



MATLAB APPS & TOOLBOXES AT JAGUAR LAND ROVER

MATLAB EXPO – 5TH OCTOBER 2016

David Barry

Simulation Strategy & Tools | Simulation Group | Vehicle Engineering

Agenda



-
- Virtual Engineering Introduction
 - MATLAB at Jaguar Land Rover
 - How MATLAB tools are distributed throughout the organisation as apps and toolboxes using an in-house store
 - Best practices for MATLAB tool development and how they are shared and encouraged



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JAGUAR LAND ROVER

Our Business



11 vehicle lines.

3 UK vehicle assembly plants,
with 2 UK design and engineering sites.

Nearly 40,000 people globally – headcount has almost
doubled over the last five years.

Plants in China, India and Brazil.

Employs over 9,000 engineers and designers.

Sales network in 154 countries.

Jaguar Land Rover is the largest automotive employer
in the UK.


150 awards won in 2015/16.



The Challenge for Engineering



“More Great Product Faster”




154 Global Markets

5 Functions:
Body, Chassis, Powertrain,
Electrical, Vehicle


18 Customer attributes:
e.g. Ride & Handling,
Performance & Economy

10,000 Requirements
100,000 Test Cases



1000s New Parts
55 Major Systems
1,200 features

100s New Leading Edge
Technologies



Massively increased
Systems Complexity

100 ECUs
>100 Millions of lines of code

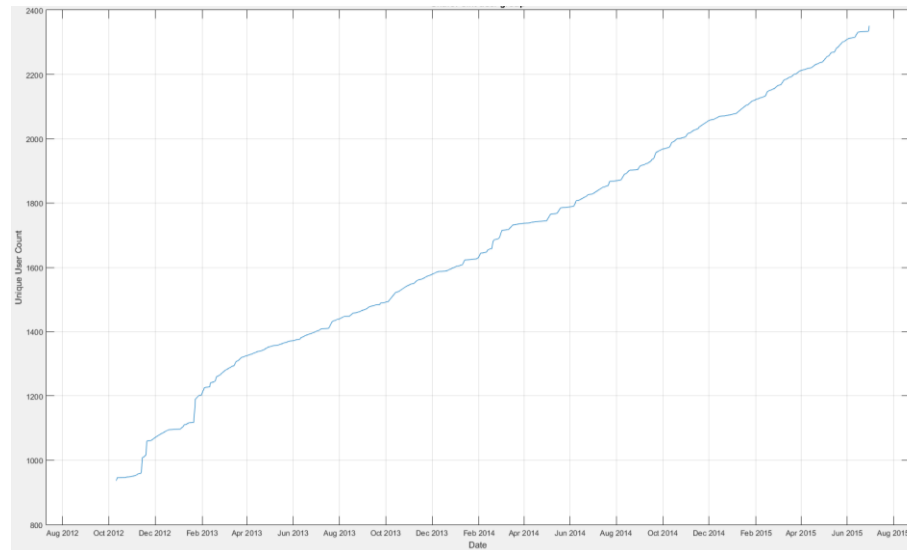
4500 Data Signals
Refreshed 100*/Sec

Agenda



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- Virtual Engineering Introduction
 - **MATLAB at Jaguar Land Rover**
 - How MATLAB tools are distributed throughout the organisation as apps and toolboxes using an in-house store
 - Best practices for MATLAB tool development and how they are shared and encouraged

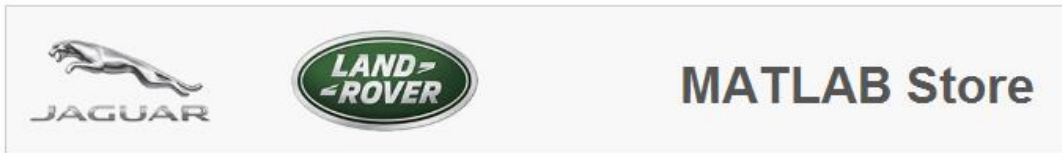
- Best in class tool – professionally developed & supported
- Highly productive and integrated environment for engineers to do their job
- Toolboxes provide out of the box capability for specialist engineering tasks
- Framework to build our own tools



The Code Sharing Challenge



- Strategic partnership with MathWorks helped to develop an internal MATLAB user community
- Recognised opportunities for code sharing and consolidation
 - No consistent way to share code across the business
 - Non-value add overhead for developers to maintain custom code sharing mechanisms
 - Difficult and time consuming for new users to get started
 - Difficult to know what is available - duplication of effort across teams
- MathWorks Consulting helped us to develop a solution – **JLR MATLAB App Store**



JLR Apps & Toolboxes

- Examples



- Many departments manage all of their automation routines through centralised toolboxes

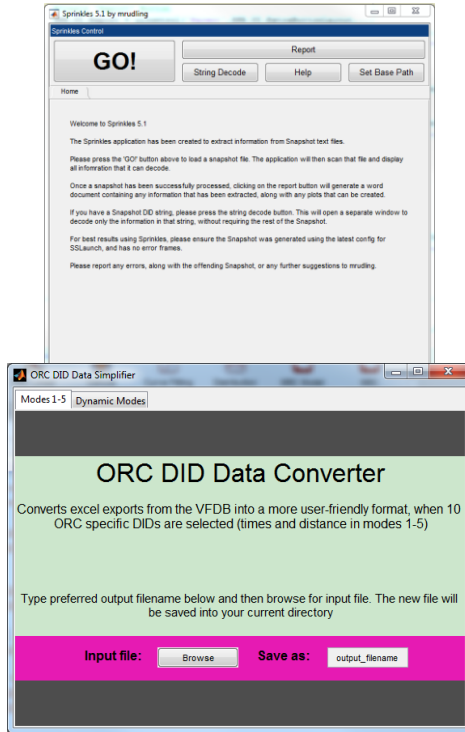


JLR Apps & Toolboxes

- Examples

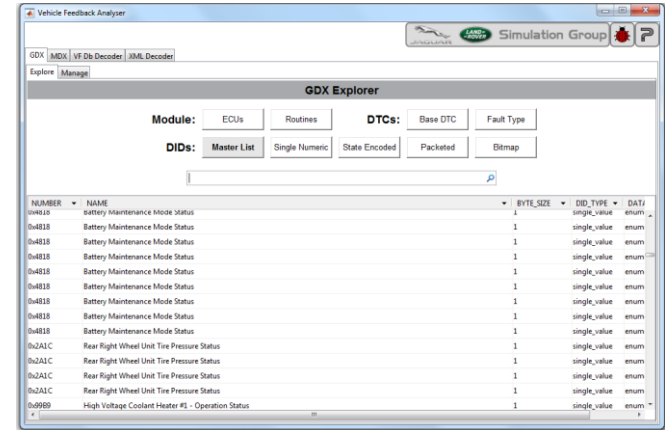


- Vehicle diagnostics analysis – 2 similar apps on the store – common code now part of central toolbox



Vehicle Feedback Toolbox version 1.0.6 by Simulation Group

Tool for analysis of Vehicle Feedback Data and to search through GMRDB/MDX files



JLR Apps & Toolboxes

- Examples

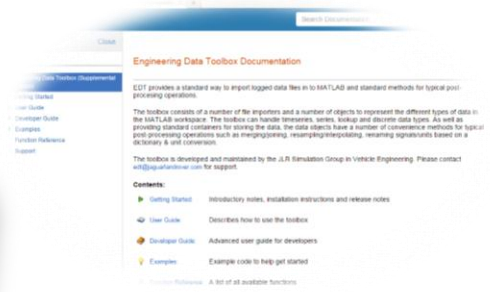


- Toolbox for centralised development of data structures & file handlers



Engineering Data Toolbox version 1.3.1 by Simulation Group

Toolbox

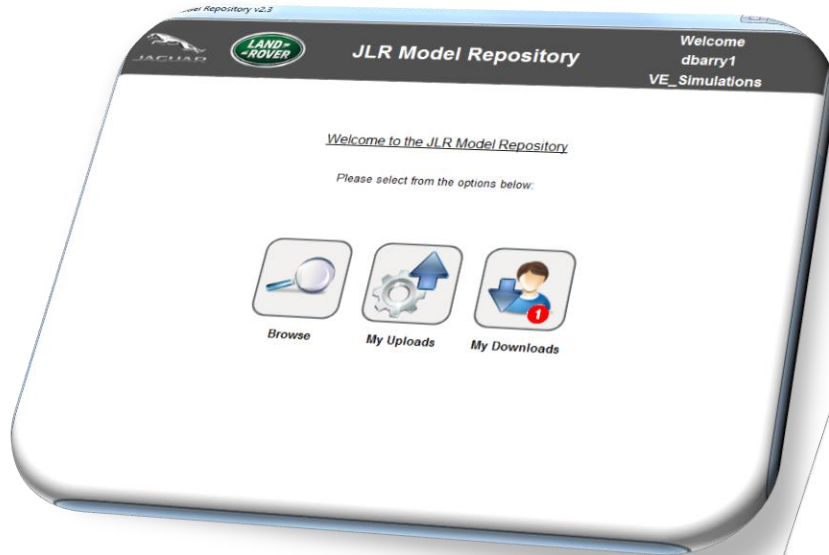


JLR Apps & Toolboxes

- Examples



- Apps for managing and sharing models & engineering data

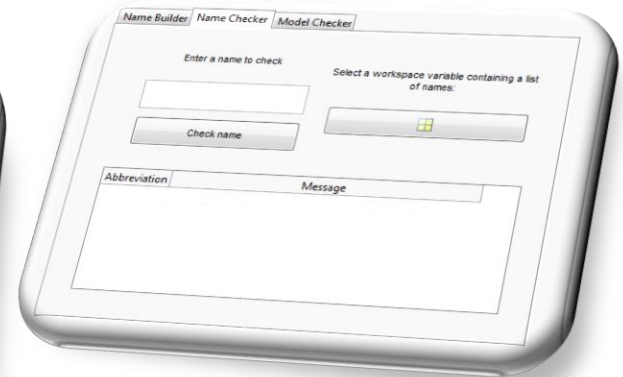
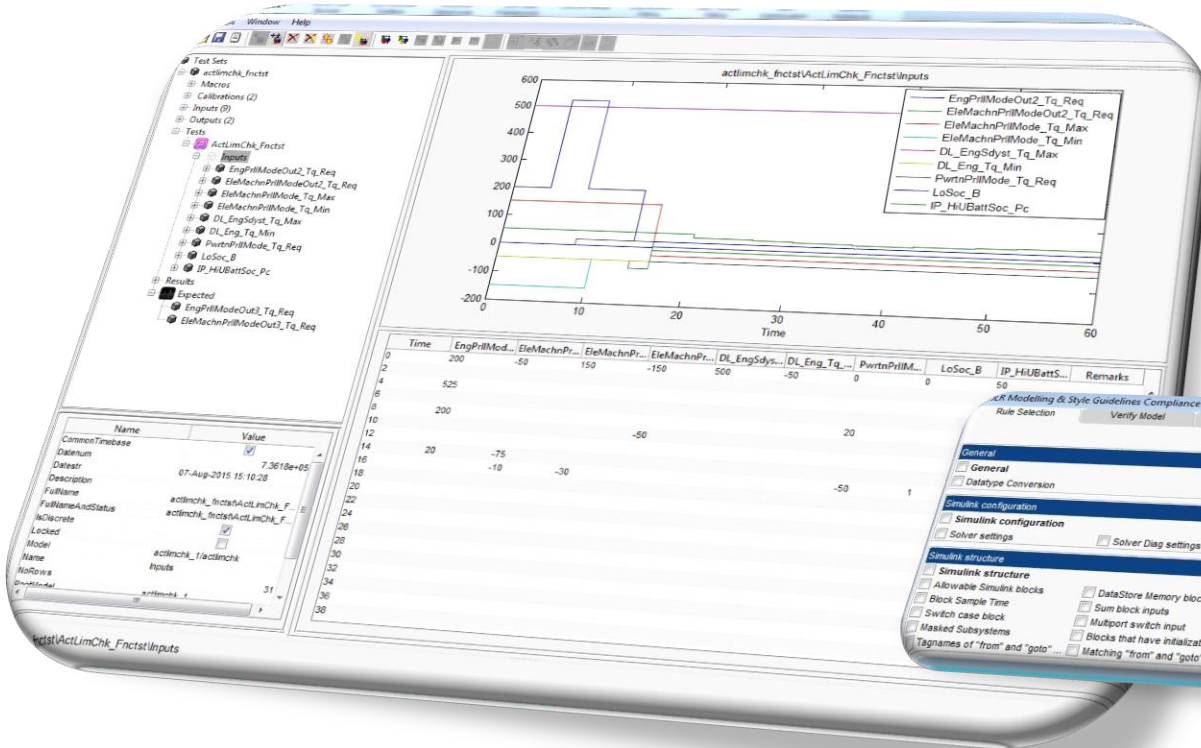


JLR Apps & Toolboxes

- Examples



- Apps for testing Simulink models

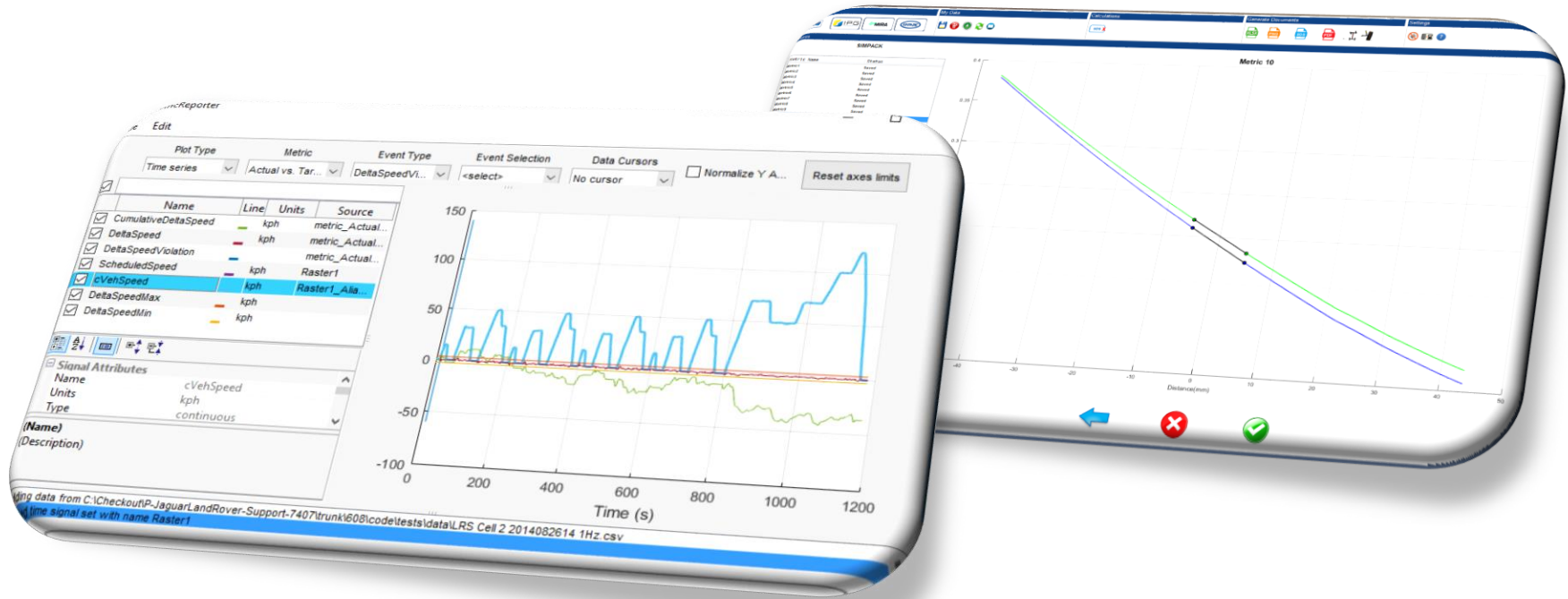


JLR App Store

- Examples



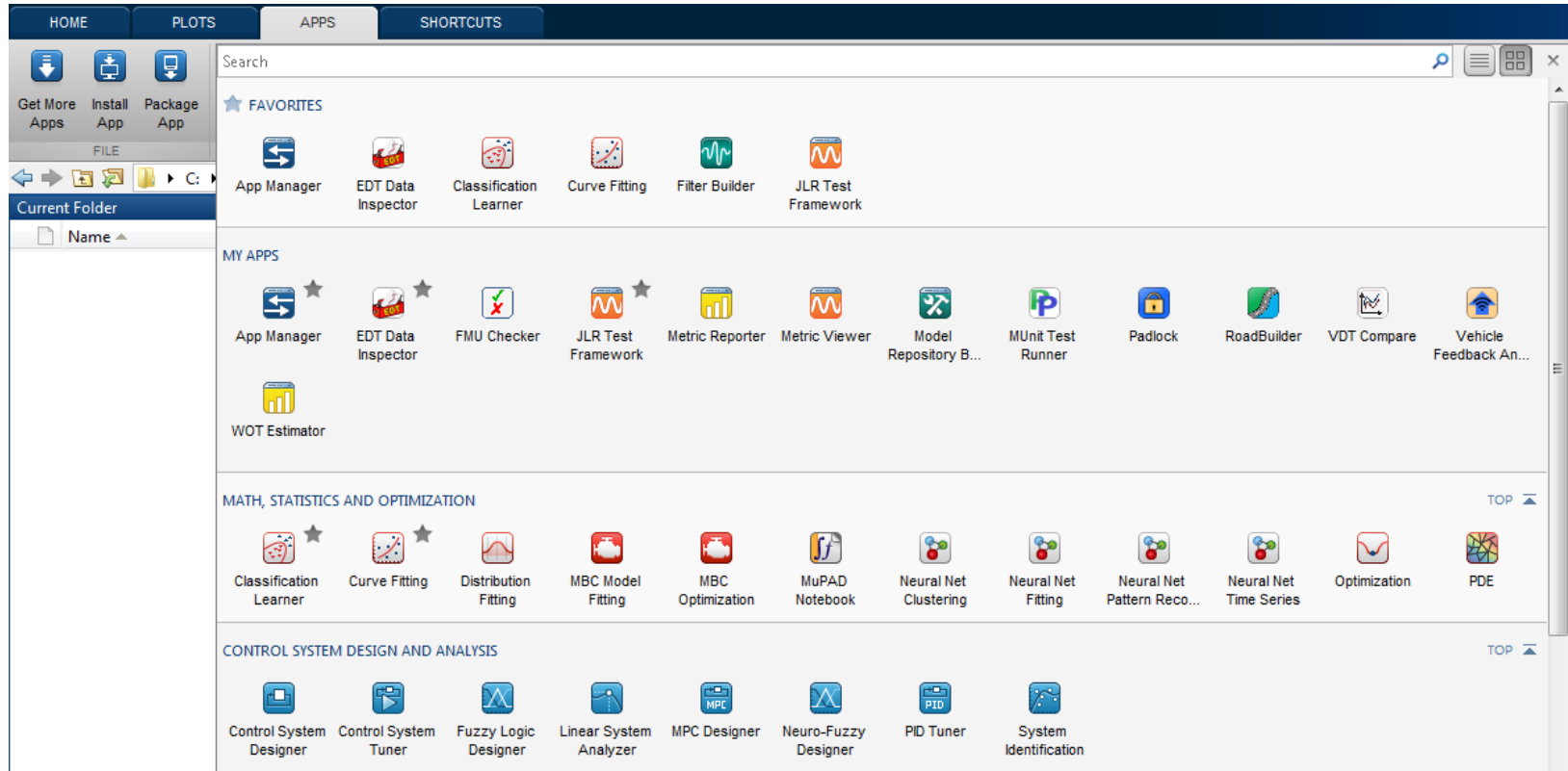
- Event extraction & metric calculation



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The screenshot displays the MATLAB App Designer interface, which is organized into several sections:

- Navigation and Tools:** At the top, there are tabs for HOME, PLOTS, APPS, and SHORTCUTS. Below these are icons for "Get More Apps", "Install App", and "Package App". A "FILE" menu is also visible.
- Search:** A search bar is located at the top right of the main content area.
- FAVORITES:** A section containing icons for App Manager, EDT Data Inspector, Classification Learner, Curve Fitting, Filter Builder, and JLR Test Framework.
- MY APPS:** A section containing icons for App Manager, EDT Data Inspector, FMU Checker, JLR Test Framework, Metric Reporter, Metric Viewer, Model Repository B..., MUnit Test Runner, Padlock, RoadBuilder, VDT Compare, and Vehicle Feedback An... (partially visible). Below this is a "WOT Estimator" icon.
- MATH, STATISTICS AND OPTIMIZATION:** A section containing icons for Classification Learner, Curve Fitting, Distribution Fitting, MBC Model Fitting, MBC Optimization, MuPAD Notebook, Neural Net Clustering, Neural Net Fitting, Neural Net Pattern Reco..., Neural Net Time Series, Optimization, and PDE.
- CONTROL SYSTEM DESIGN AND ANALYSIS:** A section containing icons for Control System Designer, Control System Tuner, Fuzzy Logic Designer, Linear System Analyzer, MPC Designer, Neuro-Fuzzy Designer, PID Tuner, and System Identification.

MATLAB Apps & Toolboxes

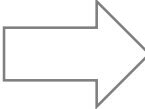
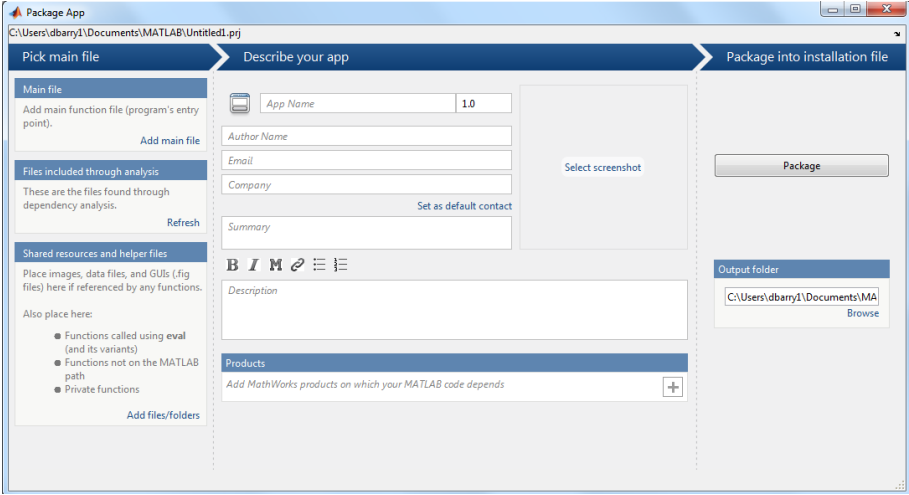
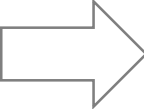
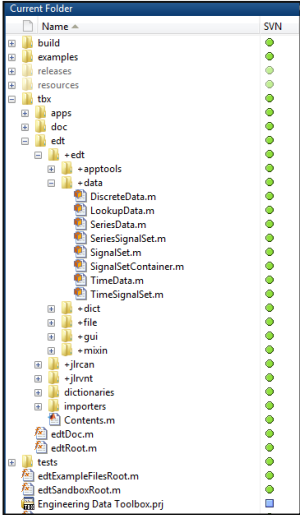


The screenshot shows the MATLAB Add-On Manager window. At the top, there is a 'Sort By' dropdown menu set to 'Type' and two buttons: 'Get Add-Ons' and 'Import'. Below this is a list of installed toolboxes, each with a small icon, name, version, author, and installation date. Action buttons for each entry include 'Open Folder', 'Learn More', and 'Uninstall'.

Toolbox Name	Version	Author	Installation Date	Actions
Communications System Toolbox	6.1	MathWorks	27 January 2016	Learn More, Uninstall
Statistics and Machine Learning Toolbox	10.1	MathWorks	27 January 2016	Learn More, Uninstall
GUI Layout Toolbox	2.2.2	David Sampson	22 September 2016	Open Folder, Learn More, Uninstall
App Management Toolbox	1.5	MathWorks	22 September 2016	Open Folder, Learn More, Uninstall
Java Widgets Toolbox	1.0.1	Simulation Group	22 September 2016	Open Folder, Learn More, Uninstall
WOT Estimator Toolbox	1.6	MathWorks	23 September 2016	Open Folder, Learn More, Uninstall
Model Repository Browser	2.5	MathWorks	29 September 2016	Open Folder, Learn More, Uninstall
Engineering Data Toolbox	1.3.1	Simulation Group	30 September 2016	Open Folder, Learn More, Uninstall
Metrics Toolbox	1.1.2	MathWorks	30 September 2016	Open Folder, Learn More, Uninstall



- MATLAB Apps & Toolbox technology provide the mechanisms for packaging our code





MyOwnApp.mlappinstall
MyOwnToolbox.mlitbx

Developing Robust MATLAB Code and Apps
15:45-17:00


JLR App Store Features

- Web based store





MATLAB Store



[Upload Add-On](#) **Control Panel:** [Administrator](#) [Recommender](#)

[Contact Administrator](#)

[Request Tag](#)

Author

- Abhishek Singhal
- Anni Piirainen
- Anthony Bobbie
- Arun Raveendran
- Azam Din
- Ben Tordoff
- David Sampson

Type

- App
- Toolbox

Tag

- App Design
- CANape
- CarMaker
- Chassis
- DID
- DTC
- FMI


Compatibility

- R2016b
- R2016a
- R2015b
- R2015a
- R2014b
- R2014a

Pages: 1 2 3 4 5 6 7 8 9 10 11

[Clear filters](#) - Sort by: [Title](#)

Add-ons per page: 10



Vehicle Feedback XML Analyser Application

by Simulation Group


This application is intended to import Vehicle Diagnostic Data (DTCs/DIDs) from various XML file formats from around the business

Version 1.0

1 rating ★★★★★

0 comments - 4 tags

194 downloads



Engineering Data Toolbox

by Simulation Group


Toolbox providing importers for JLR engineering data files and a set of common data preparation methods. Type editDoc to get started.

Version 1.3.0

3 ratings ★★★★★

5 comments - 4 tags

144 downloads



App Manager

by Mathworks

Tool for managing installed apps and toolboxes

Version 3.4

3 ratings ★★★★★

1 comment - 1 tag

162 downloads

[Show screenshot](#)

[Download](#)

[Share](#)

Owner

[Permissions](#)

[Compatibility](#)

[Remove](#)

Recommender

[Latest](#)

[Version 3.4](#)

[App Design X](#) [Add Tag](#)

[Add Comment](#)

The App Manager allows you to:

- Connect to a MATLAB Store, either local or in a SharePoint site
- Check for new versions of installed apps and toolboxes
- Check for app and toolbox recommendations
- Update and downgrade apps and toolboxes to a specified version

The App Manager uses MATLAB release compatibility information when suggesting and displaying add-on versions, if this information is provided by the store.

Owner

Packaged in: R2015a

Uploaded: 2016-02-05

Compatibility: Works with MATLAB from R2012b to R2015a

Recommended as 'Latest Version' to:

1. JLR\INTESA\domain users

Barry, David (D.) (dbarry1) 18 Dec 2015, 09:35

This is the latest version of the App Manager which supports the new compatibility feature recently added to the store. Please upgrade to this version. If you are using MATLAB R2015b then you should download the App Management Toolbox rather than this app.

JAGUAR | LAND-ROVER | **MATLAB Store** | 

Upload Add-On | Control Panel: Administrator | Recommender | Approver | Clear filters - Sort by: Title | Add-ons per page: 10

Contact Administrator | Request Tag | Pages: 1



Search X

- Author X
- Mathworks
 - Simulation Group

- Compatibility X
- R2016b
 - R2016a
 - R2015b
 - R2015a
 - R2014b
 - R2014a
 - R2013b

- Status X
- Approved
 - Recommended

Pages: 1 | Add-ons per page: 10

	App Manager by Mathworks Tool for managing installed apps and toolboxes	Version 3.4 2 ratings 7 comments - 0 tags 0 downloads
	Materials LCF File Analysis by Simulation Group Application for importing and analysing LCF files obtained from a material extensometer test.	Version 1.1.0 1 rating 0 comments - 0 tags 0 downloads

Pages: 1 | Listing 2 of 2 - Apps per page: 10



- Libraries
- Site Pages
- Drop Off Library
- Lists
- Discussions
- Recycle Bin
- All Site Content



Upload Add-On | Control Panel: Administrator | Recommender | Approver | Clear filters - Sort by: Title | Add-ons per page: 10

Pages: 1 | Request Tag | Search | X

- App Manager** | Version 3.4 | 2 ratings | 7 comments | 0 tags | 0 downloads
by Mathworks
Tool for managing installed apps and toolboxes
- Materials LCF File Analysis** | Version 1.1.0 | 1 rating | 0 comments | 0 tags | 0 downloads
by Simulation Group
Application for importing and analysing LCF files obtained from a material extensometer test.
- RoadBuilder** | Version 1.1.0 | 0 ratings | 0 comments | 0 tags | 0 downloads
by Simulation Group
Converts GPS data into a digitised XYZ road file that can be imported into IPG CarMaker.

- Author X
- Mathworks
 - Simulation Group
- Compatibility X
- R2016b
 - R2016a
 - R2015b
 - R2015a
 - R2014b
 - R2014a
 - R2013b
- Status X
- Approved
 - Recommended

Pages: 1 | Listing 3 of 3 - Apps per page: 10



All Site Content



JAGUAR | LAND-ROVER | MATLAB Store

- Upload Add-On
- Contact Administrator
- Request Tag
- Search

- Author
- Anthony Bobbie
 - Arun Raveendran
 - Azam Din
 - Ben Tordoff
 - David Sampson
 - David Smith
 - Davoed Bonyad
- Type
- App
 - Toolbox
- Tag
- App Design
 - CANape
 - CarMaker
 - Chassis
 - D1D
 - DTC
 - FMI
- Compatibility
- R2016b

Pages: 1 2 3 4 5 6 7 8 9 | Clear filters - Sort by: Title | Add-ons per page: 10

	Add-on Approval Toolbox by MathWorks Helps reviewers validate that a toolbox or app adheres to the approval standards required by the MATLAB App Store.	Version 1.1.4 1.1.3 0 ratings ☆☆☆☆☆ 0 comments - 0 tags 1 download
	App Management Toolbox by MathWorks Toolbox for managing installed apps and toolboxes from the MATLAB Store	Version 1.5 1.4 more ... 2 ratings ☆☆☆☆☆ 1 comment - 1 tag 68 downloads
	App Manager by Mathworks Tool for managing installed apps and toolboxes	Version 3.4 3.3 more ... 3 ratings ☆☆☆☆☆ 1 comment - 1 tag 163 downloads
	Automated Datasheet Creator by Virtual Hub Application for extracting & translating SIMPACK model files into suspension datasheets.	Version 1.1 1.0 1 rating ☆☆☆☆☆ 0 comments - 1 tag 22 downloads
	Charge Balance Data Analyser by Karthik Ponudurai App for processing Power Supply Charge Balance data from vehicle and test rig.	Version 1.4 1.3 more ... 4 ratings ☆☆☆☆☆ 1 comment - 0 tags 14 downloads
	Crawl Speed by James Price Automated analysis of crawl speed test data.	Version 1.1 0 ratings ☆☆☆☆☆ 0 comments - 0 tags 14 downloads
	CRG Converter by Simulation Group	Version 1.1.0 1.0.0 1 rating ☆☆☆☆☆

JLR App Store Features

- App Manager



The screenshot shows the 'App Manager' window with a menu bar (Store, Add-Ons, Help) and a toolbar. A table lists various applications with their installed versions and suggested actions. The 'Driving Sim VBox Client' is highlighted in blue, and its details are shown in a pane below. The details pane includes fields for Name, Version, Author, Summary, Compatibility, Description, and Recommended to. A legend at the bottom left explains the status icons: a dot for 'Installed', a green checkmark for 'Approved', and a red circle with a dot for 'Recommended'. An 'Install' button is located at the bottom right of the details pane.

App Name	Installed Version	Suggested Action
JLR Test Framework	1.7.2	
Java Widgets Toolbox	1.0.1	
MUnit Test Runner	1.1.3	
Metrics Toolbox	1.1.2	Upgrade to Latest
Model Repository Browser	2.3	Upgrade to Latest
Padlock	1.0.1	
RoadBuilder	1.3.0	
VDT Compare	1.3	
Vehicle Feedback Analyser	4.0.6	Downgrade to Compatible
Vehicle Feedback Toolbox	1.0.6	
Driving Sim VBox Client	Not Installed	Install Recommended
Driving Sim VBox Control	Not Installed	Install Recommended

Available Versions

1.2

Name: Driving Sim VBox Client
Version: 1.2
Author: Simulation Group
Summary: Video VBox client interface for use on Driving Simulator rig

Compatibility: R2015b and later
Description: Video VBox client interface for use on Driving Simulator rig. This relies on the video vbox control interface application.

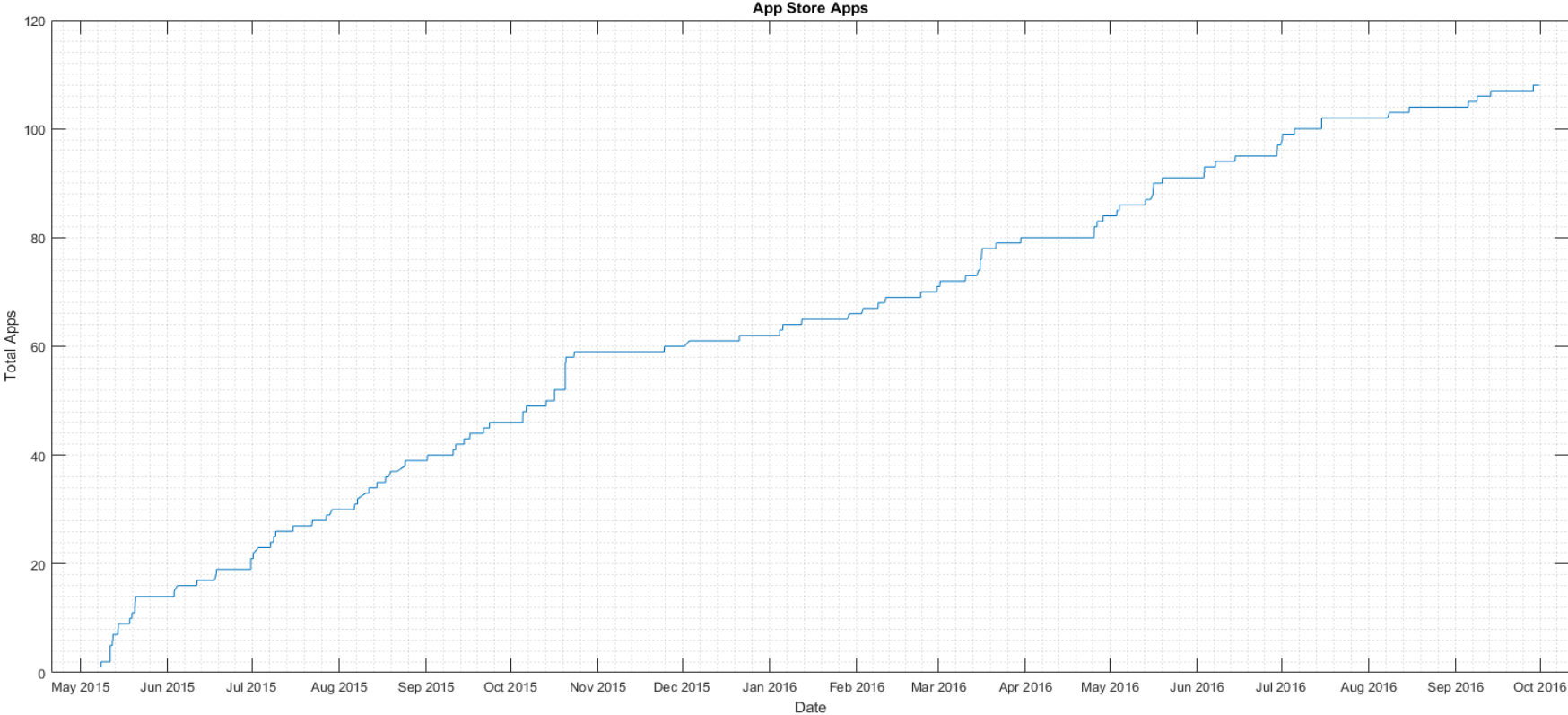
Recommended to: Chappell, Paul (P.A.)

• : Installed
✓ : Approved
• : Recommended

Install

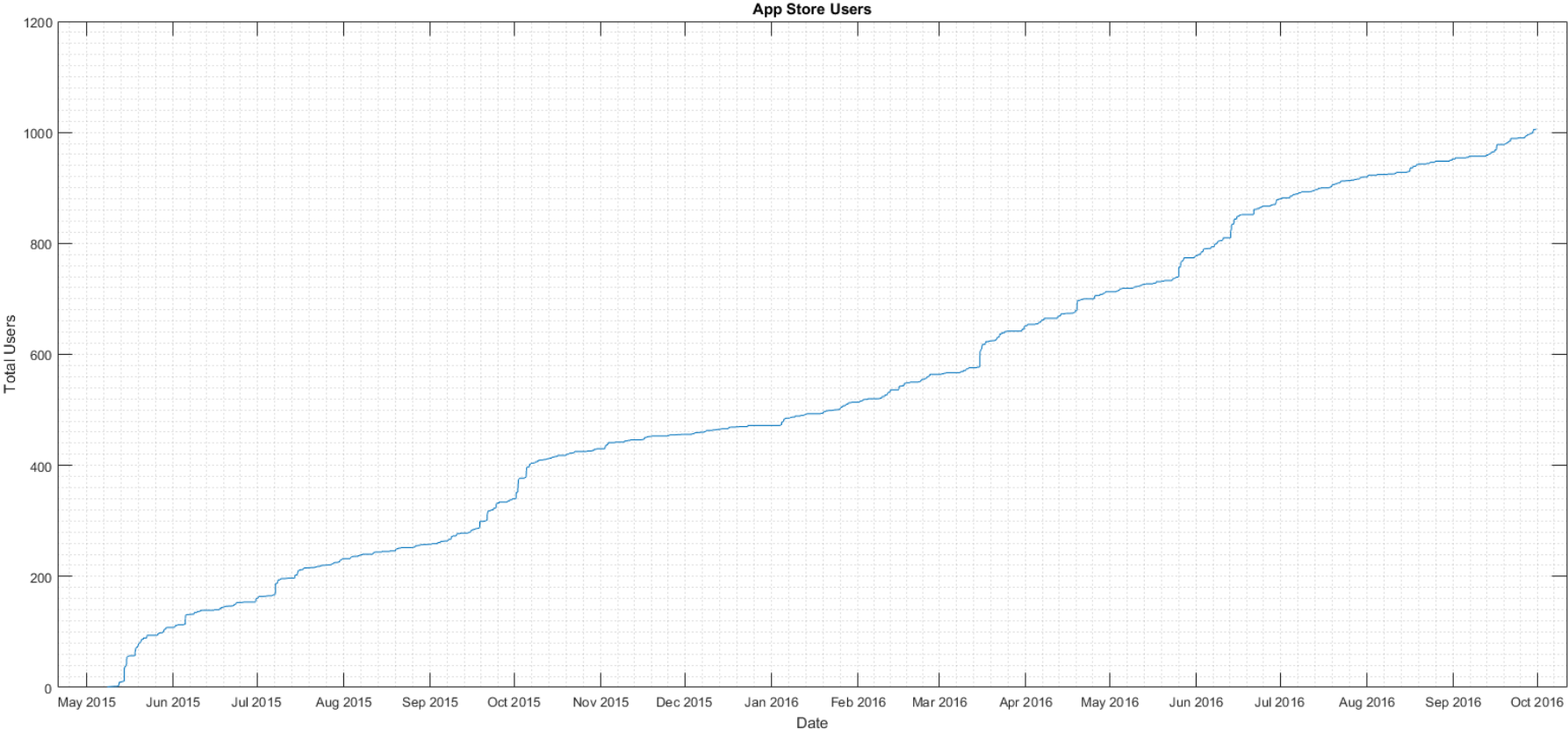
JLR App Store

- Usage > Number of submissions



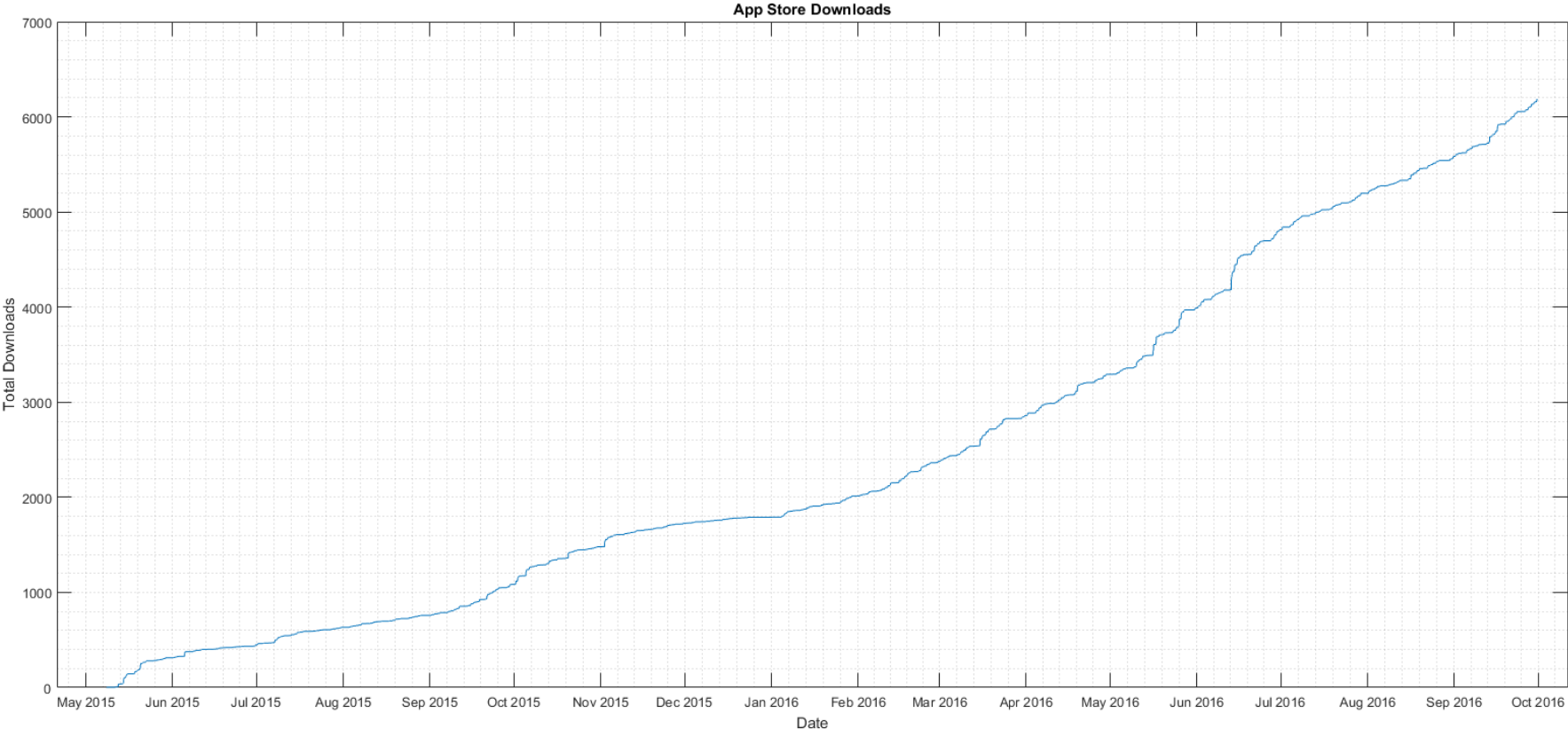
JLR App Store

- Usage > Number of users



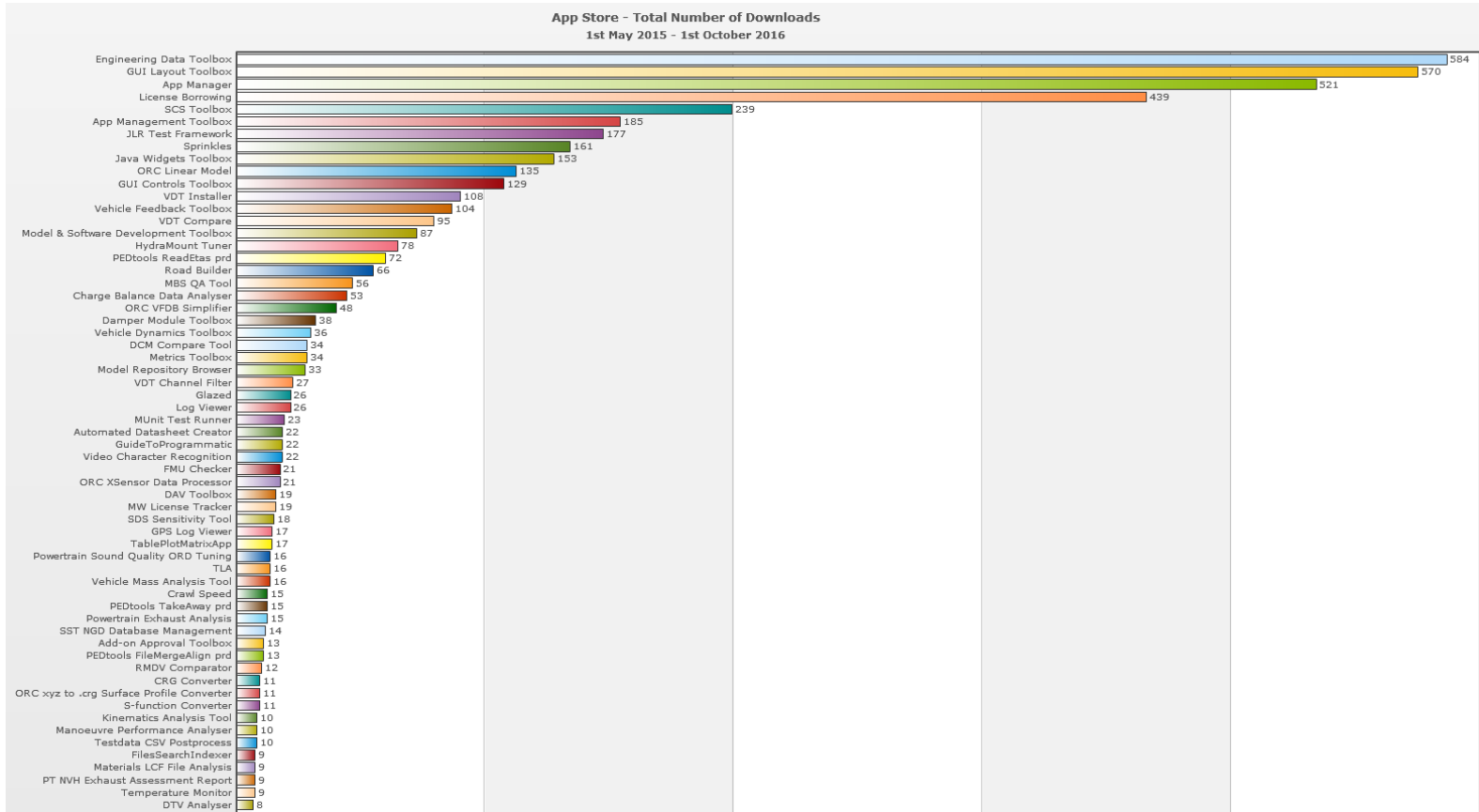
JLR App Store

- Usage > Number of downloads



JLR App Store

- Usage > Number of downloads



JLR App Store

- Benefits



- Accelerate adoption of existing tools by new users
- Reduce duplication
- Improve quality & usability
- Reduce time spent on non-value-add tasks
- Encourage and recognise sharing of high-impact tools
- Educate developers

- Approved Apps & Toolboxes – check for JLR coding standards and best practices



Add-on Approval Toolbox

by MathWorks

Helps reviewers validate that a toolbox or app adheres to the approval standards required by the MATLAB App Store.

MATLAB (R2015b)

Tests run at: 15-Feb-2016 14:00:02

Diary Capture		No diary output to review.
Unit Tests		all 2 tests passed
Folder Structure		matches recommended layout
Contents Summary		

Folder	Code Analyzer	File Coverage	Line Coverage	TODO/FIXME	Help
.\src\customToolbox					

Example 2

A report where some checks require further review.

MATLAB (R2015b)

Tests run at: 15-Feb-2016 13:54:23

Diary Capture	helping.m	has output to review.
Unit Tests	test.m and test2.m	contains 393 tests, 4 of which failed
Folder Structure	.\src\customToolbox	has output to review.
Contents Summary		

Folder	Code Analyzer	File Coverage	Line Coverage	TODO/FIXME	Help
.\src\cfig					
.\src\cfig\appstools					Help
.\src\cfig\data				Review	Help
.\src\cfig\doc					Help
.\src\cfig\fig					Help
.\src\cfig\resources					Help

The following files have no coverage information

- .\src\cfig\appstools\Contents.m
- .\src\cfig\appstools\TaskDetailsAppViewer.m
- .\src\cfig\fig\FigContents.m
- .\src\cfig\fig\FigAppInputFactory.m
- .\src\cfig\fig\FigAppOutputFactory.m
- .\src\cfig\fig\fig.m
- .\src\cfig\fig\fig.m
- .\src\cfig\fig\fig.m

- Integrate the store with automated testing environment

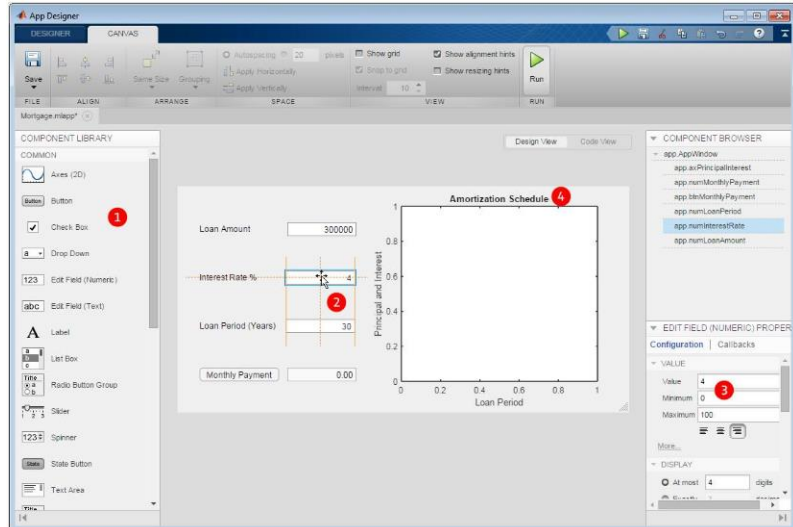
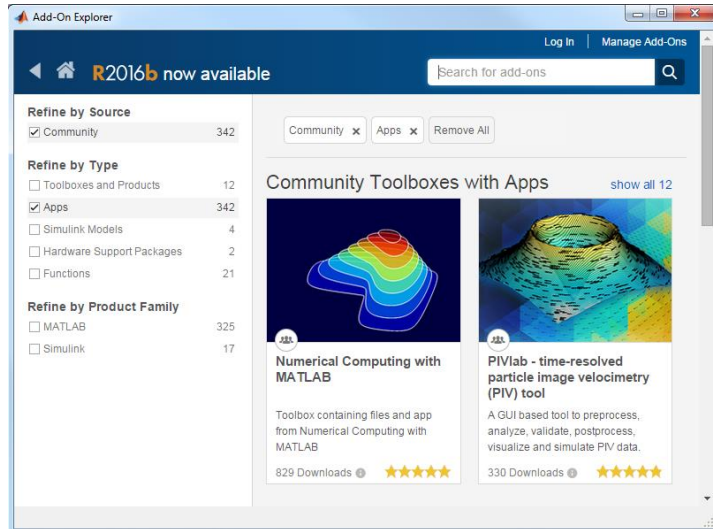


Jenkins

App Store Future Development Plans



- Continue to engage with MathWorks developers for enhancements to MATLAB
- Add-On Explorer integration with JLR store
- Manage custom toolbox dependencies
- Improvements to App Designer



Agenda



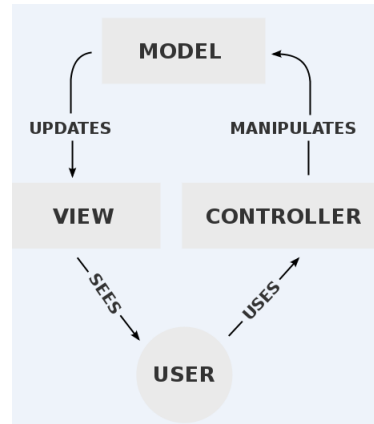
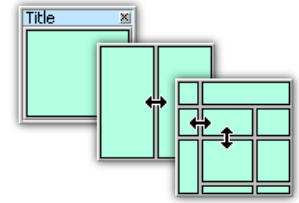
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Writing MATLAB Tools

- JLR best practices



- Apps are hand-written using GUI Layout Toolbox for positioning & resizing
- Apps should follow the Model View Controller (MVC) design pattern



Developing and Sharing MATLAB Apps and Toolboxes
14:30–15:15

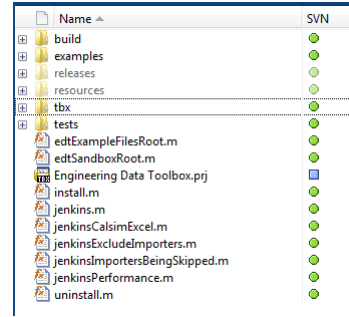
- Use a consistent look and feel for user interfaces
- Make use of GUI mockup and architecture/class diagram tools for large projects

Writing MATLAB Tools

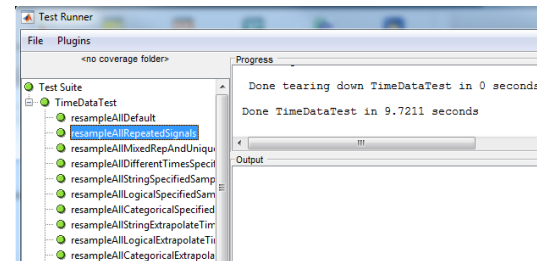
- JLR best practices



- Use a source control and bug tracking tool
- Use a consistent naming convention
- Know your end-user – casual vs developer interfaces
- Use MATLAB Unit Testing Framework



Developing Robust MATLAB Code and Apps
15:45–17:00



Profiler Coverage Report	
Run the Coverage Report after you run the Profiler to identify how much of a file ran when i (Learn More)	
[Rerun This Report] [Run Report on Current Folder]	
Report for folder C:\Users\jdbarry1\SVN\edt\code\toolbox\edt\edt\+data	
TimeData.m	
TimeData>TimeData.TimeData	Total coverage: 95.0% Coverage: 100.0% Total time: 0.8 seconds Total lines: 4
TimeData>TimeData.addSignalSrc	Coverage: 100.0% Total time: 0.8 seconds Total lines: 3
TimeData>TimeData.resampleAll	Coverage: 98.99% Total time: 6.1 seconds Total lines: 87
TimeData>TimeData.setSignalNames	Coverage: 81.5% Total time: 0.1 seconds Total lines: 27

Writing MATLAB Tools

- JLR best practices

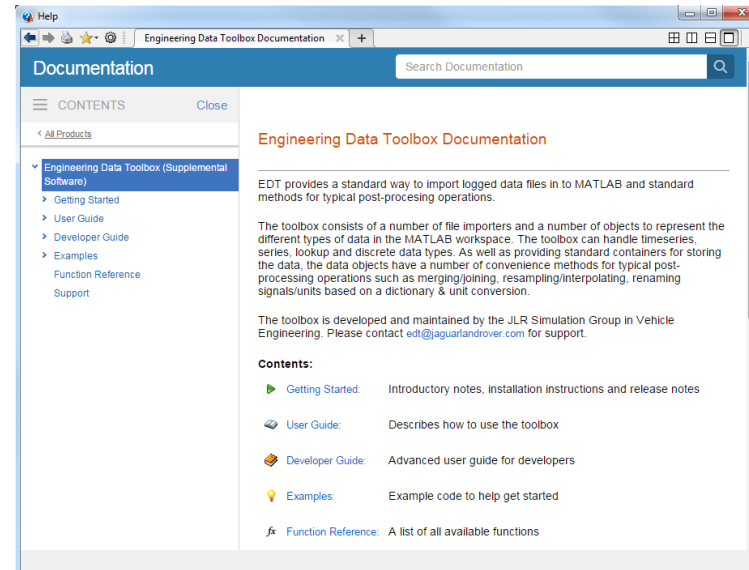


- Develop a standard toolbox to group together data structures and file handlers
- Document all of your code as you write it
- Use MATLAB custom documentation to provide help and examples for your own toolboxes



```
function c = addme(a,b)
% ADDME Add two values together.
% C = ADDME(A) adds A to itself.
% C = ADDME(A,B) adds A and B together.
%
% See also SUM, PLUS.

switch nargin
    case 2
        c = a + b;
    case 1
        c = a + a;
    otherwise
        c = 0;
end
```



Writing MATLAB Tools

- Sharing best practices



- User guides & how-to videos on the App Store
- On-site MathWorks training including JLR custom courses for OOP & app building
- MathWorks consulting projects
- Internal go-to experts
- Monthly lunch & learn events
- Internal WebEx sessions
- Website & blog for internal MATLAB user community



THANK YOU

David Barry

Simulation Strategy & Tools | Simulation Group | Vehicle Engineering

dbarry1@jaguarlandrover.com