

在先进研究中利用MATLAB和Simulink平台加速 理论到工程实践

MathWorks CHINA MATLAB TOUR 2016

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演讲人介绍



- 罗龙，电子科技大学，通信与信息系统博士学位
- 华为技术有限公司算法架构设计部部长，主要从事通信系统算法研究、芯片架构设计等工作。
- 先后从事过无线WCDMA、LTE/5G、光通信、微波、铜线及SDN/IP等领域算法及架构设计

目录

- 基本情况介绍
- 面临的挑战和未来策略
- **MATLAB和Simulink应用效果**
- 经验总结

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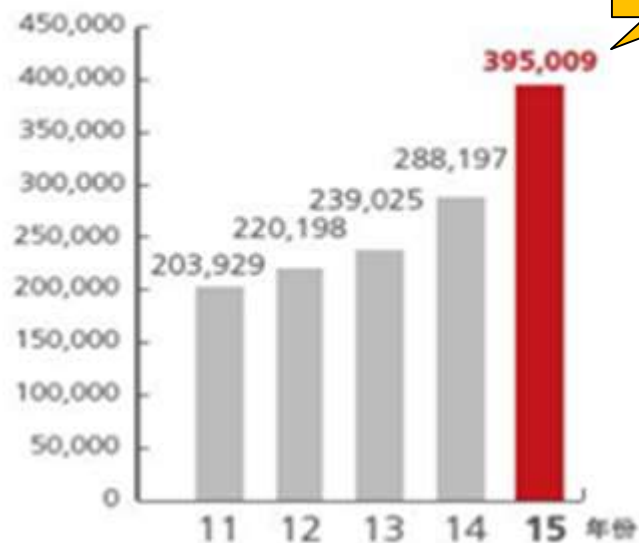
华为公司介绍



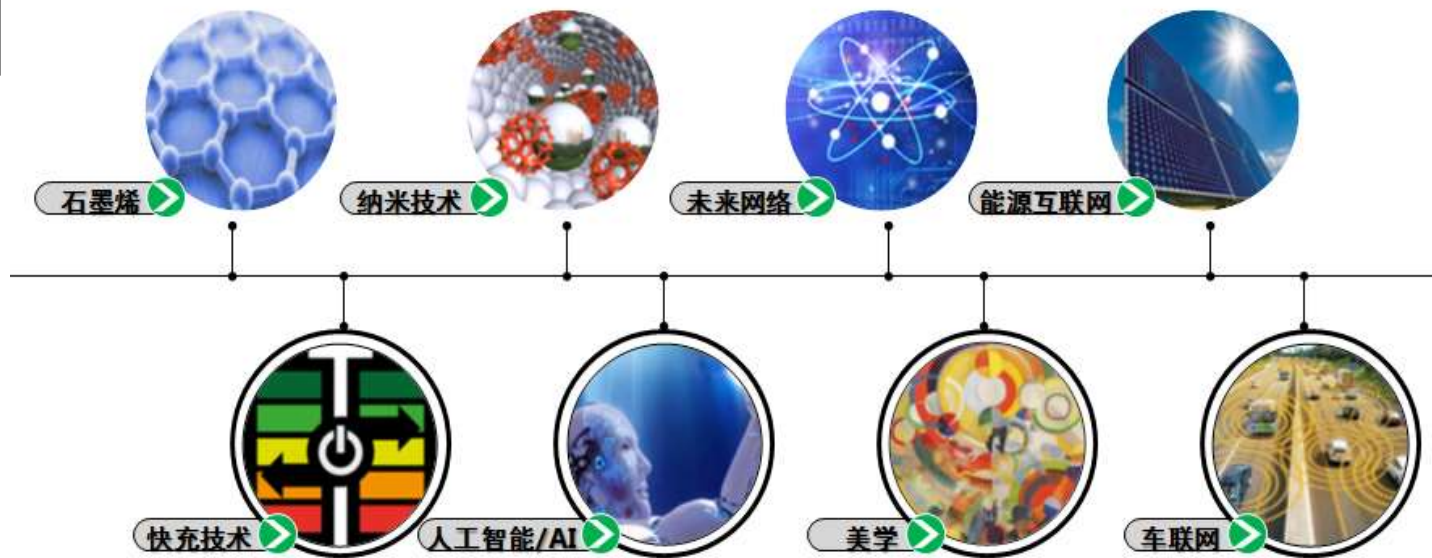
持续研发投入，参与重塑未来的创新

年复合增长率：18%

人民币百万元



15年研发投入
59607

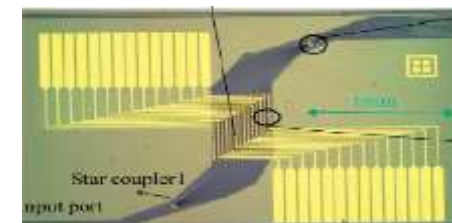


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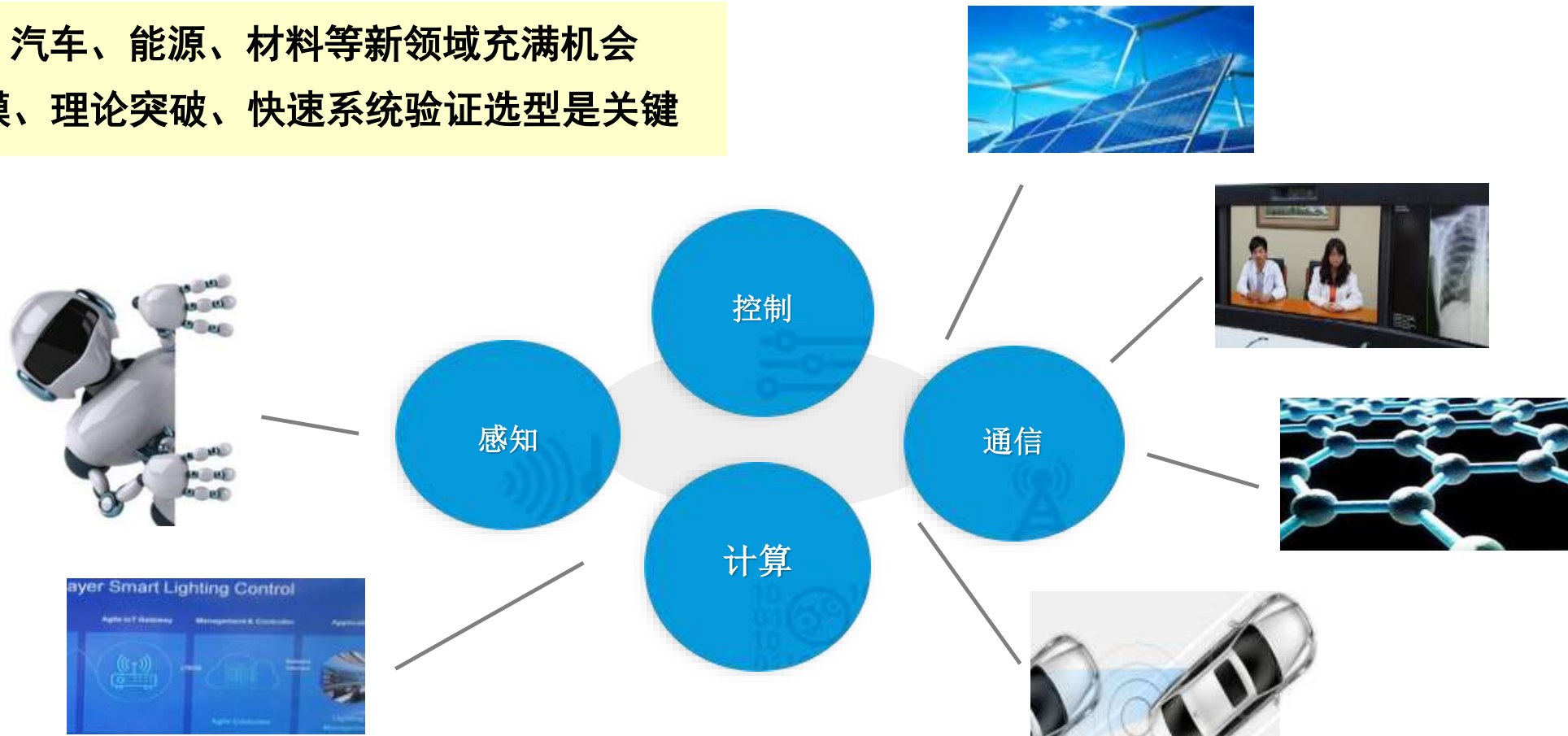
通信网络技术持续创新

- 随着业务的发展，未来网络及终端面临巨大的创新机会
- 高效的系统设计、快速样机验证选型、利用业界成果是关键



开拓重塑未来新领域

- 物联网、医疗、AI、汽车、能源、材料等新领域充满机会
- 机器学习、数学建模、理论突破、快速系统验证选型是关键



持续创新所面临挑战

**依托理论突破，加速创新idea工程化、提升产品化效率
更好满足客户需求**

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- 基本情况介绍
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MathWorks解决方案

- MathWorks解决方案很好的帮助了华为应对所面临的挑战
- 在无线领域、光传输领域、终端、及其他新型创新领域发挥了很大作用

MathWorks解决方案

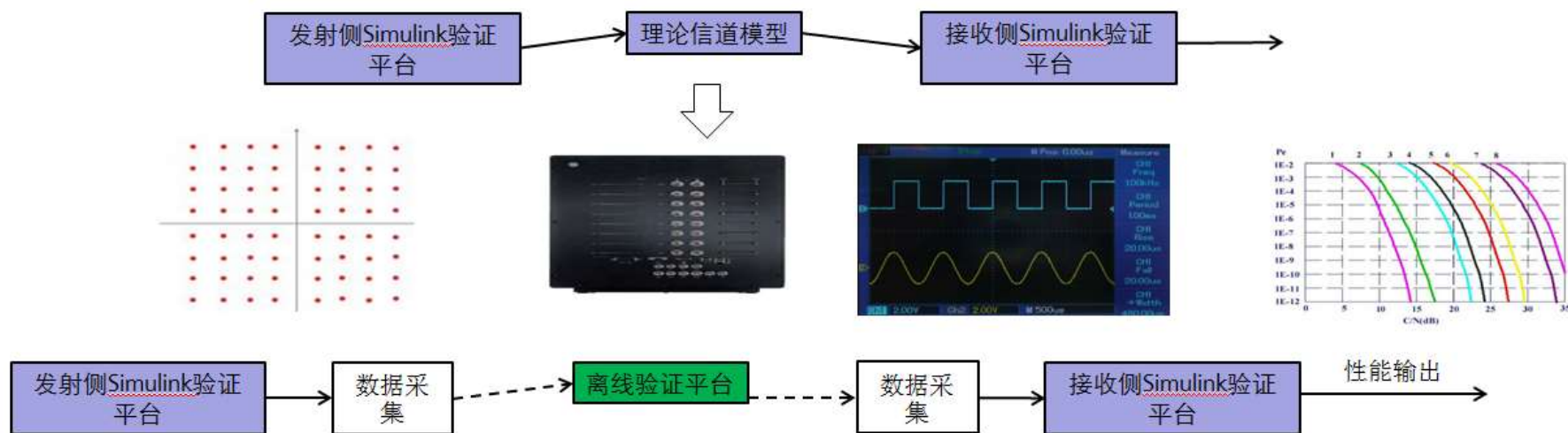
- 基于模型的自顶向下的设计方法
- 完善的工具箱覆盖
- 完备的生态环境
- 代码生成和迭代验证

华为面临的挑战

- 理论与研究与突破
- 多个领域的联合设计、共享，快速的概念选型
- 从模型到样机验证直至工程化的快速迭代
- 业界及学术界理论进展快速集成

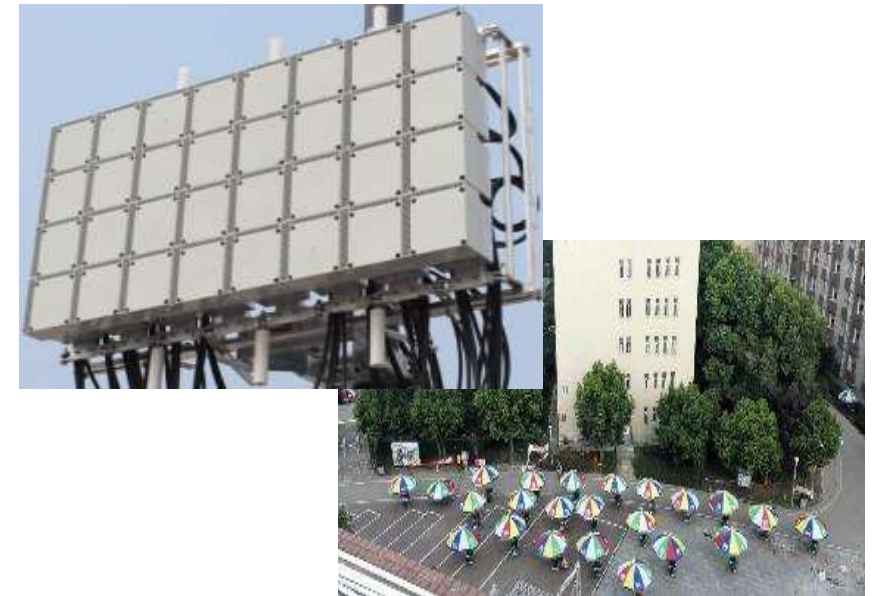
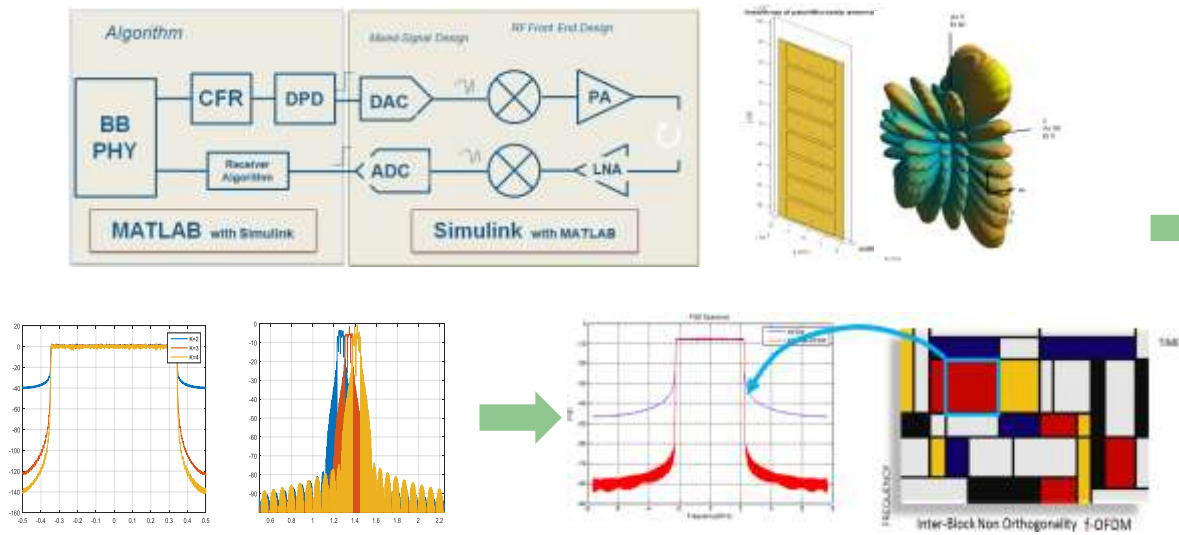
Simulink辅助超高速算法仿真与离线验证

- 搭建发射/接收仿真链路，发送侧数据通过超高速/带宽器件，仪器快速提取/保存离线数据
- 离线数据导入接收侧仿真链路，接收仿真链路对数据进行解调、仿真性能分析



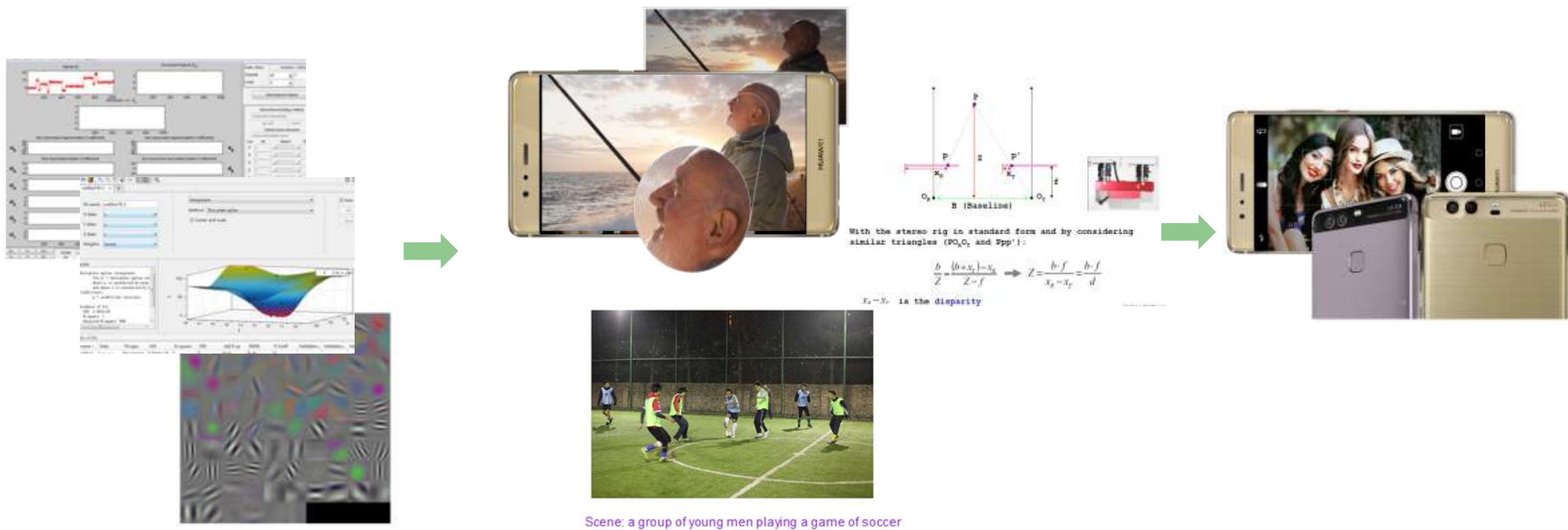
下一代无线新技术设计与验证

- 搭建空口链路、导入参数、模型，算法仿真分析
- 生成硬件代码导入硬件平台验证
- 外场测试及数据报表生成和分析



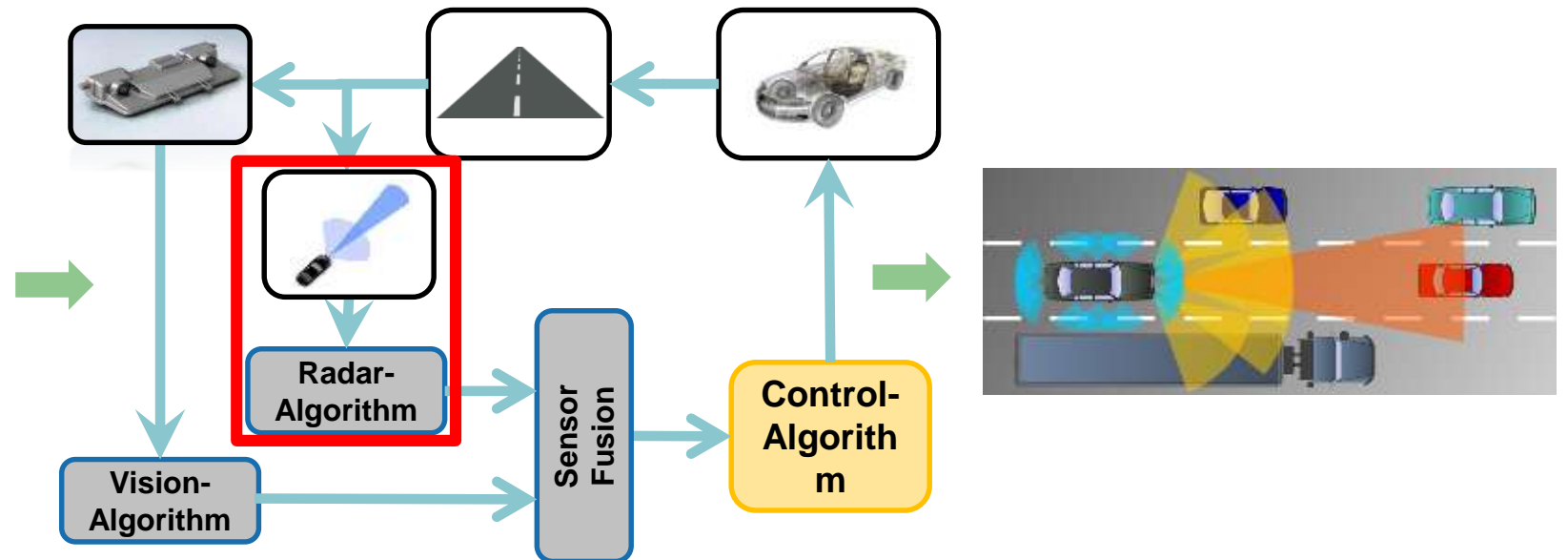
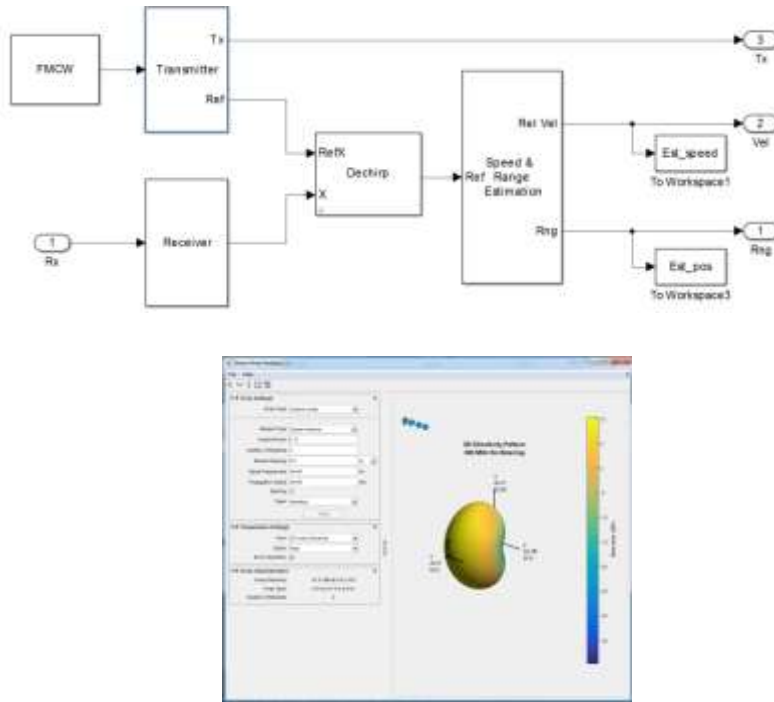
图像处理及识别

- 利用工具箱实现图像补偿、景深计算及计算机图像识别



自动驾驶

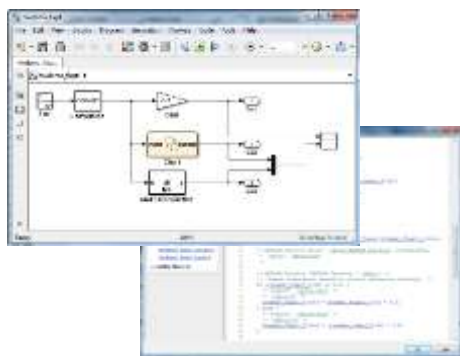
- 通过雷达建模，实现雷达辅助的EAI（Educated Application Intelligence）自动驾驶建模



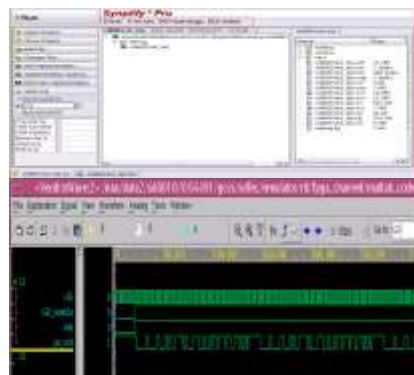
高速FEC代码生成支持快速验证

- 通过代码生成，与手工相比可以提高50%效率
- 资源占用略高于手工编写，时序与手工相当，满足算法验证要求

HDL coder代码生成



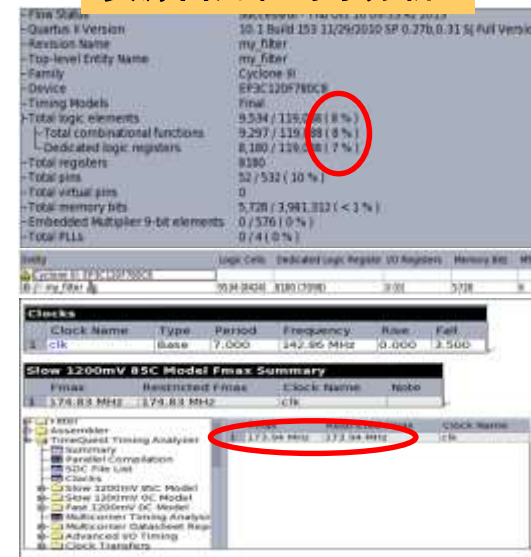
综合/仿真实证



FPGA加载 上板验证



资源占用和时序分析



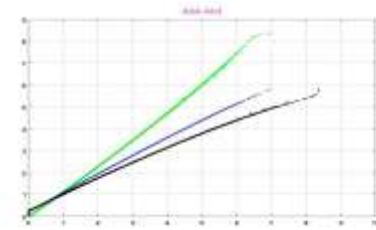
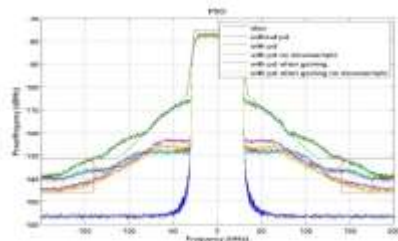
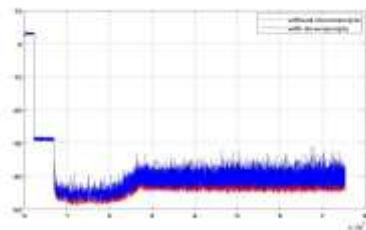
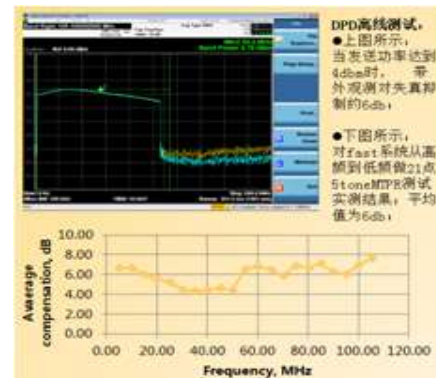
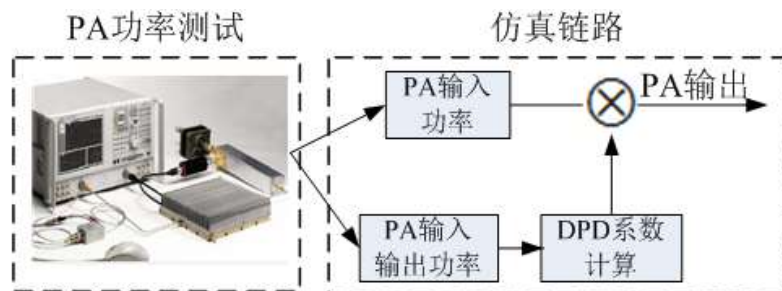
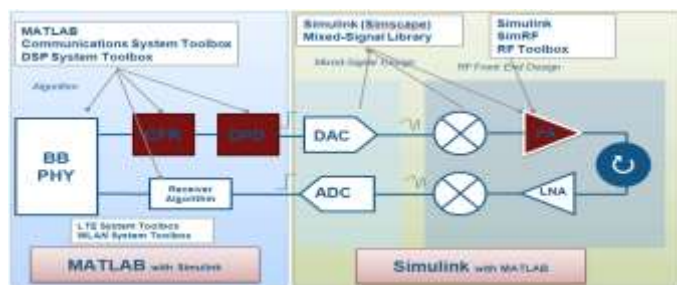
File Name	Value
Quartus II Version	10.1 Build 153 11/29/2010 SP 0.27b.0.31 [6 Full Version]
Revision Name	my_fiber
Top-level Entity Name	my_fiber
Family	Cyclone II
Device	EP2C125F780C8
Timing Models	Final
Total logic elements	9,534 / 116,081 (8%)
- Total combinational functions	9,297 / 116,081 (8%)
- Dedicated logic registers	8,180 / 116,081 (7%)
Total registers	8180
Total pins	52 / 532 (10%)
Total virtual pins	0
Total memory bits	5,728 / 3,941,312 (< 1%)
- Embedded Multiplier 9-bit elements	0 / 576 (0%)
Total FLLs	0 / 4 (0%)

Checks	Clock Name	Type	Period	Frequency	Allow	Fail
1	clk	Base	7,000	142.86 MHz	0,000	2,500

Slow 1200mV BSC Model Fmax Summary	Fmax	Revised Fmax	Clock Name	Note
1	173.94 MHz	173.94 MHz	clk	

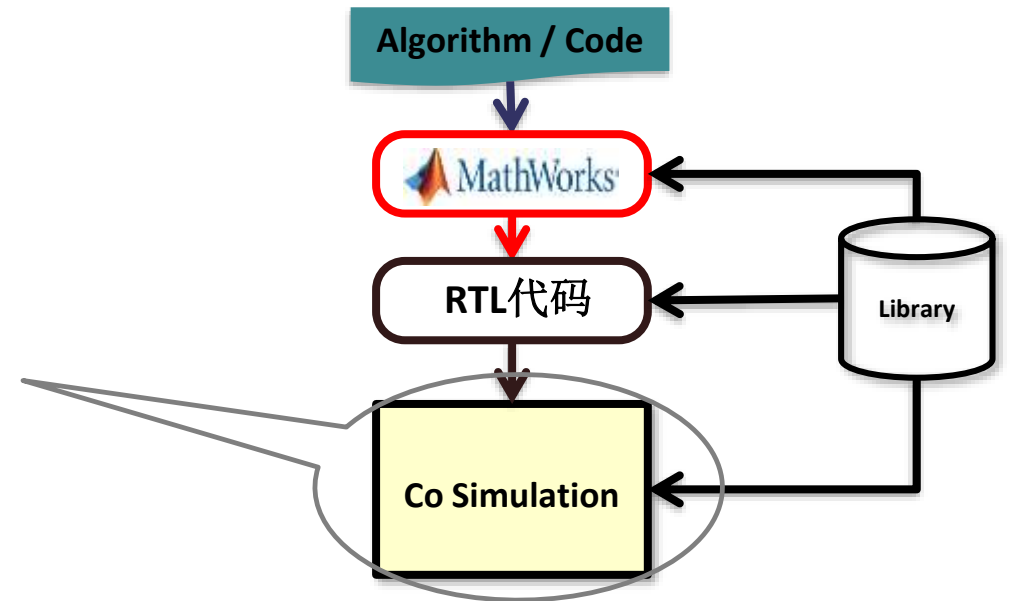
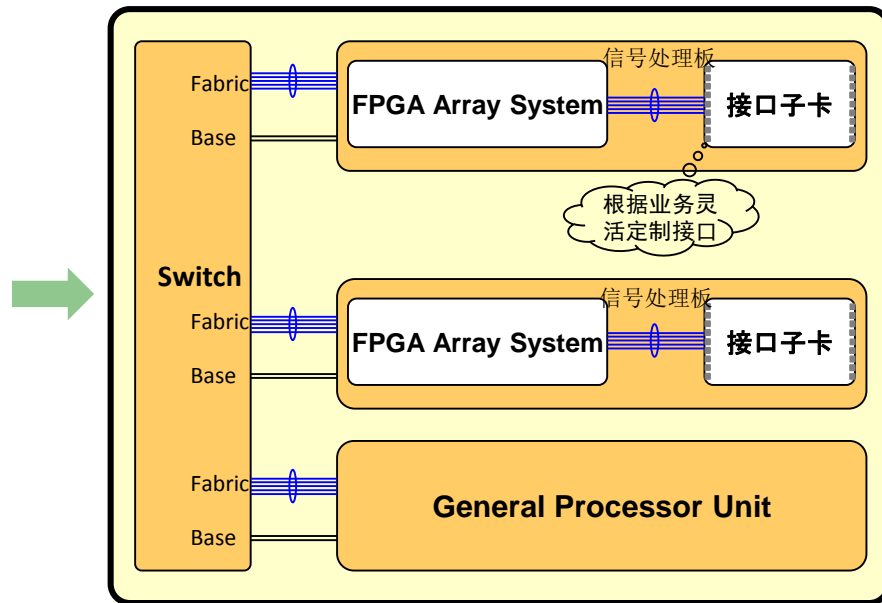
毫米波DPD算法设计

- 根据高频功率放大器类型，建立功放非线性模型
- 通过Simulink进行非线性补偿算法验证



与定制硬件平台结合

- 定制硬件加速算法平台硬件在环系统
- 利用代码生成加速算法验证及选型

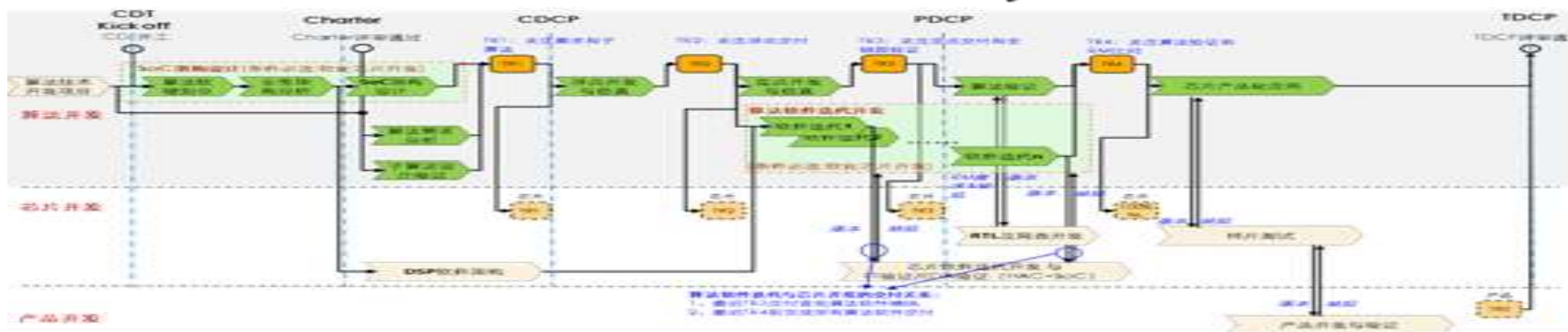
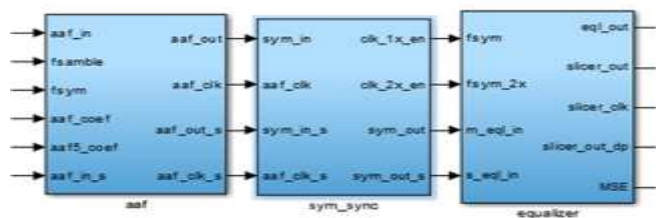


模型驱动的系统设计方法

$$R = HWS + N$$

$$W = SFZ \begin{pmatrix} h_1 & h_2 & h_3 & h_4 \\ h_1 & h_2 & h_3 & h_4 \\ h_1 & h_2 & h_3 & h_4 \\ h_1 & h_2 & h_3 & h_4 \end{pmatrix} S = \begin{pmatrix} s_1 & -s_1^* & -s_1^* & s_4 \\ s_1 & s_1^* & -s_1^* & -s_4 \\ s_1 & -s_1^* & s_1^* & -s_4 \\ s_4 & s_1^* & s_1^* & s_4 \end{pmatrix}$$

$$\begin{cases} \hat{S} = GR + \hat{N} \\ G_{MSE} = [H^H H + \sigma^2 I]^{-1} H^H \\ = H^H [H H^H + \sigma^2 I]^{-1} \\ = H^H R^{-1} \end{cases}$$



- 产品需求导入
- 建模及数学分析

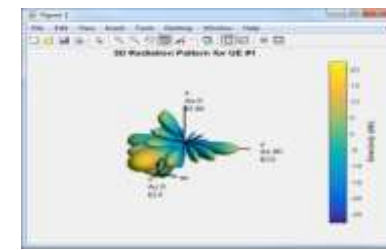
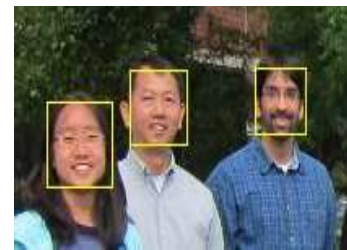
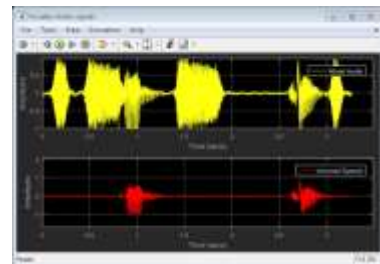
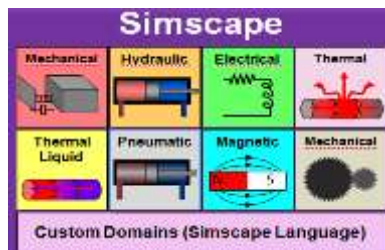
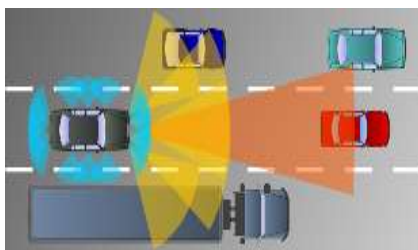
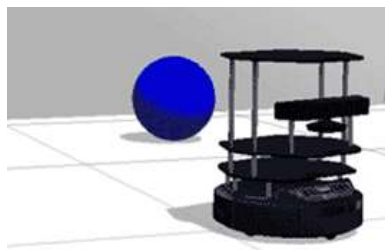
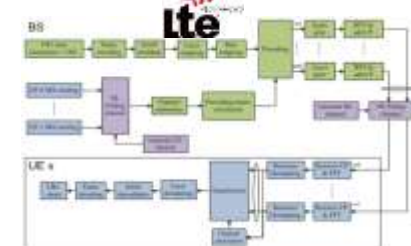
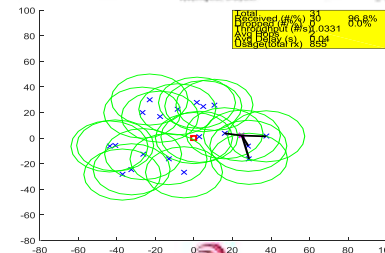
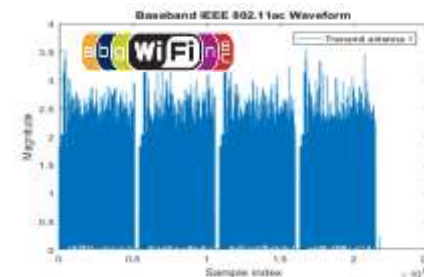
- 搭建系统仿真链路
- 算法选型与优化

- RTL代码生成、调测
- 样机系统验证回归测试

- 支持快速样片及测试

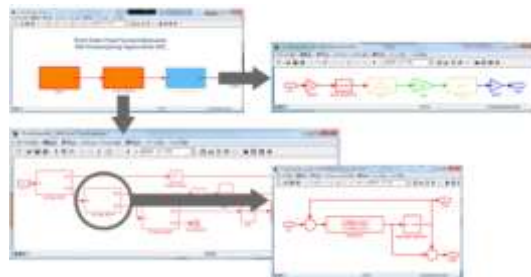
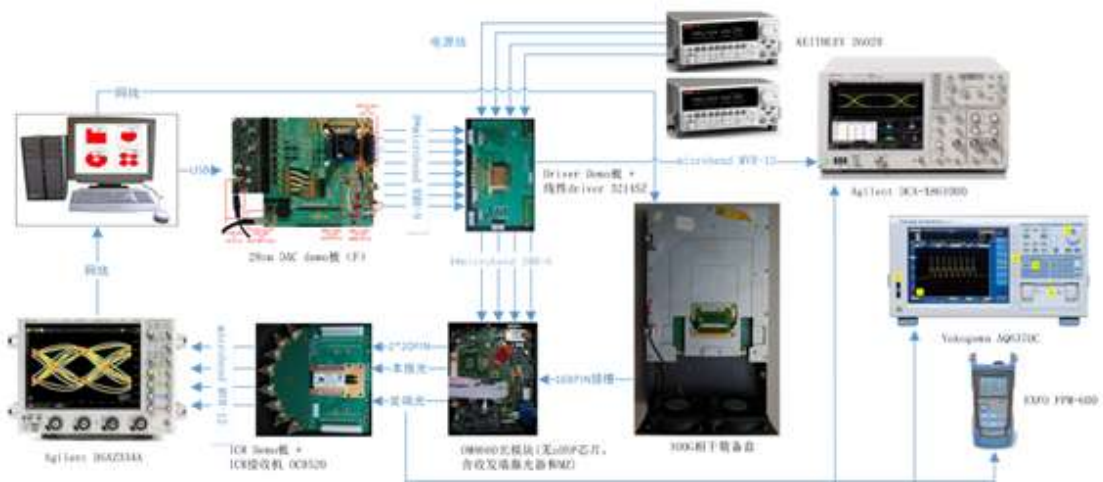
完善的理论/工程应用工具箱

- 支持最新算法理论快速应用
- 及时为最新的创新方向提供帮助
- 完整的工程应用工具箱覆盖
- 为终端、网络、自动驾驶、AI、5G等方面提供了有力的支持

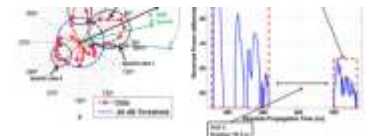


完备的生态环境

- 与业界成熟开发设计工具、仪器仪表无缝结合，快速实现系统设计到工程化实现
- 成为学术界、工业界共享的平台，构建关键算法、模块库，加速理论到实现转化



The Curiosity Mars rover before launch.



NYU WIRELESS 5G Millimeter Wave Statistical Channel Model Suitable for 3GPP and Academic/Industrial Simulations

Project Description
 Extensive measurements and 5G millimeter-wave channel model were developed from 2 to 75 GHz. This work provides a complete statistical channel model and simulation code for MATLAB. The code is highly suitable for 3GPP and other standard channel models and is available for academic and industrial use.



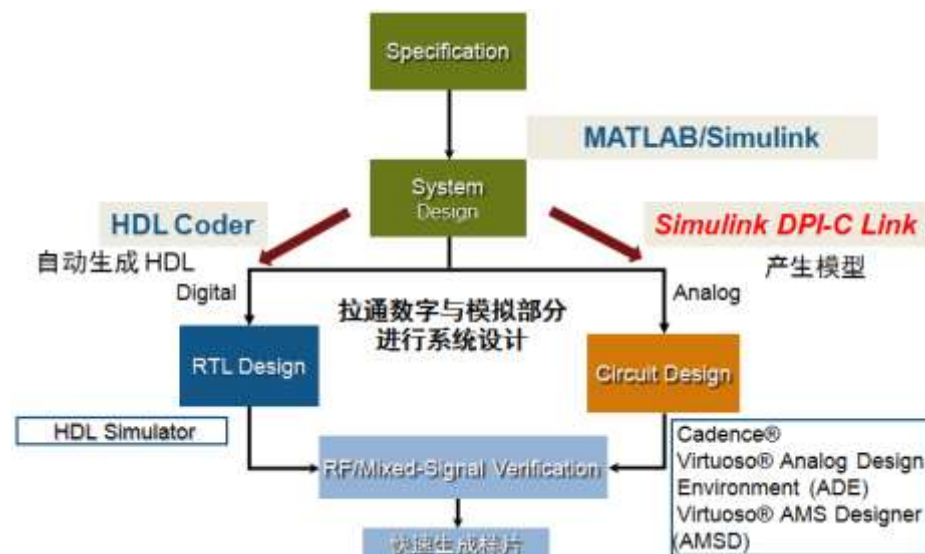
ASIMO, an ATR/Robotics Institute robot developed by Japanese firm and the University of Michigan

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经验总结

- **模型到工程化有较完善的工具链**
 - 强化系统设计、缩短时间：DPD
 - 代码生成节省迭代次数：高速FEC设计
 - 需要与研发流程逐步融合
- **较完备的工具箱有力支持创新需要**
 - 快速理论研究与突破：深度学习
 - 多领域联合设计/共享/快速概念选型：自动驾驶
- **对业界的工具有较好的支撑**
 - 业界及学术界理论进展快速集成
 - 研究成果迅速产业化



下一步展望

- 丰富并促进资源库建设、加强最新理论/热点技术支持
- 满足目标FPGA/DSP要求的高效率代码生成
- 进一步提升超高速信号处理算法仿真效率

Thank you

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