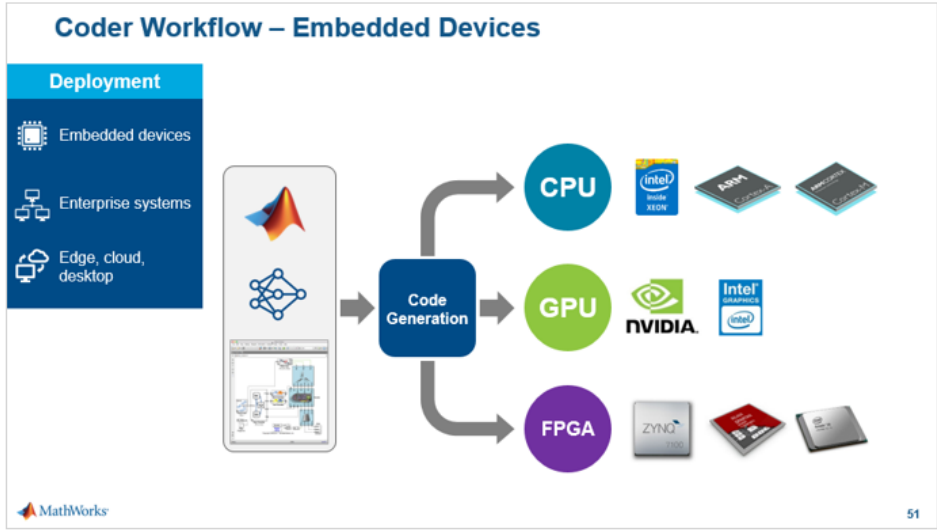
# 以最佳性能部署到任意处理器

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

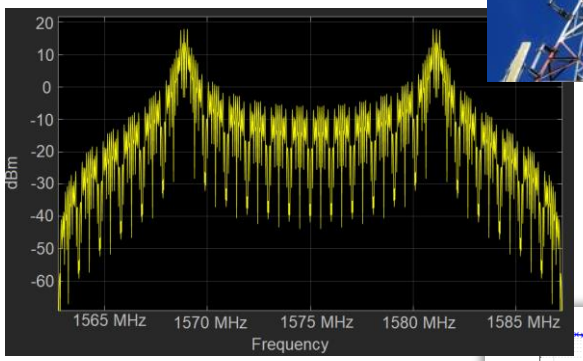
- 嵌入式设备
- 企业系统
- 边缘，云，桌面

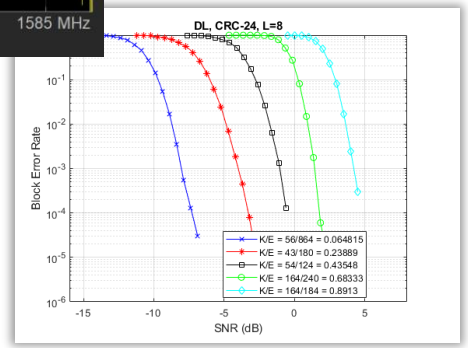


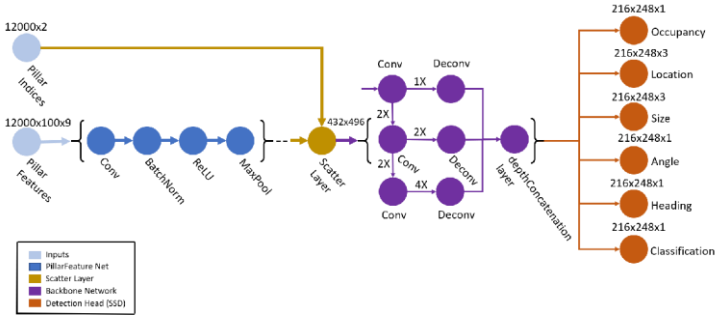



# 目录





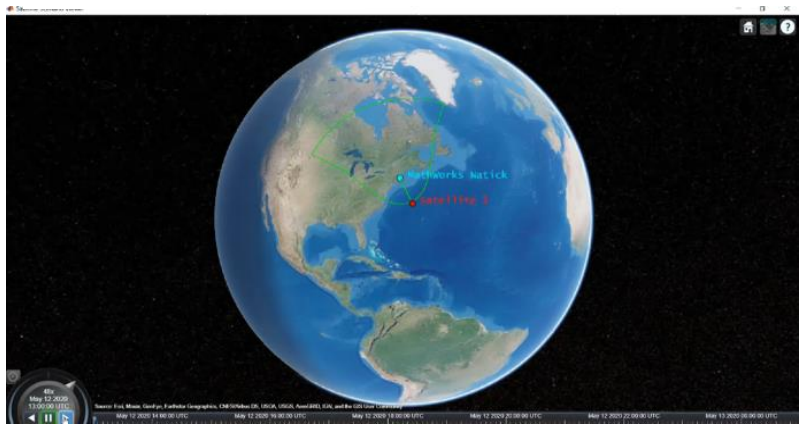



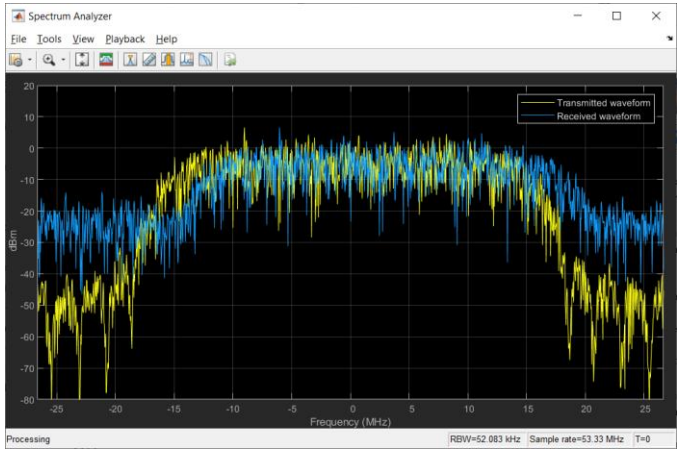



# 如何了解更多信息

## 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