



System level Radar Simulation using Model based Design

Dr. Dyana A

Scientist 'D'

Center for Adaptive Sensing Technology (CFAST)

LRDE, DRDO

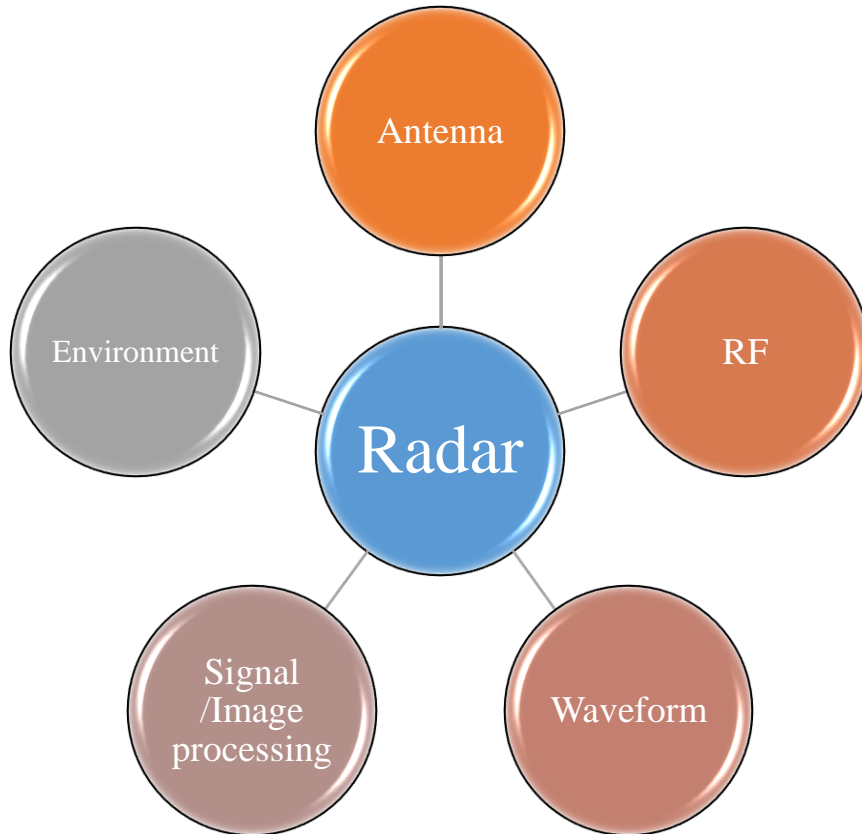
Bangalore



Introduction

- ❖ Phased Array Radar System consists of different subsystems such as Antenna, Waveform, RF, Signal and Data Processing.
- ❖ The system is also dependent upon external entities such as target, clutter, jammer and channels.
- ❖ The system requires a model based design approach for end to end radar design, analysis and simulation

Challenges

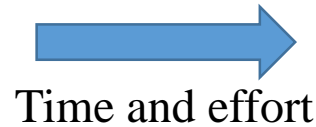


- ❖ Multi Domain
- ❖ Multiple Teams
- ❖ Interdependency among subsystems
- ❖ Duplication of work in multiple projects

Challenges



Frequent interactions



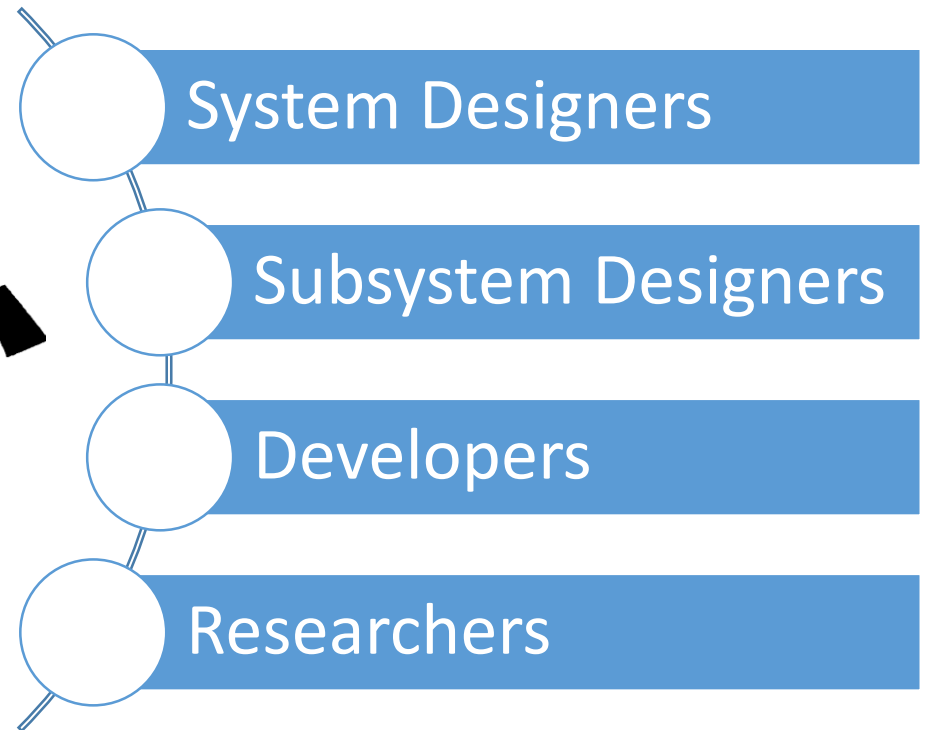
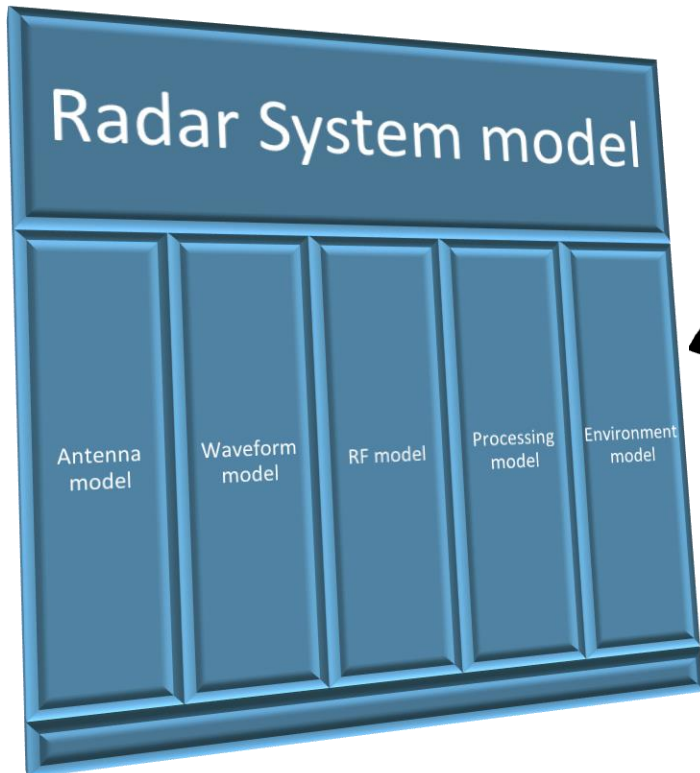
Time and effort

System Design

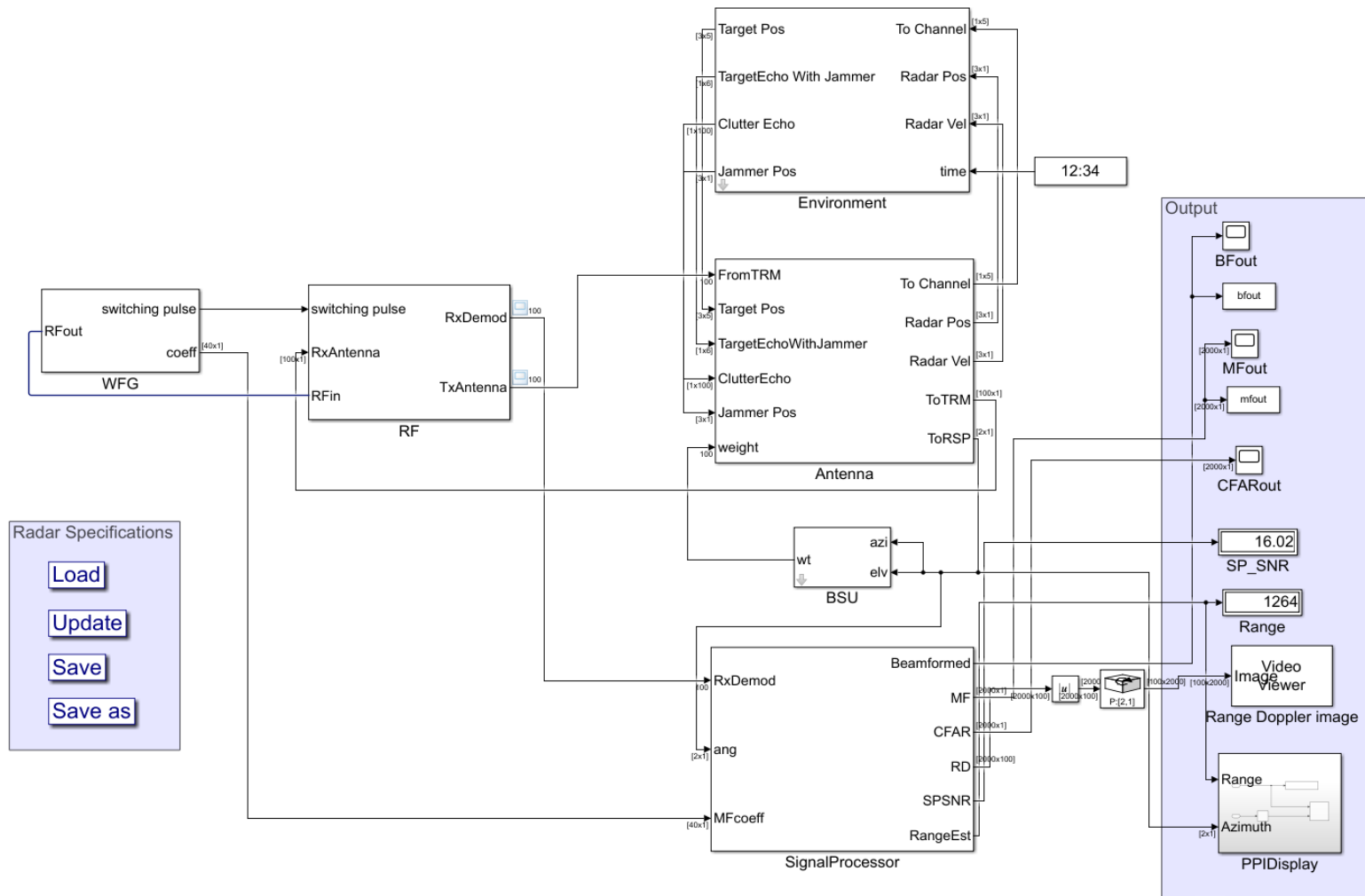


Multiple platforms and
simulations

Model based design



Model based design using Simulink



Antenna array model Features

- Antenna element type (standard and custom)
- Antenna array arrangement (including conformal)
- Derivation of Directivity, Beamwidth, Side lobe levels
- Analysis using Radiation patterns (2D & 3D), Grating lobe diagram

Settings

Element:

Frequency: MHz 10ghz.csv

Array Type:

Lattice:

Taper:

Nx: dx: m

Ny: dy: m

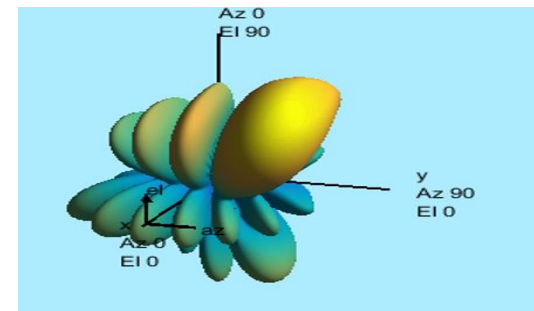
Steering Angle
Az: El: deg

Array Characteristics

Directivity : 18.2539 dBi

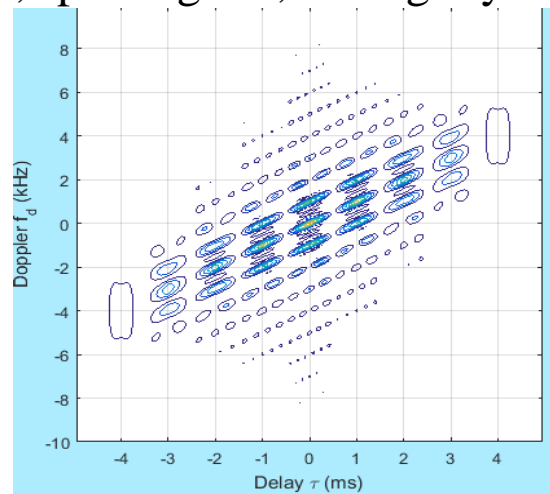
Beamwidth : HPBW(az):25.93 dB
HPBW(el):45.75 dB

PSLL(az):9.66 dB
PSLL(el):17.31 dB



Waveform model Features

- Design of different waveforms:
 - Rectangular
 - Linear FM
 - Stepped FM
 - Stepped Chirp (Custom)
- Derivation of range resolution, Doppler resolution, Time Bandwidth product, unambiguous range, duty cycle etc.
- Analysis using spectrum, spectrogram, Ambiguity diagrams



Ambiguity diagram

RF model Features

- Design of Transmit and Receive modules
- Design of RF units using SimRF
 - Power amplifiers
 - LNA
 - Bandpass filters
 - Attenuators
 - Phase shifters

Transmitter

Peak power Watts

Gain dB

Loss factor dB

Receiver

Gain dB

Loss factor dB

Noise

Noise Power Watt

Noise Figure dB

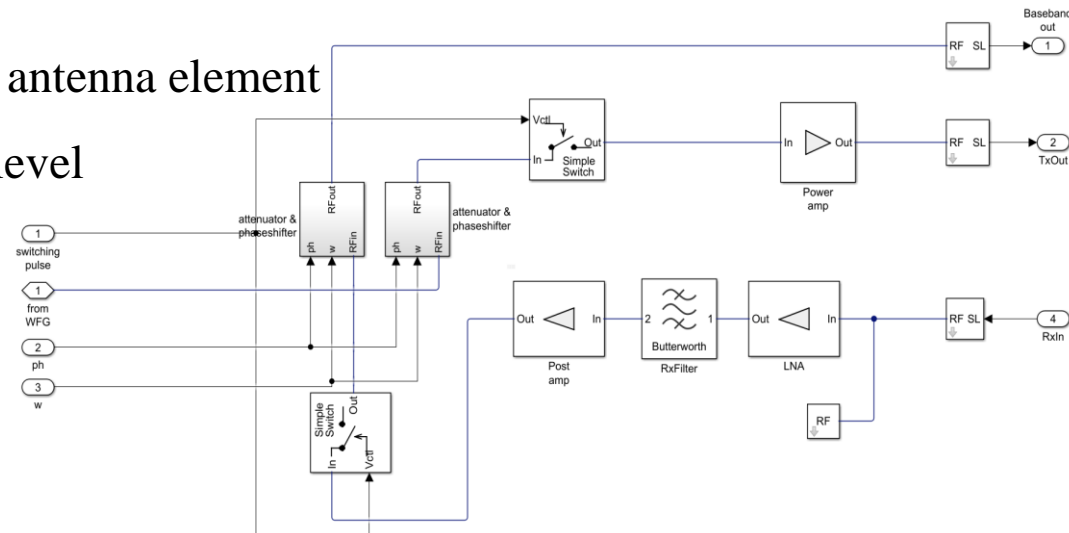
Noise Temp. Kelv

Noise complexity
 Real Complex

Phase Noise

Save
Close

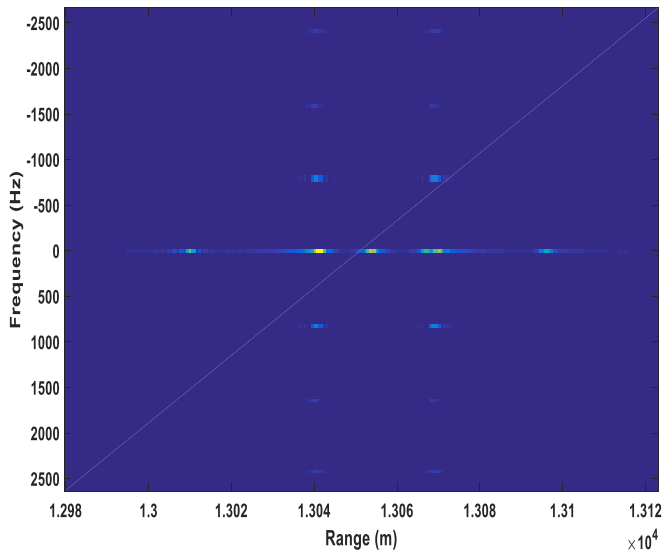
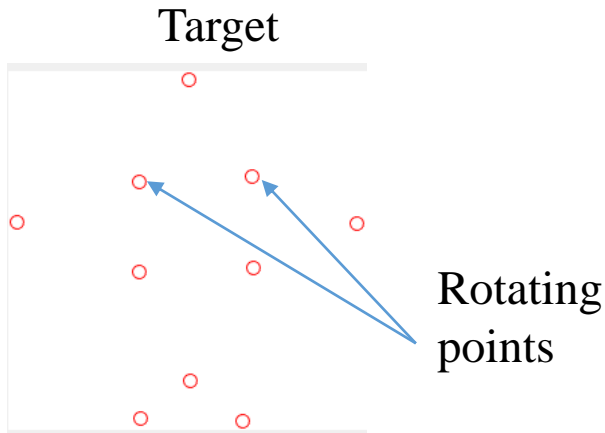
- Each TR module connected to each antenna element
- Simulation at abstract and detailed level



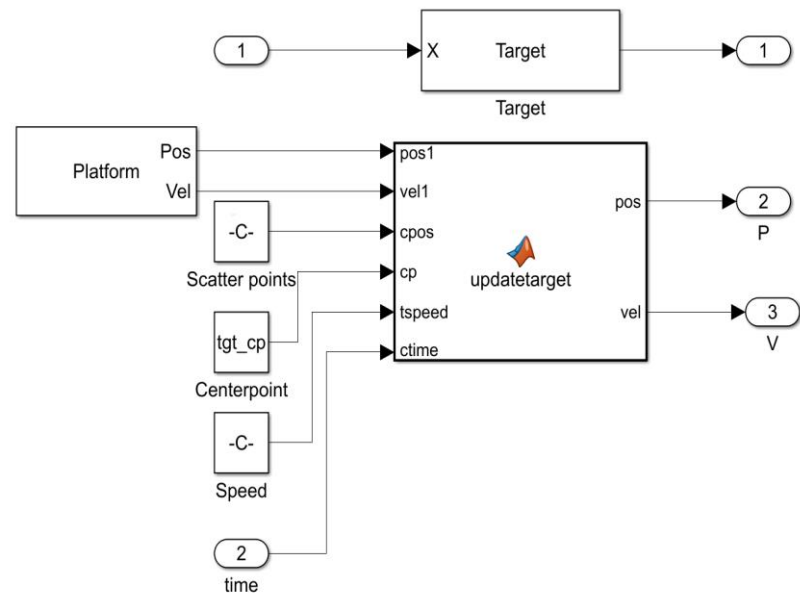
Environment model

Target	Clutter	Jammer	Channel
<ul style="list-style-type: none">• Point scatters• RCS• Swerling Model• Position (Geographical and Cartesian)• Velocity• Acceleration• Trajectory	<ul style="list-style-type: none">• Constant gamma• Different terrain models	<ul style="list-style-type: none">• Barrage jammer• Platform motion	<ul style="list-style-type: none">• Temperature• Pressure• Vapour density• Rain rate• Target and jammer channel

Target modelled with multiple point scatters



Range Doppler Image



System simulation



System specifications



Graphical user interface



Simulink model parameters

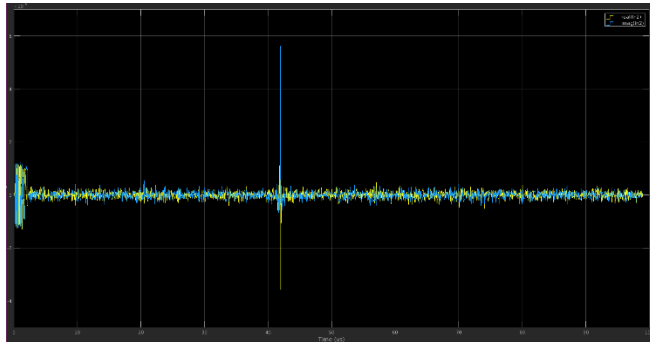


Simulation

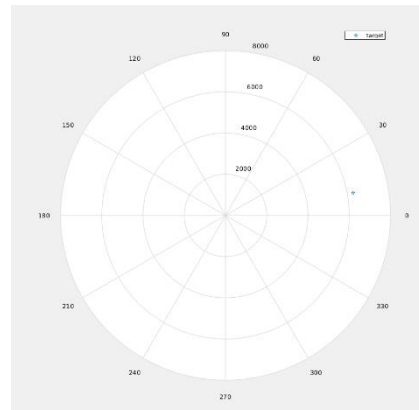


Results

(Detection, Range Doppler Images)

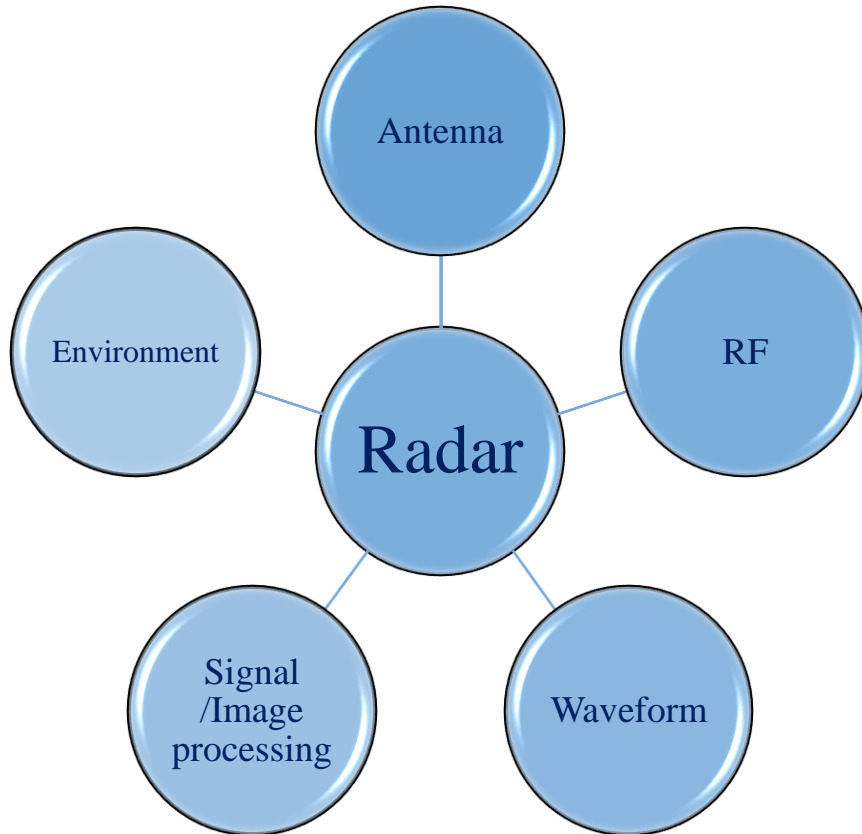


Matched Filter output



Detection

Benefits



- ❖ Multi-domain system in a single simulation using Simulink
- ❖ Reduces dependency on human expertise
- ❖ Eases subsystem dependency by using system objects
- ❖ Reusability in multiple projects using model based design and user friendly means of changing specifications and design



Future Scope

- Modelling of scheduler with simEvents
- Modelling of tracker
- Report generation



Thank You