The MathWorks

MATLAB&SIMULINK®

Modeling Electronic Interference Scenarios

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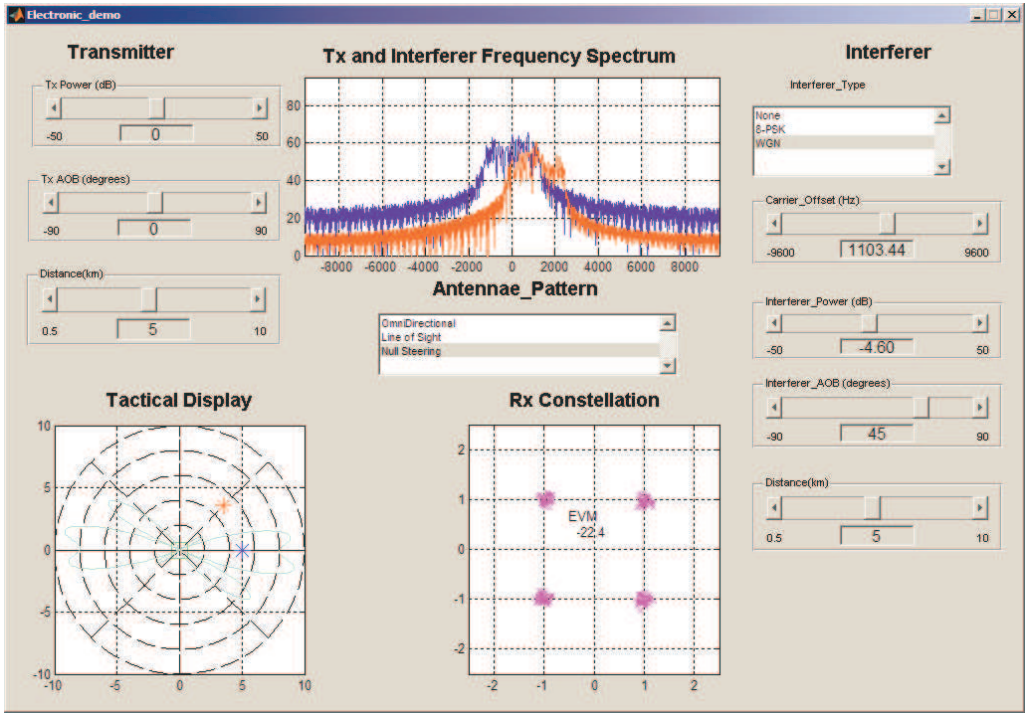
Problem Statement

- Model Communications Link with No Interferer Signal Present
- Measure Impact of Interferer on System Performance
  (EVM and BER)
- Improve Performance with different Receive Antenna Patterns

Electronic Interference Model

- Model Communications Link Tx, Channel, and Rx



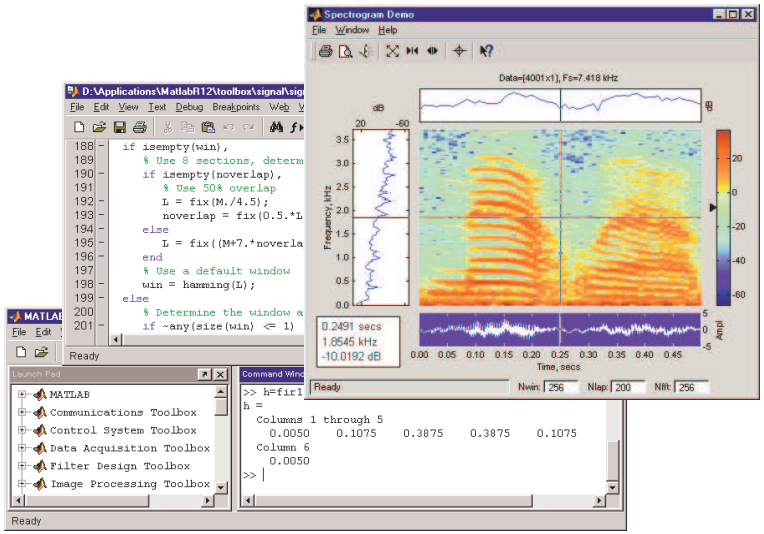
- Interactively Change
  - Type of interfering Signal
  - Interferer Power
  - Angle Off Bore-Site
  - Carrier Offset
  - Receive Antenna Pattern
- Measure Effect on EVM of System

Core MathWorks Products

MATLAB®

The leading environment for technical computing

- Numeric computation
- Data analysis and visualization
- The *de facto* industry-standard, high-level programming language for algorithm development
- Toolboxes for signal and image processing, statistics, optimization, symbolic math, and other areas
- Foundation of the MathWorks product family

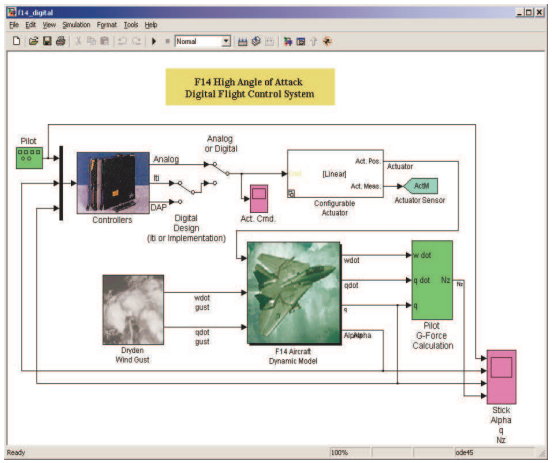


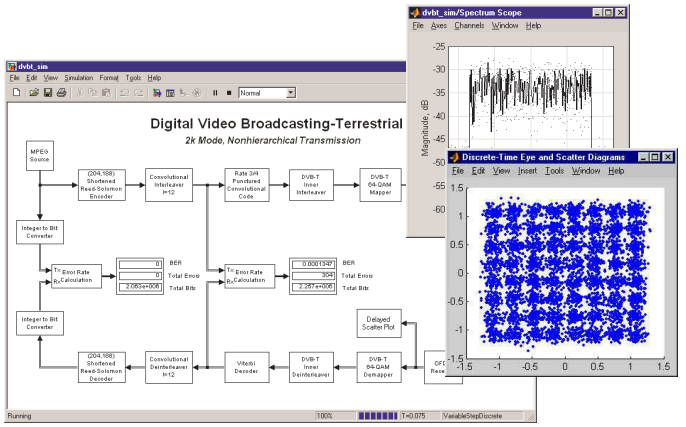
Core MathWorks Products

SIMULINK®

The leading environment for modeling, simulating, and implementing dynamic and embedded systems

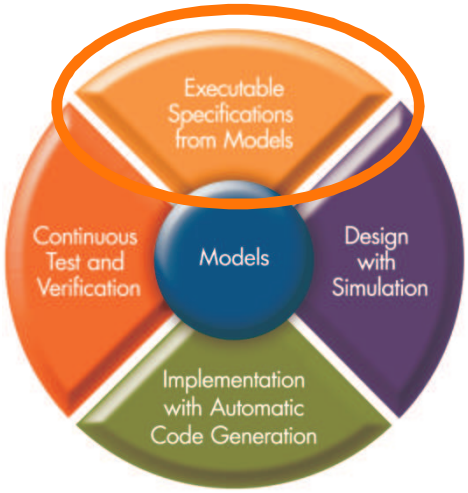
- Linear, nonlinear, discrete-time, continuous-time, hybrid, and multi-rate systems
- Foundation for model-based design, including physical-domain modeling, automatic code generation, and verification and validation
- Open architecture for integrating models from other tools
- Applications in controls, signal processing, communications, and other system engineering areas

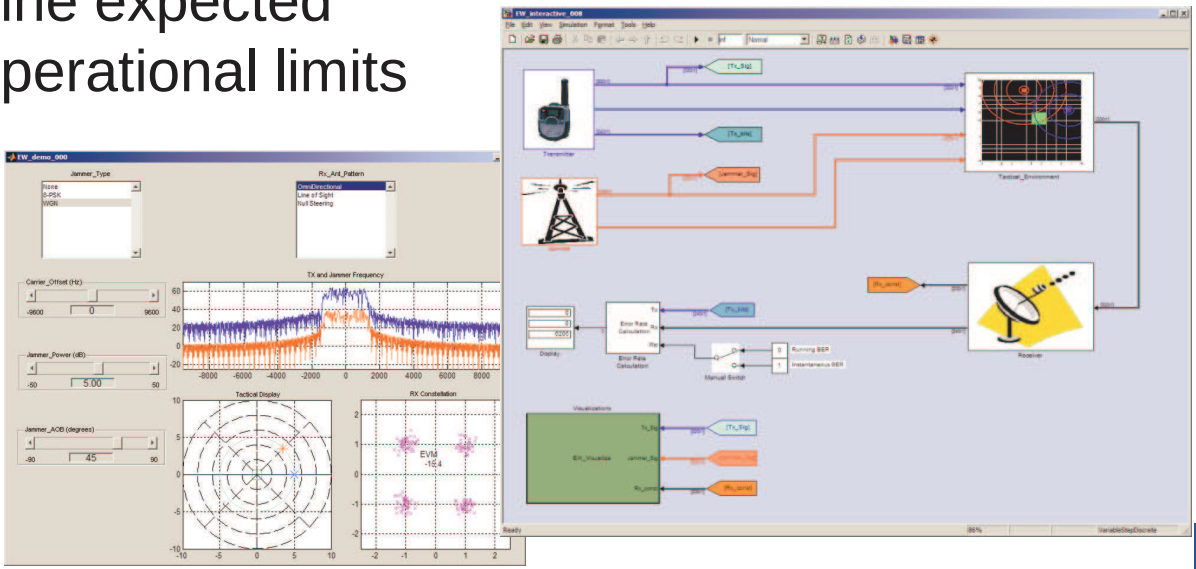




Building Executable Specifications for Communications Systems

- Partition model into Transmitter, Interferer, RF, Impairment subsystems
- Introduce Interferer, Co-channel Interference, Smart Antenna Configurations
- Simulate to determine expected performance and operational limits





Demo
>>Electronic_interactive_010

MIL-STD-188-110B Transmitter

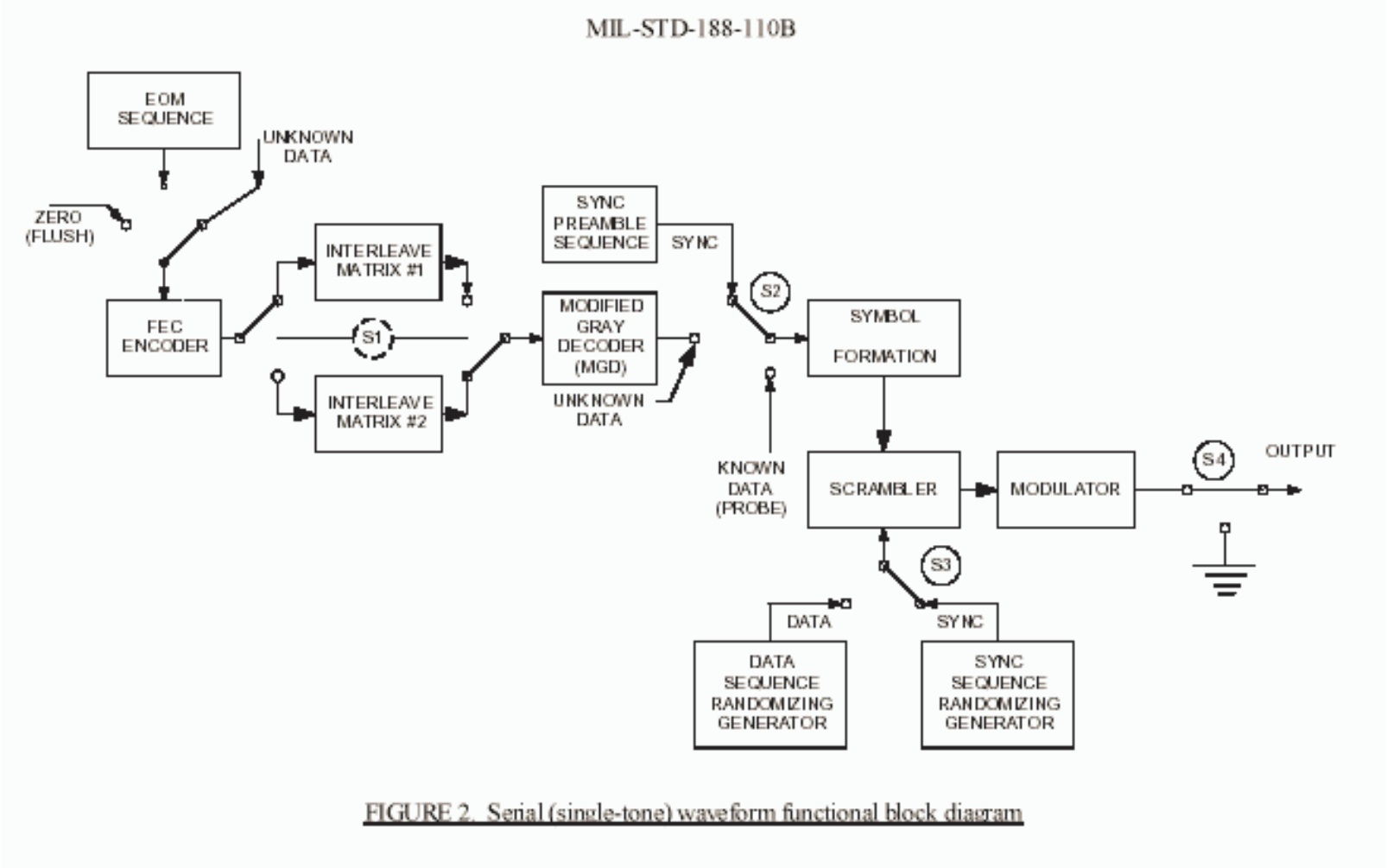
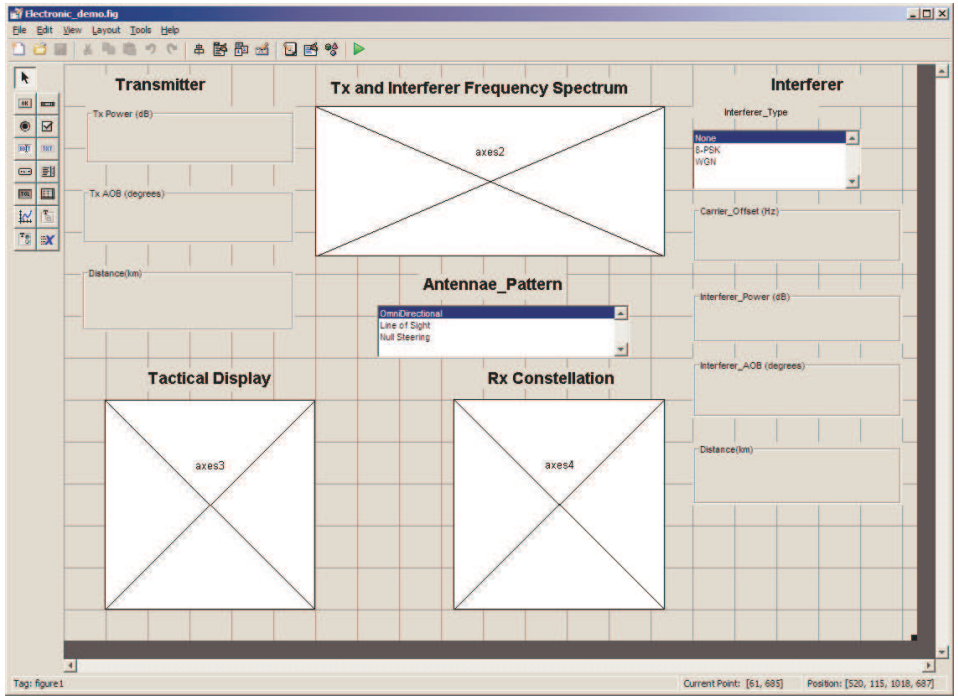


FIGURE 2. Serial (single-tone) waveform functional block diagram

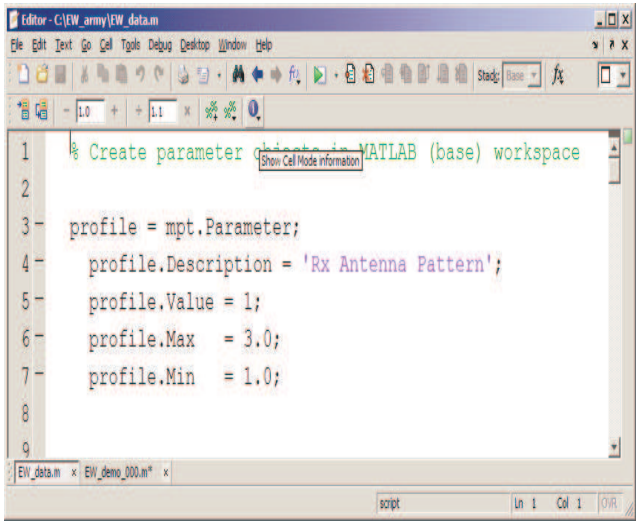
Graphical User Interface (GUI) Design

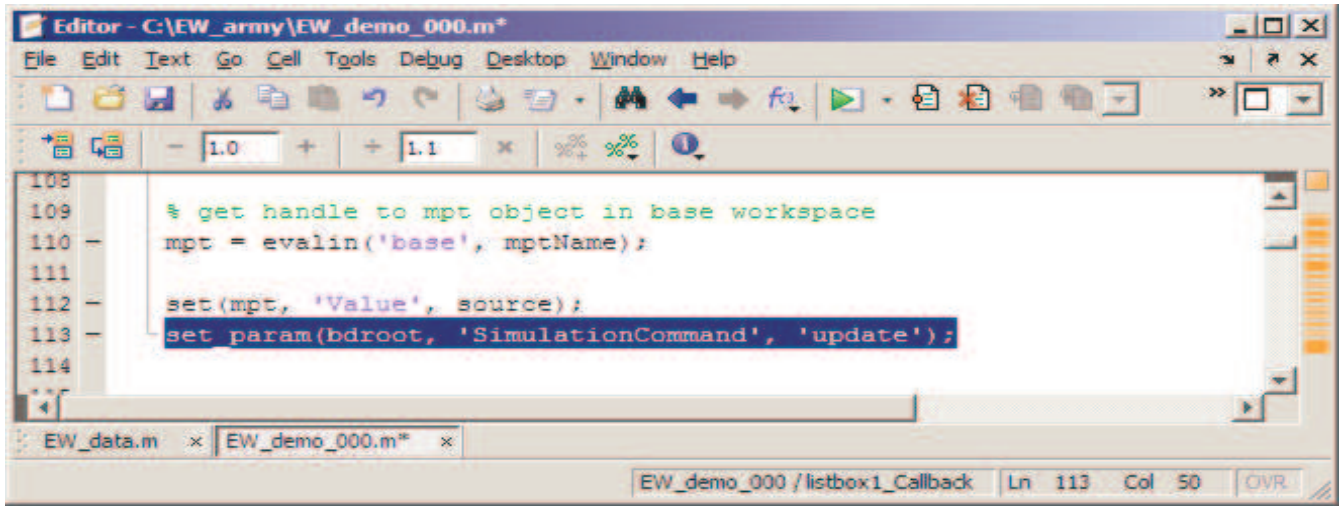
- MATLAB provides a Graphical User interface Design Environment (GUIDE)
- Layout GUI using pull-down menu's, check boxes, sliders etc.
- Generates MATLAB file that invokes MATLAB code when these buttons are pressed by user

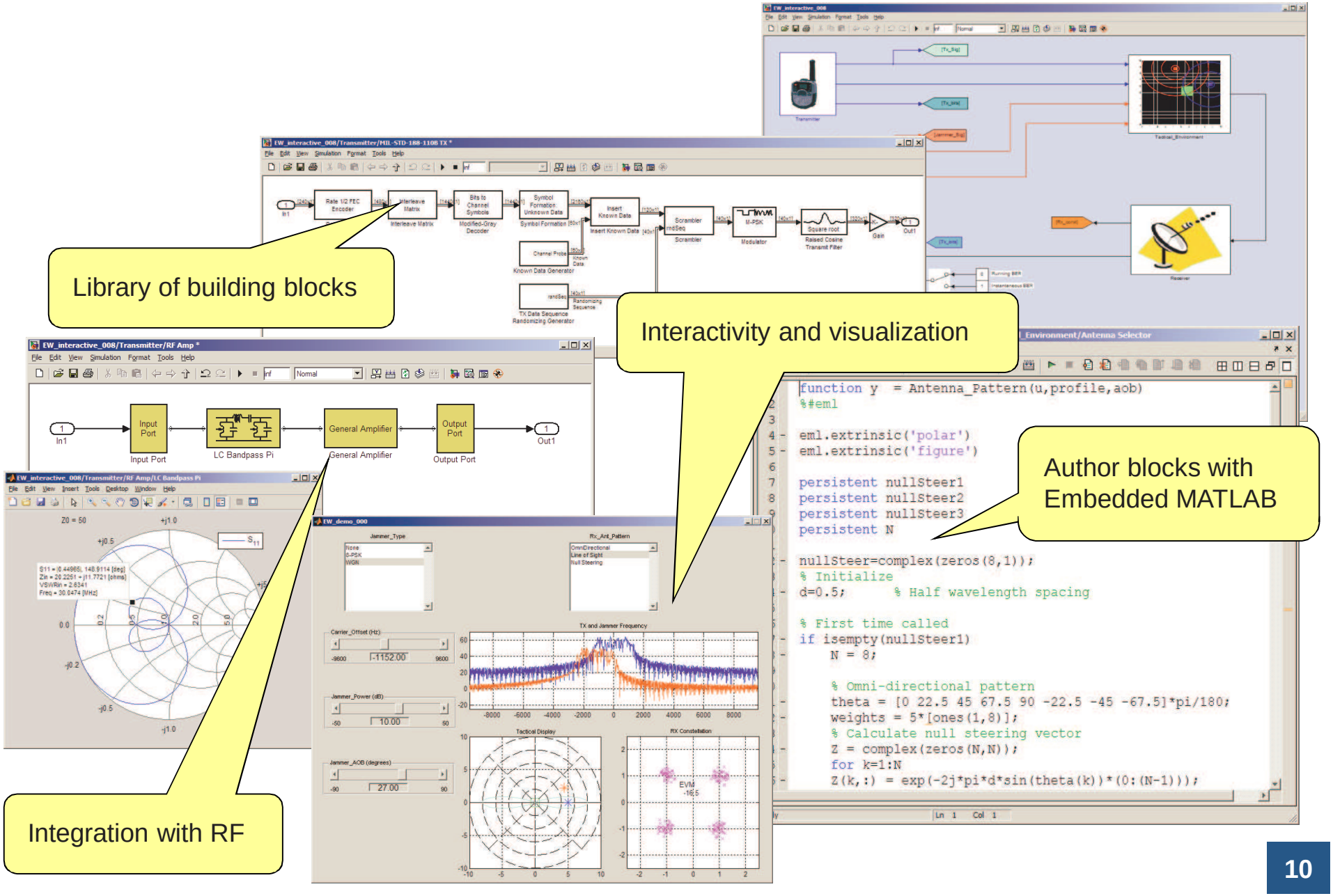


Developing an interactive Simulink Model

- Control Simulink Model parameters with MATLAB GUI
- Within GUI call Simulink update while model is running
- Call visualization code from Embedded MATLAB function






Library of building blocks
Interactivity and visualization
Author blocks with Embedded MATLAB
Integration with RF
EW_interactive_008/Transmitter/RF Amp *
Input Port
LC Bandpass Pi
General Amplifier
Output Port
In1
Out1
function y = Antenna_Pattern(u,profile,aob)
%#eml
eml.extrinsic('polar')
eml.extrinsic('figure')
persistent nullSteer1
persistent nullSteer2
persistent nullSteer3
persistent N
nullSteer=complex(zeros(8,1));
% Initialize
d=0.5; % Half wavelength spacing
% First time called
if isempty(nullSteer1)
N = 8;
% Omni-directional pattern
theta = [0 22.5 45 67.5 90 -22.5 -45 -67.5]*pi/180;
weights = 5*[ones(1,8)];
% Calculate null steering vector
Z = complex(zeros(N,N));
for k=1:N
Z(k,:) = exp(-2j*pi*d*sin(theta(k))*(0:(N-1)));

Summary

- Developed interactive Simulink Model with MATLAB GUI as an interface
- Flexible design environment for simulating a variety of EW Scenarios (antenna patterns, jammer type/power etc.)
- Easily Measure System Performance for different situations (EVM, BER, etc.)