

Tailoring Tools for Application-Oriented Development Using Model-Based Design

Tom Erkkinen
MathWorks

The Origins of MATLAB - x

Secure | <https://www.mathworks.com/company/newsletters/articles/the-origins-of-matlab.html>

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The Origins of MATLAB

By Cleve Moler, MathWorks

In the late 1970s, following Wirth's methodology, I used Fortran and portions of LINPACK and EISPACK to develop the first version of MATLAB. The only data type was "matrix." The HELP command listed all of the available functions, with their names abbreviated.

ABS	ANS	ATAN	BASE	CHAR	CHOL	CHOP	CLEA	COND	CONJ	COS
DET	DIAG	DIAR	DISP	EDIT	EIG	ELSE	END	EPS	EXEC	EXIT
EXP	EYE	FILE	FLOP	FLPS	FOR	FUN	HESS	HILB	IF	IMAG
INV	KRON	LINE	LOAD	LOG	LONG	LU	MACR	MAG	NORM	ONES
ORTH	PINV	PLOT	POLY	PRIN	PROD	QR	RAND	RANK	RCON	RAT
REAL	RETU	RREF	ROOT	ROUN	SAVE	SCHU	SHOR	SEMI	SIN	SIZE
SQRT	STOP	SUM	SVD	TRIL	TRIU	USER	WHAT	WHIL	WHO	WHY

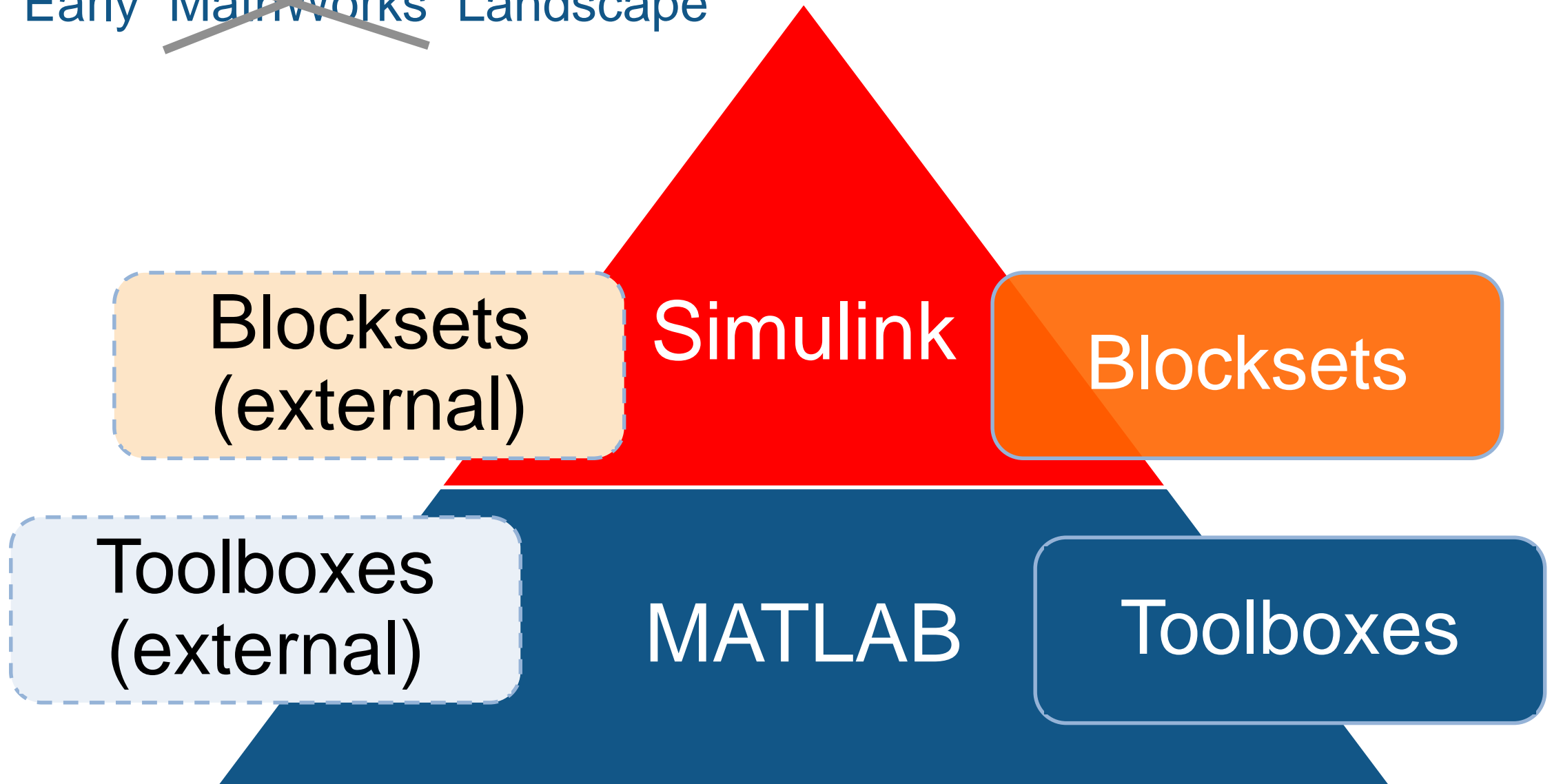
There were only 80 functions. There were no M-files or toolboxes.

MATLAB R2017a

```
>> why
```

```
The bald and not excessively bald and not excessively smart hamster obeyed a terrified and not excessively terrified hamster.
```

Early ~~MathWorks~~ Landscape



1

Today's Landscape – Prolific

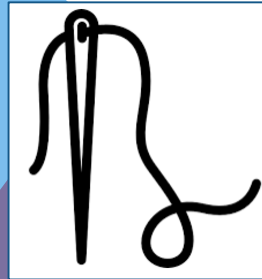
The image is a collage illustrating the 'Today's Landscape – Prolific' of MATLAB toolboxes. It features several overlapping elements:

- MATLAB Add-Ons Browser:** A browser window showing the MATLAB Add-Ons page with filters for Source, Type, and Product Family.
- Filter by Source Dialog:** A dialog box showing the number of toolboxes available from each source:
 - ☐ MathWorks: 285
 - ☐ Community: 27,048
- Toolbox Grid:** A grid of various MATLAB toolboxes, including:
 - Statistics and Machine Learning Toolbox:** Analyze and model data using statistics and machine learning.
 - Computer Vision System Toolbox:** Design and simulate computer vision and video processing systems.
 - Robotics System Toolbox:** Design and test algorithms for robotics applications.
 - Simscape:** Model and simulate multi-physics systems.
 - GUI Layout Toolbox:** Layout manager for MATLAB graphical user interfaces.
 - Deep Neural Network:** It provides deep learning tools of deep belief networks (DBNs).
 - "JSON": MATLAB:** JSONlab: a toolbox to encode/decode JSON files.
 - PIVlab:** time-resolved particle image velocimetry (PIV) tool.
 - Numerical Computing with MATLAB:** Toolbox containing files and app from Numerical Computing with MATLAB.
- Command Window:** A window showing the calculation of the sum of the number of toolboxes from MathWorks and the Community:

```
>> 285+27048  
  
ans =  
  
27333
```

Evolving Landscape

User Apps



Blocksets
(external)

Simulink

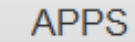
Blocksets

Toolboxes
(external)

MATLAB

Toolboxes






► Package into installation file

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Package

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User Apps


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Dave Barry
Jaguar Land Rover

MATLAB EXPO 2016



 Feedback

The Adoption of MATLAB Apps and Toolboxes at Jaguar Land Rover


Dave Barry, Jaguar Land Rover

Engineering teams across Jaguar Land Rover rely on MATLAB based apps and toolboxes to develop a wide range of advanced vehicles. This session discusses:

MATLAB Apps & Toolbox Packaging

MATLAB Store



Upload Add-On

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Request Tag

Search X

Author X

- ☐ Ben Tordoff
- ☐ Brett Shoelson
- ☐ David Sampson
- ☐ Example
- ☐ Gabor Kovacs
- ☐ Giacomo Perantoni
- ☐ Ian Noell
- ☐ James Kristoff

Type X

- ☐ App
- ☐ Toolbox

Tag X


- ☐ Admin
- ☐ Alpha
- ☐ App
- ☐ Beta
- ☐ CAN
- ☐ Charlie
- ☐ Code Generation
- ☐ Da Bizniss

Compatibility X

- ☐ R2016b

Paging: 1 2 3 4

Clear filters - Sort by: Rating
Add-ons per page: 10




MATLAB Web Maps

by David Sampson

A MATLAB web map component, with support for several popular tile services.

Version 1.2 | 1.1.5 | more ...

5 ratings ★★★★★
1 comment • 0 tags
6 downloads




Sums Game

by Simon Adelman

If Carlsberg made MATLAB apps

Version 1.0

1 rating ★★★★★
2 comments • 0 tags
0 downloads




colourTester

by unknown

Version 1.0

1 rating ★★★★★
12 comments • 33 tags
23 downloads




MATLAB Tracks

by David Sampson

Review your workout data.

Version 1.1.1 | 1.1 | more ...

4 ratings ★★★★★
3 comments • 1 tag
18 downloads




App Management Toolbox

by MathWorks

Toolbox for managing installed apps and toolboxes from the MATLAB Store

Version 1.5 | 1.4 | more ...

3 ratings ★★★★★
3 comments • 1 tag
7 downloads



GUI Layout Toolbox

by David Sampson

Layout management objects for MATLAB GUIs, for the new graphics system introduced in R2014b

Version 2.2.1 | 2.1

2 ratings ★★★★★
0 comments • 0 tags
5 downloads

Evolving Landscape

User Apps

Application-Oriented Products

Blocksets
(external)

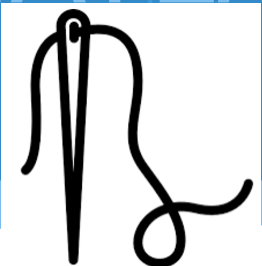
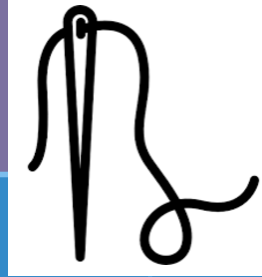
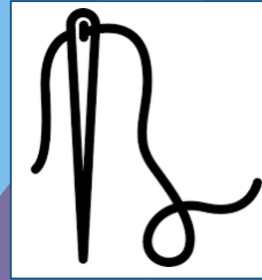
Simulink

Blocksets

Toolboxes
(external)

MATLAB

Toolboxes



Application-Oriented Products

Why Application Oriented?

- Basic blocks and functions no longer suffice
- Starting reference point is necessary
- System models are important but hard
- Let your experts focus on their expertise
 - Focus on own component, leverage elsewhere

Cost savings of nearly \$2 million per year


User Stories

User Stories | Search | Videos

GM Standardizes on Model-Based Design for Hybrid Powertrain Development

"The Two-Mode Hybrid powertrain took Model-Based Design to a new level within GM. This project provided the confidence and experience we needed to apply Model-Based Design to all of our hybrid vehicles across several product lines."

— Kent Helfrich, General Motors



"Large-scale Global Programs"


User Stories

User Stories | Search | Videos

Chery Enables In-House Development of Engine Management System Software with Model-Based Design

functionality, and resolve after-sales problems. Model-Based Design is more efficient. It lowers costs, and gives us the flexibility to allocate resources and finish development as fast as possible."

— Keguang Qi, Chery Automobile Co.

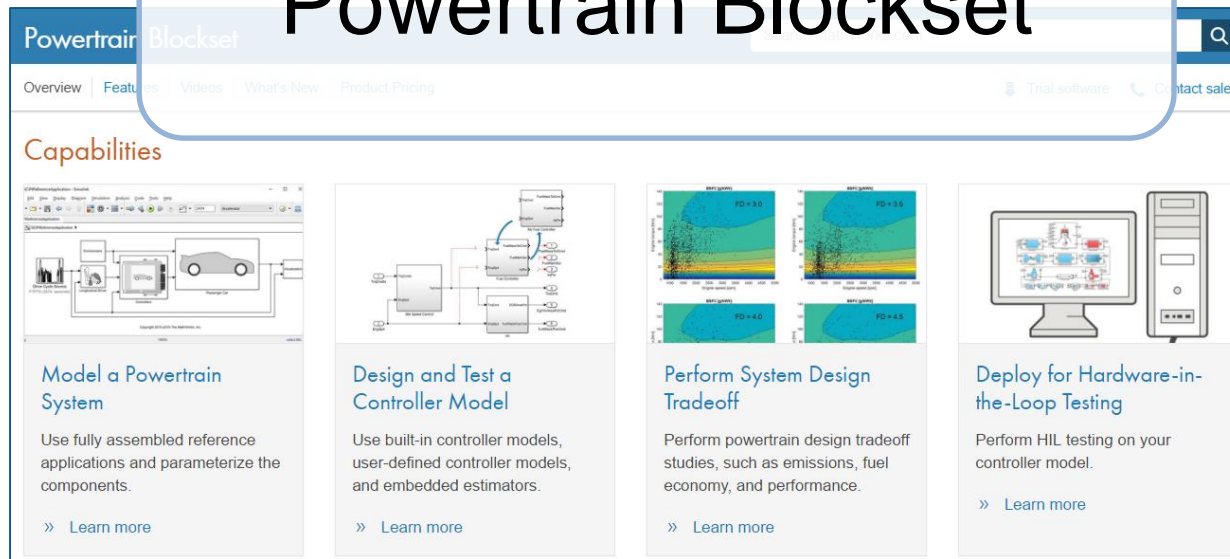


Chery engine powered by in-house developed EMS software.

"Bringing Work In-House"

Introducing ... Products for Application-Oriented Development

Powertrain Blockset

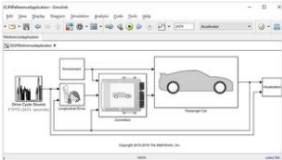


Powertrain Blockset

Overview | Features | Videos | What's New | Product Pricing

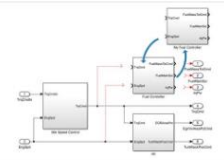
[Trial software](#) [Contact sales](#)

Capabilities

- 

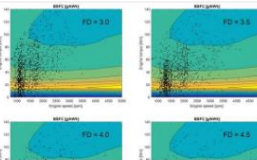
Model a Powertrain System

Use fully assembled reference applications and parameterize the components.

[» Learn more](#)
- 

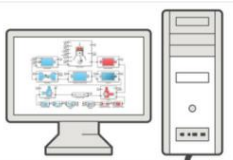
Design and Test a Controller Model

Use built-in controller models, user-defined controller models, and embedded estimators.

[» Learn more](#)
- 

Perform System Design Tradeoff

Perform powertrain design tradeoff studies, such as emissions, fuel economy, and performance.

[» Learn more](#)
- 

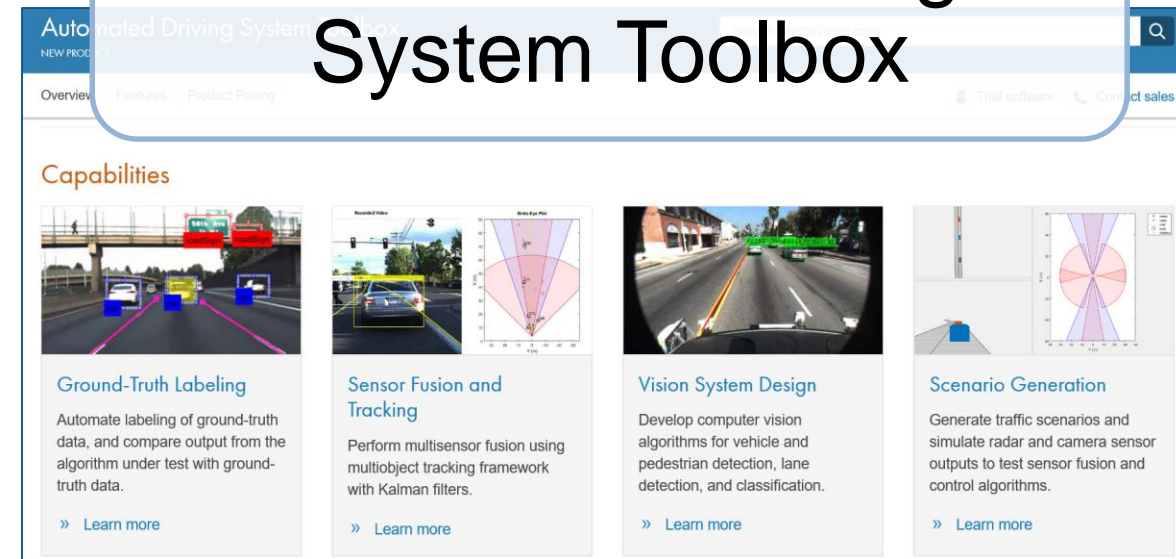
Deploy for Hardware-in-the-Loop Testing

Perform HIL testing on your controller model.

[» Learn more](#)

R2016b⁺

Automated Driving System Toolbox



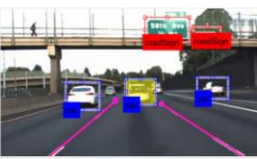
Automated Driving System Toolbox

NEW PRODUCT

Overview | Features | Product Pricing


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Capabilities

- 


Ground-Truth Labeling

Automate labeling of ground-truth data, and compare output from the algorithm under test with ground-truth data.

[» Learn more](#)
- 

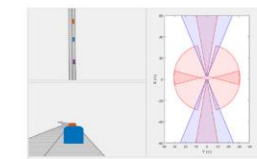
Sensor Fusion and Tracking

Perform multisensor fusion using multiobject tracking framework with Kalman filters.

[» Learn more](#)
- 

Vision System Design

Develop computer vision algorithms for vehicle and pedestrian detection, lane detection, and classification.

[» Learn more](#)
- 

Scenario Generation

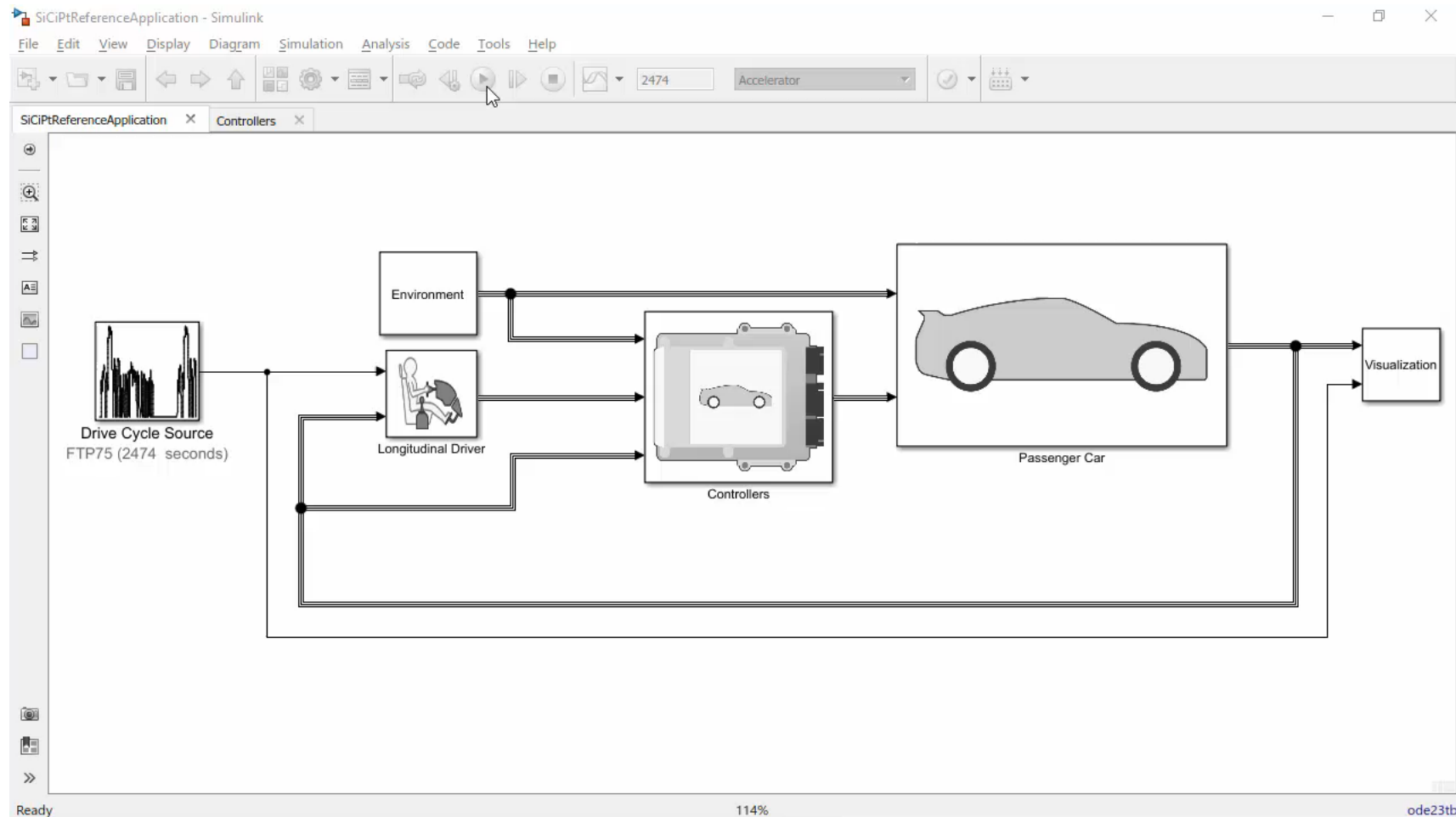
Generate traffic scenarios and simulate radar and camera sensor outputs to test sensor fusion and control algorithms.

[» Learn more](#)

R2017a

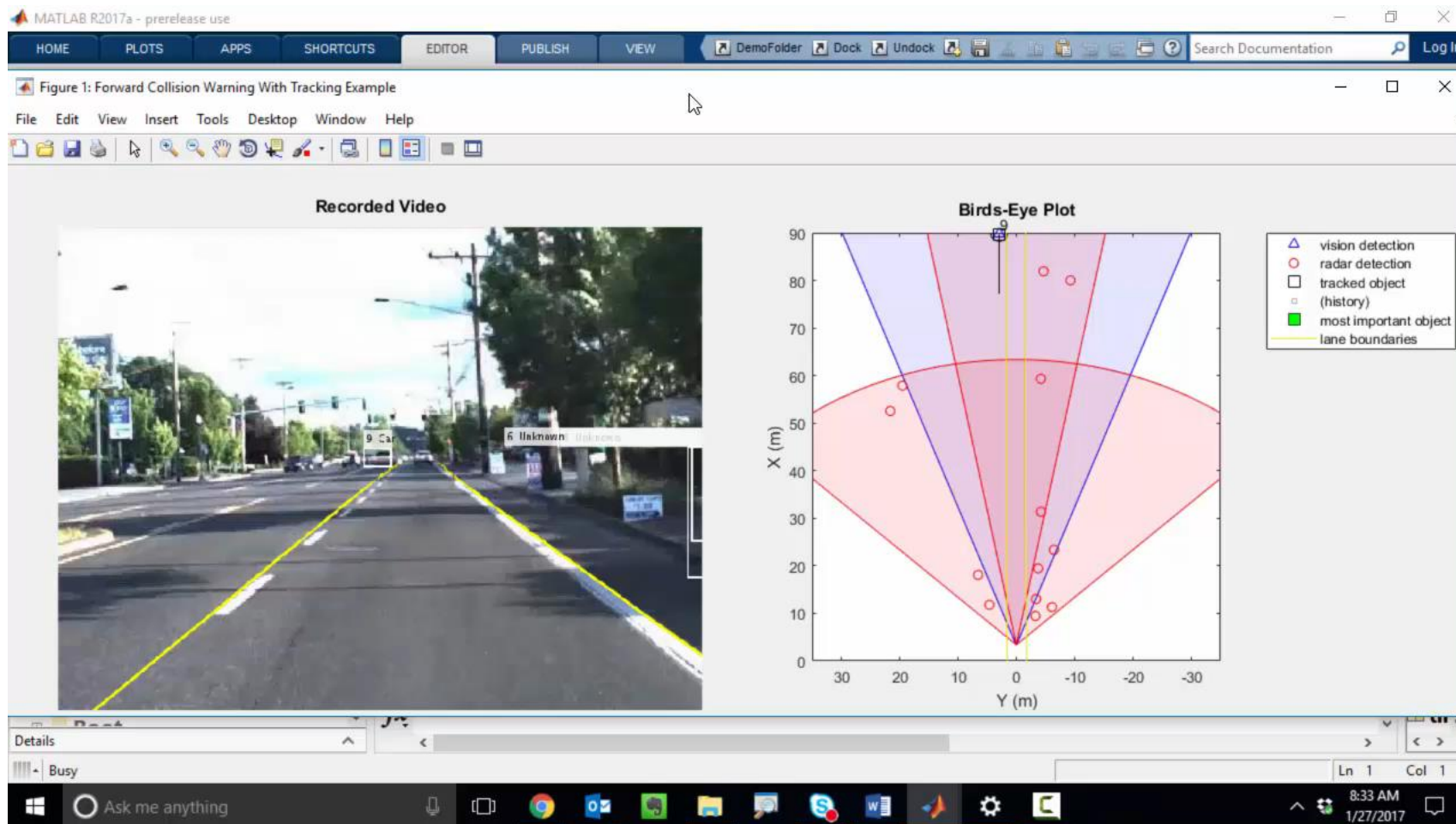
Reference Applications – Starting Point

Powertrain Blockset



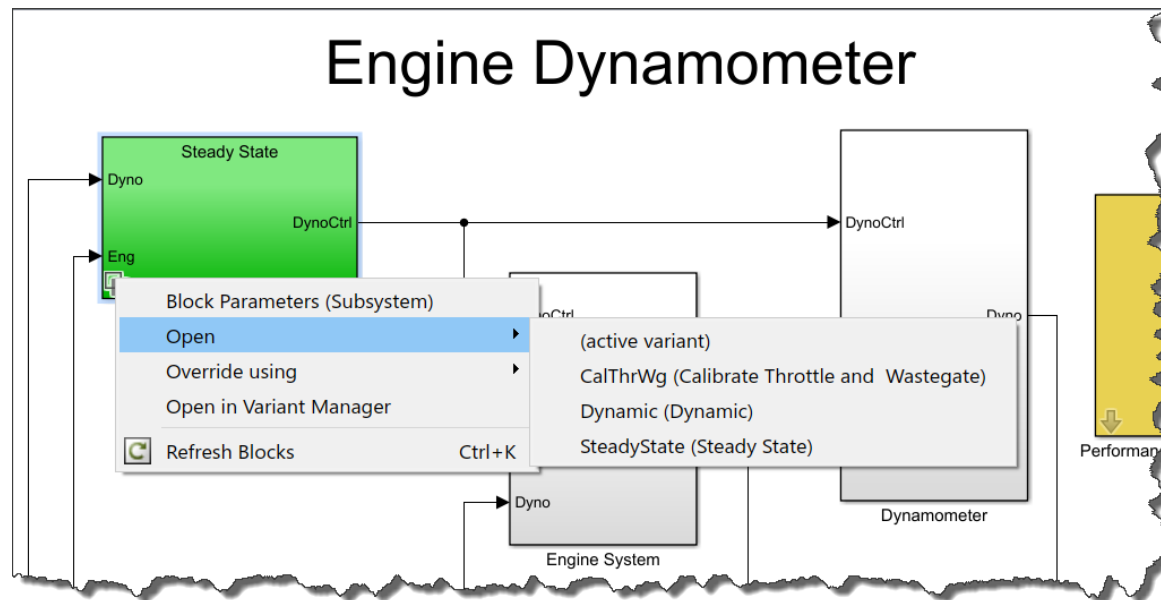
Reference Applications – Starting Point

Automated Driving System Toolbox

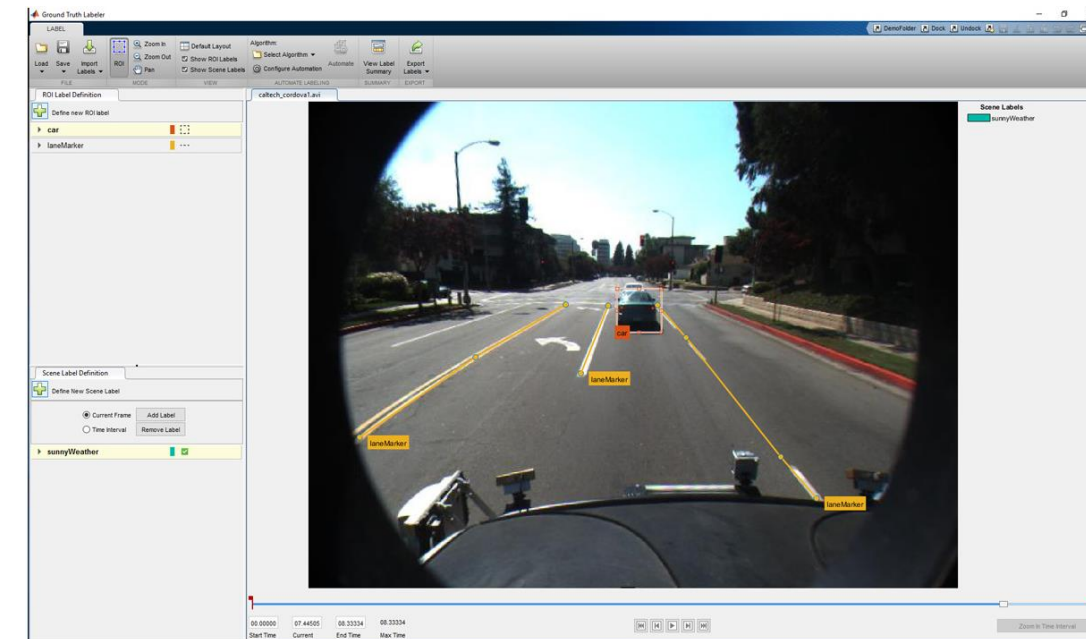


Workflow Integration - Design

Powertrain Blockset

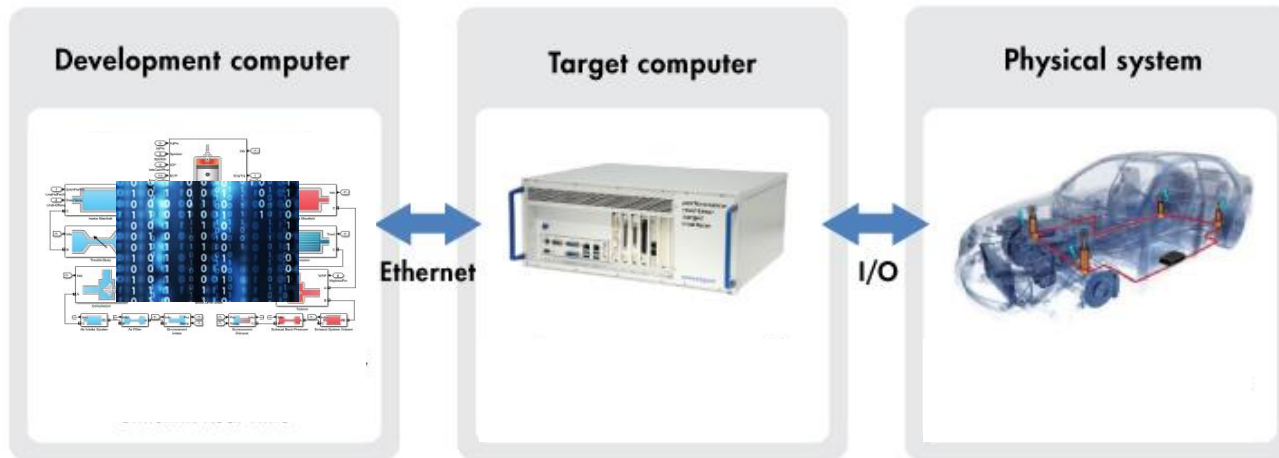


Automated Driving System Toolbox



Workflow Integration - Code

Powertrain Blockset

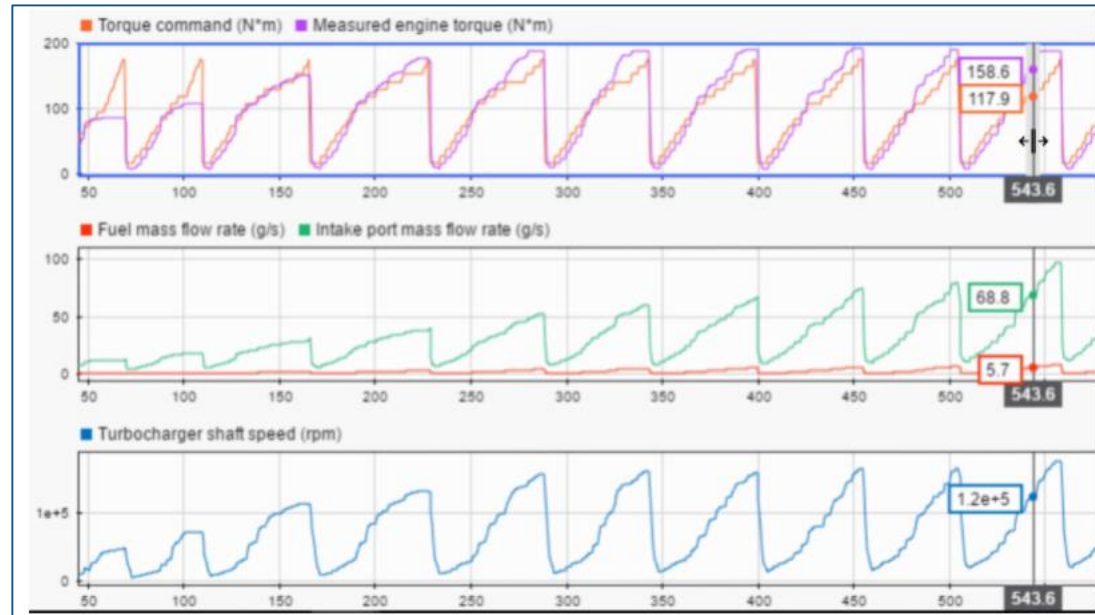


Automated Driving System Toolbox

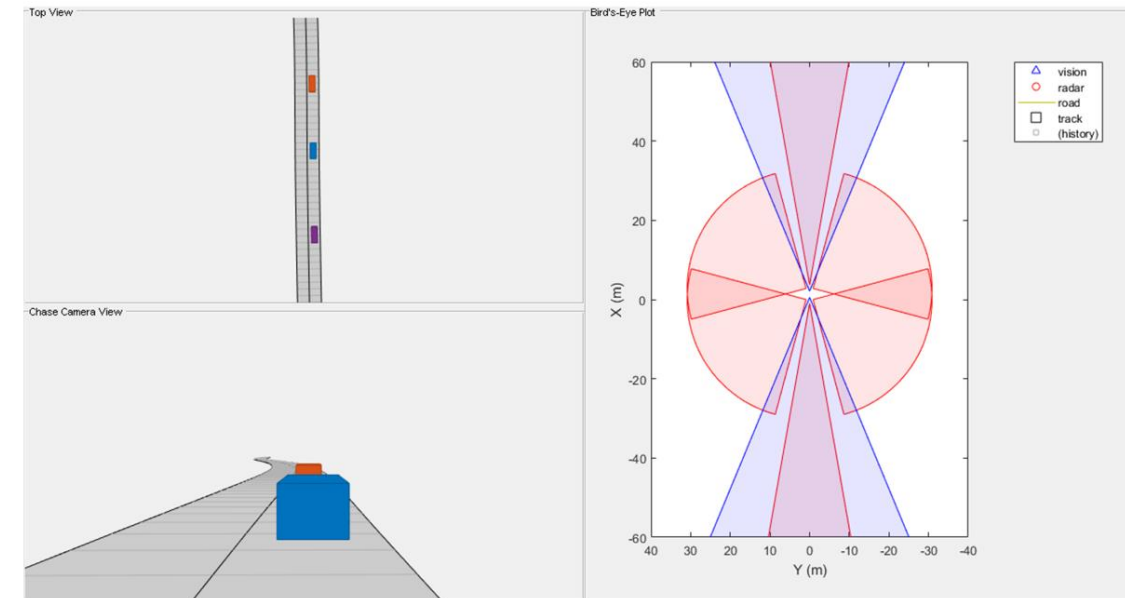
```
TrackingCodeGenerationExample.m x +
1  %% Code Generation for Tracking and Sensor Fusion
2  % This example shows how to generate C code for a MATLAB function that
3  % processes data recorded from a test vehicle and tracks the objects around
4  % it.
5  %
6  % calculate the true ground speed of a tracked object based on the
7  % relative speed and the ego car speed
8  function [Vx,Vy] = calculateGroundSpeed(Vxi,Vyi,egoSpeed)
9  % Inputs
10 % (Vxi,Vyi) : relative object speed
11 % egoSpeed : ego vehicle speed
12 % Outputs
13 % [Vx,Vy] : ground object speed
14
15 Vx = Vxi + egoSpeed; % calculate longitudinal ground speed
16 theta = atan2(Vyi,Vxi); % calculate heading angle
17 Vy = Vx * tan(theta); % calculate lateral ground speed
18
19 end
```

Workflow Integration - Verification

Powertrain Blockset

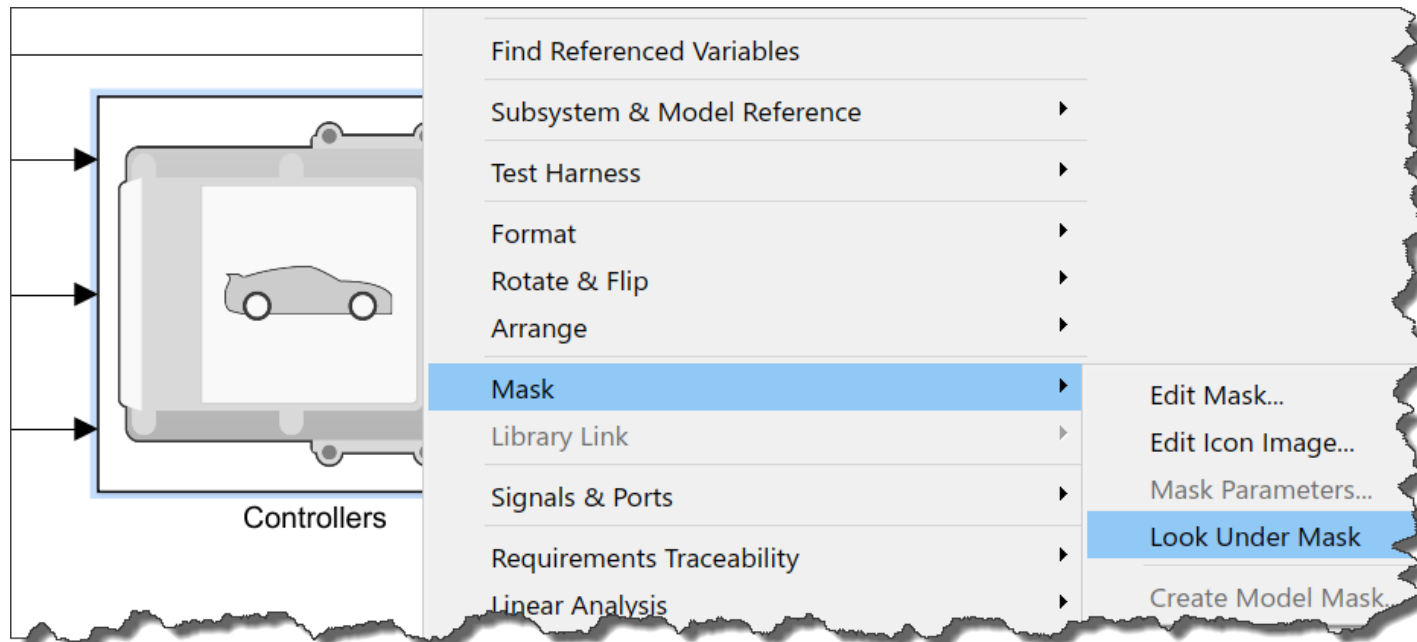


Automated Driving System Toolbox

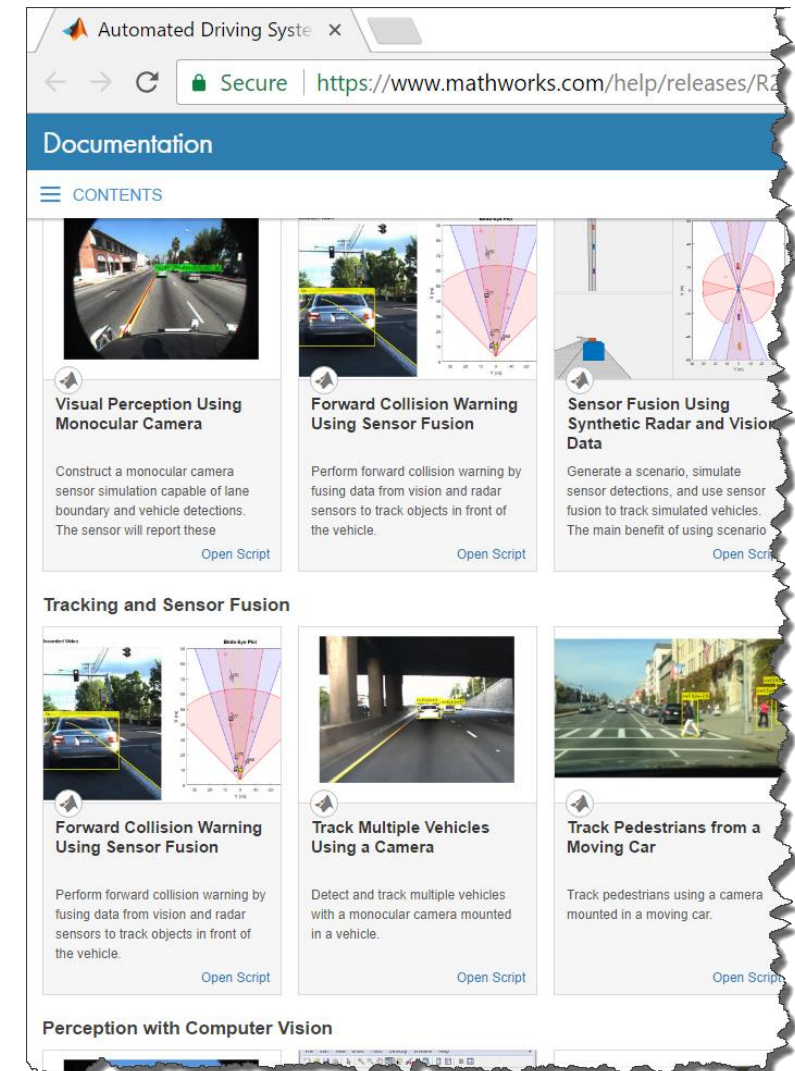


Open and Customizable - Tailoring

Powertrain Blockset



Automated Driving System Toolbox



We have other application products

Robotics System Toolbox

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Capabilities

Converting From	Axis-Angle	Euler Angle	Quaternion	Rotation Matrix	Homogeneous Transform	Transfer (rotx)
Axis-Angle (axang)	■	■	■	■	■	■
Euler Angles (eul)	■	■	■	■	■	■
Quaternion (quat)	■	■	■	■	■	■
Rotation Matrix (rotm)	■	■	■	■	■	■

Coordinate System Transformations

Transform coordinates and units into your required application format.

» Learn more

Robot Operating System (ROS)

Access ROS networks, robots, and simulators.

» Learn more

Ground Vehicle Algorithms

Use algorithms including those for map utilization, path planning, path following and state estimation.

» Learn more

Manipulator Algorithms

Calculate inverse kinematics and dynamics for rigid body tree robot representations.

» Learn more

Code Generation

Generate C/C++ code and standalone ROS nodes.

Algorithm Implementation on Supported Hardware

Test your algorithms on a physical robot.

Log File Import and Analysis

Import ROS log files from your robot.

Multipatform and Multimaster Support for ROS

Support for multiple ROS masters and nodes.

LTE System Toolbox

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Design Verification

Test an LTE design by using a golden reference implementation.

» Learn more

End-to-End Simulation

Model and simulate the physical layer of the LTE standard.

» Learn more

Conformance Testing

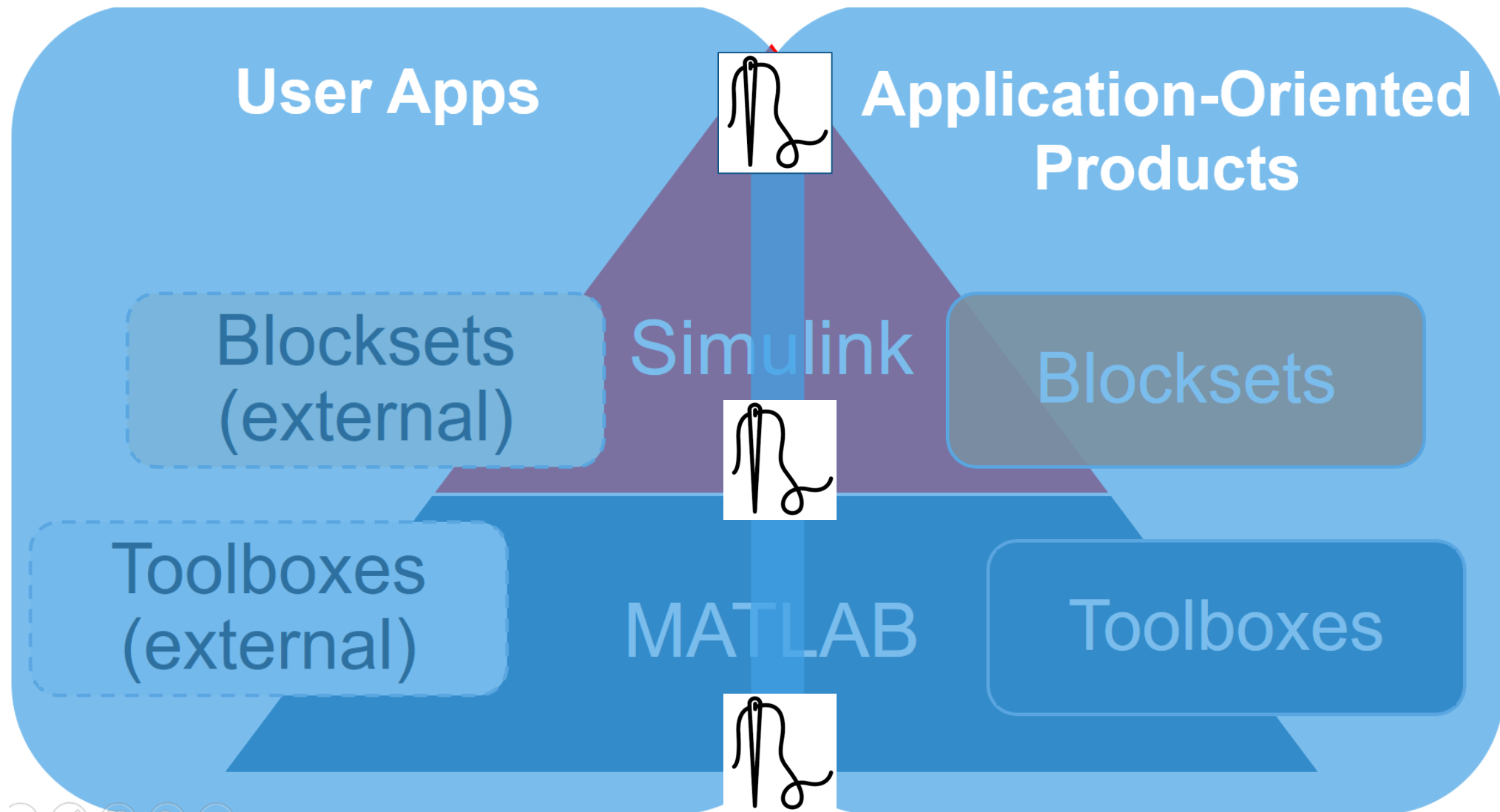
Ensure your designs comply with the supported 3GPP LTE standard releases.

5G Library

Simulate 3GPP 5G new radio technologies.

» Learn more

Workflow integration – Your workflow



Your Landscape

The Origins of Your ???

By You

>>Why