

# What is New in Wireless System Design



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# Agenda

- Landscape of Wireless Design
- Our Wireless Initiatives
  - Antenna-to-Bit simulation
  - Smart RF Design
  - Over-the-air testing
  - LTE and LTE-Advanced
  - RADAR systems
- Summary



# Landscape of Wireless Design

## Mobile Communications: LTE, 5G and beyond

- 5G standardization
  - 100-1000 times Faster speeds
  - Reliable service everywhere
  
- Greater complexity
  - New architectures
  - New frequency bands (mmWave)
  - More antennas (massive MIMO)
  - Advanced RF and DSP co-design



# Landscape of Wireless Design

## Connected Smart Devices, Internet of Things

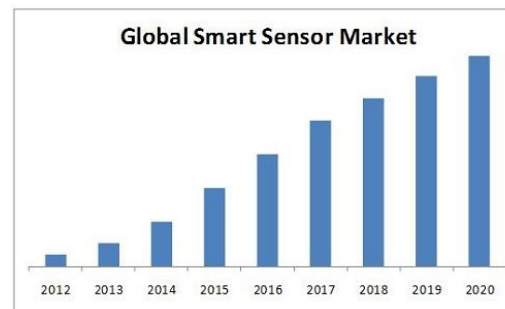
### ➤ Internet of Things

- Embedded sensors
- Digital health
- Industrial instruments



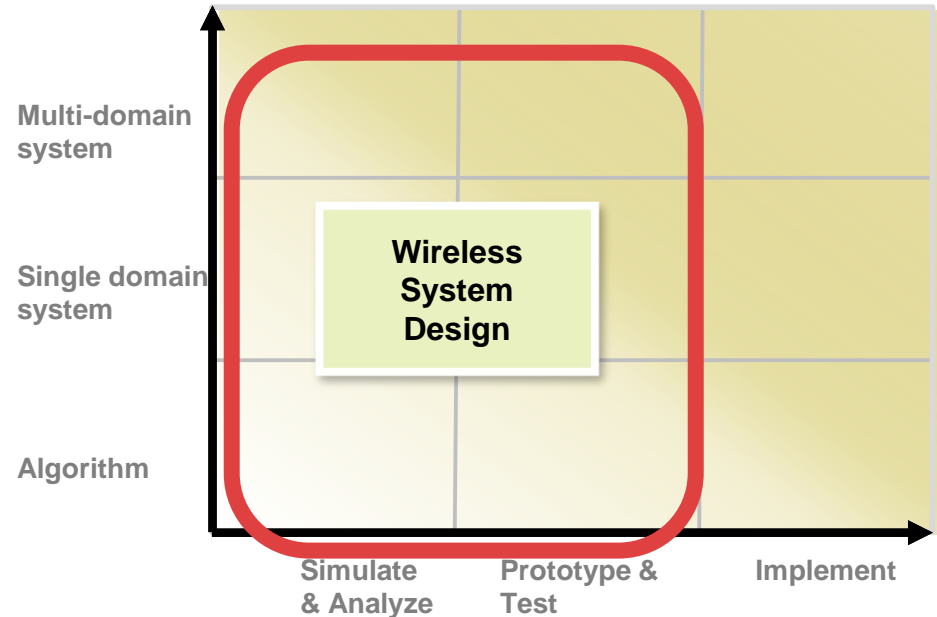
### ➤ Characteristics

- Connected wirelessly to internet
- Low power
- Generate lots of data



# Wireless System Design: MATLAB and Simulink

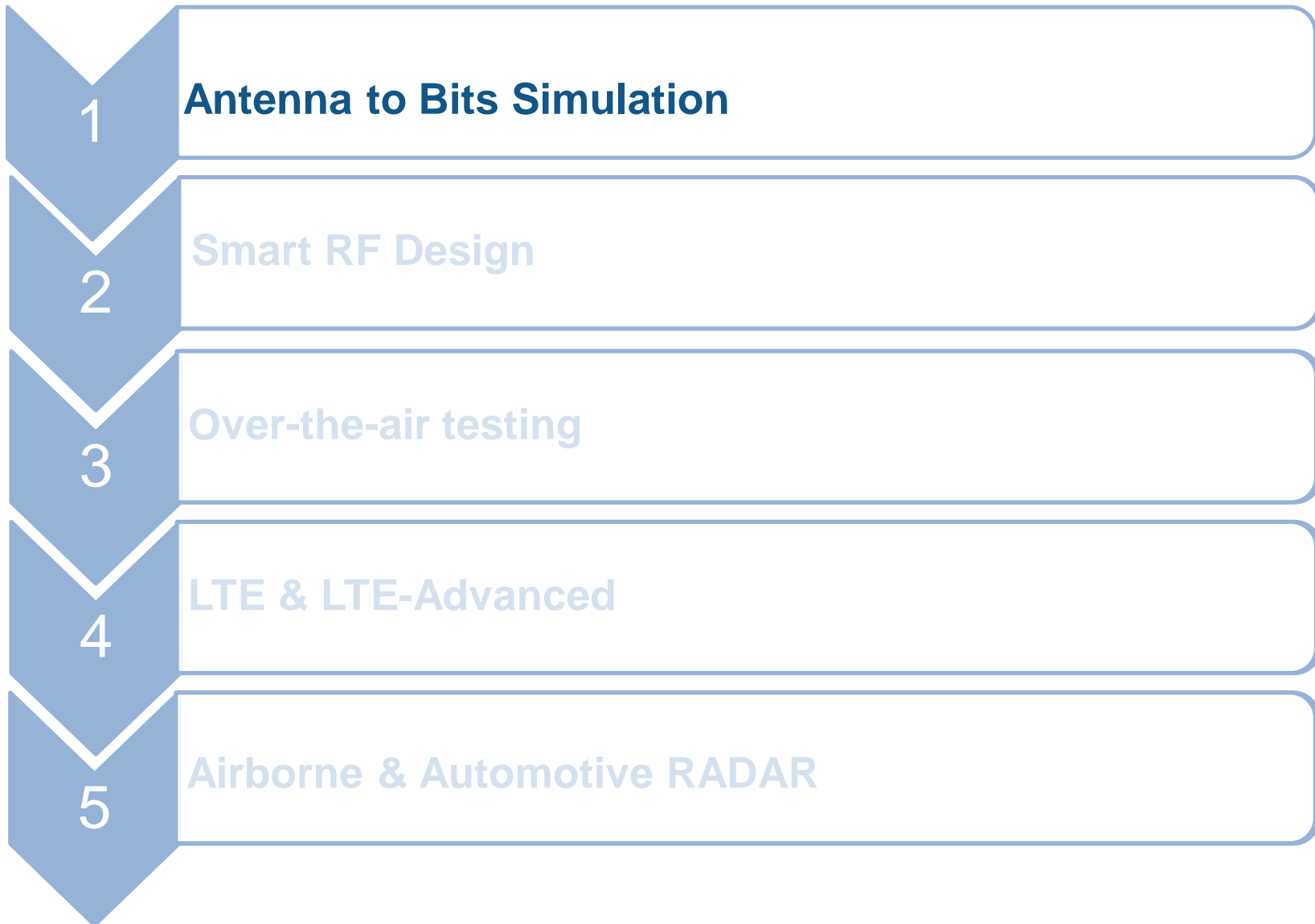
- Who are our users?
  - R&D Algorithm designer
  - Digital Baseband engineer
  - RF System engineer
  - Test or validation engineer
  
- What do they need?
  - End-to-end simulation
  - Design verification
  - Real-world over-the-air testing



# Wireless System Design: What's new in 2015?

- End-to-end simulation
  - Antenna-to-Bits Simulation
  - Smart RF Design
- Design verification
  - Standard-compliant (LTE, LTE-A)
  - RADAR systems
- Over-the-air testing
  - Connectivity to SDR and RF instruments

- **New product:**
  - Antenna Toolbox
- **Major releases:**
  - Communications System Toolbox
  - LTE System Toolbox
  - Phased Array System Toolbox
- **New Hardware Support Package**
  - Zynq® Software-Defined Radio

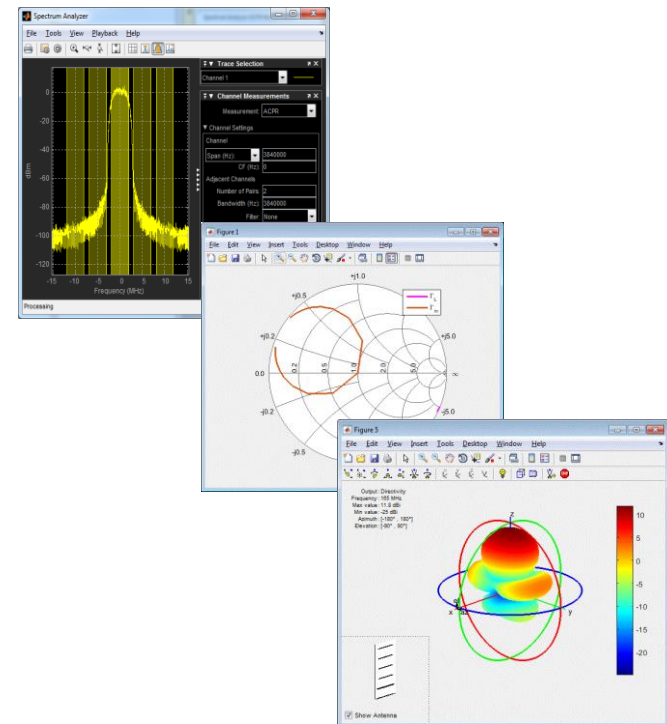
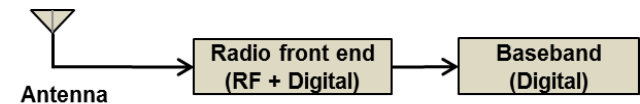


# Antenna-to-Bits Simulation

**MATLAB & Simulink**

## Simulate a complete wireless link

- Design modern wireless systems with components such as MIMO, OFDM, and adaptive beam-forming
- Analyze signals and make measurements such as EVM, ACLR, BLER, Throughput
- Generate waveforms and create verification references for downstream implementation
- New Antenna Toolbox 1.0 released in R2015a



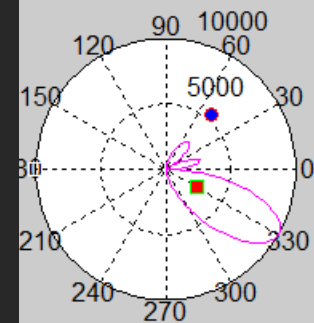
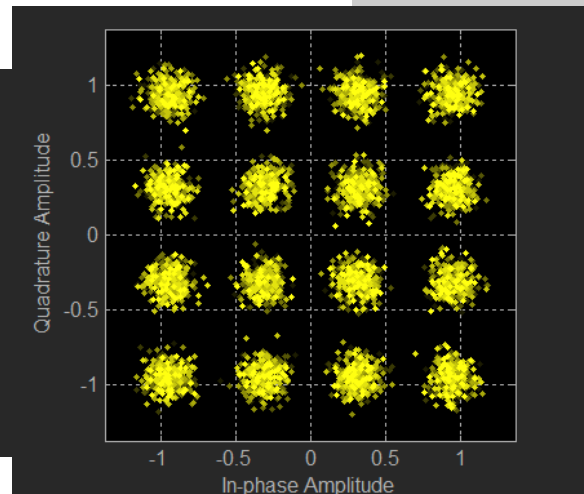
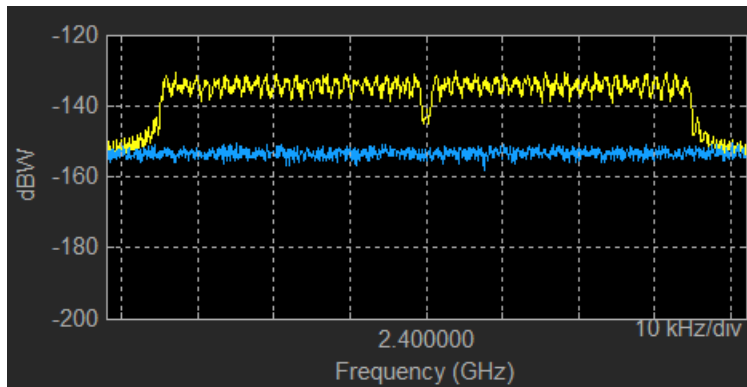
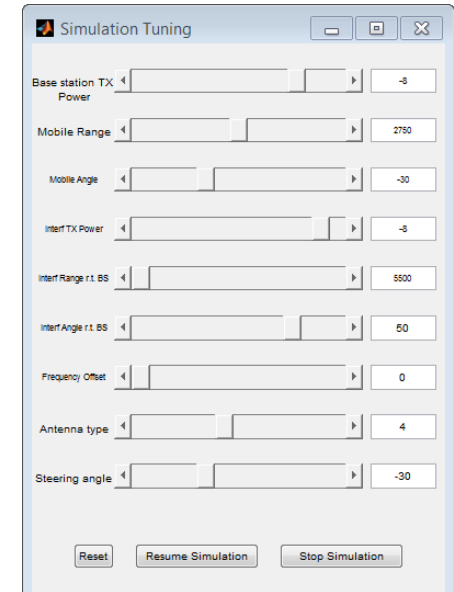
Is this for me?

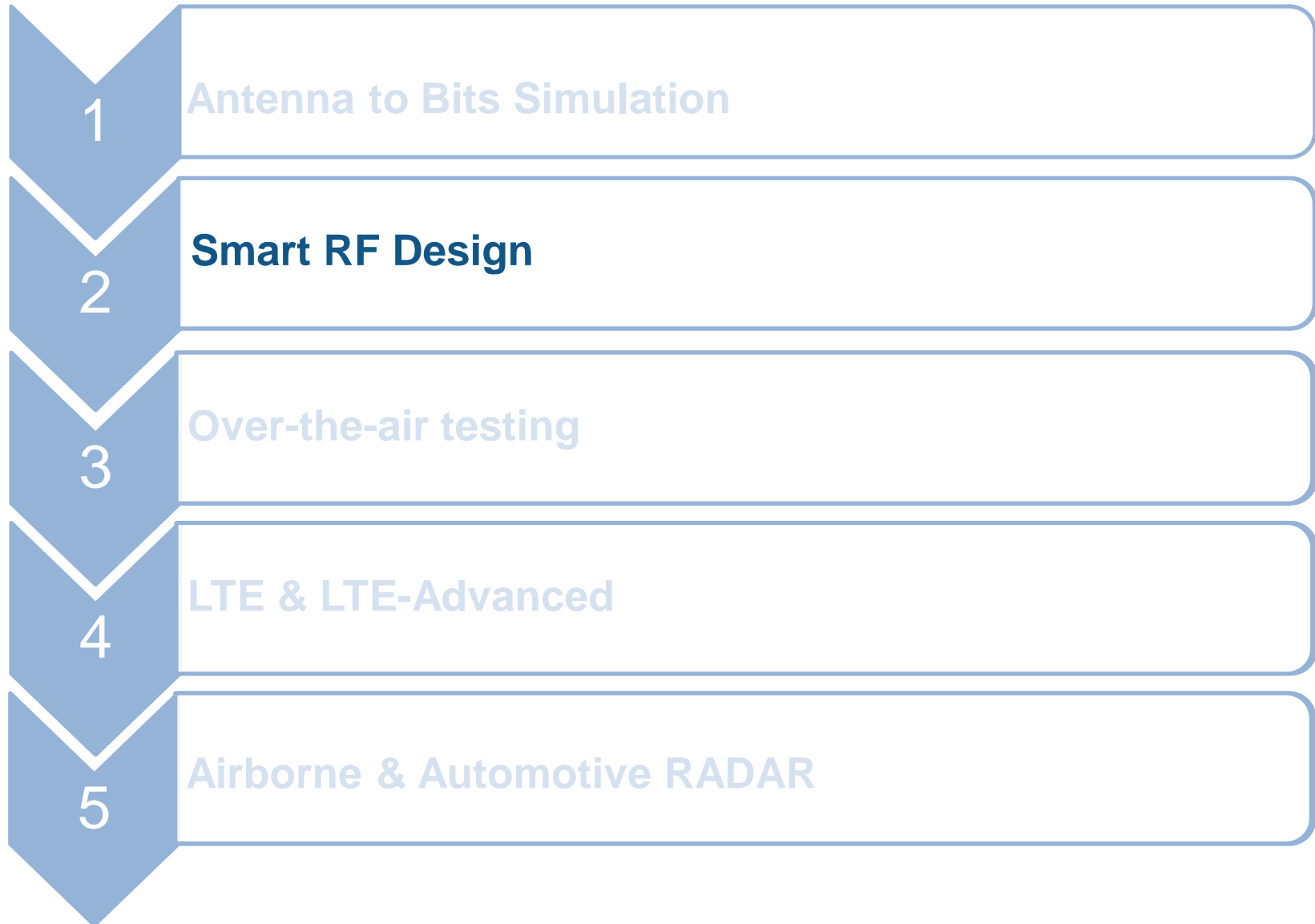
- Do you work on wireless physical layer?
- Do you simulate and measure system performance?



# Example: 802.11a/g/n/ac MIMO-OFDM system

- Step-by-step MATLAB demo
  - OFDM as the air interface technology
  - Adaptive Beam-forming (up to 8 antenna)
- Easy-to-follow end-to-end simulation
- Graphical test bench
- Tune system parameters on-the-fly



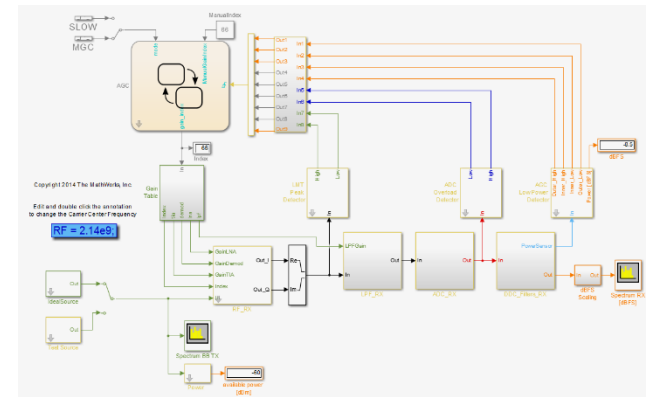


# Smart RF design

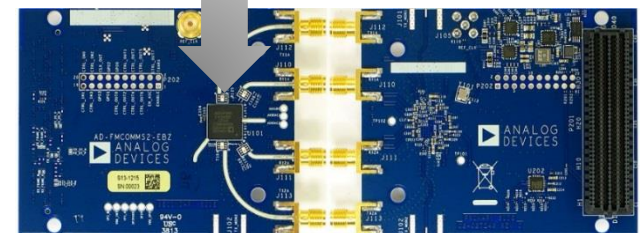
## Fast behavioral RF modeling & simulation

MATLAB & Simulink

- Model and simulate RF transceiver together with baseband algorithms
- Develop calibration and control algorithms such as DPD or AGC to mitigate impairments and interferers
- Add measured RF component characteristics
- Use circuit envelope techniques to accelerate simulation of RF transceivers



[Analog Devices AD9361](#)  
RF Agile Transceiver™



Is this for me?

- Are you an RF system designer?
- Do you jointly model RF and digital components?

# Example: Simulation of Analog Devices® RF Transceivers with MATLAB and SimRF

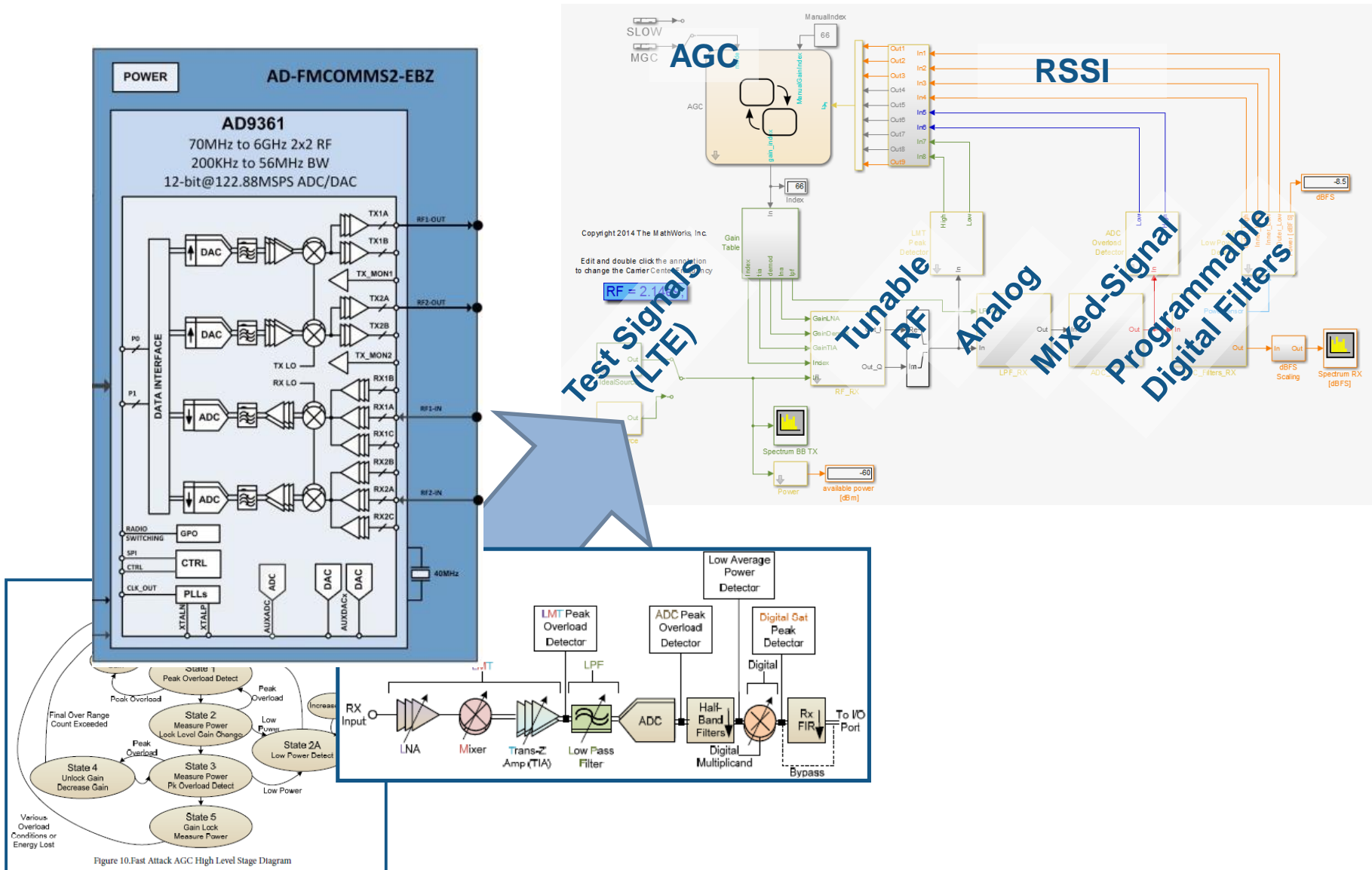
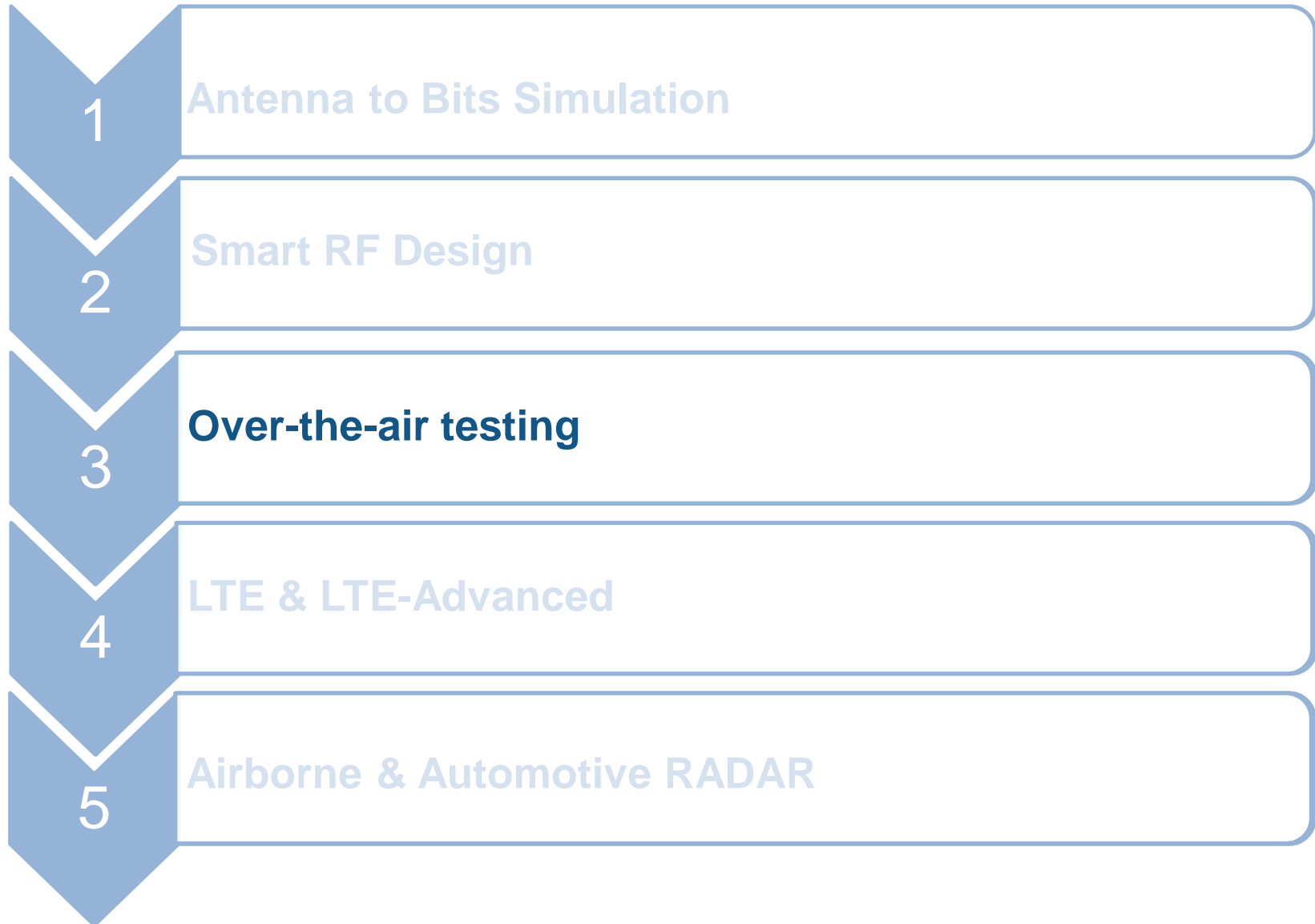


Figure 10. Fast Attack AGC High Level Stage Diagram



# Over-the-air Testing with Radio Hardware

## Transmit and receive live radio signals

- Transmit and receive generated waveforms
- Configure hardware parameters from MATLAB for a range of center frequencies and sampling rates
- Analyze acquired I/Q baseband signal with configurable measurement tools
- Verify and validate your designs based on live radio signals

**MATLAB & Simulink**



Zynq SDR



RF Signal Generator

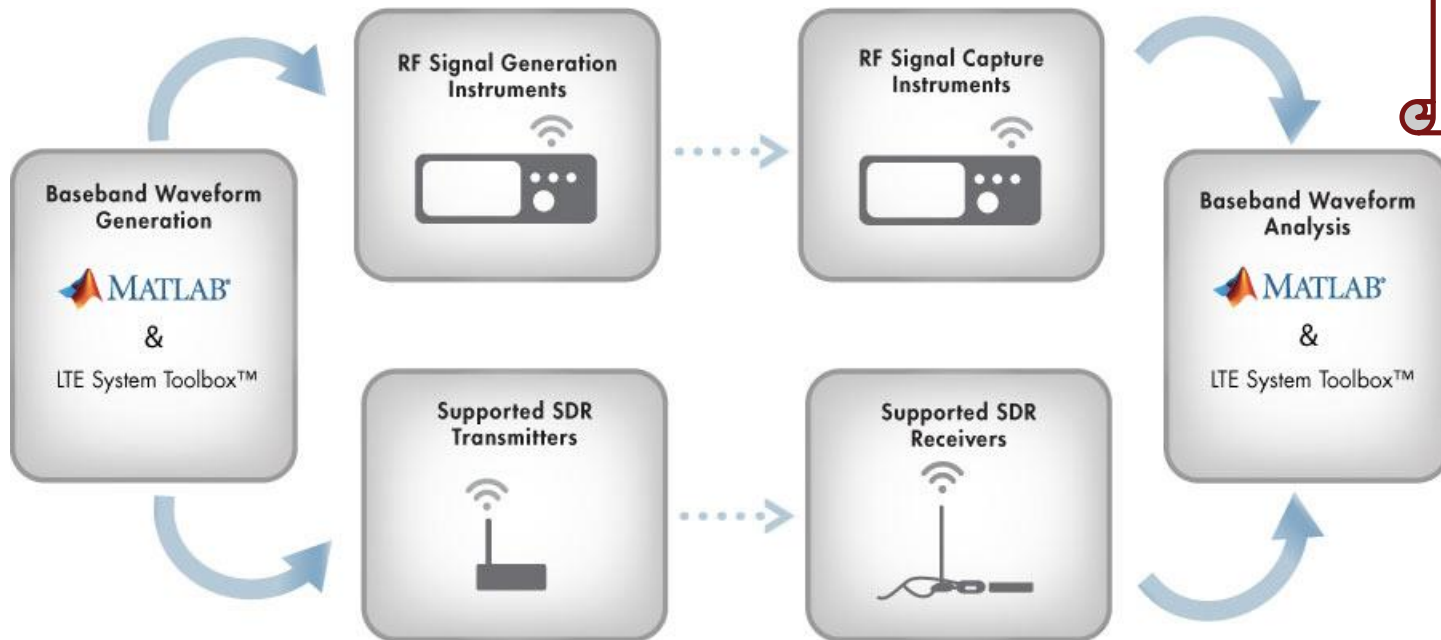


Spectrum Analyzer

Is this for me?

- Do you have a wireless lab?
- Do you need to validate your design with live signals?

# Example: Over-the-air testing with SDRs & RF instruments



Process original data bits and generate custom digital baseband waveforms in transmitter

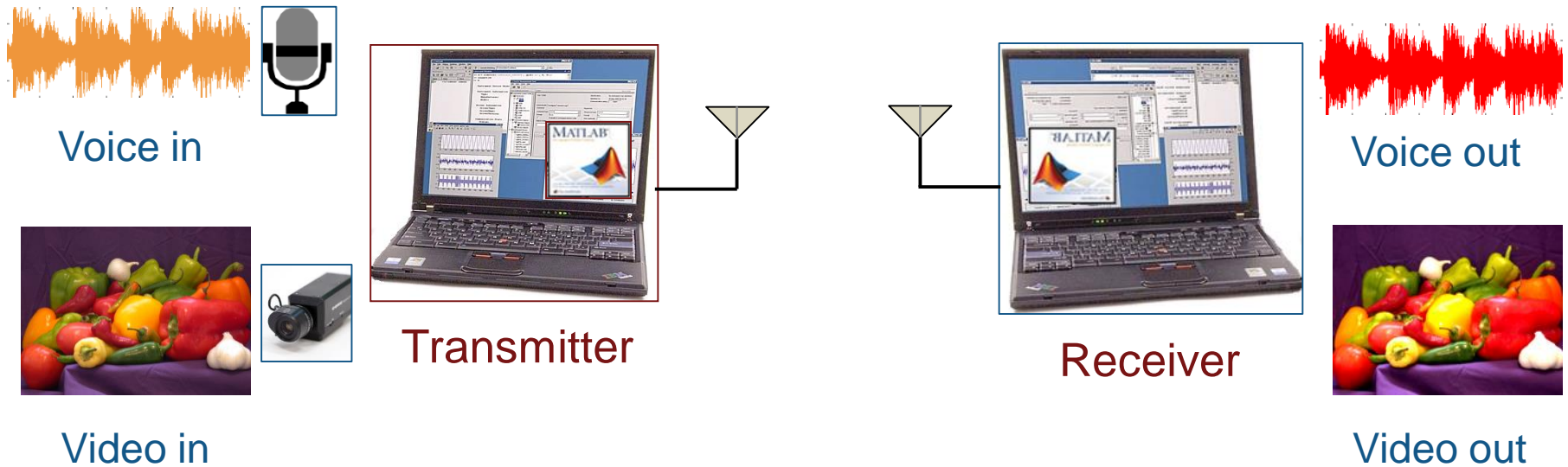
Transmit waveform using SDR devices or RF instruments

Capture received samples with SDR devices or RF instruments

Process received samples in receiver. Decode/recover original data

# Over-the-air testing with SDRs & RF instruments

## Solution





# Supported SDRs & RF instruments

RF Signal Generator



RF Spectrum Analyzer

Zynq Radio SDR



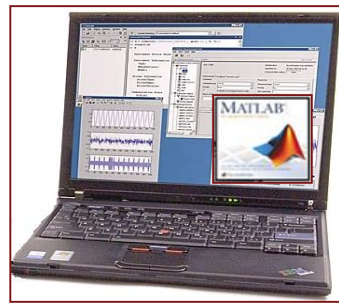
Zynq Radio SDR

USRP SDR



USRP SDR

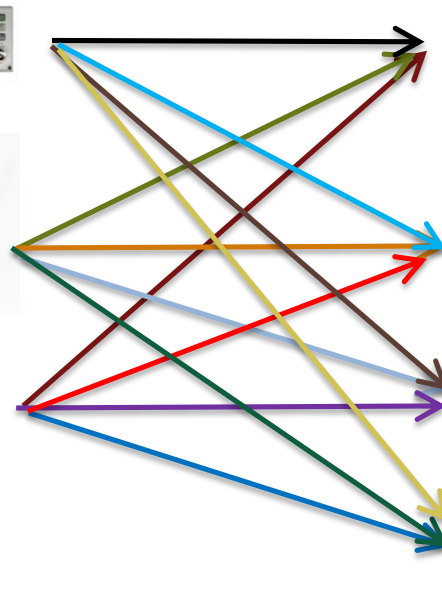
RTL SDR

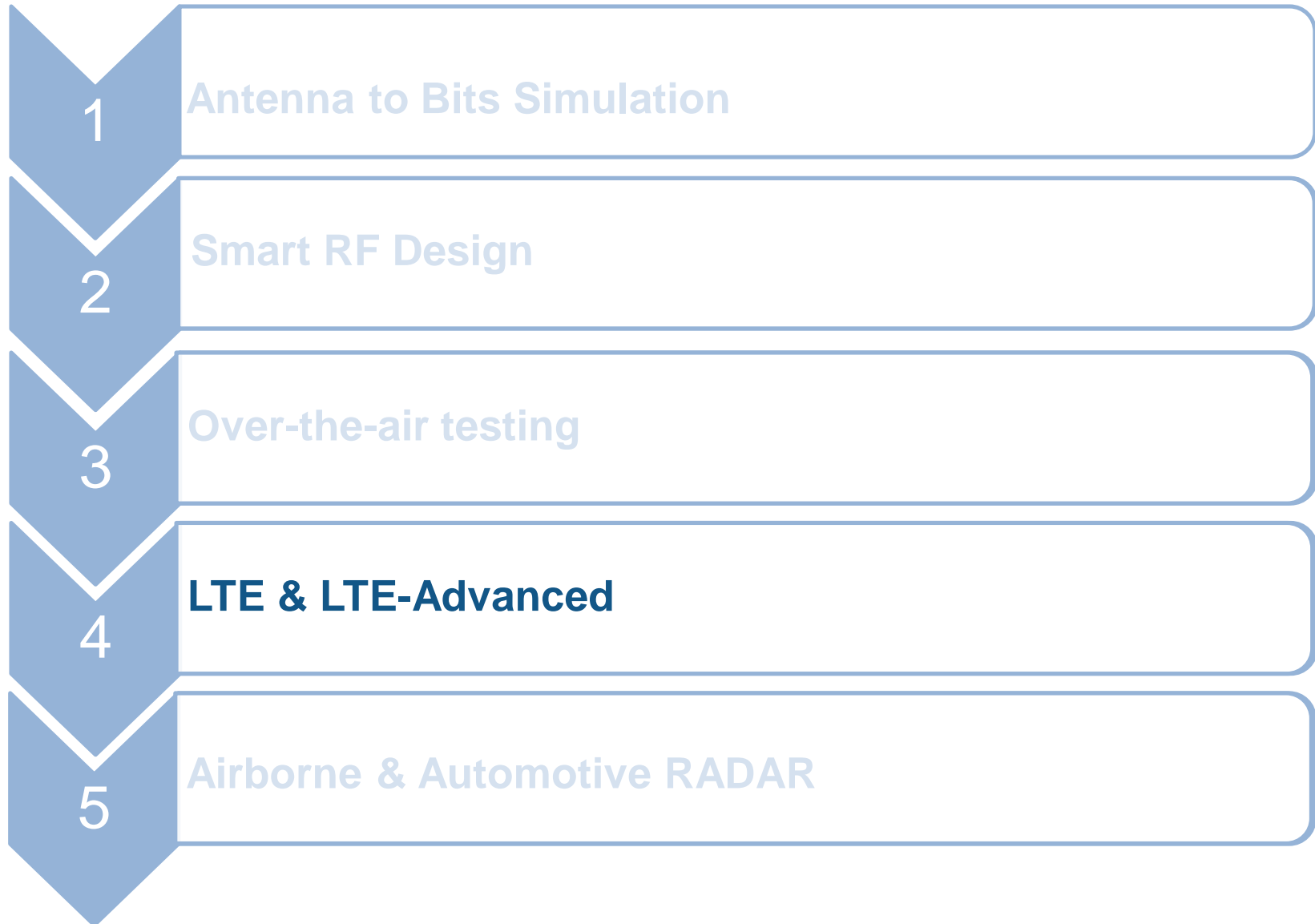


Transmitter



Receiver

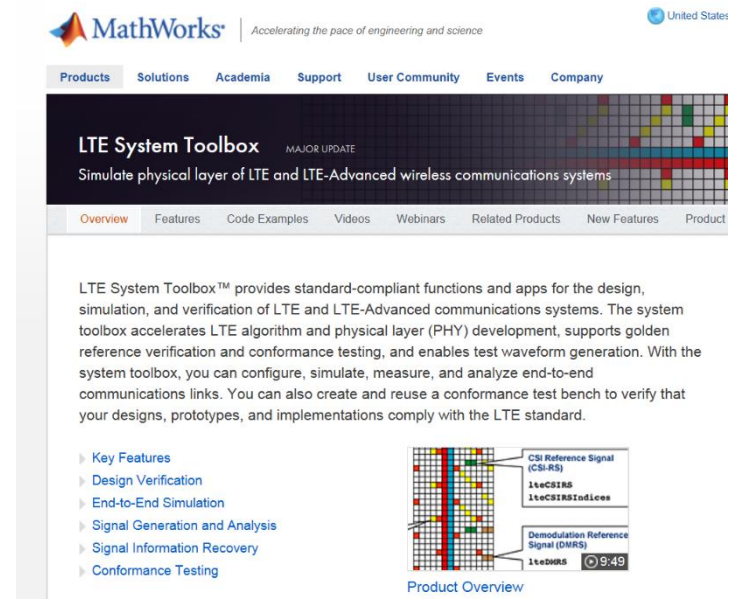




# LTE & LTE-Advanced

## Design, simulate, and test LTE and LTE-Advanced systems

- Specify your LTE and LTE-A PHY systems covering all transmission modes, channels, and signals
- Combine your LTE baseband models with RF modeling for a combined digital-RF design
- New features in R2015a
  - LTE Rel. 11 support
  - UMTS/HSPA+ Waveform Generation
  - Coordinated Multipoint (CoMP)

The screenshot shows the MathWorks website for the LTE System Toolbox. The page title is "LTE System Toolbox" with a "MAJOR UPDATE" badge. Below the title is the description: "Simulate physical layer of LTE and LTE-Advanced wireless communications systems". A navigation menu includes "Overview", "Features", "Code Examples", "Videos", "Webinars", "Related Products", "New Features", and "Product". The main content area contains a paragraph describing the toolbox's capabilities for design, simulation, and verification. To the right, there is a "Product Overview" section with a grid diagram and labels for "CSI Reference Signal (CSI-RS)", "Demodulation Reference Signal (DMRS)", and "11eCS1RS1andLee". A list of key features is provided on the left side of the content area.

**Key Features**

- ▶ Design Verification
- ▶ End-to-End Simulation
- ▶ Signal Generation and Analysis
- ▶ Signal Information Recovery
- ▶ Conformance Testing

**Product Overview**

### Qualifying question

- Are you working on LTE Physical layer?

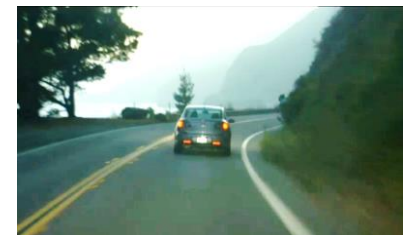
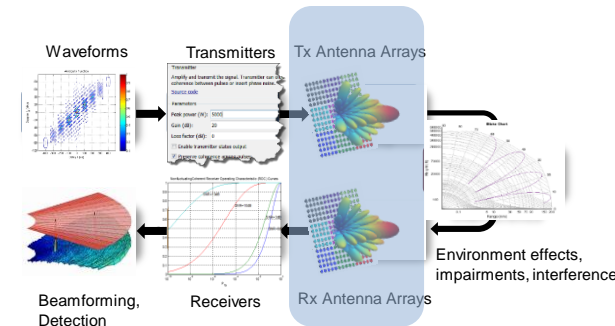


# Airborne & Automotive RADAR

## Simulate and test multi-domain RADAR systems

- Simulate ground-based, airborne, ship-borne, or automotive radar systems with moving targets and platforms
- Explore the characteristics of sensor arrays, and perform link budget analysis
- Accelerate development with a library of array processing algorithms such as beam-forming, DOA, range, and Doppler estimation and detection

### MATLAB & Simulink



### Qualifying questions

- AERO: Do you design or validate RADAR systems?
- AUTO: Do you work on driver assistance or active safety?

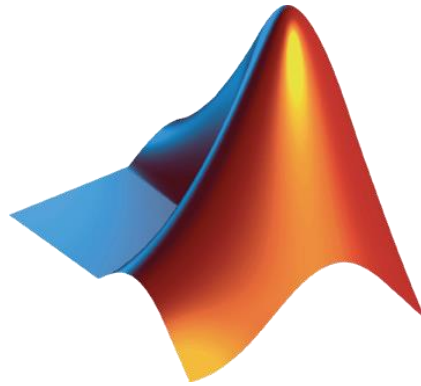
# Summary

- Simulate physical layer of wireless communication systems from antenna to bits
- Design smart RF systems such as Analog Devices AD9361 Agile RF Transceiver
- Test wireless designs with RF instruments & SDR hardware such as RTL-SDR, USRP, and Xilinx Zynq-based radio
- Analyze, simulate, and test LTE/LTE-A standard-compliant systems
- Simulate defense and automotive radar systems



[mathworks.com/communications-systems](https://mathworks.com/communications-systems)

Thank You



Q & A