MATLAB EXPO 2019

What will You Use MATLAB in Aerospace
-- MATLAB助力军工行业

Linghui Zhang (张灵惠)
MathWorks

国产大飞机


Six advanced technologies
1 Comprehensive avionics system
The technology alleviates pressure on pilots, improves navigation performance and human-machine interface.
综合航电系统
3 Comprehensive design
The design allows for the width of the middle seats and height of the luggage compartments to be increased.
综合设计
2 Structure design
Its front windshield is composed of only four pieces (instead of six pieces seen on other planes) to help reduce air resistance.
结构设计
C919
中国商用飞机有限责任公
电传操纵控制系统和主动控制技术
4 Fly-by-wire control system and active control technology
The technology improves the aircraft's overall performance.
5 Aerodynamic design
The jetliner adopts an advanced aerodynamic configuration and cutting-edge supercritical wings, which result in higher aerodynamic efficiency than other commissioned aircraft of the same type.
空气动力学设计
Source: media reports
Photos: CFP
Graphics: GT
6 Large proportion of advanced metal materials
These materials help cut the aircraft's weight while reducing noise levels.
大比例的先进金属材料

多域复杂系统

	嵌入式软件设计与架构
	配电和优化
	控制系统设计
	信号处理和通信
	机械，热，液压设计

Flight Control System / GNC

Airframe

Crew System

Radar System

Control Surface Actuation

Avionics

Communications System

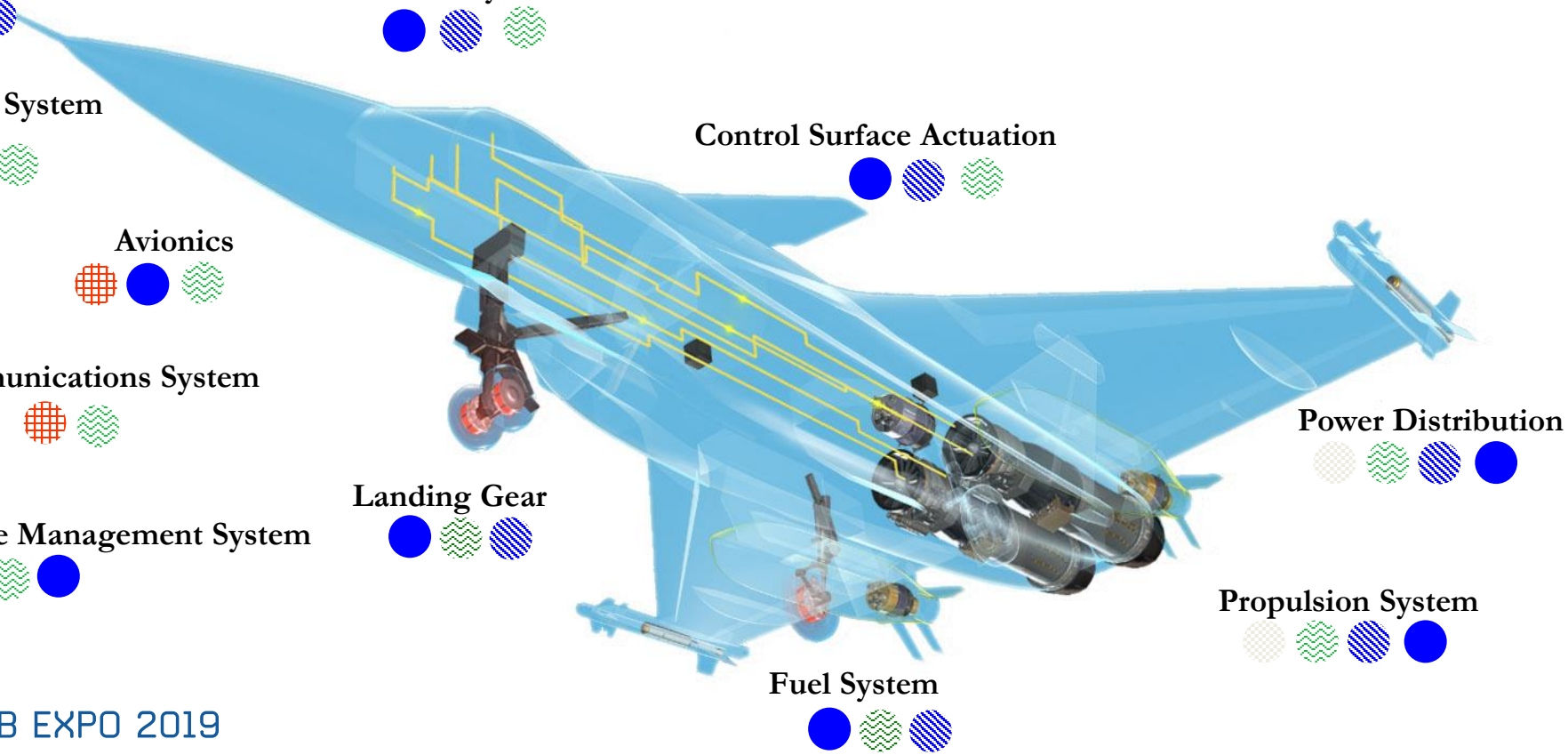
Power Distribution

Landing Gear

Failure Management System

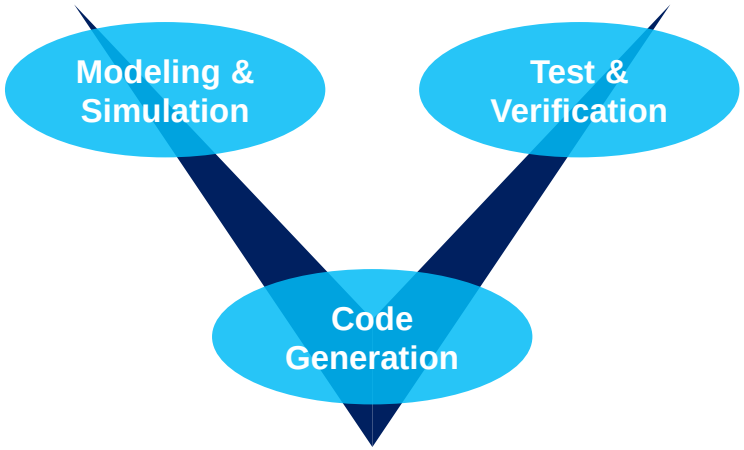
Propulsion System

Fuel System

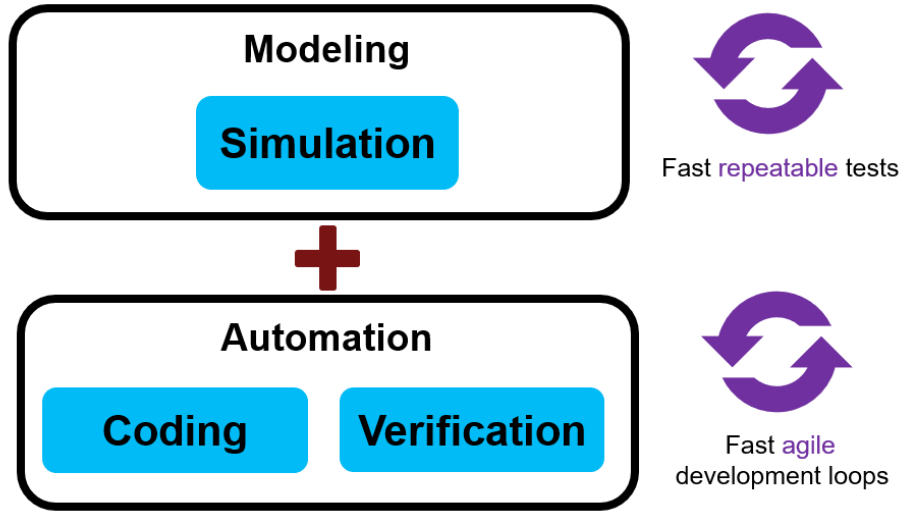


如何开发多域复杂系统

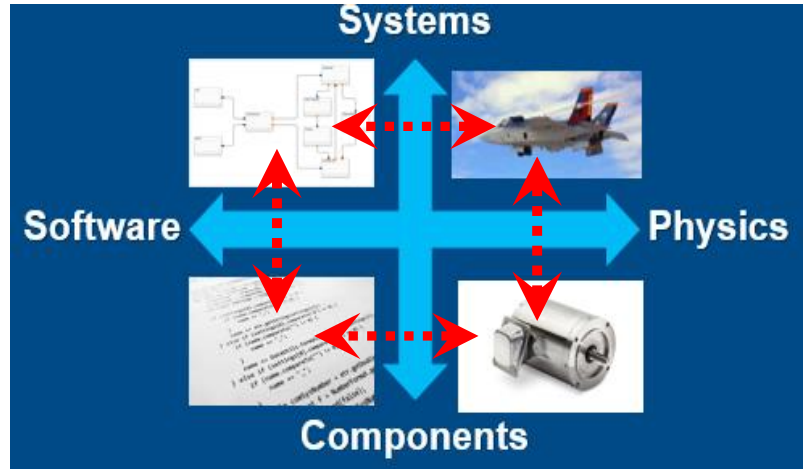
开发流程



Model-Based Design
基于模型的设计

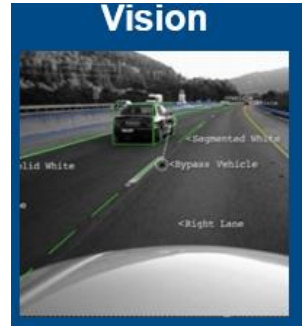


多域建模



➔ ➔ 需要一个集成平台，它可连接工作流程及承载从组件到系统的规模化设计

Simulink – 开放式集成开发平台

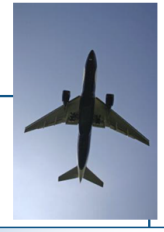


支持各类高可靠性系统级认证

- **航空领域**
  - ARP4754　系统仿真
  - DO-178C
  - DO-330/331
  - DO-254　HDL代码自动生成
  - DO-278A

- **其它高可靠系统认证**
  - ISO26262
  - EN50128
  - IEC61508

BAE（欧洲最大的国防承包商） 在DO-254 A级工程中使用HDL Coder



挑战

开发和部署控制算法到FPGA，并通过商用飞机DO-254的认证。

解决方案

在Simulink中开发控制算法，通过Simulink V&V链接需求，并且使用Simulink HDL Coder生成HDL代码

结果

- Simulink模型用于开发、验证设计和HDL代码生成
- 生成的代码是平台独立的、可读性好、效率高
- 在需求、设计和HDL代码之间的追溯评估可以用于DO-254 A级认证

"HDL Coder生成可读性高的代码，并且与需求有追溯关系，这是我们DO-254 A级软件计划的重要部分"

Mike Weaver
Senior Systems Engineer

BAE SYSTEMS

Airbus Develops Fuel Management System for the A380 Using Model-Based Design

Airbus A380, the world's largest commercial aircraft.

Challenge
Develop a controller for the Airbus A380 fuel management system

Solution
Use MATLAB, Simulink, and Stateflow for Model-Based Design to model and simulate the control logic, communicate the functional specification, and accelerate the development of simulators

Results
- Months of development time eliminated
- Models reused throughout development
- Additional complexity handled without staff increases

"Model-Based Design gave us advanced visibility into the functional design of the system. We also completed requirements validation earlier than was previously possible and simulated multiple simultaneous component failures, so we know what will happen and have confidence that the control logic will manage it."

Christopher Slack
Airbus

Link to user story

DEFENCE AND SPACE

MATLAB Tour 2017

Achievements using MBD for Safety-Critical Equipments

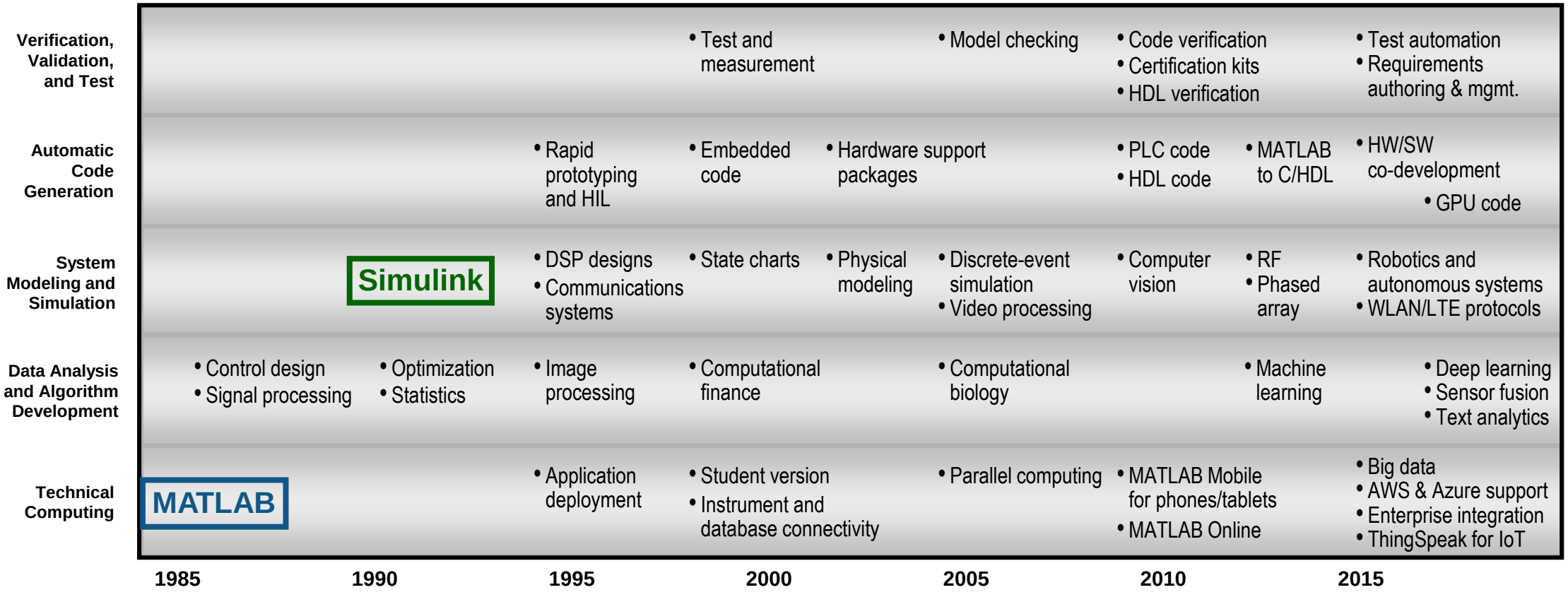
The following Toolboxes have been used during the design phase of Safety-Critical Equipments for these Aircrafts:
- A330-MRTT
- A400M
- C-295 (EIS in 2018)

MathWorks Tools
MATLAB / Simulink
Stateflow
Embedded Coder
Simulink Code Inspector
Polyspace
Fixed-Point Designer
HDL Coder
HDL Verifier
MATLAB Coder
Simulink Verification and Validation
Simulink Design Verifier
DO Qualification Kit

13 9 May 2017 Uso de Modelos durante el Ciclo de Desarrollo en V para Plataformas de Avionica

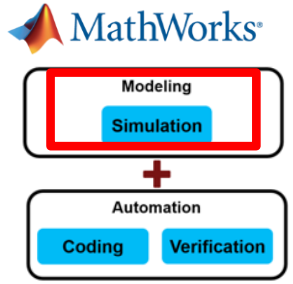
AIRBUS

MATLAB/Simulink平台为工程师及科学家提供的核心能力



MathWorks founded in 1984

建模与仿真的强大能力



建模

- 物理组件
- Simscape 针对物理建模

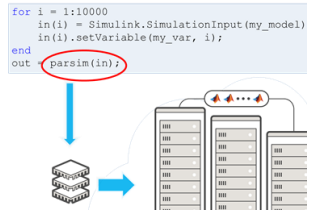
马达

雷达

电池

仿真

- 仿真集成 (多域及多工具联合仿真和分析)
- 并行计算和多线程联合



软件组件

- 使用高级语言进行高级抽象工作: MATLAB, Simulink, Stateflow
- 组件建模：可重用组件，变体管理

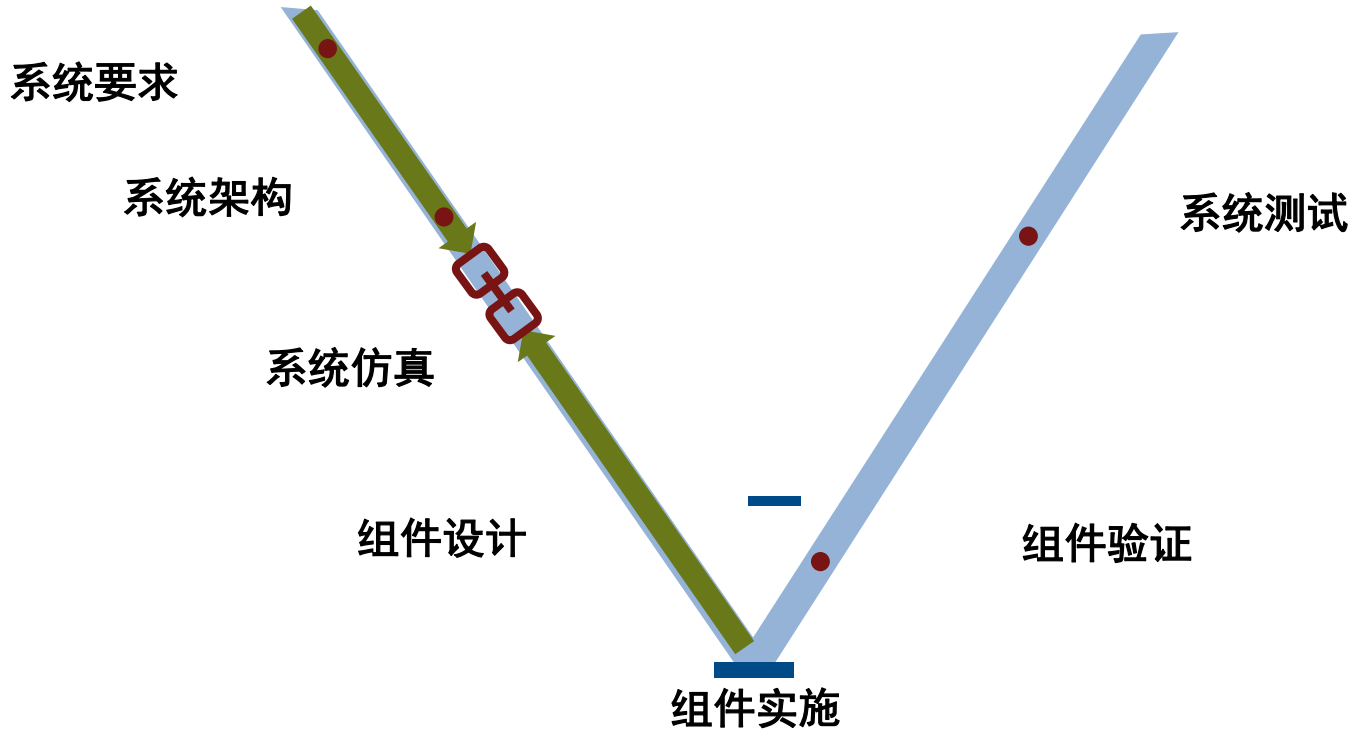
软件和系统架构

- 系统工程：System Composer

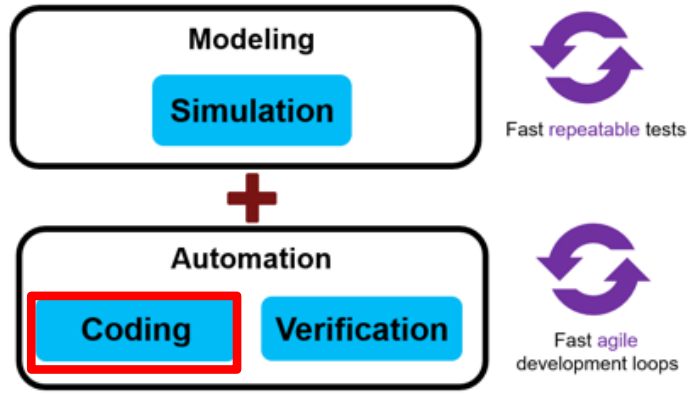
深层解决方案

- 控制，信号处理，射频，视觉，机器人，....
- 行业产品及行业参考应用 (Aerospace Blockset, Aerospace Toolbox, 信号处理，视频算法， ...)
- 人工智能 (机器学习, 预测与维护, ...)

链接自上而下和自下而上的工作流程



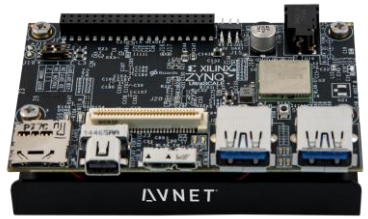
针对不同应用和目标的代码生成



CPU / DSP
Low Cost

Embedded Coder (C/C++)

FPGA / ASIC
Lowest Power

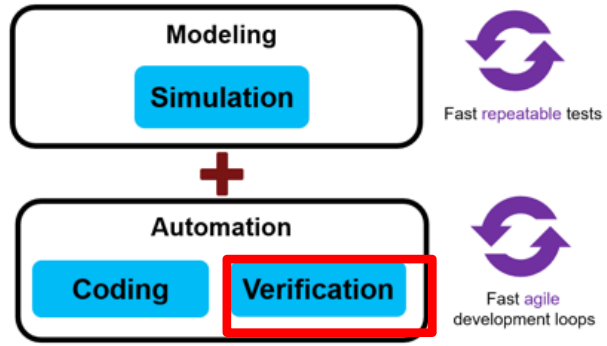


HDL Coder (VHDL/Verilog)

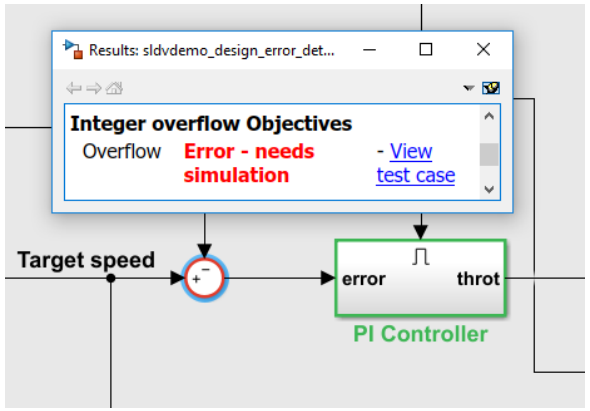
GPU
Fastest

GPU Coder (CUDA)

自动测试和验证

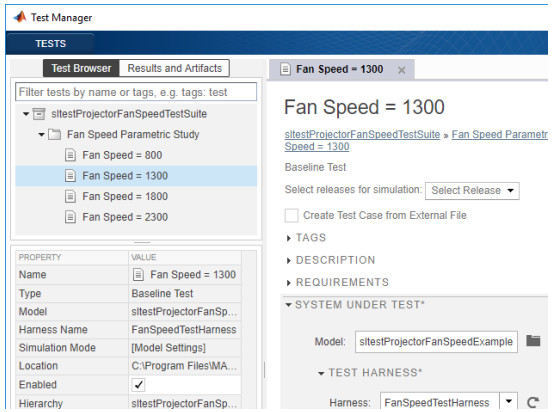


发现错误



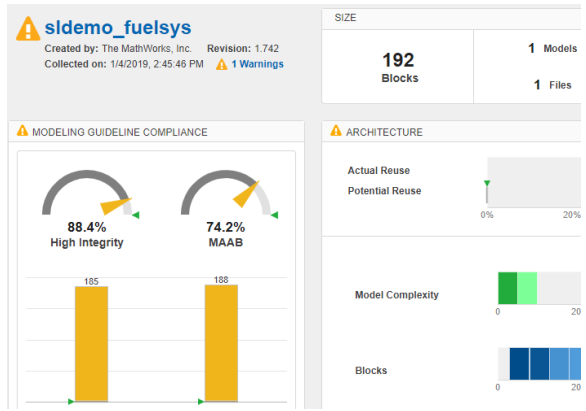
Simulink Design Verifier
Polyspace Bug Finder

管理测试



Simulink Test

检查和覆盖



Simulink Check
Simuink Coverage

检查代码

Code Verification Results : Verified

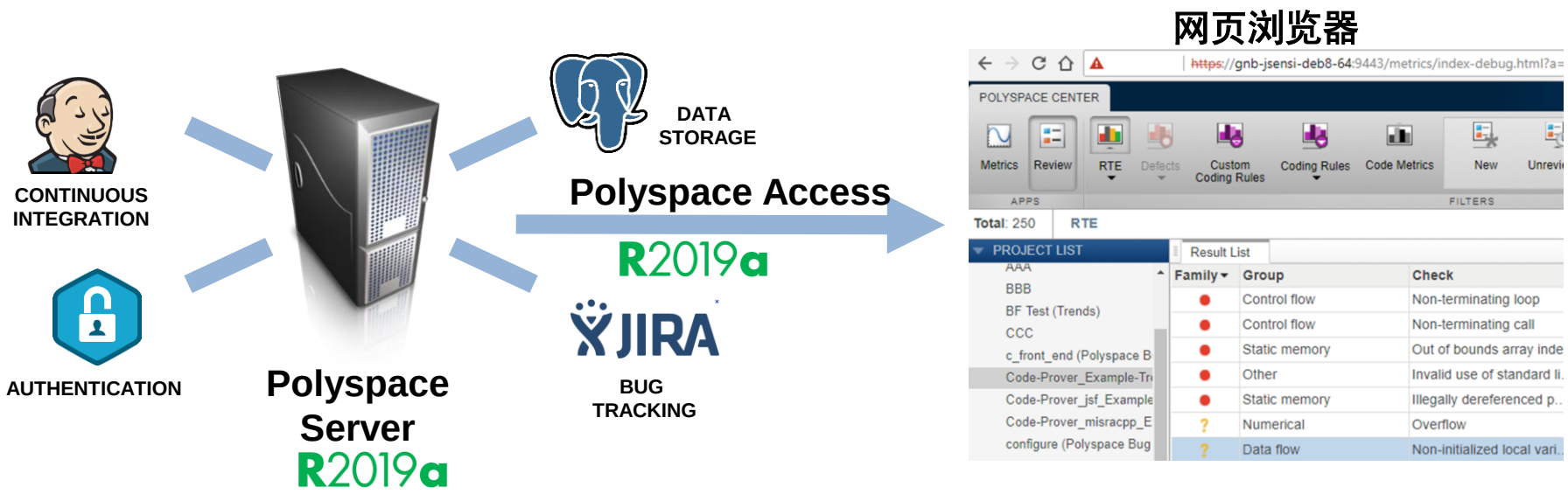
Function Interface Verification Results : Verified

Function	Status	Details
slcidemo_roll_initialize	Verified	-
slcidemo_roll_step	Verified	-

Model To Code Verification Results : Verified

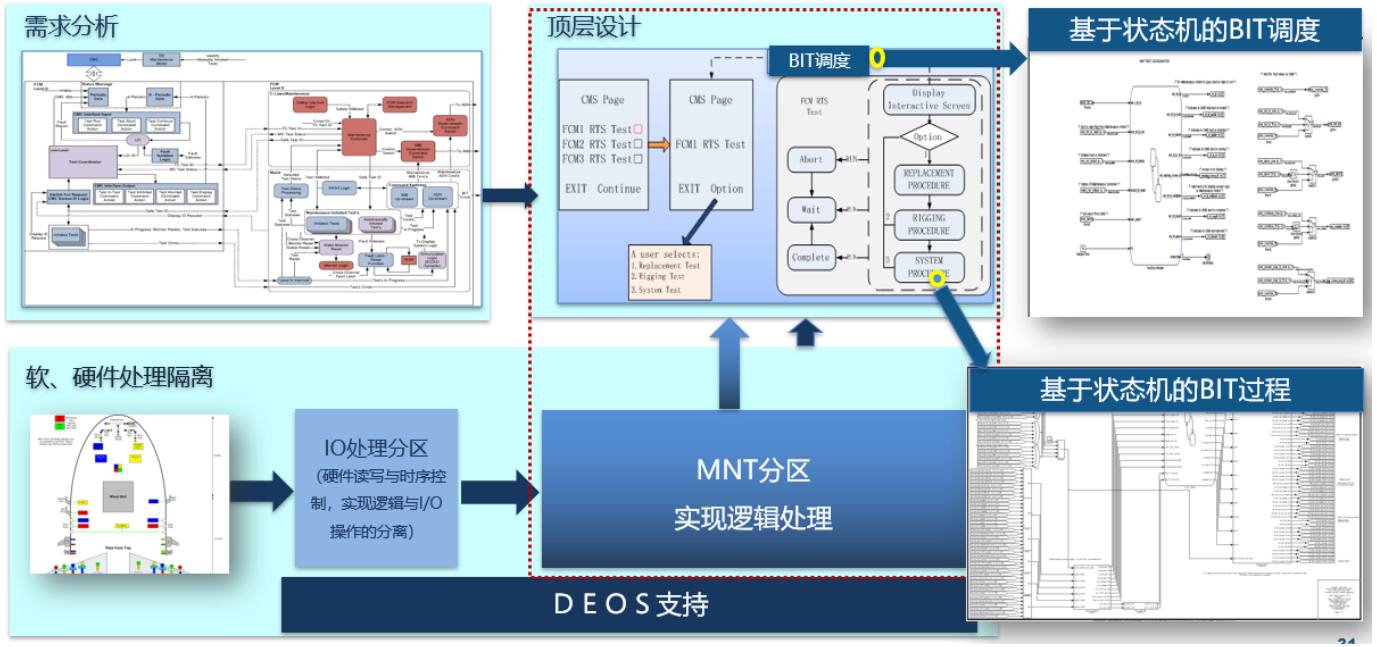
Status	Details	
Verified	Model objects with status Verified :	42
	Model objects with status Partially processed :	0
	Model objects with status Unable to process :	0
	Model objects with status Failed to verify :	0

在线访问测试和验证


CONTINUOUS INTEGRATION
AUTHENTICATION
Polyspace Server R2019a
DATA STORAGE
Polyspace Access R2019a
JIRA
BUG TRACKING
网页浏览器
https://gnb-jsensi-deb8-64:9443/metrics/index-debug.html?a=
POLYSPACE CENTER
Metrics
Review
RTE
Defects
Custom Coding Rules
Coding Rules
Code Metrics
New
APPS
FILTERS
Total: 250
RTE
PROJECT LIST
Result List
AAA
BBB
BF Test (Trends)
CCC
c_front_end (Polyspace B
Code-Prover_Example-Tr
Code-Prover_jsf_Example
Code-Prover_misracpp_E
configure (Polyspace Bug
Family
Group
Check
Control flow
Non-terminating loop
Control flow
Non-terminating call
Static memory
Out of bounds array inde
Other
Invalid use of standard li
Static memory
Illegally dereferenced p
Numerical
Overflow
Data flow
Non-initialized local vari

助力中国国产大飞机 (实例)

基于模型设计完成C919项目的核心维护功能调度



Honeywell
THE POWER OF CONNECTED

助力中国国产大飞机一飞冲天!

1架卓越客机!

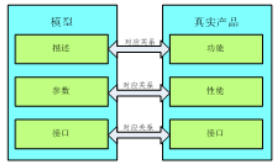
“伴随C919翱翔天际的是几代人的希冀。无数航空人将青春与梦想挥洒在C919研发、制造和测试的每一个环节，最终造就了这架中国航空史上最先进的国产大型客机。我们衷心祝贺中国商飞!”

与中国合资伙伴一路同行

助力中国航天(实例)

01 某型号分系统设计与仿真(Simulink-Stateflow)

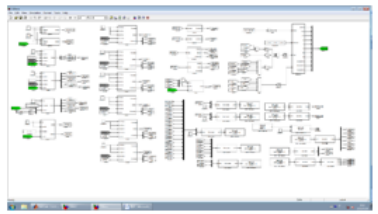
- 对产品的功能、性能、时序、接口、供电逻辑等进行了细致地描述，能够以数字化手段实现对系统的近似半物理的建模。

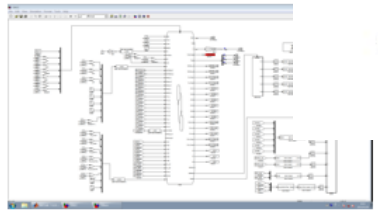


求 实 / 求 是 / 卓 越 / 超 越 北京控制工程研究 Beijing Institute of Control Engineering

02 某型号分系统快速原型(Simulink-Embedded Coder)

1. 将相关的硬件接口驱动等包装成模型库，添加到模型中;
2. 完成模型的自动代码生成并将代码与VxWorks相关文件联合编译，生成下位机可执行程序;
3. 下载到目标机，运行目标代码，目标机成为产品的快速原型;





02 某型号分系统快速原型(Simulink-Embedded Coder)

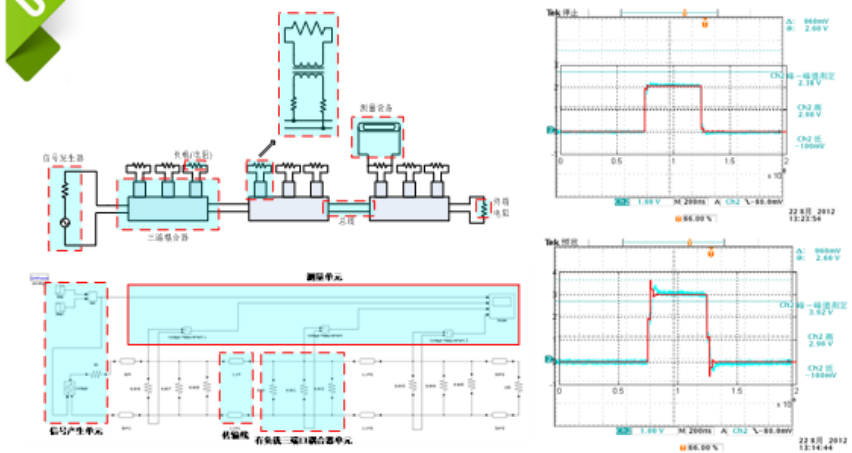
4. 控制器模型下载在一个下位机中;
5. 除控制器以外的模型下载在另外一个下位机中;
6. 两者通过1553B链路进行数据通信;
7. 上位机对下位机的运行进行控制，对产生的数据进行监视。

03 某型号分系统硬件在环(Simulink-HIL)

针对AT697/BM3803等航天用处理器的硬件在环开发

操作系统	通信接口	资源封装
VxWorks for SPARC	处理器片上串口	GPIO 串口 定时器等

04 奉送：1553B总线电气性能仿真(Simulink-Simscape)



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