Scaling up Model-Based Design: Moving from First Success to Optimized Deployment
提升基于模型的设计：从第一次成功到优化部署

Paul Barnard
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MathWorks
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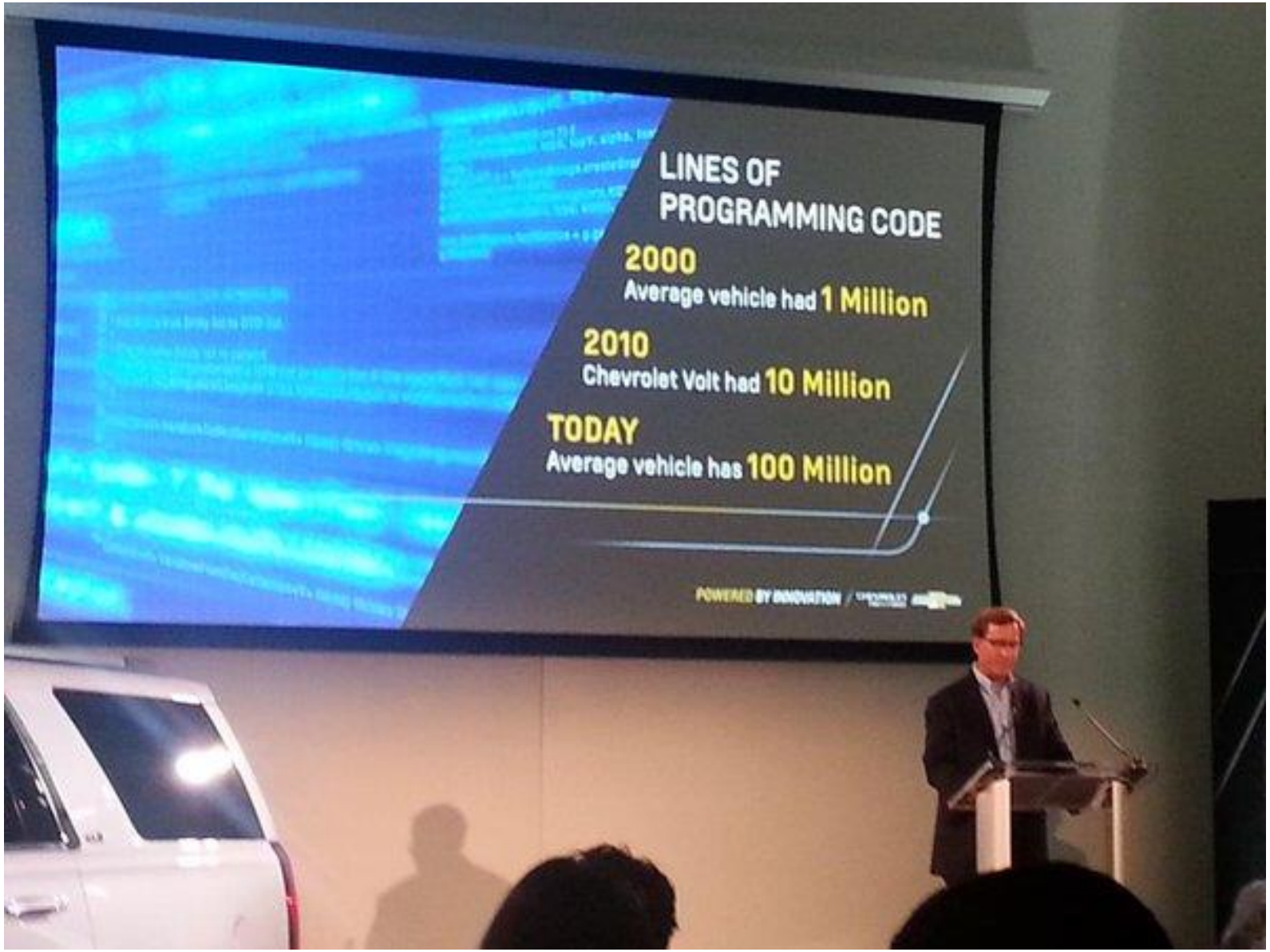
“When I step into a new car these days, I don’t smell leather anymore, I smell software”

MATLAB Automotive Conference, Stuttgart, 2015

“这些天当我走进一辆新车的时候，我不再闻到真皮座椅的味道，而是闻到了软件的气息。”



John Lauckner, CTO at General Motors

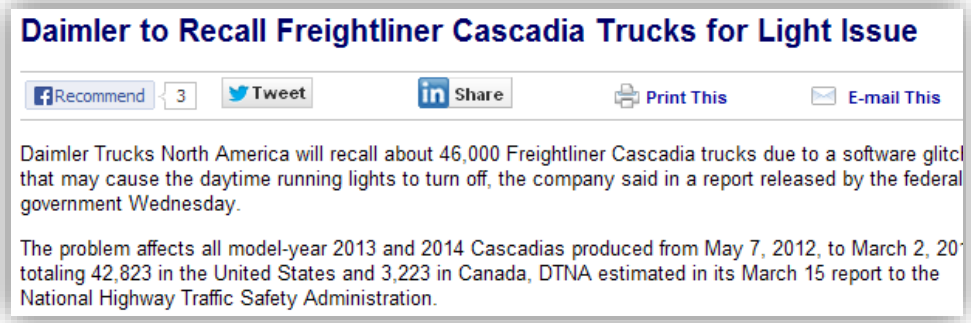
Recalls in the automotive industry
汽车行业的召回

Breaking News - Business

Chrysler recalls 630,000 SUVs over defects

(06-06 21:03)

Just two days after refusing a US government request to recall 2.7 million older-mode Jeeps, Chrysler has decided to do two other recalls totaling 630,000 vehicles worldwide.
The automaker will recall more than 409,000 Jeep Patriot and Compass small sport utility vehicles across world capitals from the 2010 and 2012 model years to fix air ba and seat-belt problems. It's also recalling 221,000 Jeep Wranglers worldwide from 2012 and 2013 to fix transmission fluid leaks, according to documents posted today o the National Highway Traffic Safety Administration website. AP reports.



Daimler to Recall Freightliner Cascadia Trucks for Light Issue

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Daimler Trucks North America will recall about 46,000 Freightliner Cascadia trucks due to a software glitch that may cause the daytime running lights to turn off, the company said in a report released by the federal government Wednesday.

The problem affects all model-year 2013 and 2014 Cascadias produced from May 7, 2012, to March 2, 20 totaling 42,823 in the United States and 3,223 in Canada, DTNA estimated in its March 15 report to the National Highway Traffic Safety Administration.

Lexus Recalls 2013 GS 350 F Sport for Potential Steering Hazard

By CHRISTOPHER JENSEN

Toyota is recalling about 660 of its redesigned Lexus GS 350 sedans because of a steering problem that may occur when leaving a parking space, the automaker told the National Highway Traffic Safety Administration.

The models affected have rear-wheel drive and are equipped with the F Sport

- Increasing news of recalls
- 不断增加的召回新闻

- Often due to ECU software bug
- 原因通常是ECU的软件缺陷

- SW complexity worsens situation
- 软件复杂程度使形势更加严峻

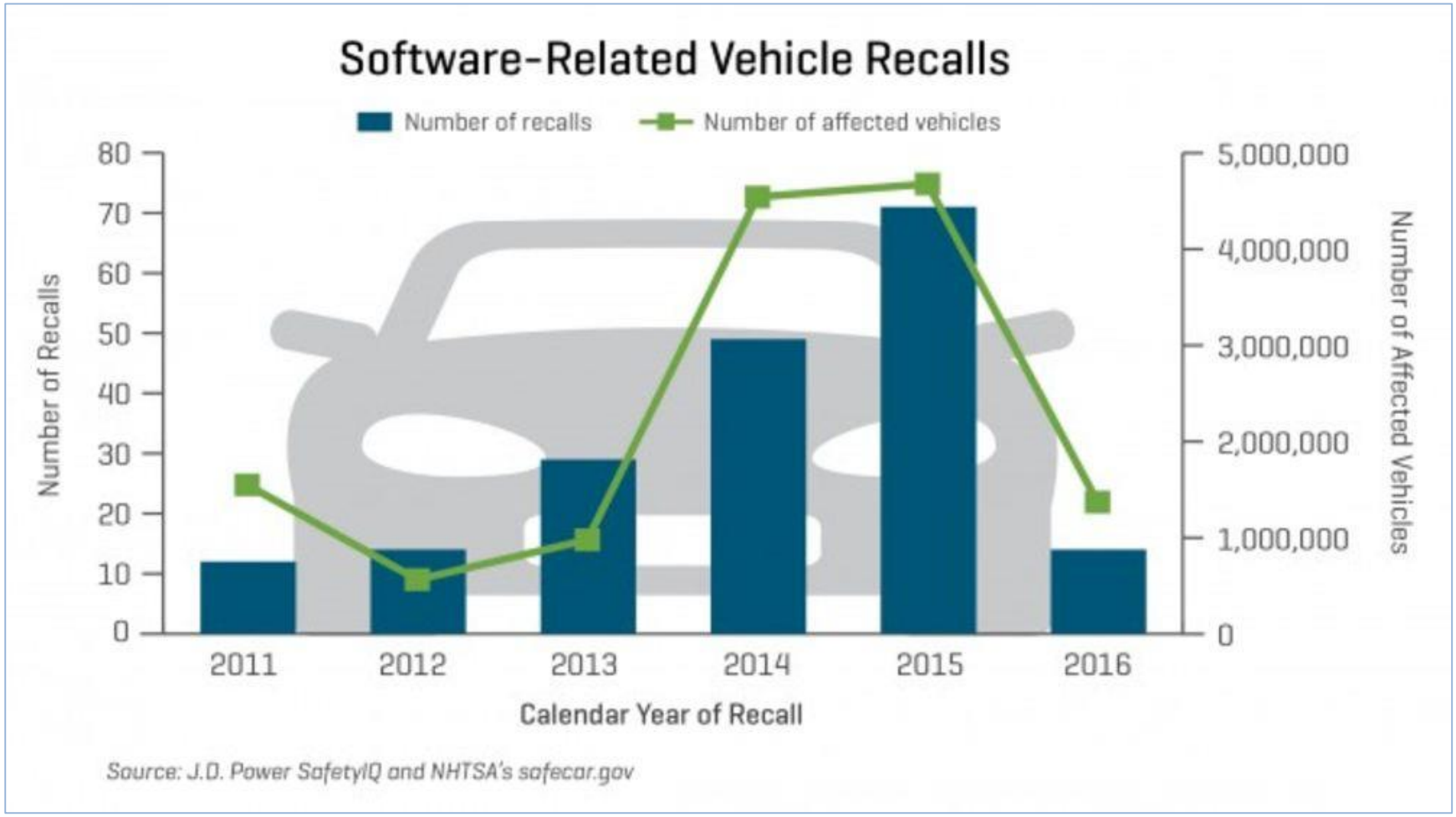
- Expensive, damaging to OEMs
- 给整车厂商带来昂贵的破坏性后果

Recalls in the automotive industry
汽车行业的召回

SOFTWARE NOW TO BLAME FOR 15 PERCENT OF CAR RECALLS

YOU CAN'T JUST HOLD THE HOME AND LOCK BUTTONS TO SOLVE THIS ONE

Bengt Halvorson / The Car Connection Posted June 2, 2016



Altran study: Study participants reported that quality improvement was a strong reason to move to Model-Based Design
Altran研究表明：质量改进是转向采用基于模型设计的重要原因

	No critical reason	Strong reason	Very strong reason
1 A new function with high complexity is being developed	1,5%	28,8%	69,7%
2 Increase of the product quality	1,6%	28,1%	70,3%
3 Shorter development times and earlier Time-to-Market-Time	4,9%	31,1%	63,9%
4 Cost savings in the software development	6,1%	43,9%	50%
5 Reuse of the function in other car lines is planned	6,5%	30,6%	62,9%

MathWorks Automotive Virtual Conference, June 2013

Dr. Jens Zimmermann, Altran

MAB 1998

3 Organizations

1998年，MathWorks咨询委员会（MAB）
起始于三个组织

Alex Ohata
Toyota

Armin Muller
Daimler-Benz

Ken Butts
Ford

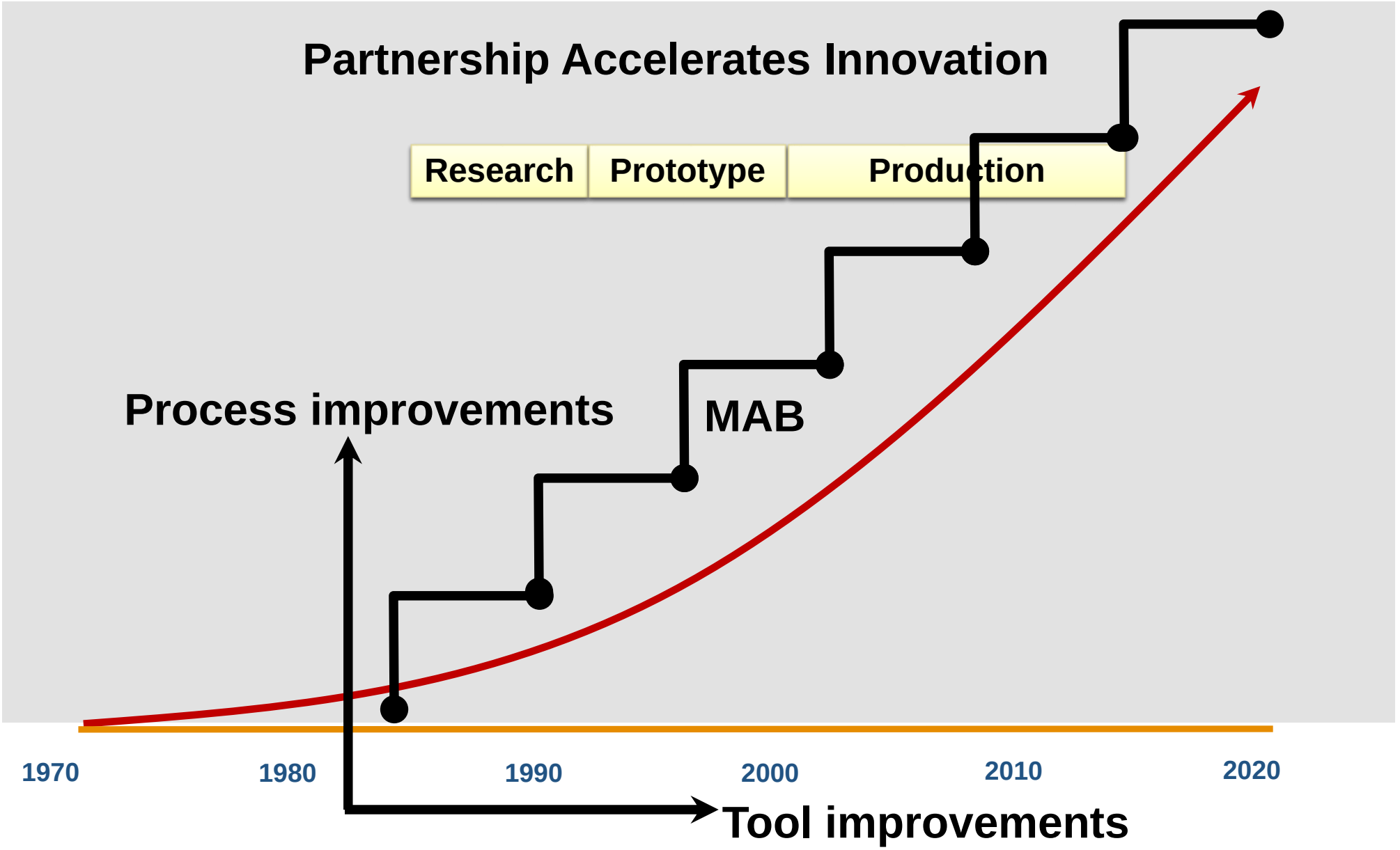
MAB 2015

Boston: 107 Organizations

Europe, China, Japan, Korea, India …

2005年，MathWorks咨询委员会（MAB）
波士顿：拥有107个组织参加
另外还有欧洲/中国/日本/韩国/印度等等

Model-Based Design Adoption 采用基于模型的设计



Automatic Code Generation has been an Important Motivation for Deploying Model-Based Design

自动代码生成已经成为采用基于模型设计的重要驱动力

Daimler: Vehicle Controller
Delphi: Radar Module
Caterpillar: Machine Control

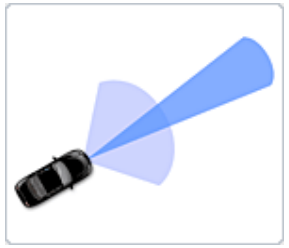
GM: Hybrid Powertrain
Continental: Active Suspension
Delphi: Common Rail Diesel

Toyota: Hybrid Control Unit
Lear: Body Control Module
Cummins: Diesel EMS

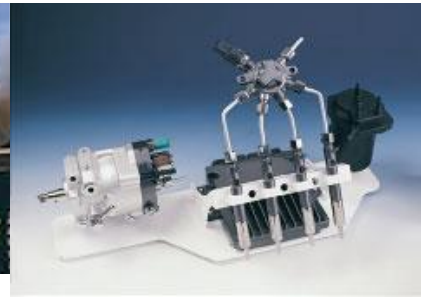
CNH: Combine Control Unit
GM: HVAC Module
Vodafone: Telematics





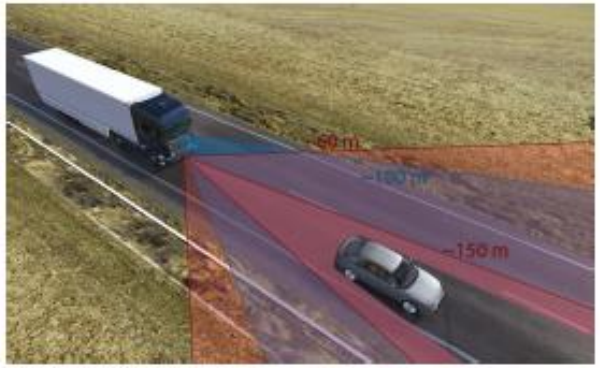




MATLAB and Simulink Help Engineers Put ADAS and Autonomous Driving on the Road
MATLAB 和 Simulink 帮助工程师将ADAS与自主驾驶在真实路面上得以实现

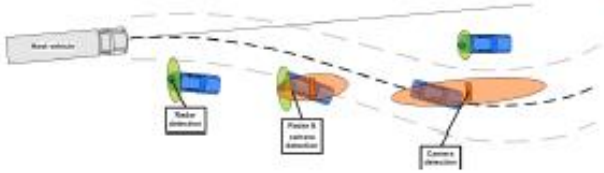
Sensor fusion
Two sensors -> One "truth"



Sensors have different advantages

- Radar
  - \+ Range (longitudinal)
  - \+ Relative velocity
  - \+ Solid object reflection
  - \- No shapes
  - \- Lateral position
- Camera
  - \+ Object type
  - \+ Object width
  - \+ Lateral position
  - \- Range
  - \- Optical illusions

Redundance required for stationary objects

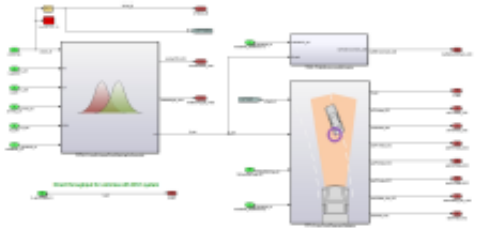


2015-09-24 Jonny Andersson

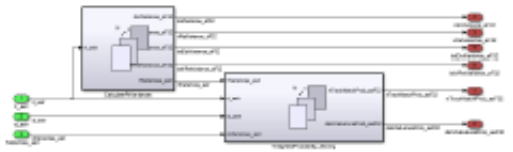
SCANIA

Model Based Design for fusion

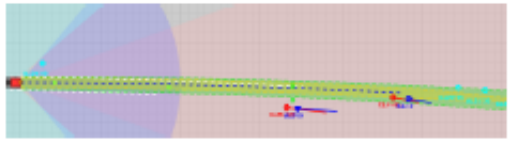
Easy to get nice and readable architecture



For-each systems and Matlab Function blocks, suitable for loops and similar calculations.



MATLAB is a suitable platform for debugging and visualization.



Easy debugging in Matlab Function Block

2015-09-24 Jonny Andersson

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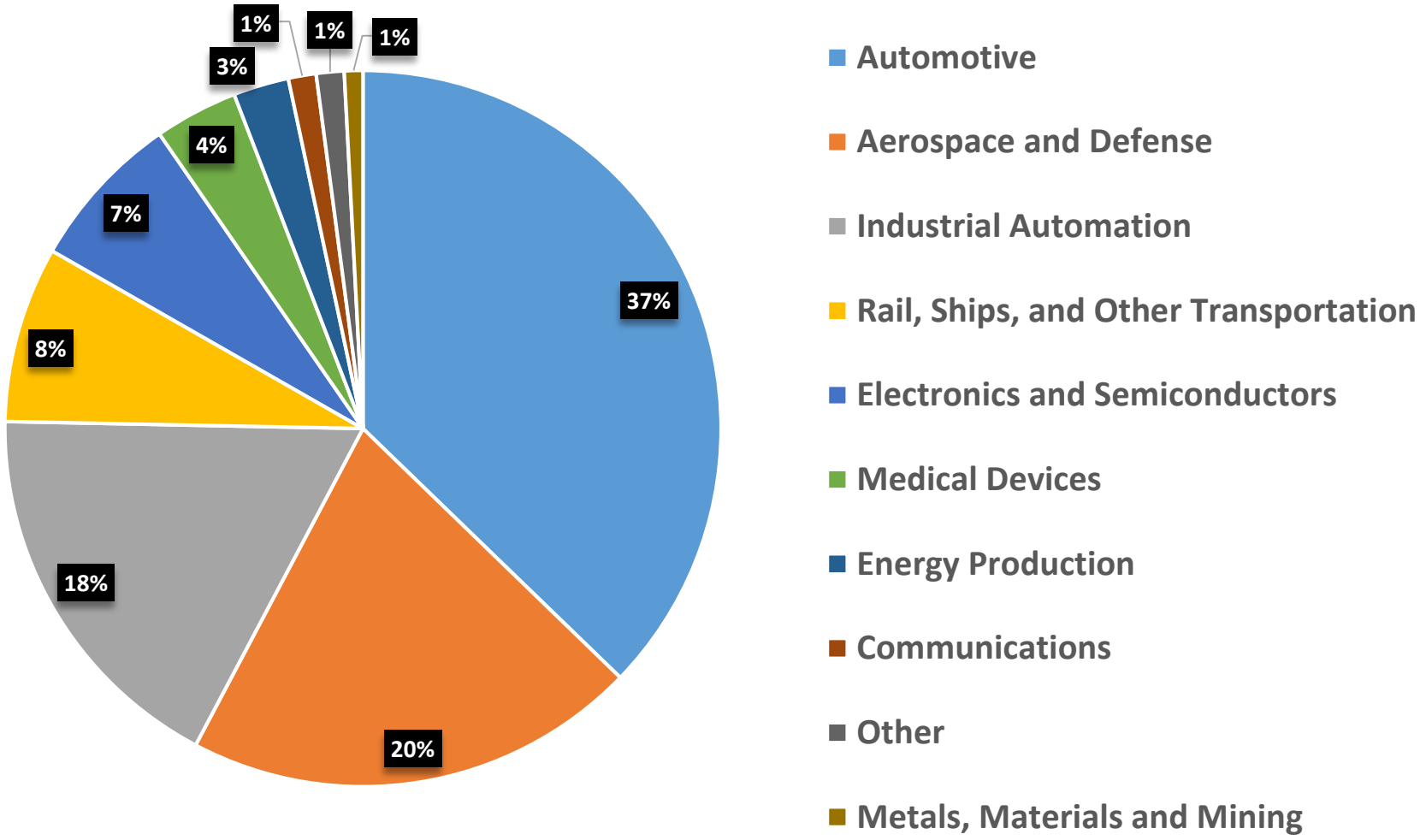
Model-Based Design and Code Generation for AEB Sensor Fusion

Surveys from 3 continents, 176 companies representing 30,000+ users
以下调查来自于：三个大陆，176家公司，代表了30000多名用户



Source: 2015 MathWorks Model-Based Design Survey

Perceived Current Benefit Versus Traditional Methods
与传统方法相比，可以看出当前MBD的优势

MBD Component	Benefit
Desktop simulation	4.17
Graphical authoring of algorithms	4.14
Real-Time Prototyping	4.05
Production code deployment	4.04
Plant modeling	4.04
On target prototyping	3.93
Hardware-in-the-Loop	3.91
Model verification	3.72
Textual authoring of algorithms	3.66
Code verification	3.62

5 = very high
4 = high
3 = medium
2 = low
1 = very low

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趋势表明：如果你刚接触MBD，可以考虑从以下方面作为开展MBD的突破口。

1. 桌面仿真
2. 可执行的需求描述
3. 快速原型与产品代码生成

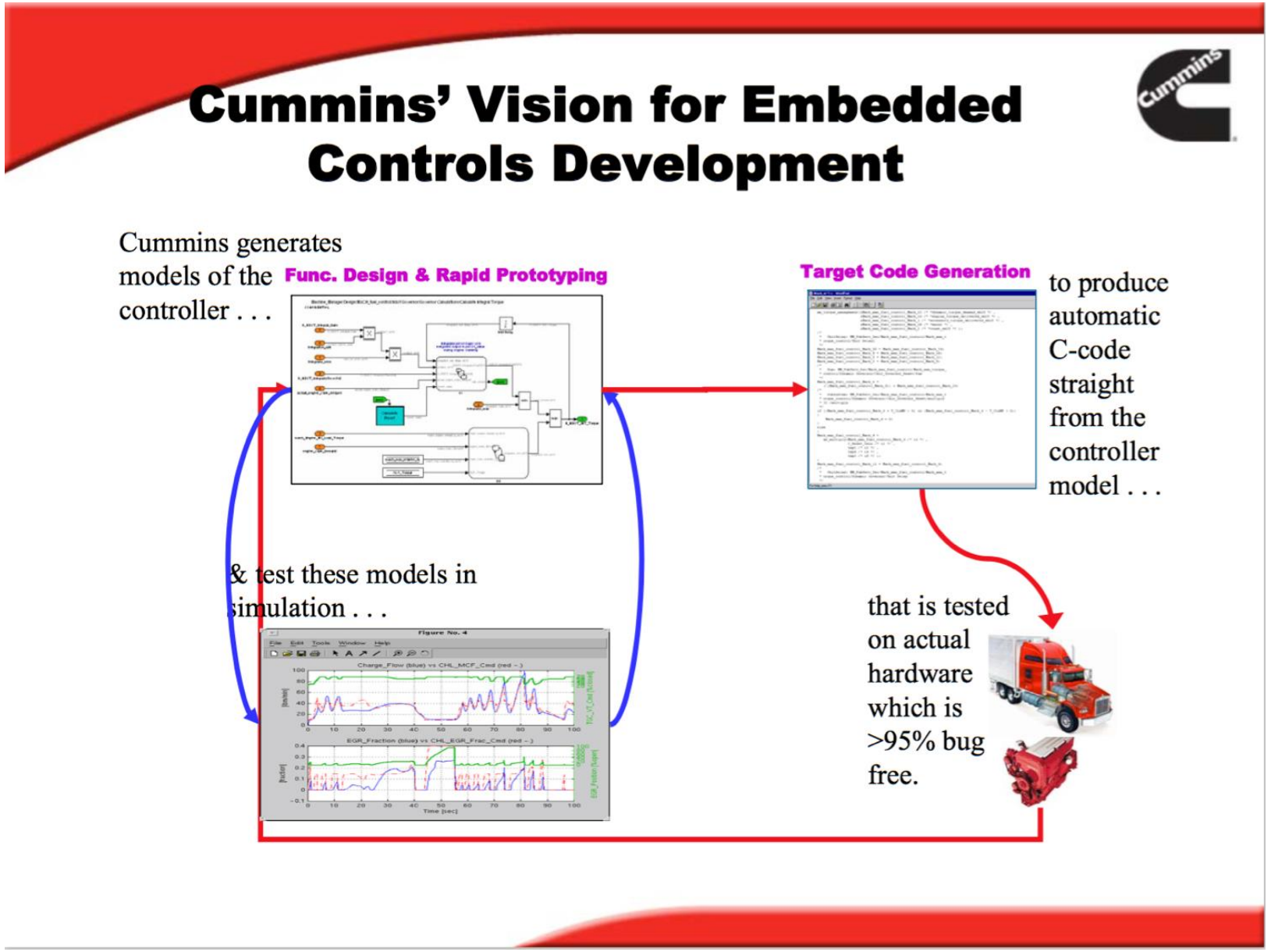
Cummins in 2007
康明斯，2007年

采用代码生成：

功能设计与快速原型

目标码生成

在真实硬件中进行测试



MathWorks Automotive Conference
Dearborn, MI
June 2007

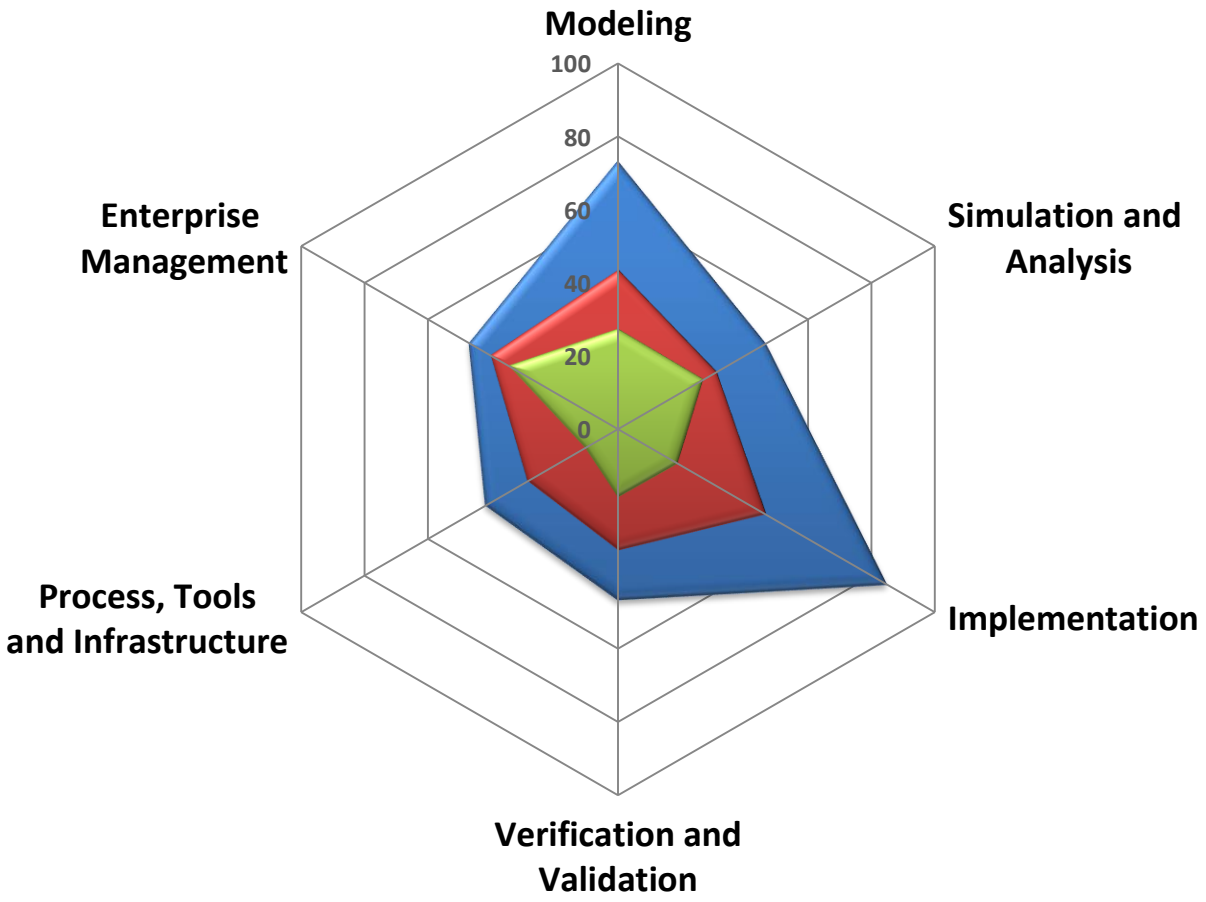
Difference between perceived current benefit and future benefit
当前获得的优势与未来可获得优势的区别

MBD Component	Delta in benefit*
Code verification	0.40
Plant modeling	0.39
Model verification	0.38
Hardware-in-the-Loop	0.34
Desktop simulation	0.32
Production code deployment	0.31
Textual authoring of algorithms	0.30
Graphical authoring of algorithms	0.29
On target prototyping	0.28
Real-Time Prototyping	0.26

调查结果建议如果你正在应用MBD，接下来请考虑关注以下两方面：

1. 验证与确认
2. 被控对象物理建模

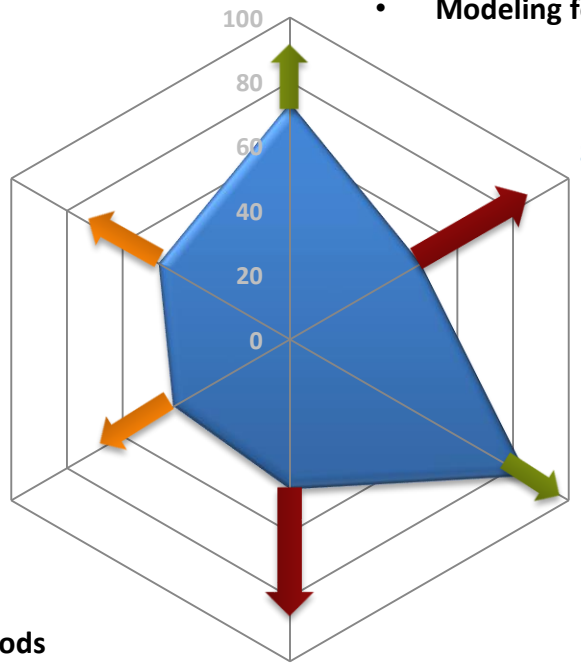
Model-Based Design Maturity Auto Industry Maturity:
汽车行业基于模型设计的成熟度：
Top 20%, Average, Bottom 20%



Model-Based Design Auto Industry Leaders: Trends and Focus Areas
汽车行业基于模型设计的领导者：趋势与关注领域

Modeling
- Scalable architecture
- Plant modeling
- Modeling for reuse

Enterprise Management
- Enterprise-level Model-Based Design strategy
- Strategic measures and indicators
- Training and knowledge management
- Supplier collaboration and management



Simulation and Analysis
- System-level simulation and optimization
- Virtual calibration capability
- Multi-core
- Hardware software co-design

Process, Tools and Infrastructure
- Process definition and improvement
- Continuous upgrade strategy
- Improved metrics and estimation methods
- Regression testing framework

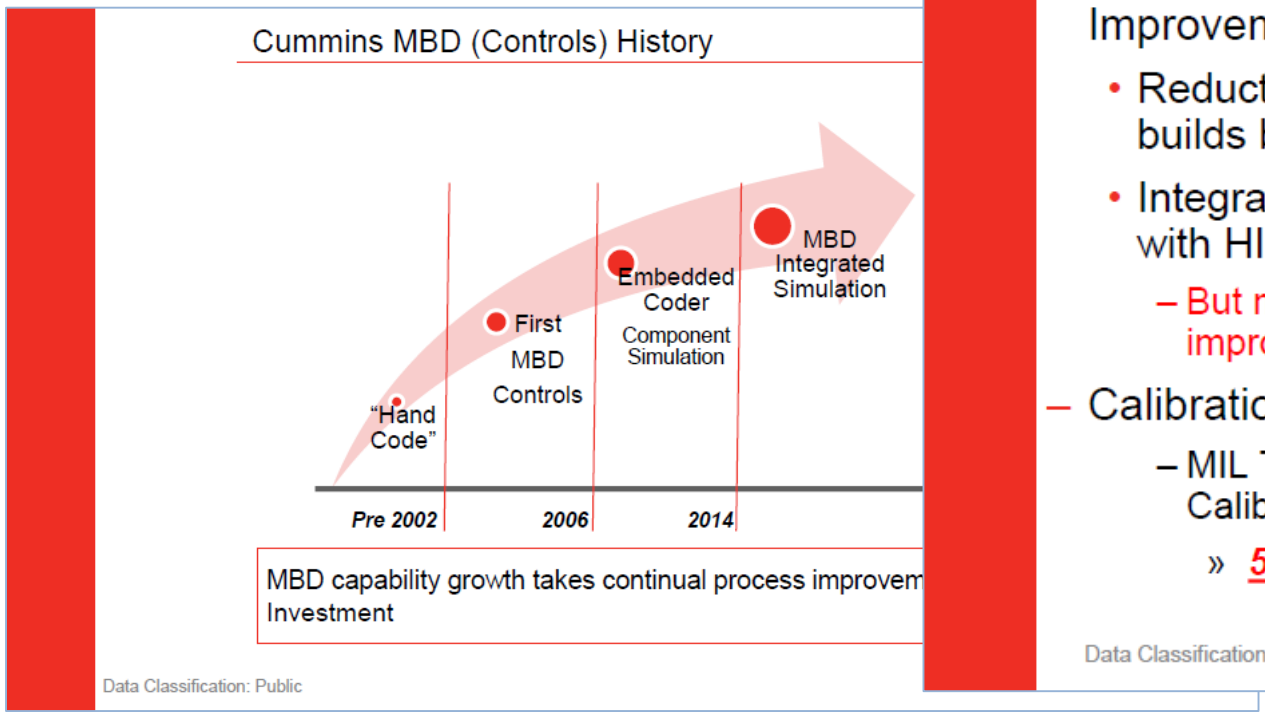
Implementation
- AUTOSAR
- HDL code
- Further reduction of manual tasks

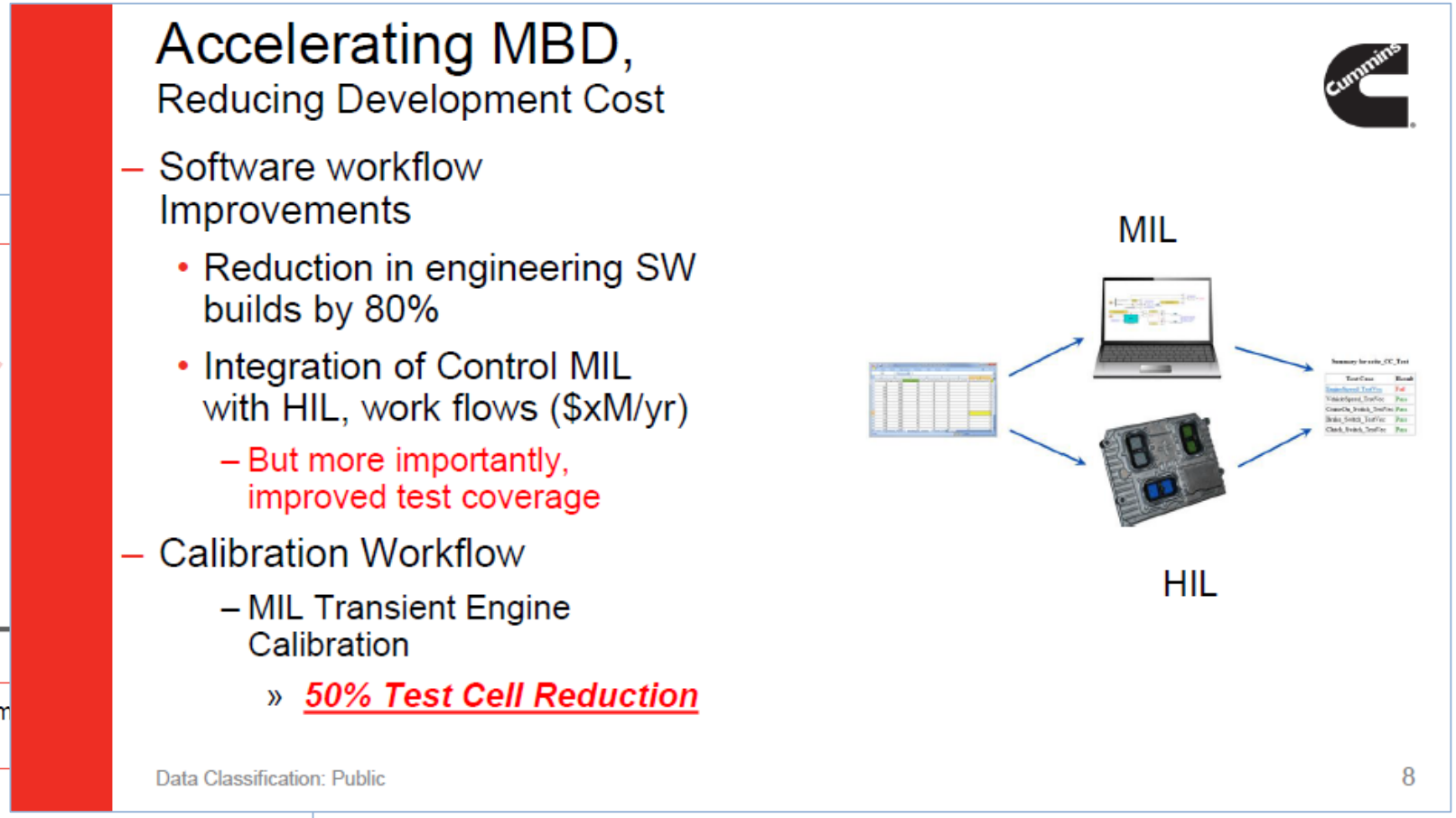
Verification and Validation
- Requirements traceability
- Automated test generation and execution
- Regulations and standards compliance

Low
Medium
High

Cummins: Model-Based Design Deployment History
康明斯: 基于模型设计的部署历史

基于模型设计为软件工程师带来的益处

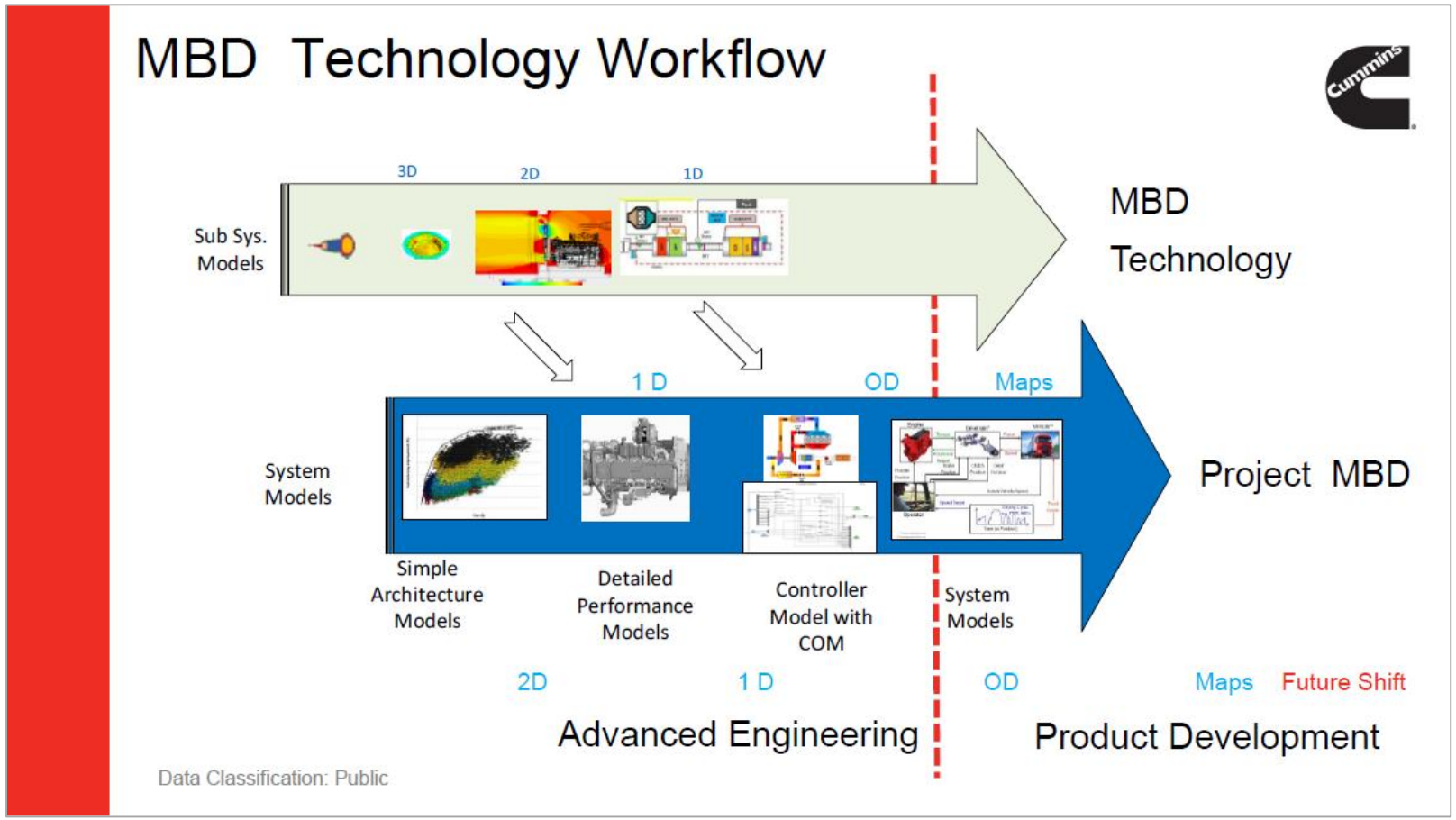




Model Based Controls: Moving Beyond Software Domain, Ed Hodzen, Director, Advanced Engineering, Cummins, Inc., MathWorks Automotive Conference, May 2015, Plymouth, Michigan, USA

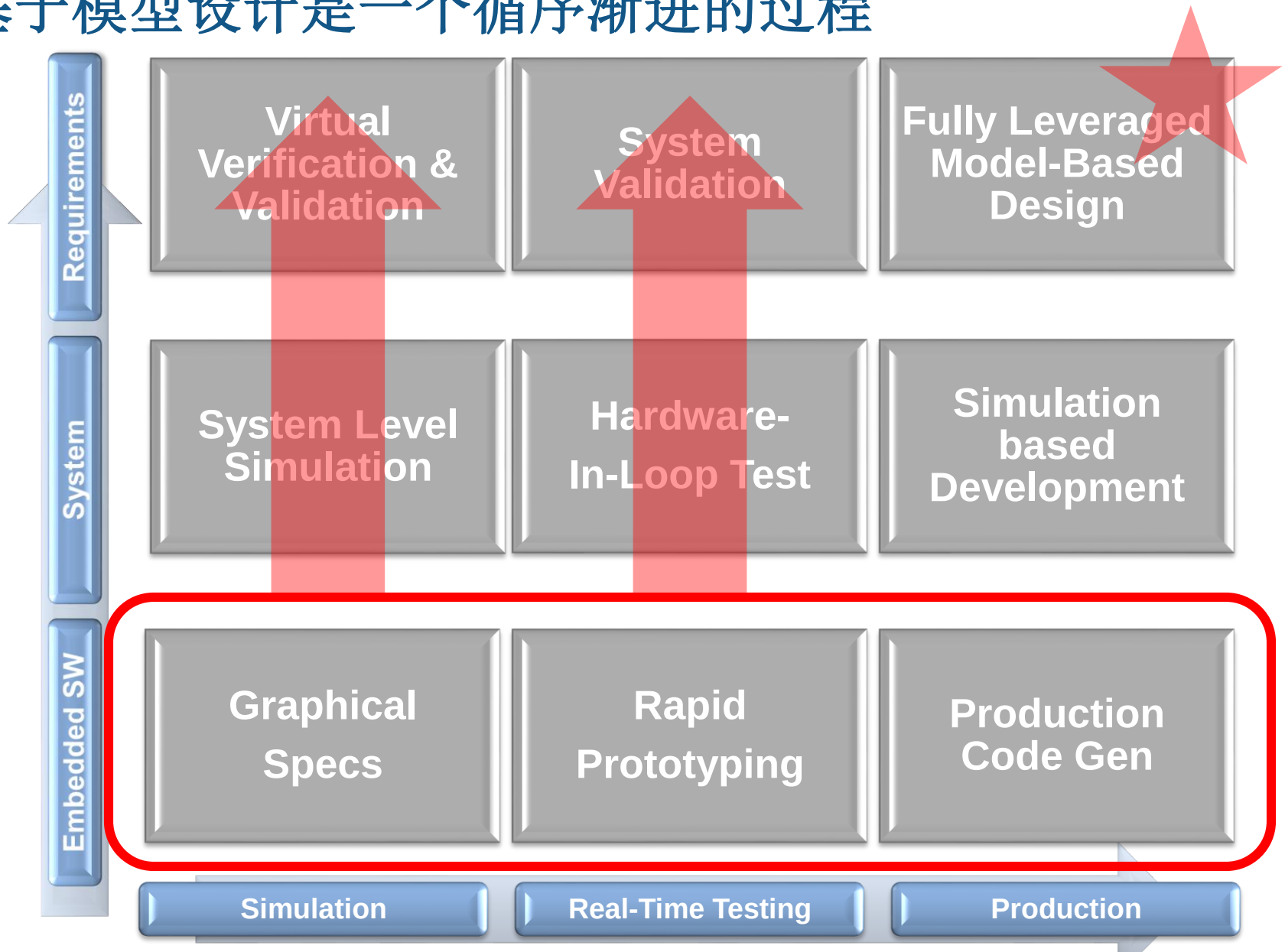
Cummins: Moving Beyond Software Domain
康明斯: 超越软件范畴

加速系统开发



Model Based Controls: Moving Beyond Software Domain, Ed Hodzen, Director, Advanced Engineering, Cummins, Inc., MathWorks Automotive Conference, May 2015, Plymouth, Michigan, USA

Applying MBD is a Step-by-Step Process
采用基于模型设计是一个循序渐进的过程



What Capabilities Can I Leverage?

1. System modeling 系统建模

2. Verification and Validation 验证与确认

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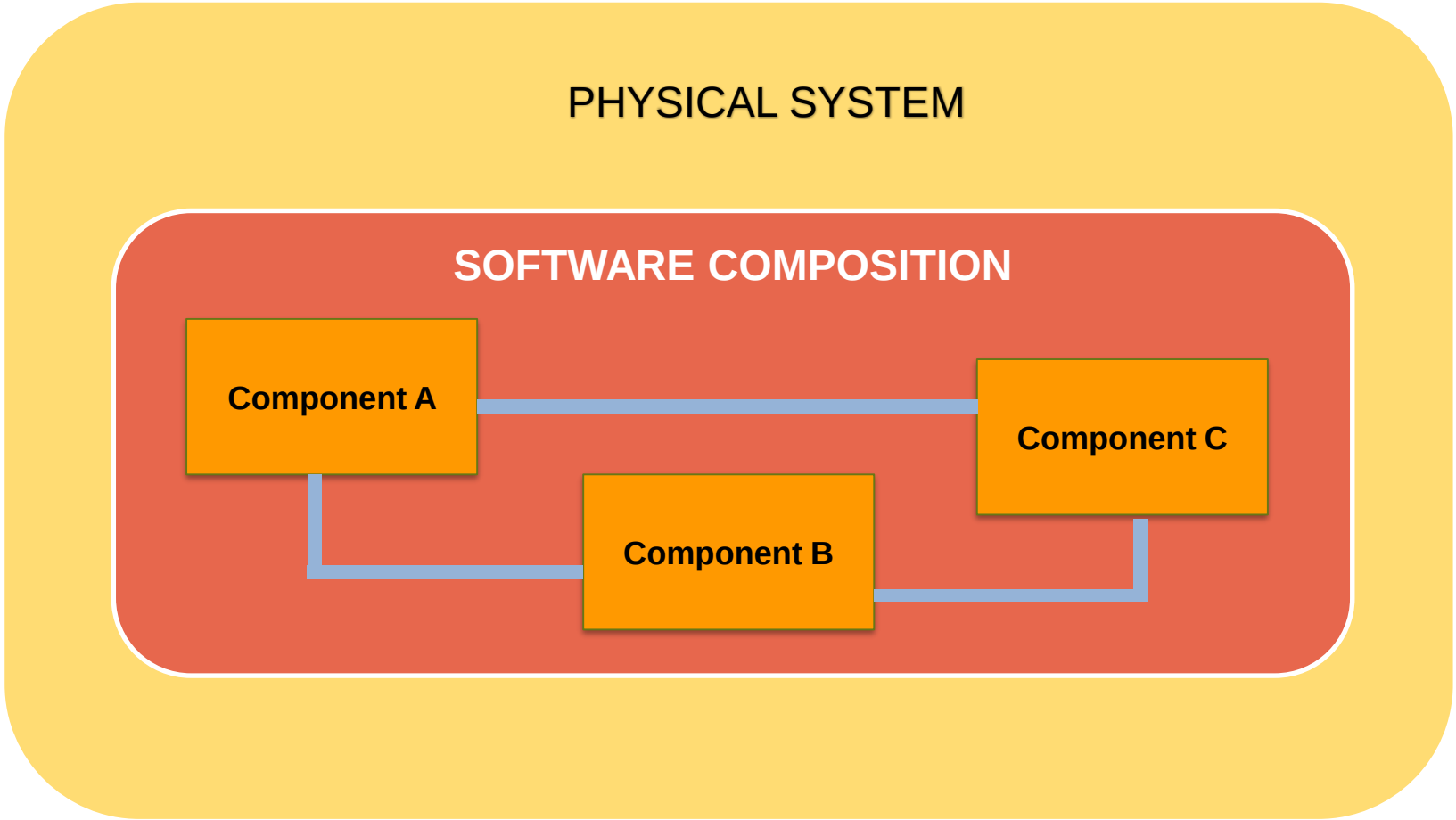
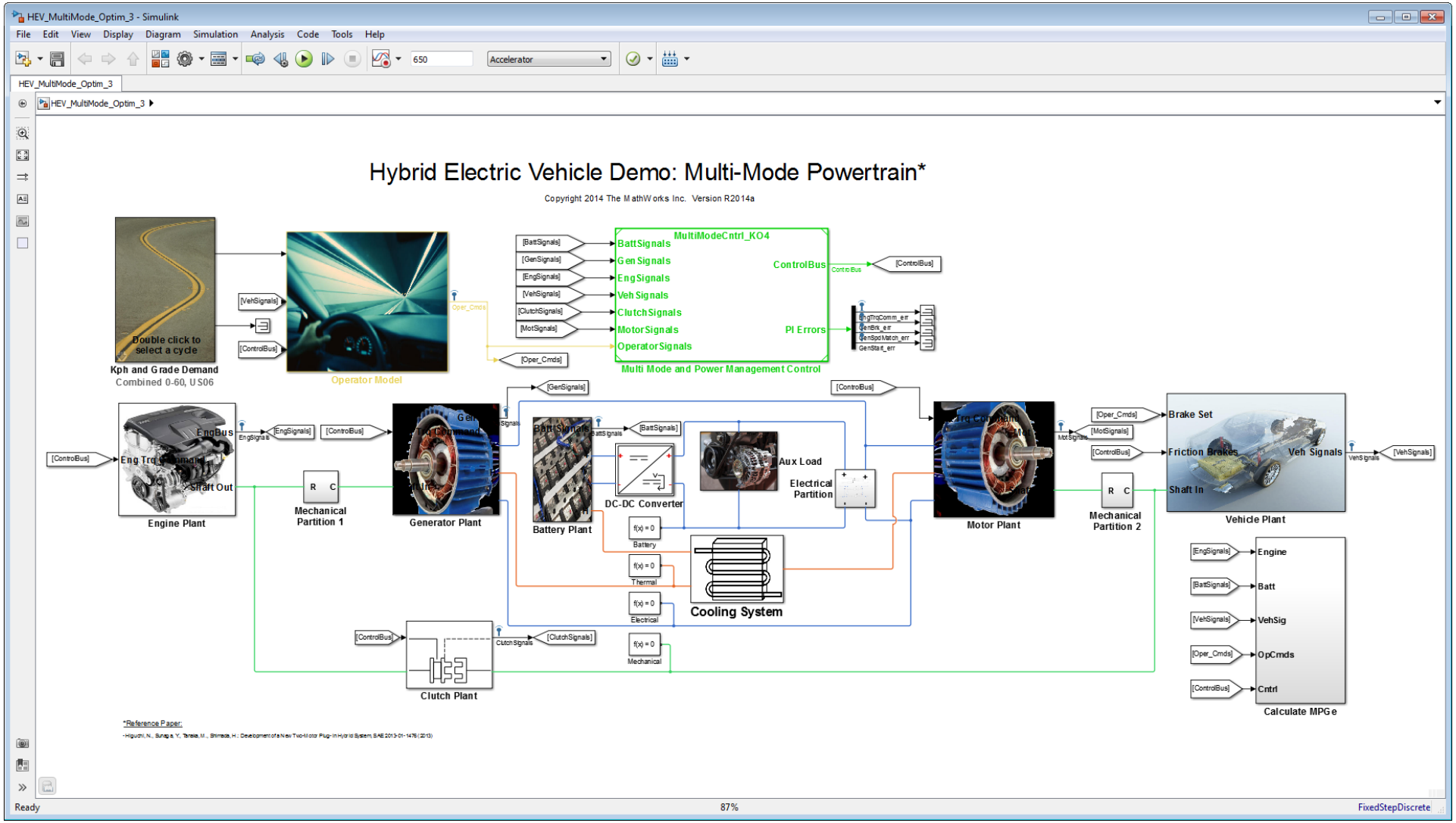
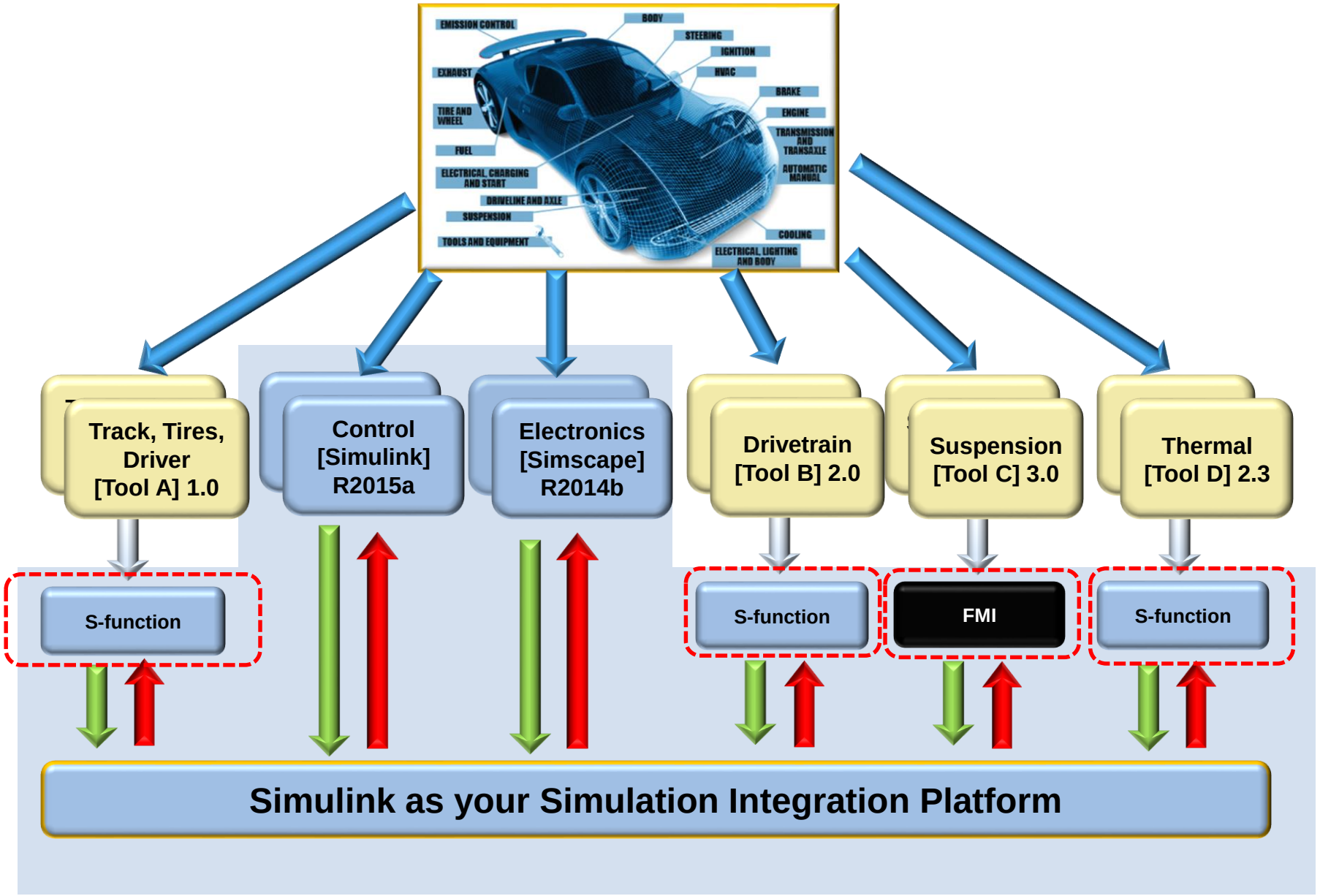
Full system
完整系统





System model 系统模型

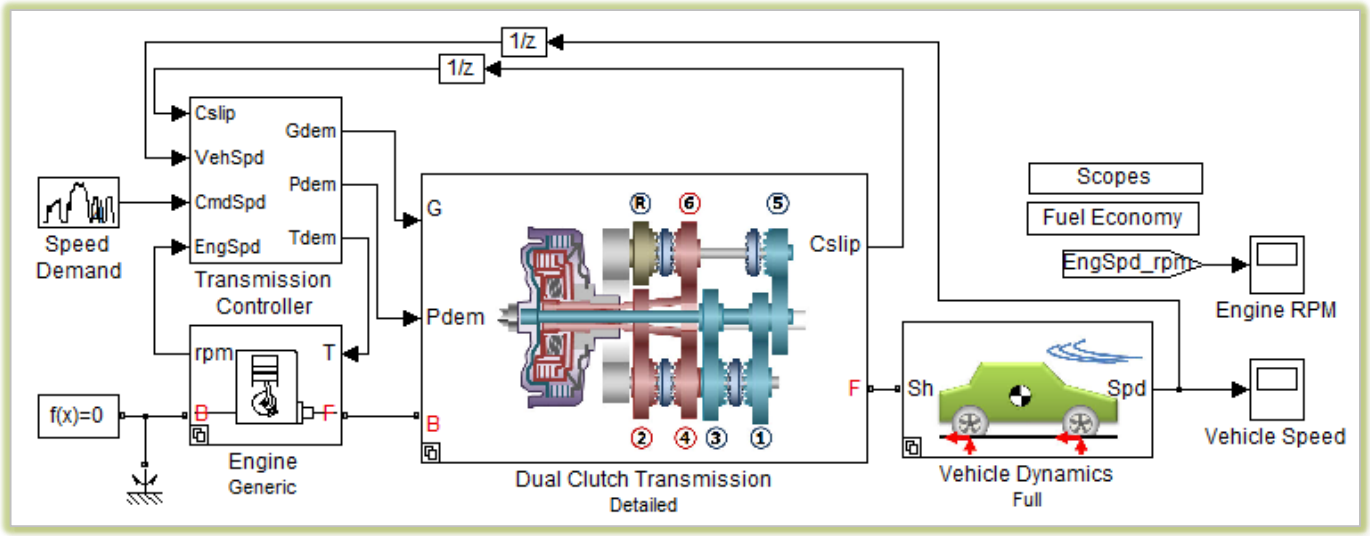
Multi-Tool Simulation Integration 多工具仿真集成



Simulation Integration Platform Characteristics
仿真集成平台的特征

Authoring environment
for component Models
不同组件模型的构建环境

Mature and extensive API
for 3rd party component integration
成熟与广泛的第三方组件集成接口



Multidomain simulation
environment
多域仿真环境

Scalable
environment
可扩展的环境

Analysis and Debug
capabilities
分析与调试能力

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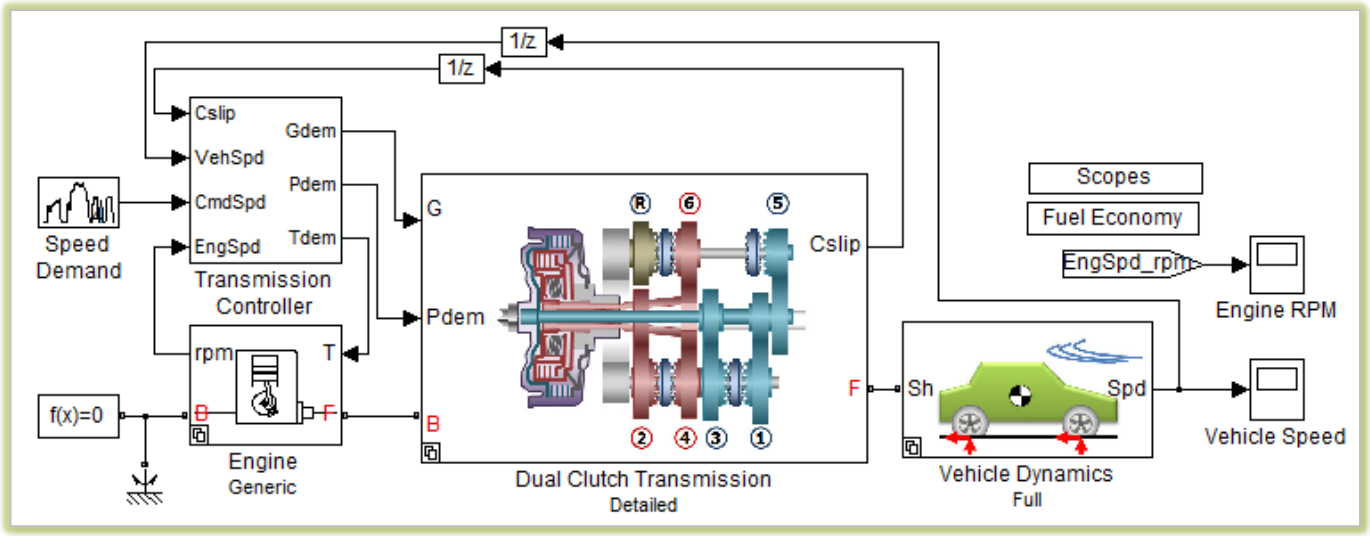

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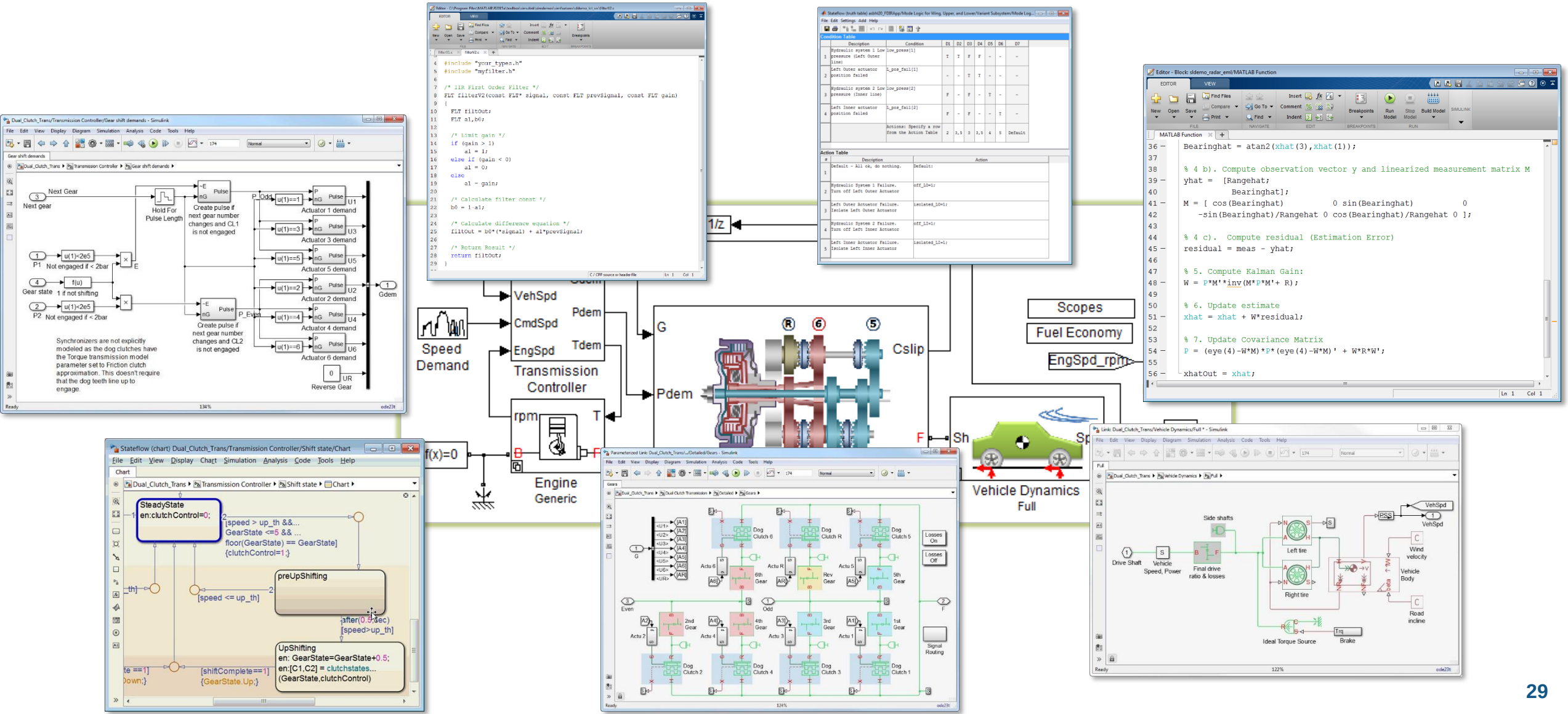
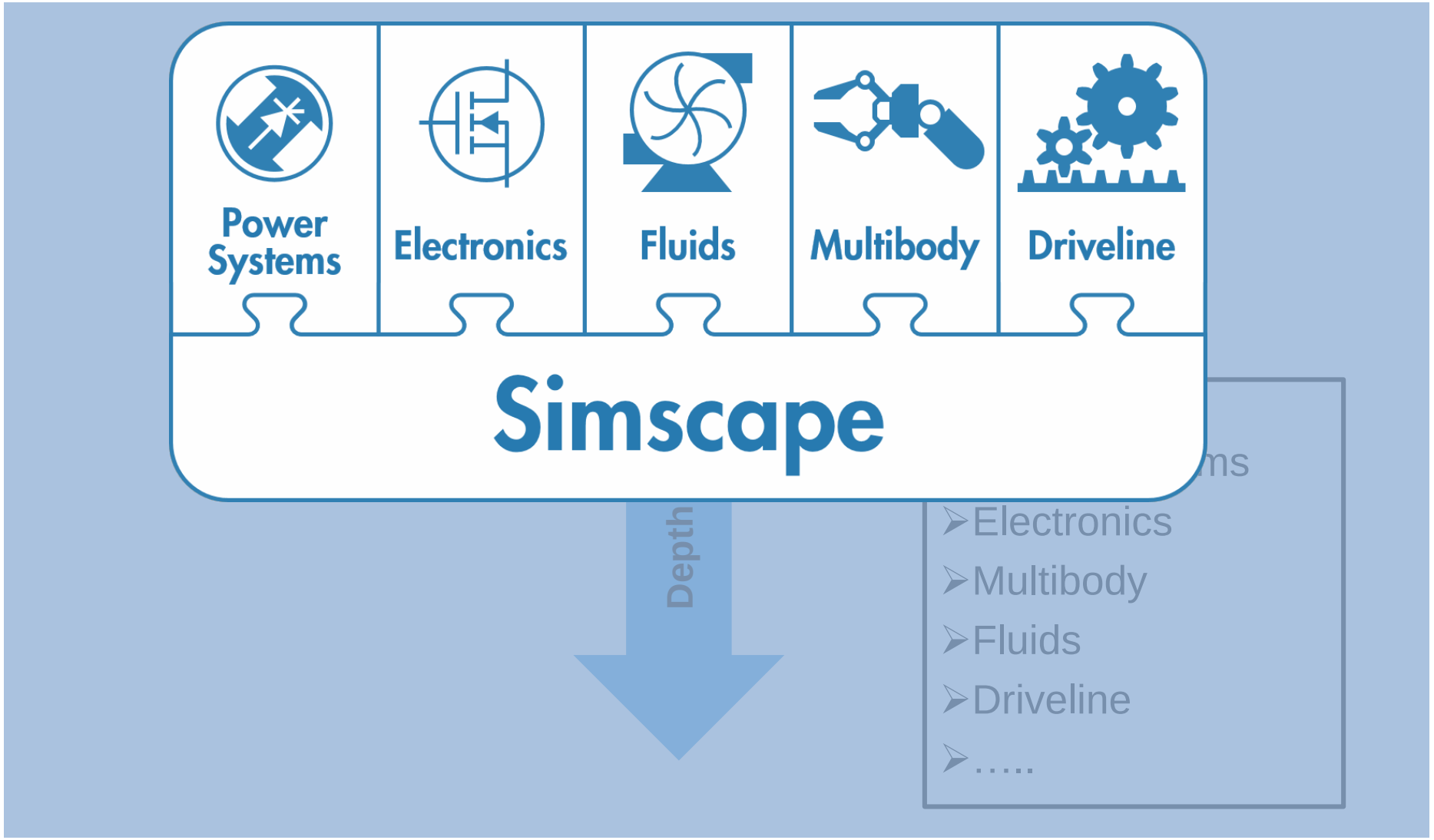
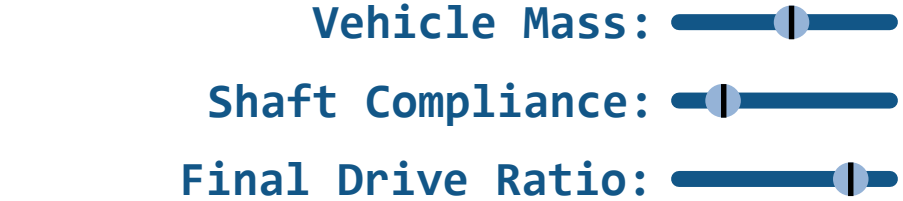


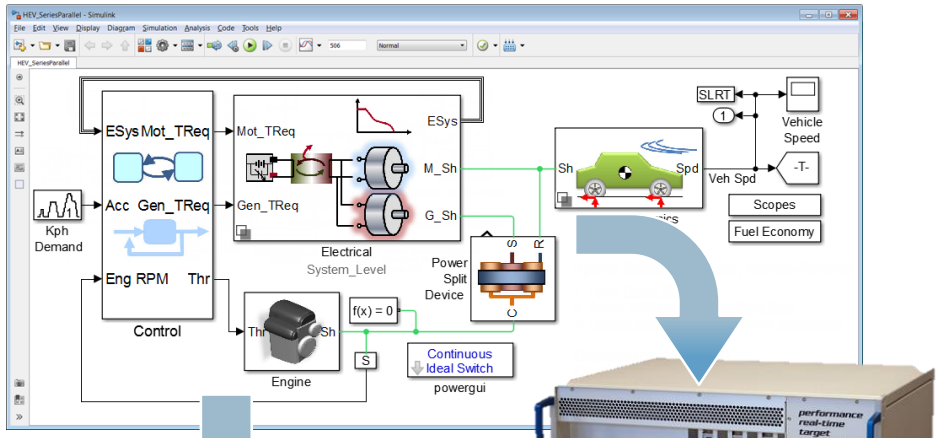
Physical modeling 物理建模

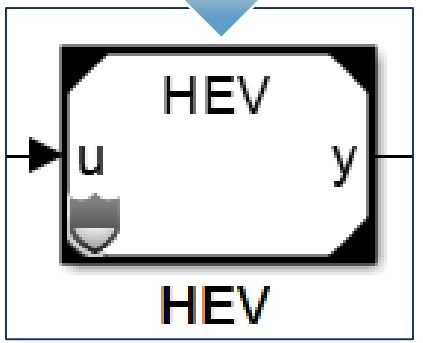


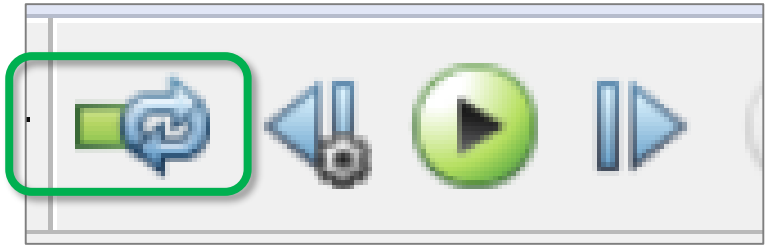
Simscape Runtime Parameters （ Simscape运行时参数） R2016a



- During HIL tests
- In protected models
- During iterative simulation workflows
- For power systems and other modeling domains







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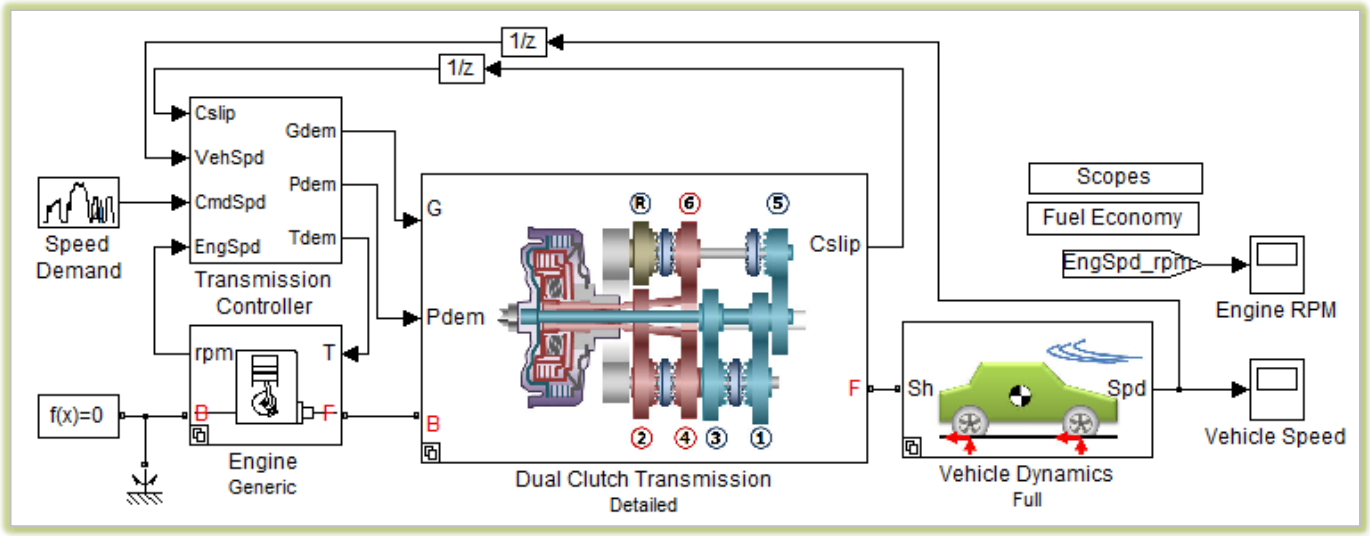

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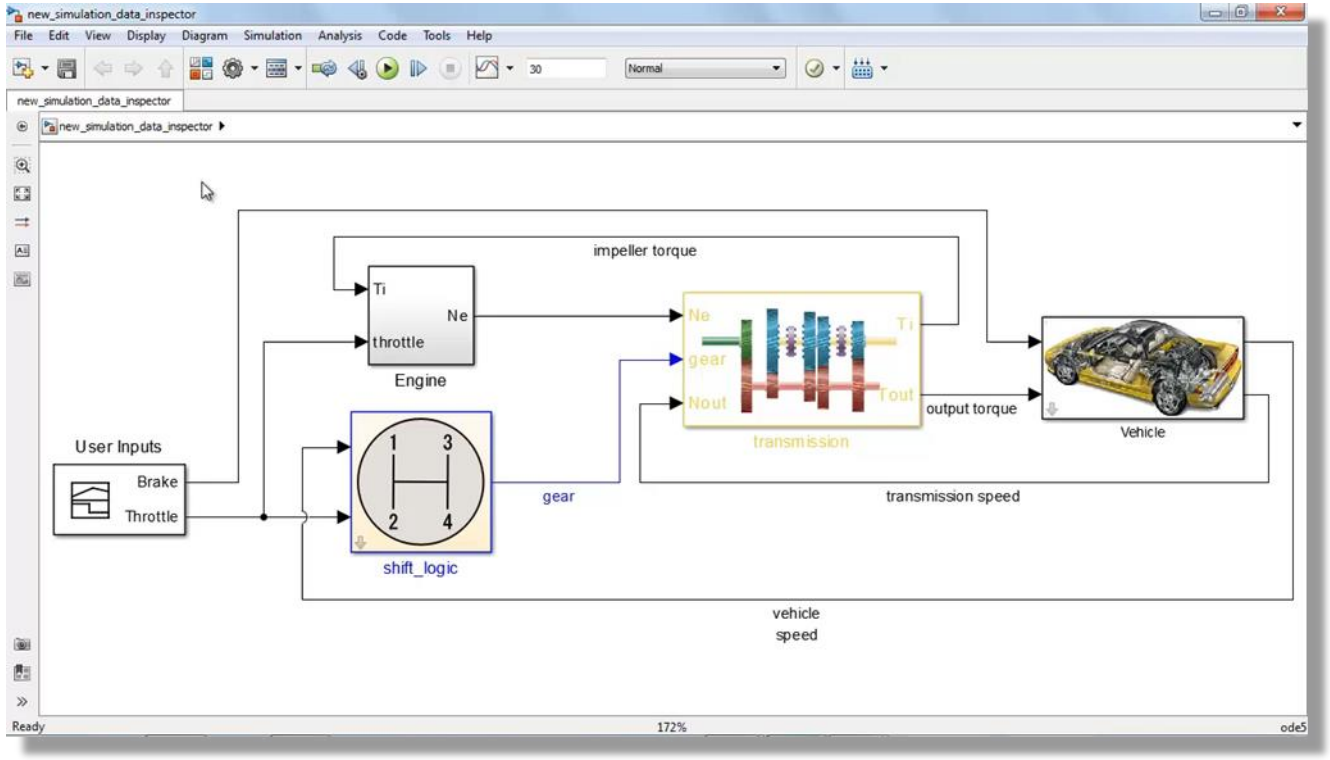
Simulation Integration Platform Characteristics
仿真集成平台的特征

分析与调试能力

仿真集成平台必须具备以下能力：

- 分析仿真结果
  - 仿真过程中选择并监测信号
  - 比较仿真值
- 诊断未预计到的行为
  - 向前和后退调试
  - 设置时间和条件断点
  - 提供诊断信息



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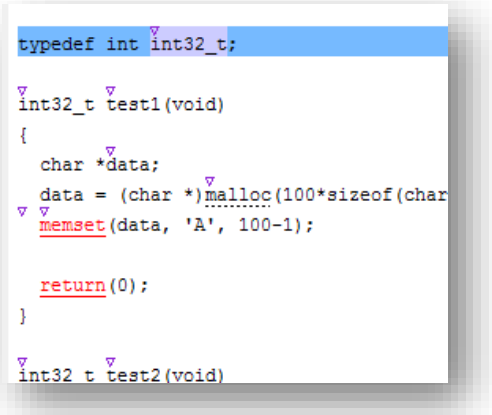
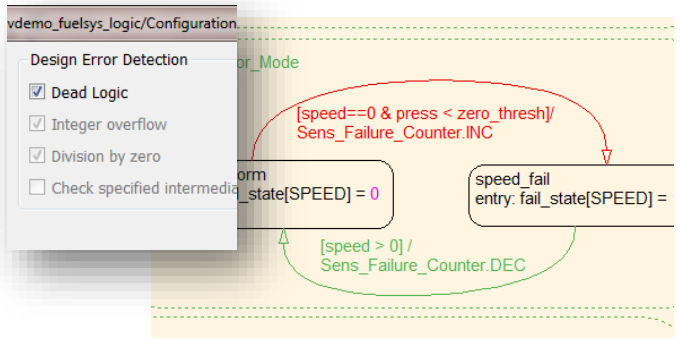
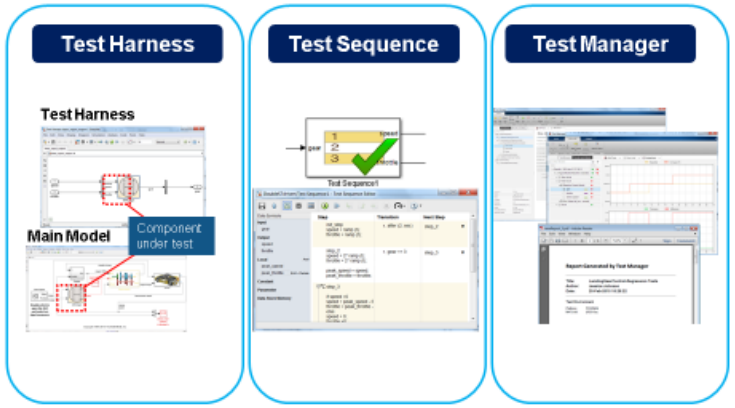
Verification and validation 验证与确认:
Automate testing and find design errors 自动化测试并发现设计缺陷



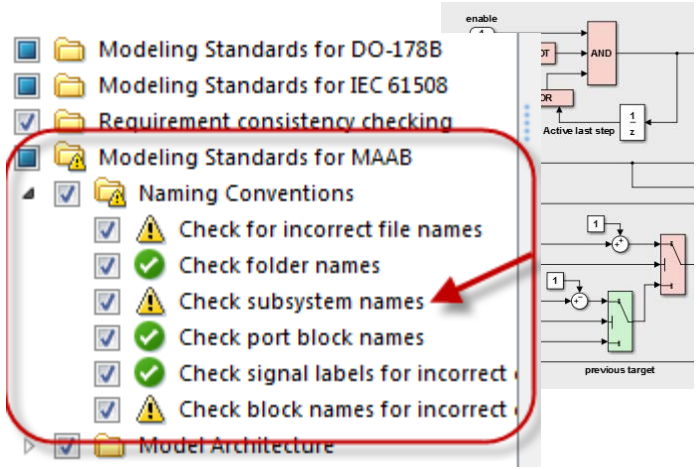
Polyspace



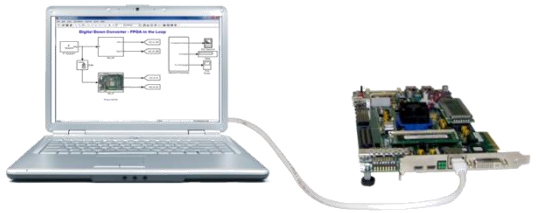
Simulink Design Verifier



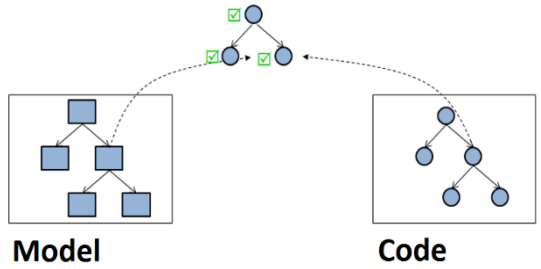
Simulink Test



Simulink Verification & Validation



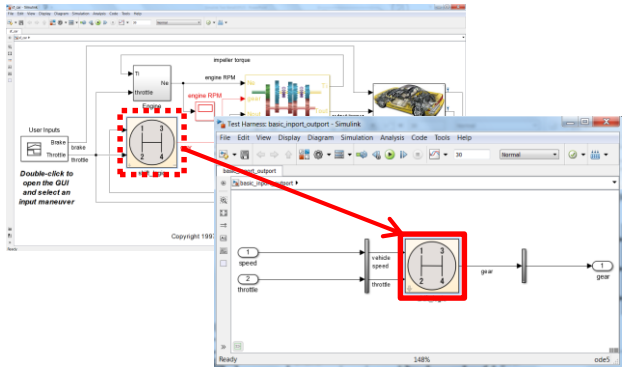
HDL Verifier



Simulink Code Inspector

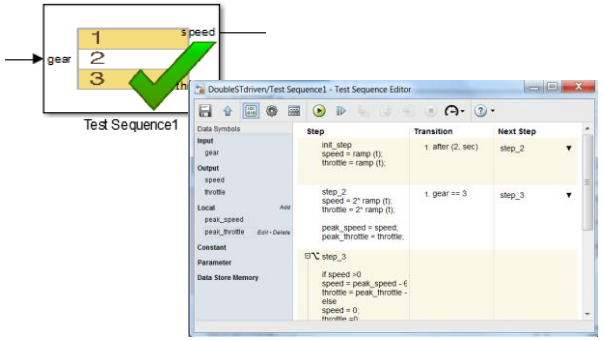
Simulink Test New Features in R2016a
Simulink Test 在2016a版本中的新功能

Test Harnesses



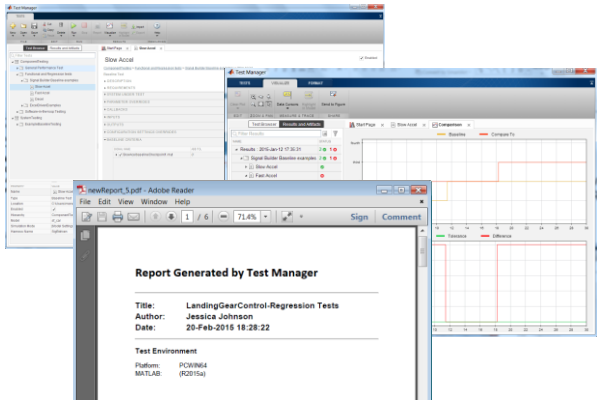
- Harness list dialog
- Library harnesses
- Simulink functions/export function models support (AutoSAR)
- Externally-saved harnesses
- Requirements linking

Test Sequence Block



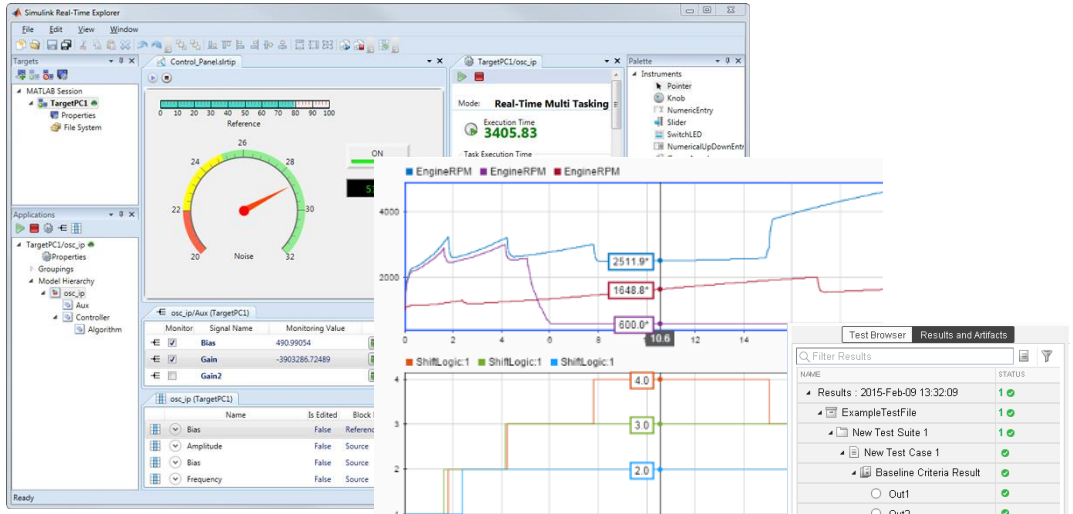
- Syntax highlighting
- Tab completion
- Enhanced symbol sidebar
- Message I/O, function call
- Description column
- "verify" statement
- API
- Requirements linking

Test Manager



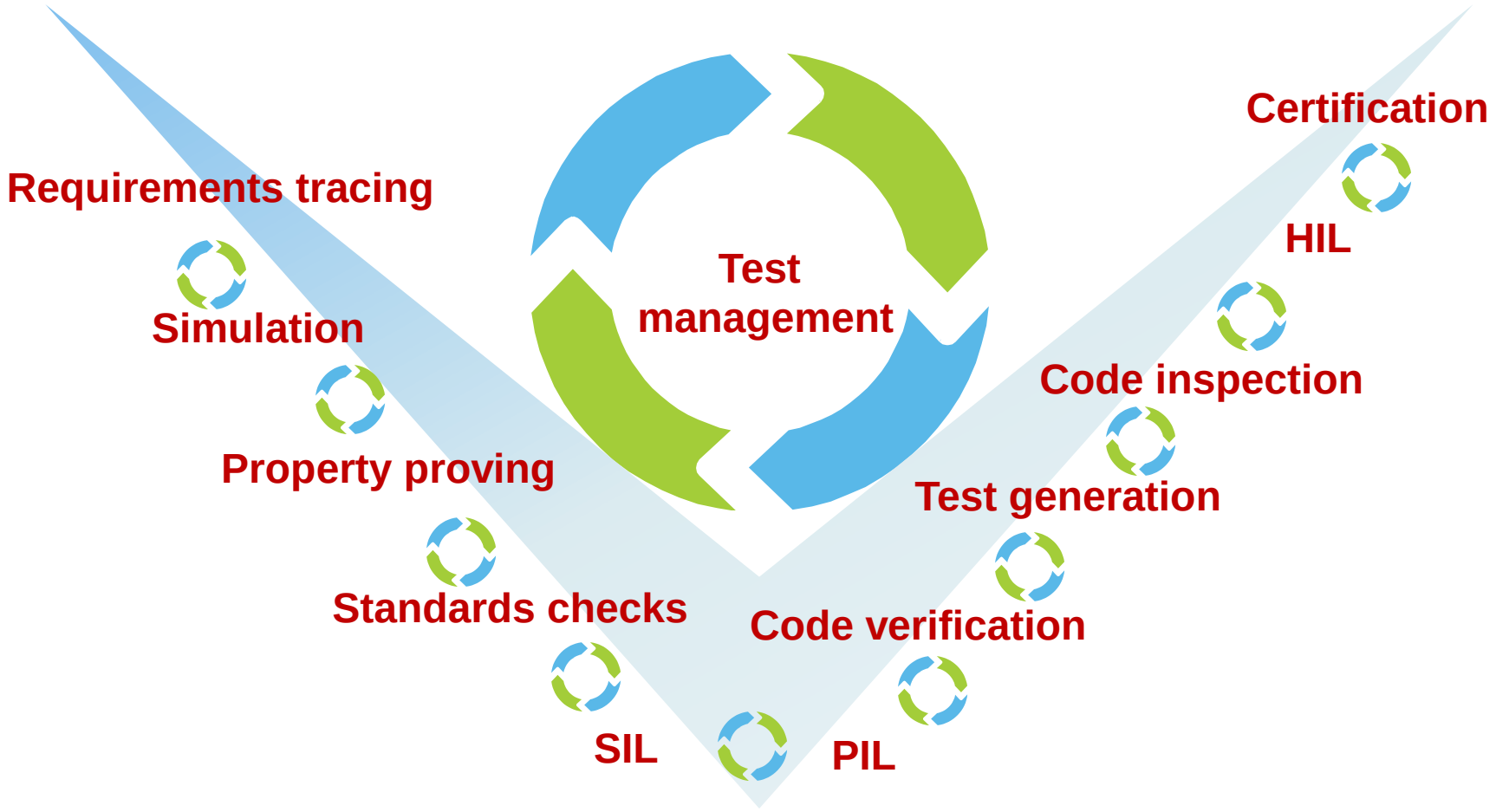
- Coverage
- Parallel test execution
- Report customization
- Iterations
- Dependency/impact analysis
- Test for subsystems
- Real-time test cases (SLRT)

Simulink Test R2016a:
Author and execute real-time tests 构建并执行实时测试



- Run tests/assessments on Simulink Real-Time target
- Start simulation tests from model, application, connect to running target
- Test sequence assessments to verify behavior without stopping the test
- Bring back real-time test data for analysis in the test manager

Verification 验证
Fast and Small Iterations 快速与微小迭代



Summary 总结

- Model-Based Design is in widespread use for new product development

  基于模型设计在新产品开发中得到广泛应用

- Automatic code generation provides significant benefit

  自动代码生成带来了显著优势

  - Often the first technology to adopt by automotive companies
  - Widespread usage including high performance and safety critical applications

- Beyond code generation 自动代码生成以外

  - Model verification and closed loop simulation are key to front loading
  - System modeling extends the scope and benefit of Model-Based Design

- MathWorks focus is to evolve the tooling for Model-Based Design

  迈斯沃克公司专注于基于模式设计相关工具的设计与发展