The *Transformative Fusion of* Sensing, Computing, Communication & Control

Richard Rovner
Vice President, Marketing
MathWorks
@RichardRovner

Three Key Points

1. Technologies are fusing together to transform industries, companies, employment, and education.

2. This is happening now, in your work. Many industries, many applications, many markets.

3. MATLAB & Simulink form a technical foundation for this fusion and transformation.

Software update magically makes the Tesla Model S P85D even faster

Over-the-air update will knock 0.1 second off 0-60 time, says Musk

Road & Track 29 January 2015

Tesla Motors' Over-the-Air Repairs Are the Way Forward

Tesla and GM have both issued fire-related recalls, but Tesla's fix doesn't require owners to bring their cars in.

MIT Technology Review 14 January 2014

Tesla Model S

Tesla Says It Will Now Be "Impossible To Run Out Of Range Unintentionally" In A Model S

techcrunch.com 19 March 2015

Google's solar-drone Internet tests about to go airborne

Project Titan gets FCC permission to begin testing

Computerworld 13 March 2015

FACEBOOK LAYS OUT ITS ROADMAP FOR CREATING INTERNET-CONNECTED DRONES

Wired 23 September 2014

Amazon's Drone Delivery Dreams Just Took a Step Closer to Reality

Alex Fitzpatrick @alexjamesfitz | 4:43 PM ET

But don't expect a drone on your doorstep anytime soon

Amazon's hopes of delivering shipments to customers via drones got a little more real Thursday as federal regulators granted the company approval to test its unmanned aircraft.

The Federal Aviation Administration gave Amazon's drones what's called

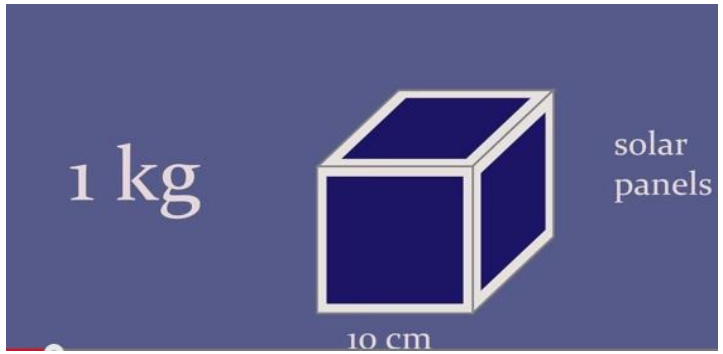
Peter Endig—dpa/Corbis

time.com 19 March 2015

SpaceX launch illustrates NASA's growing use of private companies

Pew Research Center 14 April 2014

Cubesats explained and why you should build one

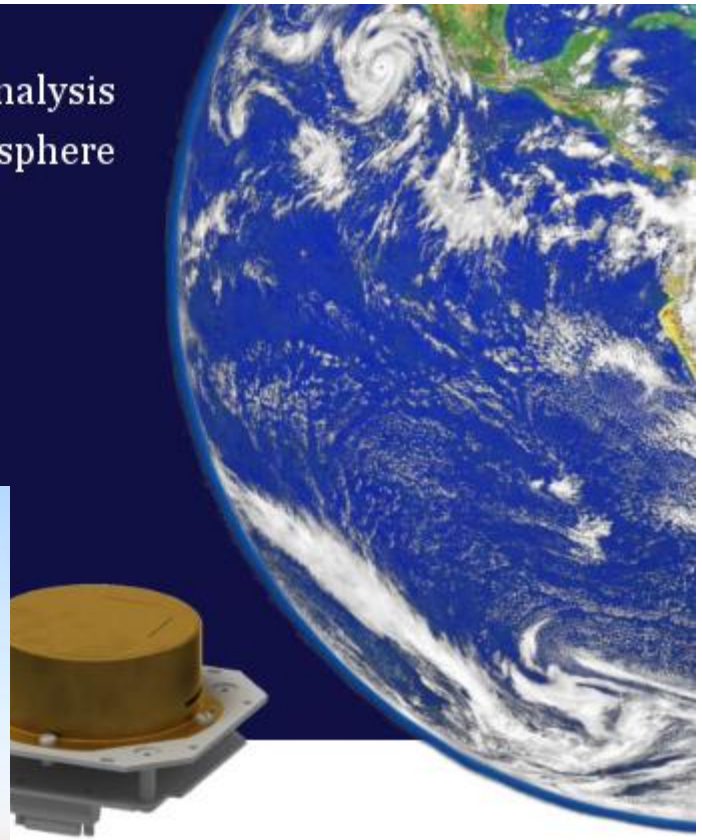


DIY Space Exploration website

MathWorks

Multiple Scientific Instruments for the Analysis of the Lower Thermosphere

- **INMS** (**I**on/**N**eutral **M**ass **S**pectrometer)
- **FIPEX** (**F**lux **Φ** **P**robe **EX**periment)
- **mNLP** (**m**ulti **N**eedle **L**angmuir **P**robe)



7th EUROPEAN CUBESAT SYMPOSIUM

Liège, Belgium

9 - 11 September 2015

www.cubesatsymposium.eu

9th QB50 WORKSHOP

Liège, Belgium

8 September 2015

(by invitation only)

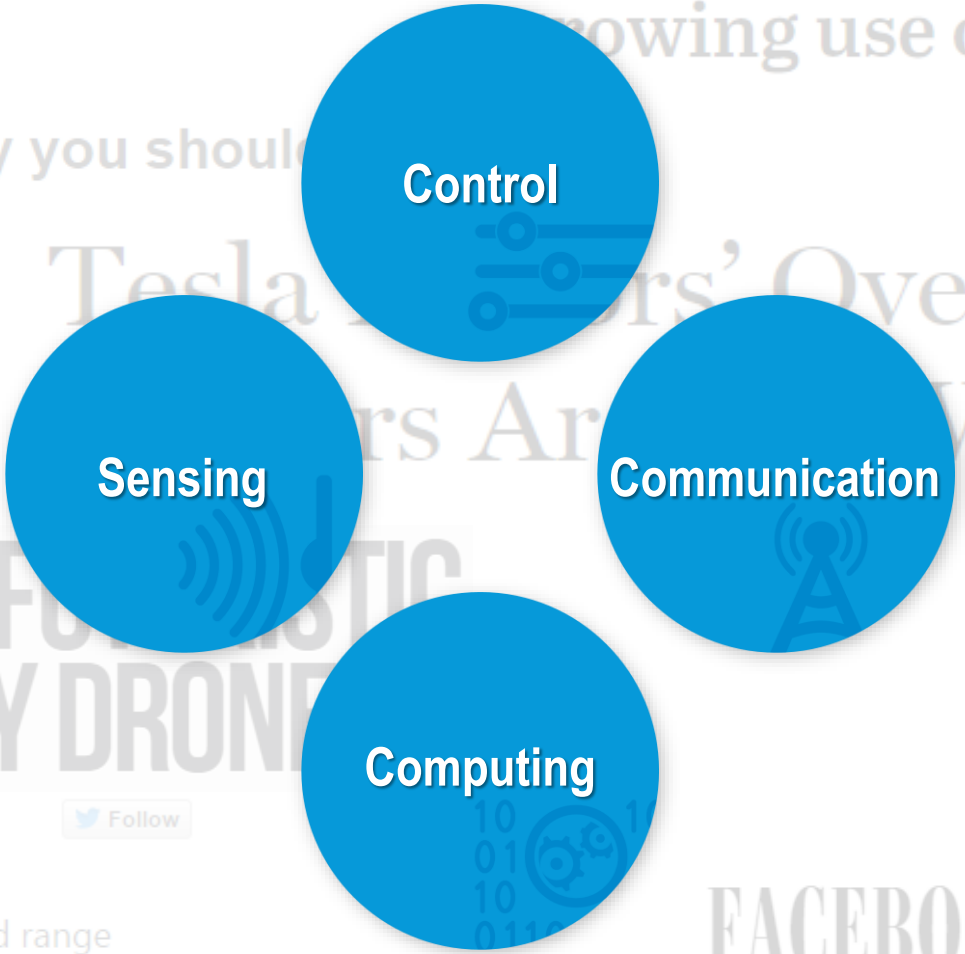
An Apple car? Computer firm hires automotive engineers

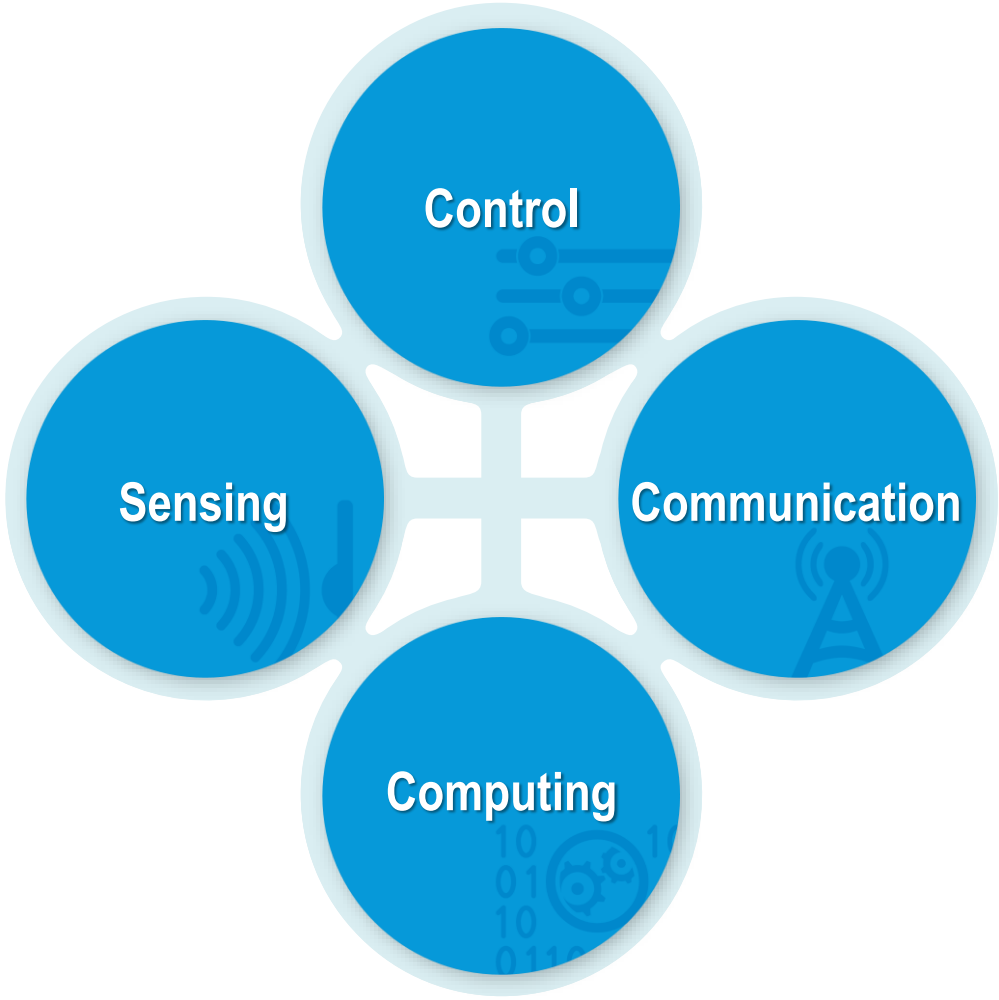
Reports suggest Apple employees are designing and building a car

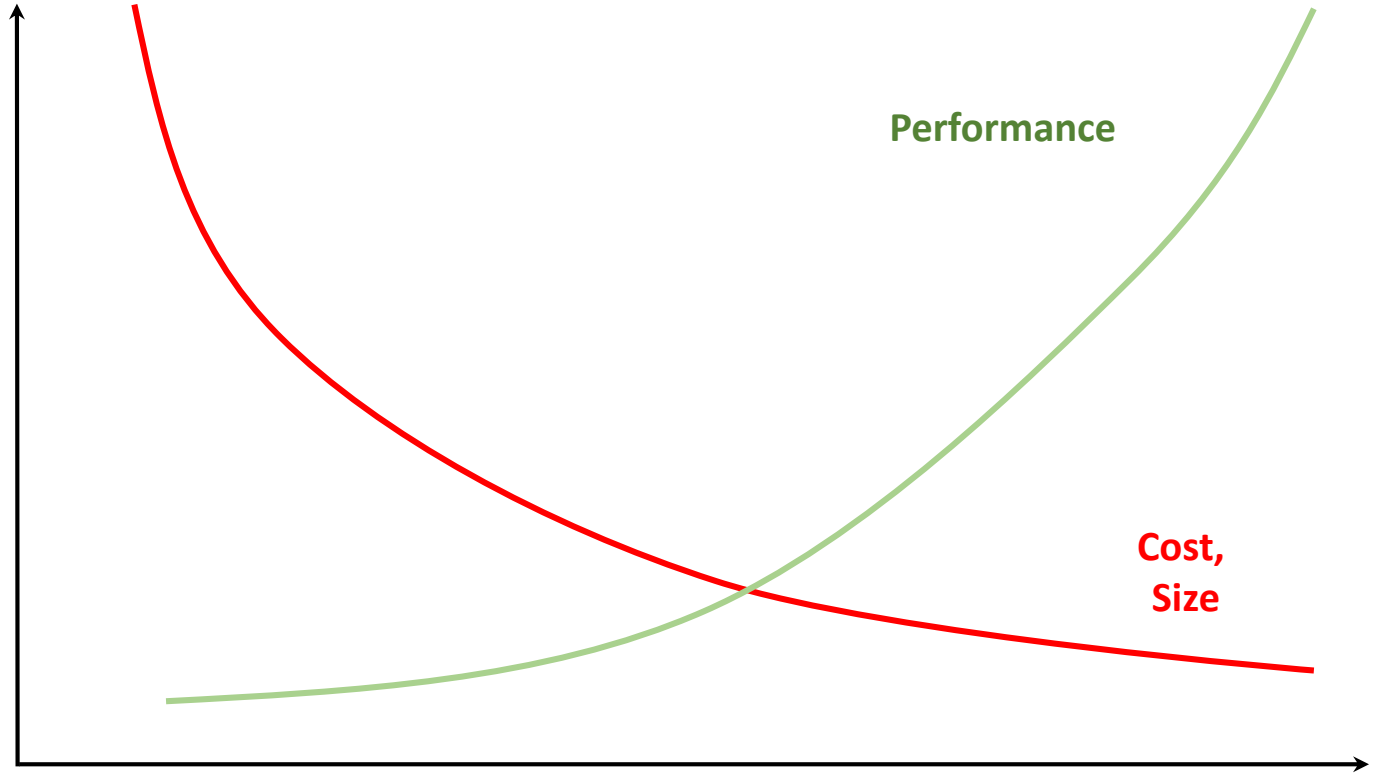
The Guardian 13 February 2015

Ford Opens New Silicon Valley Research Center Led By Former Apple Engineer

Forbes 22 January 2015


Control
Sensing
Communication
Computing





Powerful, low-cost sensors and cameras

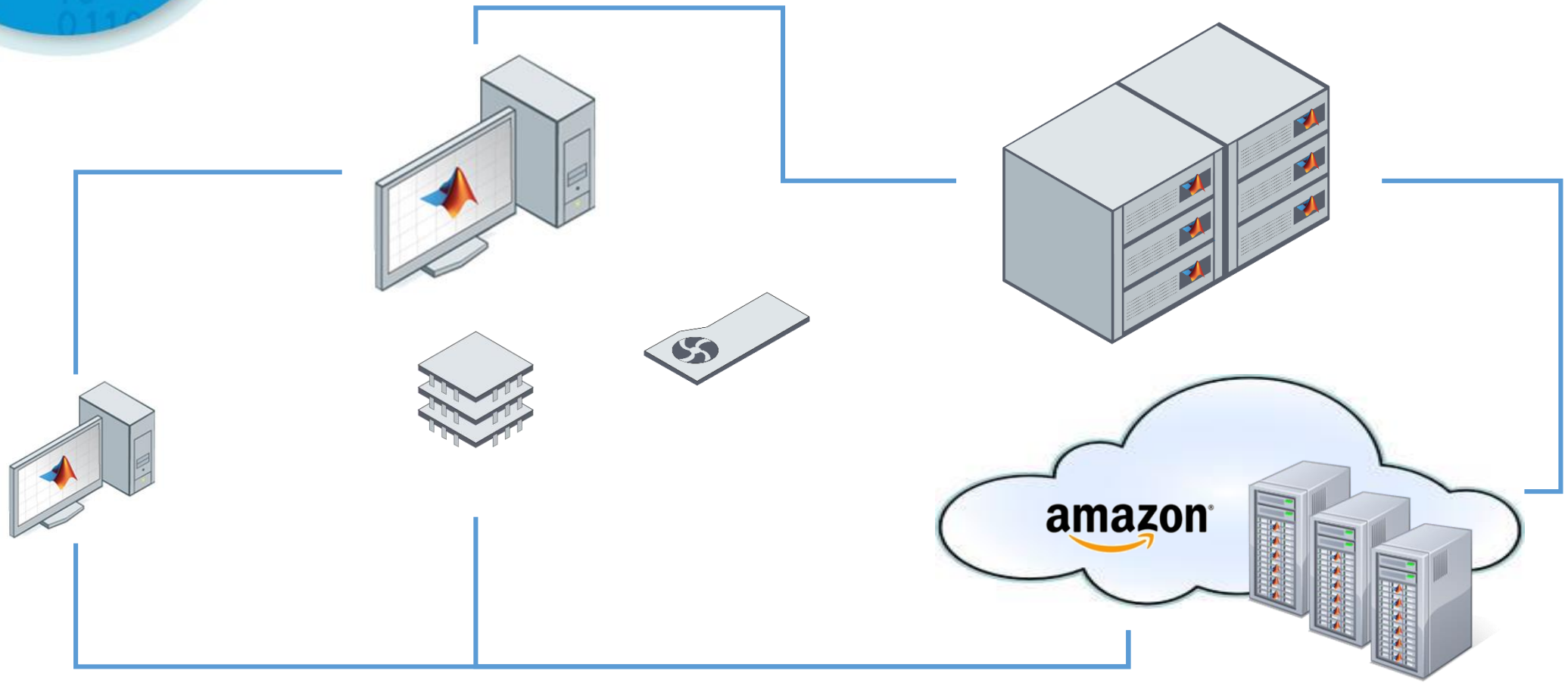
Smartphones have
15 *or more sensors!*

Sensing

MathWorks

Computing

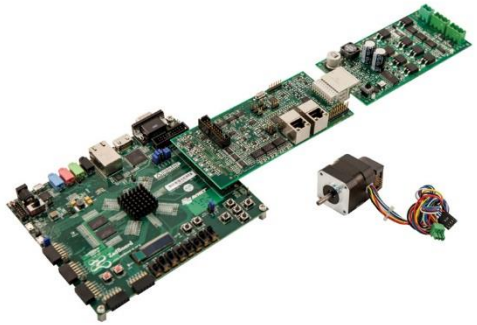
Unlimited computing power



Range of computing choices

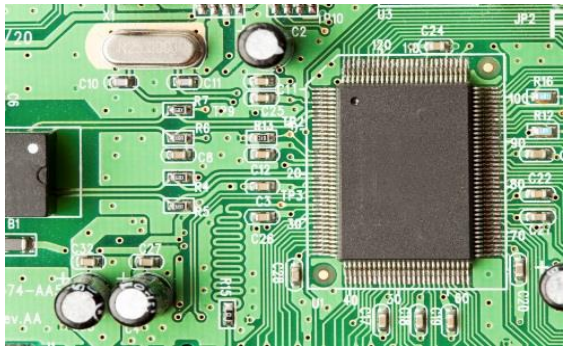
Custom ASIC

Microcontroller



FPGA

Programmable SOC

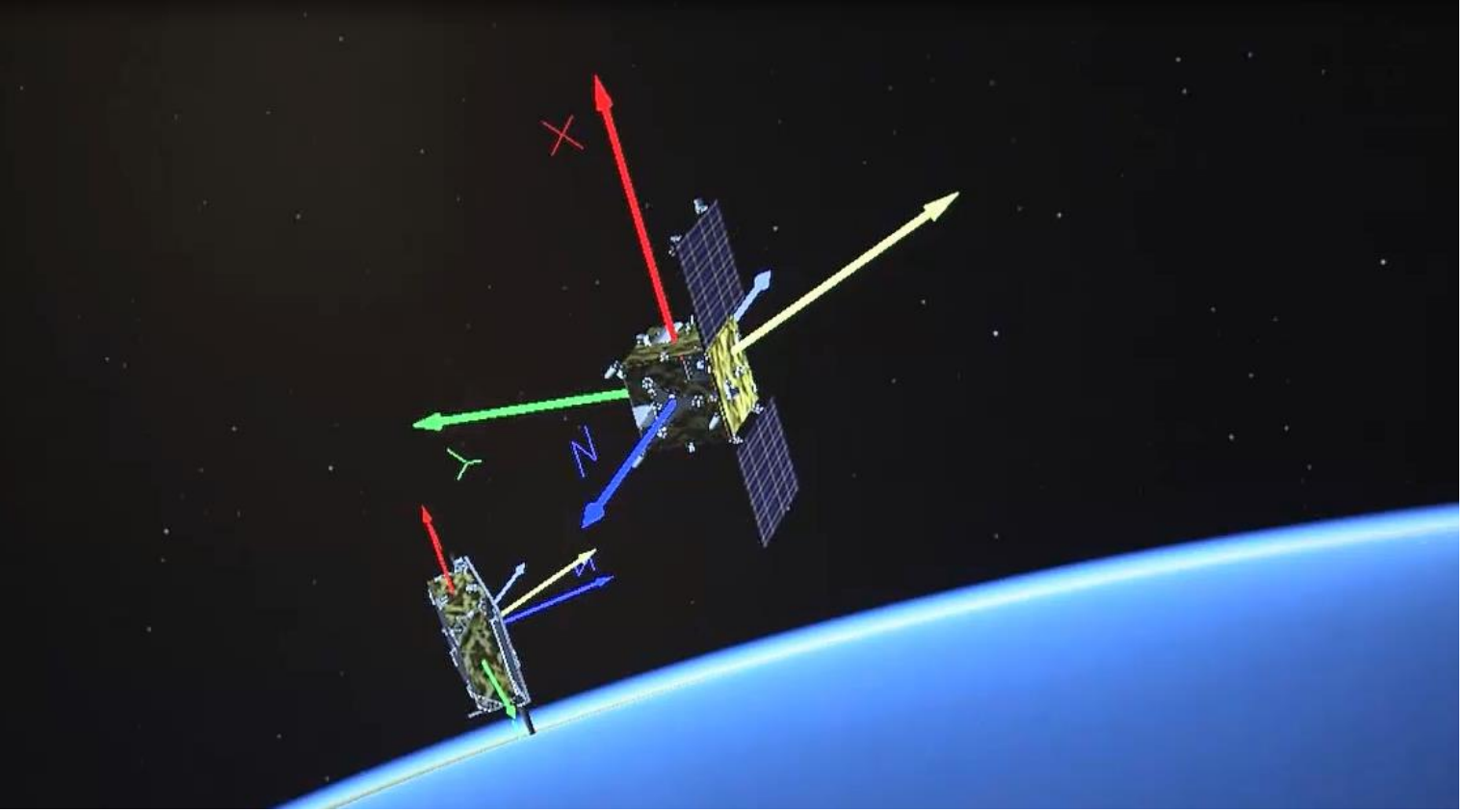


Microprocessor

Communication

4G and beyond

Evolution from 2G to 5G, **Source:** TU Dresden 2013a



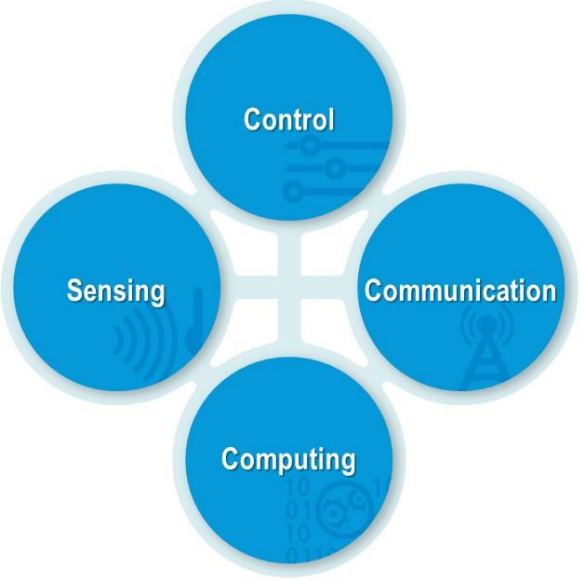
Mango and Tango
Autonomous Formation Flying

"We work with models from concept to implementation, and we have the automatically generated code flying in space."

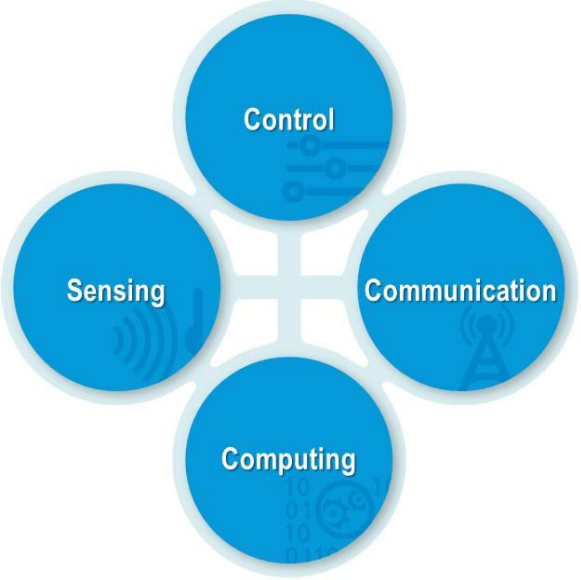
Ron Noteborn,
OHB

Model-Based Design

MathWorks



*Transformation happens when these **combine***

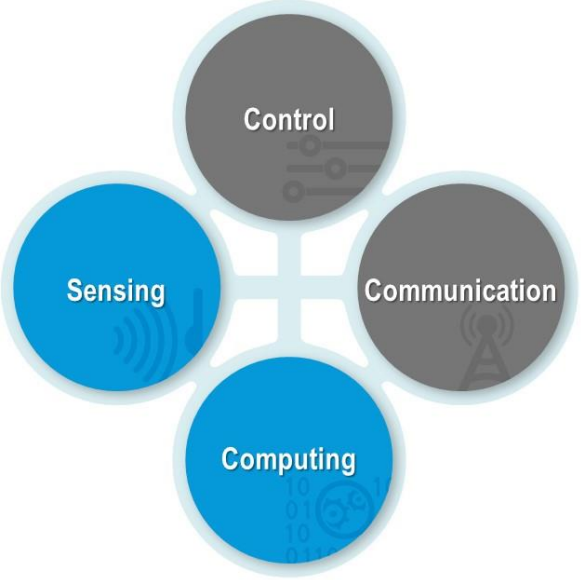


*Transformation happens when these **combine***

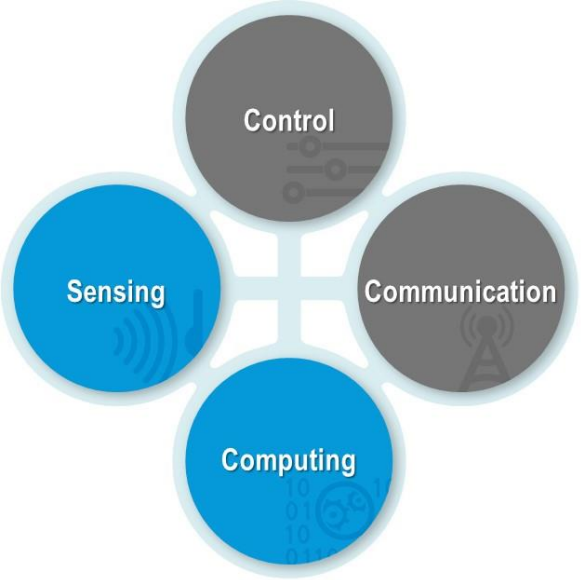
Model-Based Design at CNH – Plenary Session

"This is the highest a
industry. Receiving it creates a p
perception of New Holland in the market."

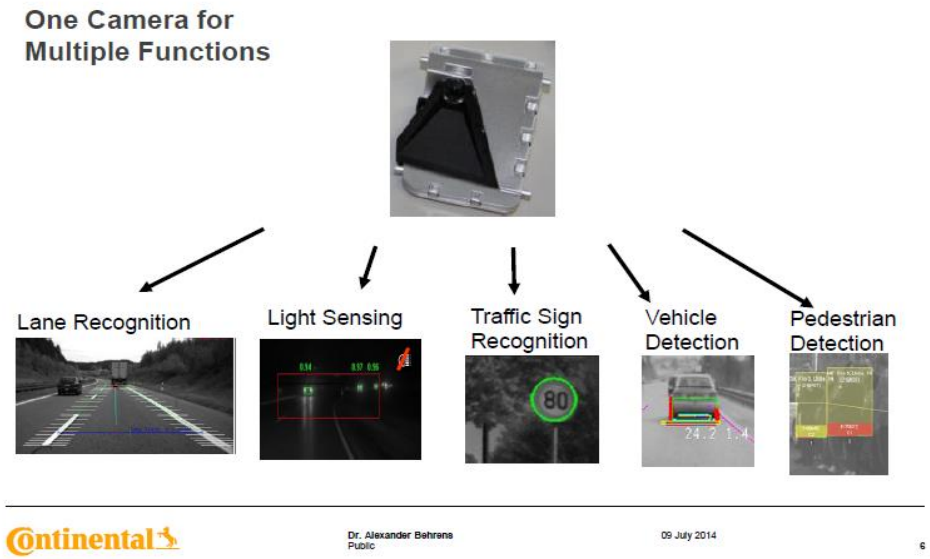
-- Karel Viaene, CNH System Engineer



*Cars processing **video** in real time*

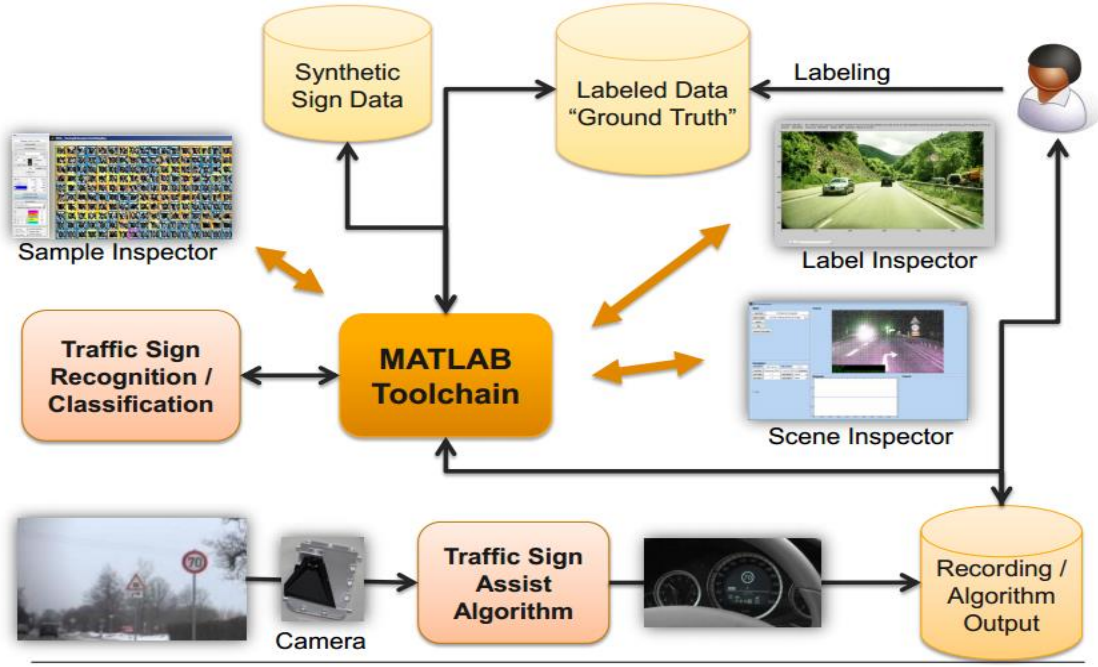


"Traffic sign recognition in driver assistance systems- MATLAB at Continental"
Dr Alexander Behrens, Continental, MATLAB Expo, July 2014, Munich, Germany.



"MATLAB is used in daily work for development and evaluation of driver assistance functions"

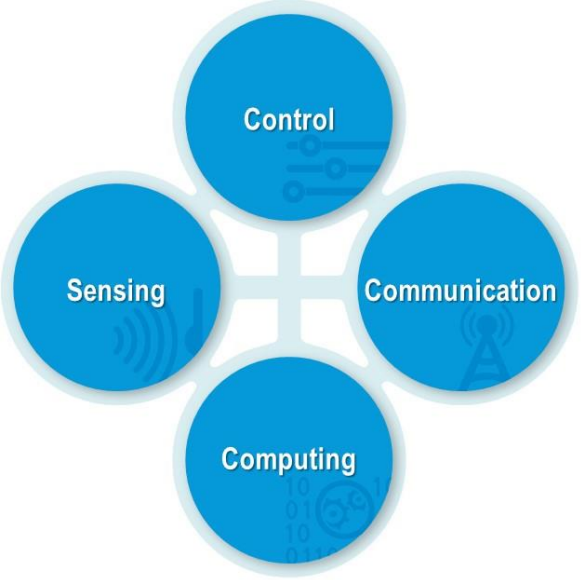
"Engineers having good MATLAB programming skills are in high demand"



***Machine Learning* done with**

Image Processing Toolbox
Signal Processing Toolbox
Statistics and Machine Learning Toolbox

MathWorks

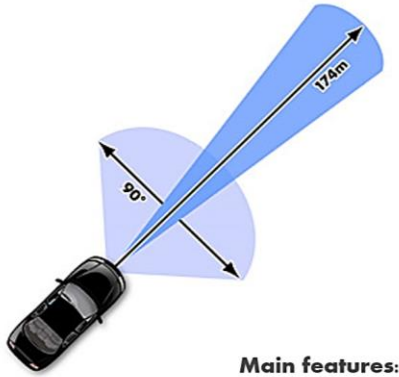


"Design, Analyze, and Implement Radar Sensors' Alignment Algorithm with MATLAB" - Ling Ma, Delphi, MathWorks Automotive Conference, May 2014, Michigan, USA.

*Cars controlled with **video** and **radar***

Delphi Electronically Scanning Radar

Three main properties of radar targets:
- **Range**
- **Range rate**
- **Azimuth**



Main features:
- **Adaptive Cruise Control**
- **Collision Mitigation**
- **Rear and Side Detection System**

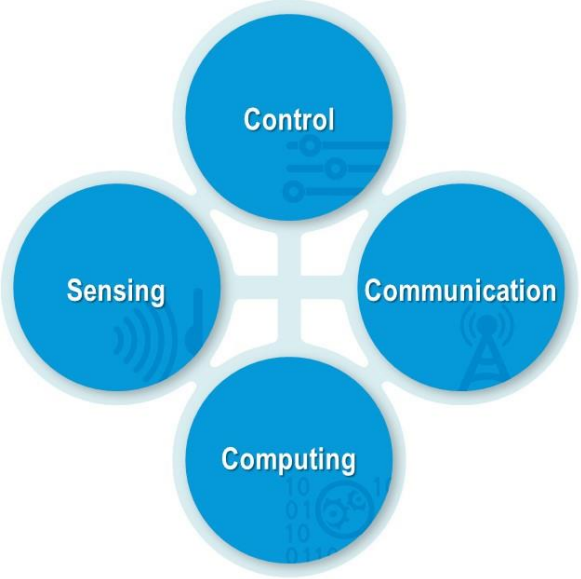
Delphi E&S

DELPHI

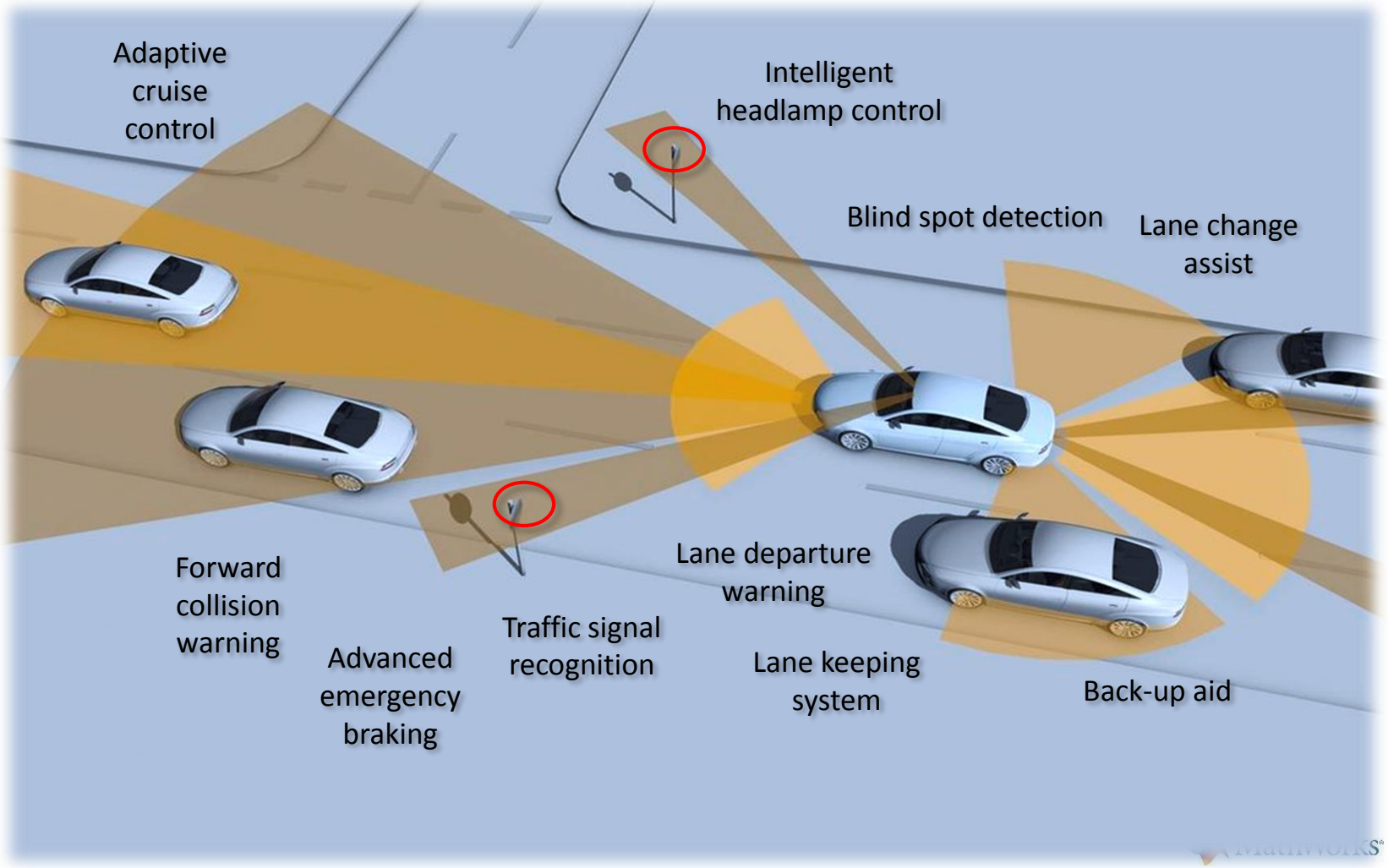
Coder Code Performance

Conclusions:

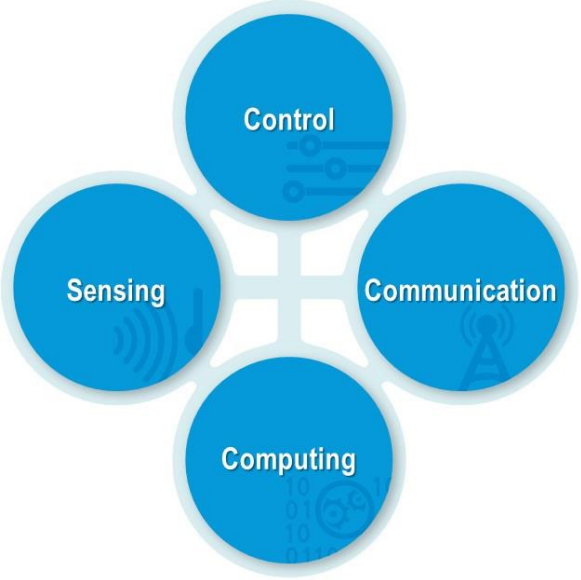
- ✓ Reliable. Coder code has been used in production code for half a year and no bug is found;
- ✓ Efficient. This improved alignment algorithm with coder code can run as fast as previous old algorithm with hand code.
- ✓ Easy to integrate.



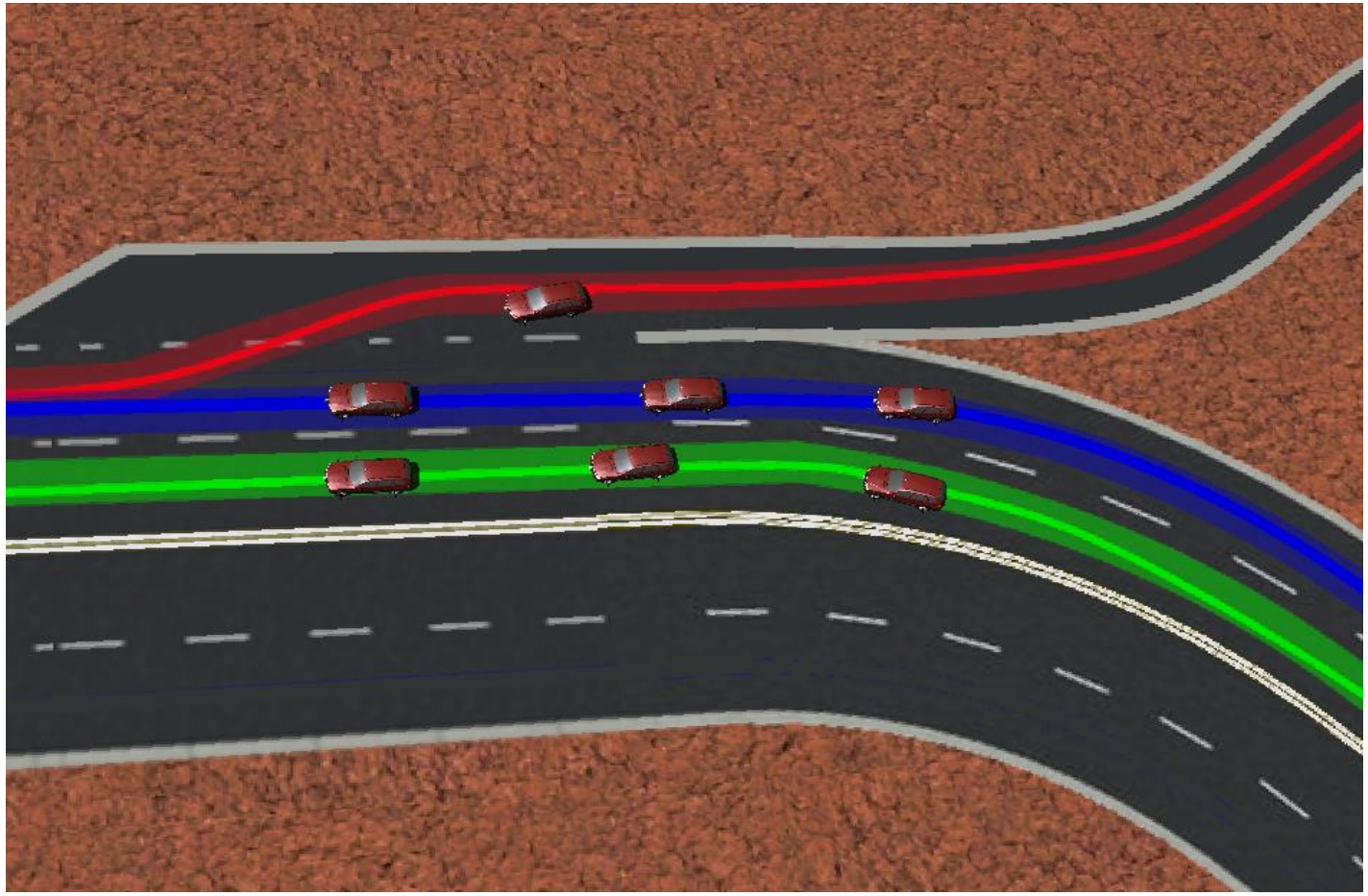
Advanced Driver Assistance Systems (ADAS)



*from "***Advanced Driver Assistance Systems Market"**
Continental AG, KSAE 2011

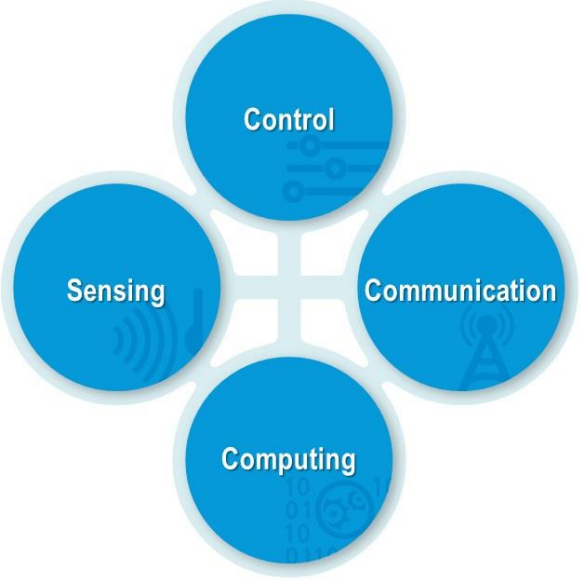


Automated Highway Systems



Dynamic platooning algorithm for intelligent cars

École Polytechnique Fédérale de Lausanne



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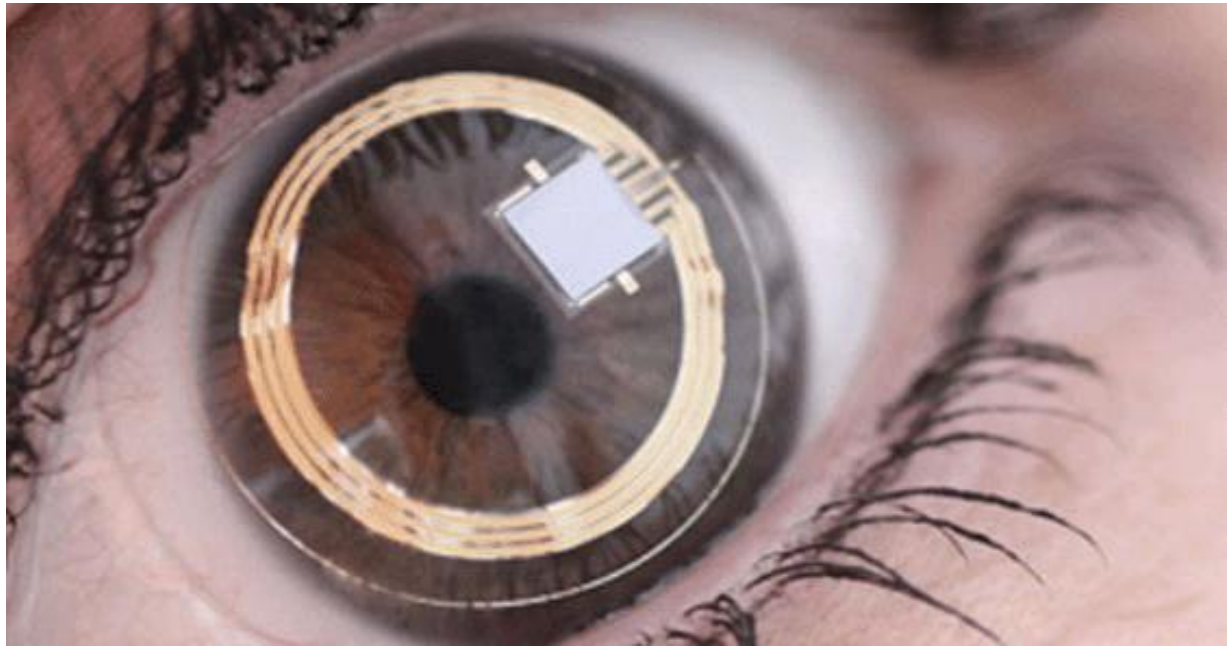
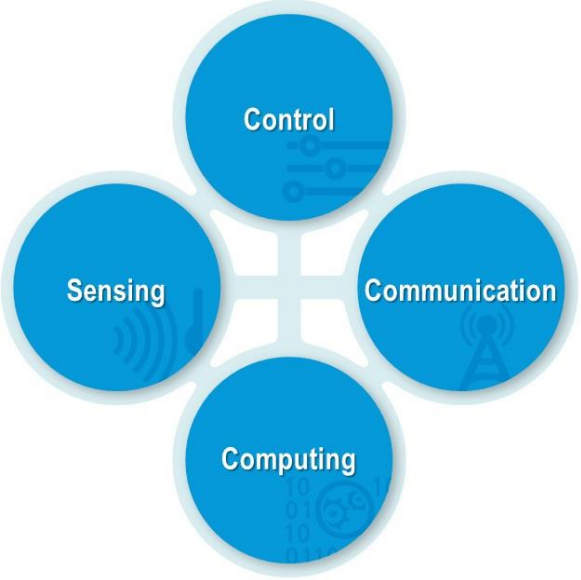




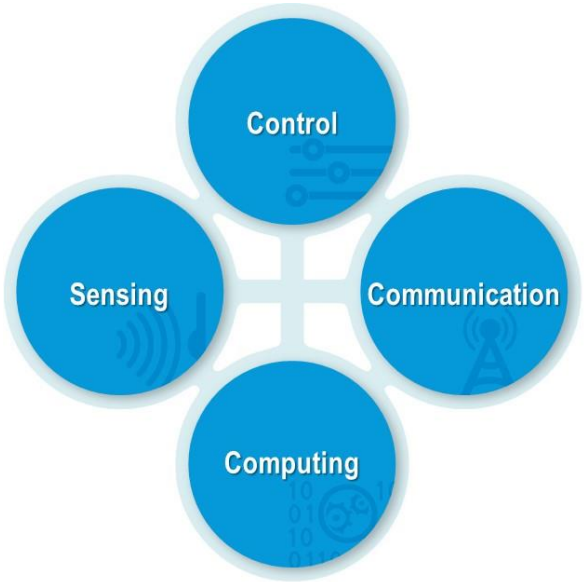
*Transformation happens when these **combine***

Wearables that detect cardiac arrhythmias

*"The **fixed-point** test platform we built with **MATLAB** enabled us to conduct rigorous tests at every stage and automatically identify discrepancies in the results."*

-VivaQuant

The arrhythmia service uses an FDA 510k cleared Holter recorder to non-invasively record a 24-hour or longer three-lead ECG



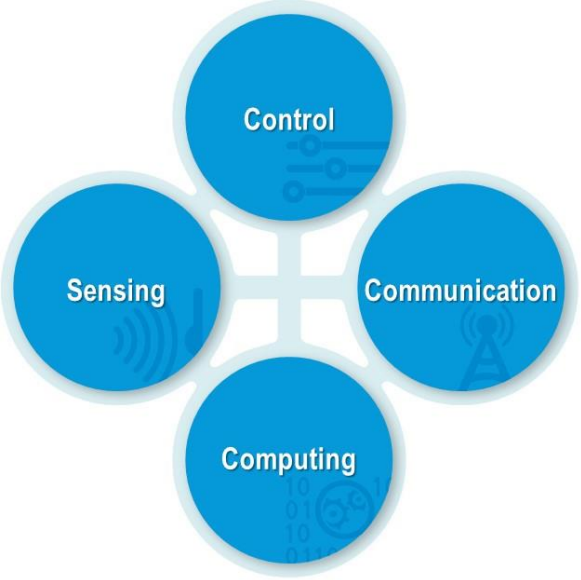
Mobile healthcare app with cloud-based analytics

The AirSonea device connects to an asthma patient's smartphone and communicates with wheeze analysis algorithms on iSonea's server.

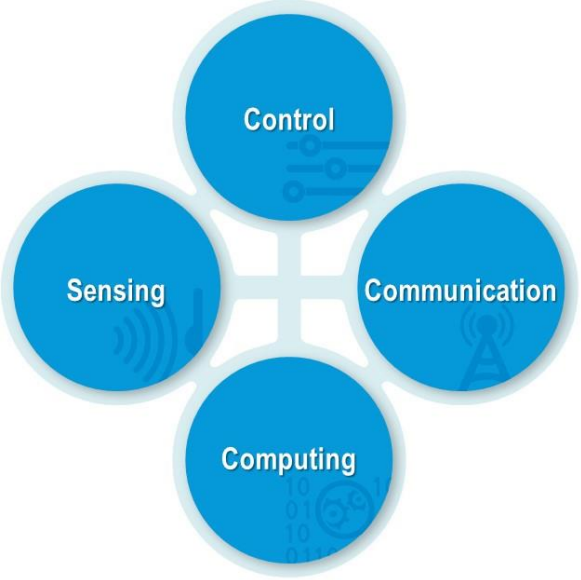
*"MATLAB enables us to rapidly develop, debug, and test sound-processing algorithms, and **MATLAB Coder** simplifies the process of implementing those algorithms in C.*

There's no other environment or programming language that we could use to produce similar results in the same amount of time."

- iSonea



Thought-controlled prosthetics



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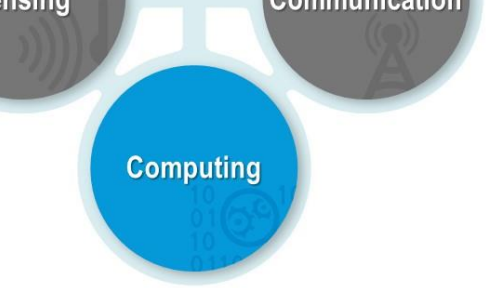
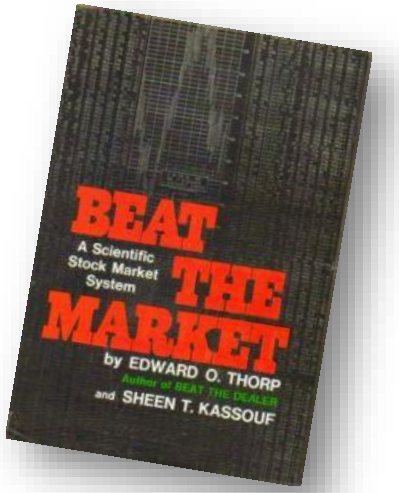


How Algorithms Have Changed the Face of Wall Street

JEFF DESJARDINS on June 19, 2014 at 5:42 pm



Inside Wall Street

Math nerds are taking over Wall Street

The Telegraph

Home Video News World Sport Finance Comment Culture Travel Life Women F

Companies | Comment | Personal Finance | ISAs | Economy | Markets | Property | Enterprise | Dea

HOME » FINANCE

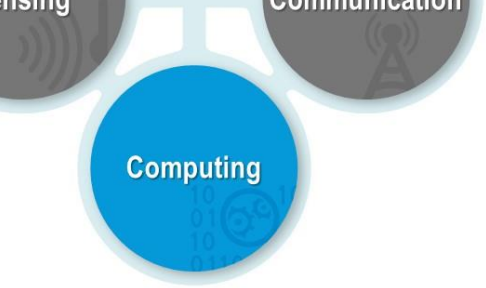
Matthew Lynn
Mega-mergers have been consigned to history - as they should be

Roger Bootle
Three big challenges could uproot economic success

Jeremy Warner
Austria is fast becoming Europe's latest debt nightmare

Quants: the maths geniuses running Wall Street

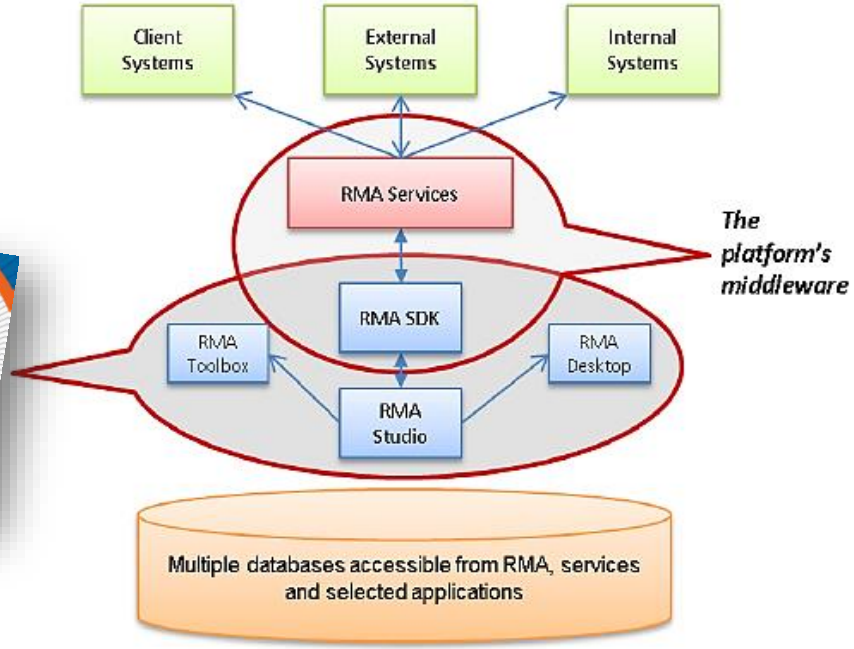
Forget Gordon Gekko. Old-style City traders are being replaced by maths geniuses who use super-computers to beat the markets. But are 'quants' a force for good or evil?



The MRTL Platform

Munich RE

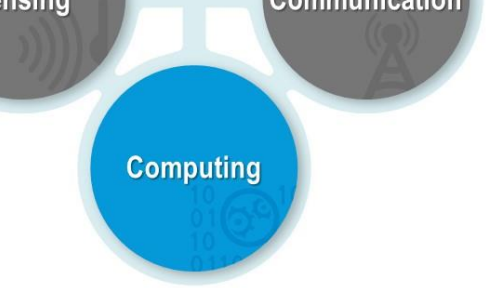
A Financial Engi
Edward Byrns, Jr., MunichRE Tradi
LLC, MATLAB Virtual Conference,
March 2015.



Quite possibly the largest production integration of Matlab ever

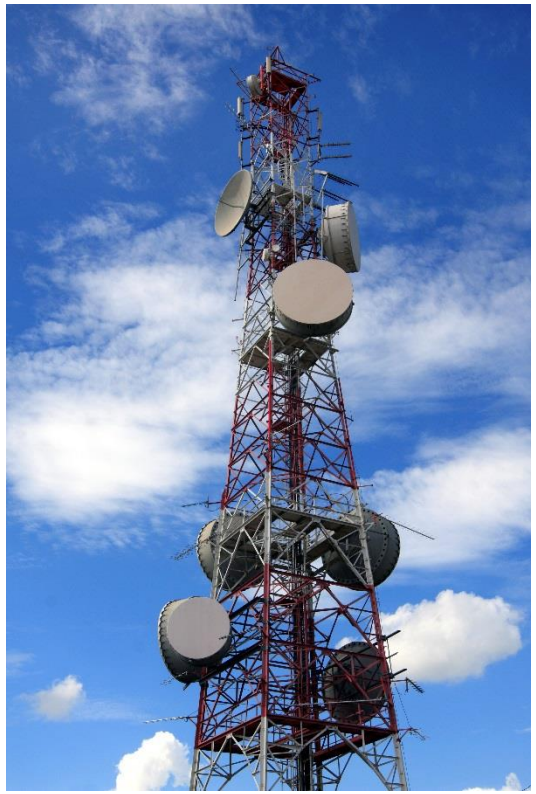
- ~2400 Matlab events per day
- ~3000 CPU minutes of Matlab execution per day
- Excess of 1.5 GB of data captured or created per day

MathWorks



Data-Intensive Analytics

Machine Learning to detect customer churn

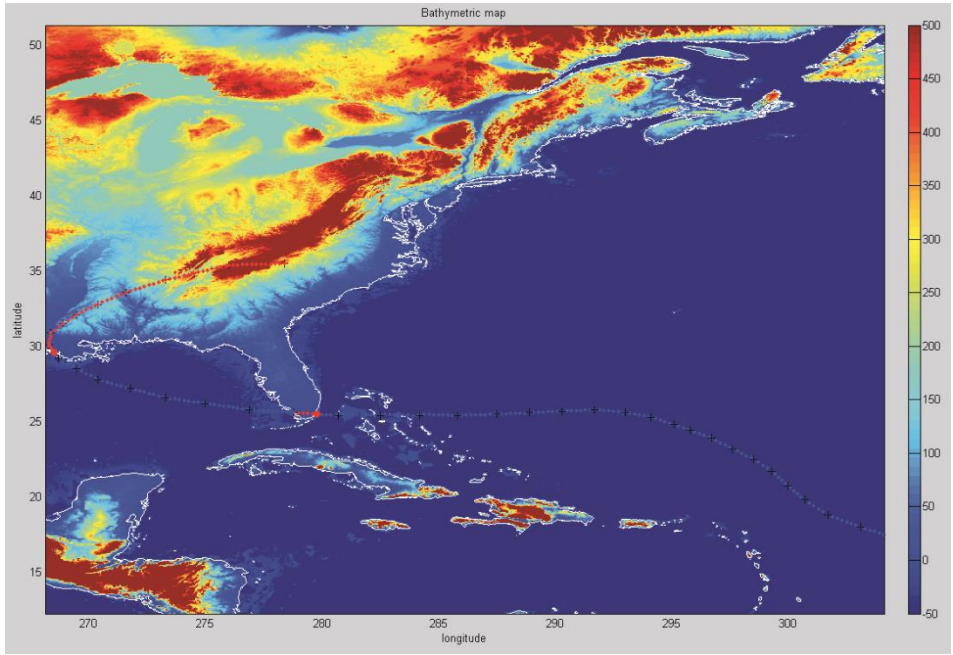


"MATLAB made it easy to clean, visualize, and analyze more than 500 gigabytes of data with no additional software or add-ons."

"No matter what industry our client is in, and ***no matter what data they ask us to analyze—text, audio, images, or video—MATLAB enables us to provide clear results faster."***

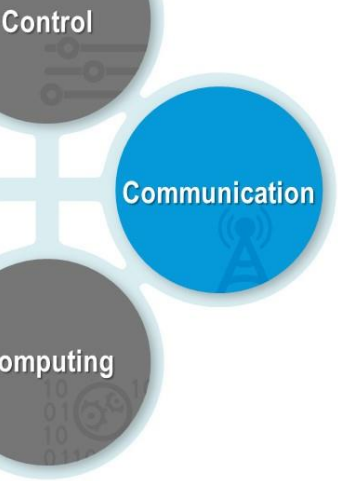
– Cognizant

Geographical modeling to predict losses

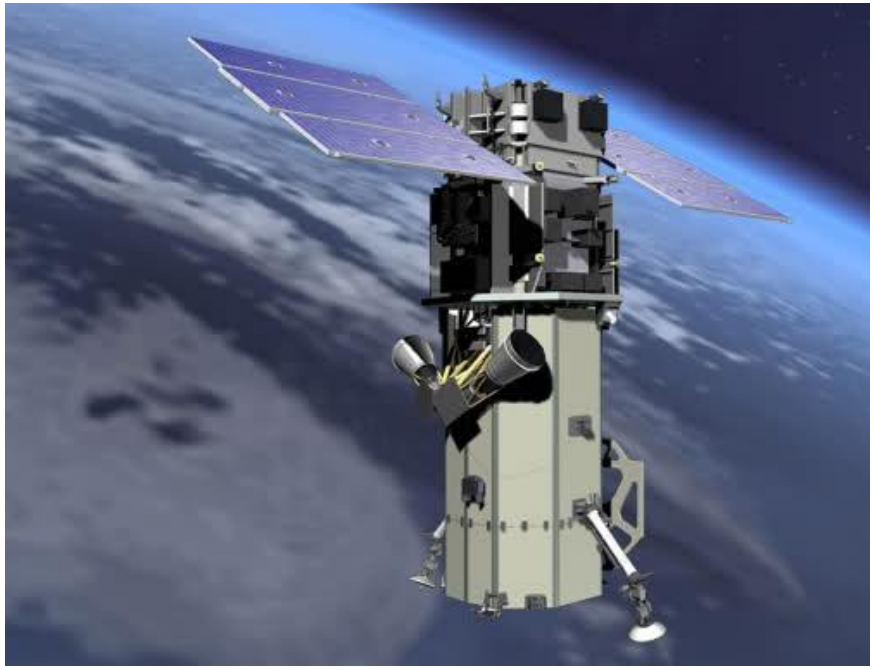


*"**MATLAB handles huge amounts of data**, features highly sophisticated graphics, and … interfaces for importing and exporting data into other applications, such as GIS, Excel, or text documents."*

– SwissRE



Rapid and reliable transmission of satellite data

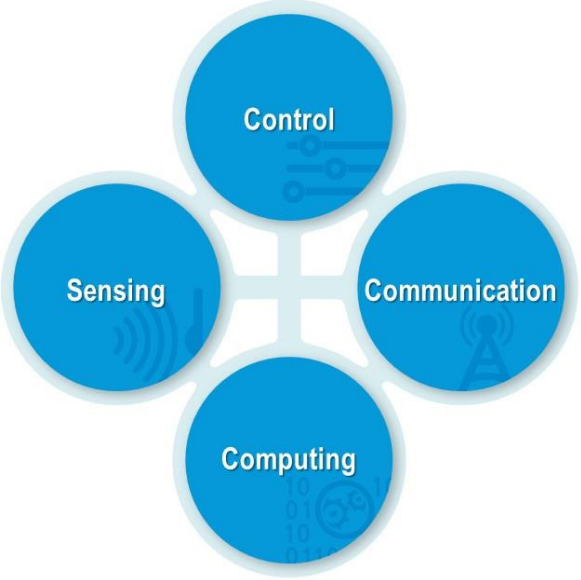


"We built a communications system capable of 1200 Mbps.

"With Simulink, for the first time I can see past the noise effect and understand how distortion is affecting the link.

"Without those simulations it would be impossible for me to show management that the system is going to work."

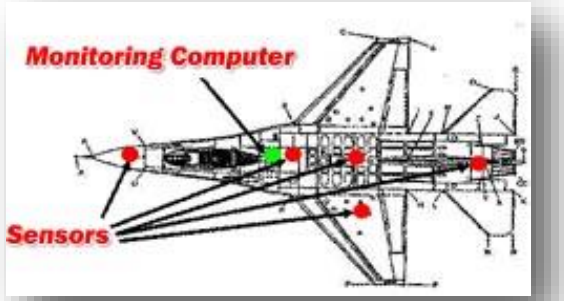
– Digital Globe



Big Data from the Internet of Things

Fleet Analytics

Sensor Analytics

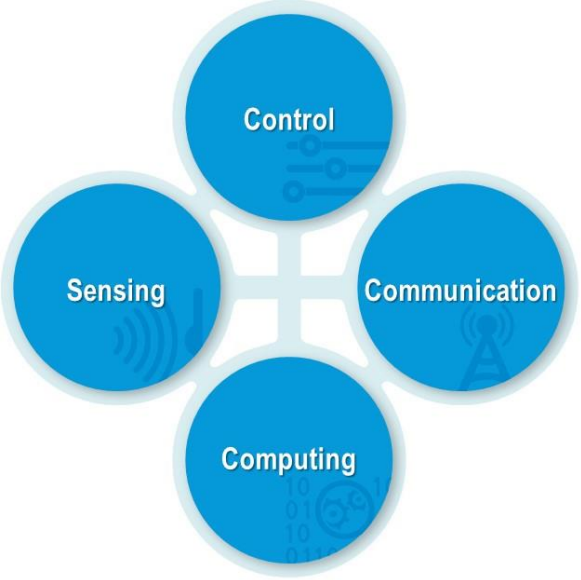


Vehicle Health Monitoring

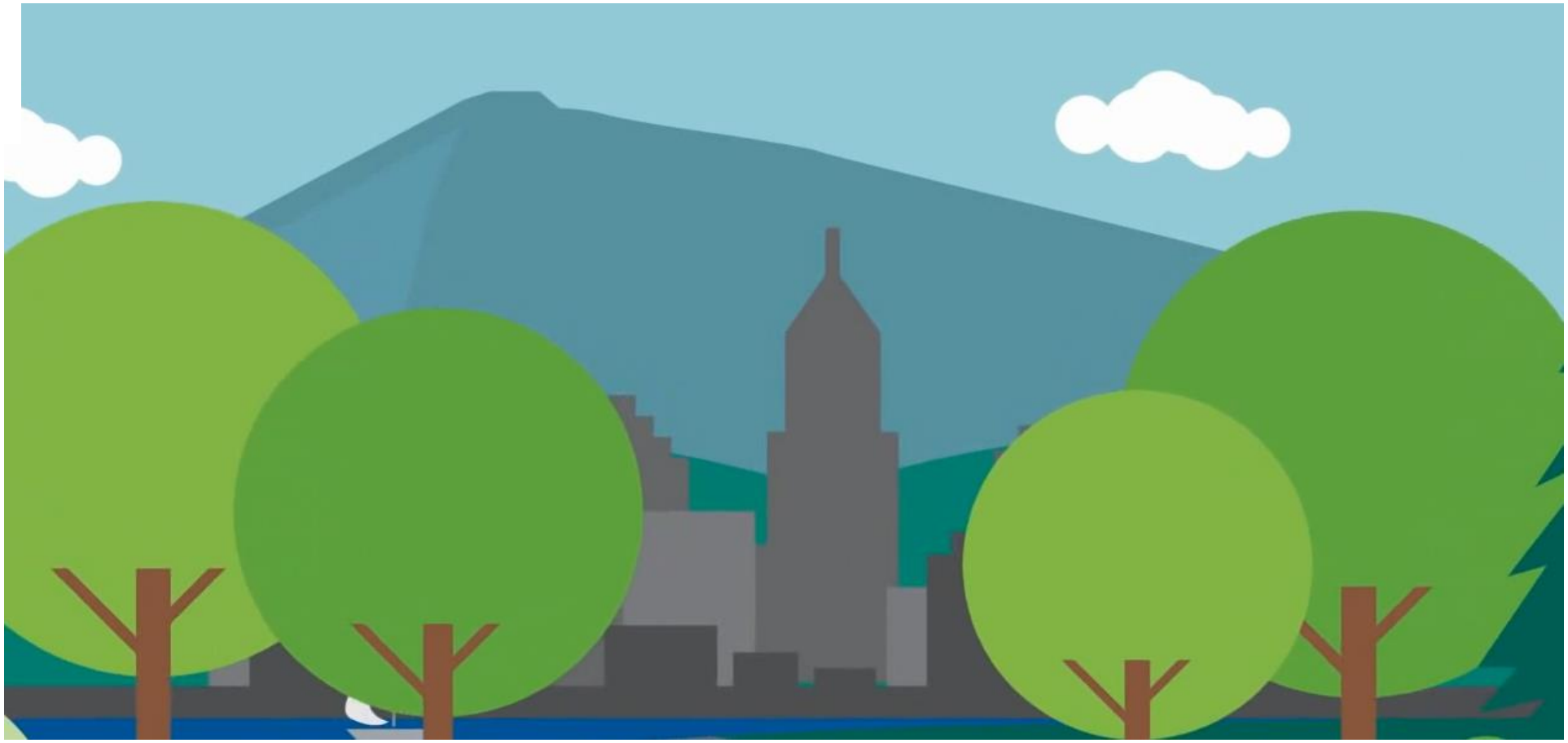
Asset Data Analytics

Financial Trading

Healthcare Predictive Analytics



Smart Emergency Response System



Amie Ferris-Rotman Become a fan

How Drones Are Helping Nepal Recover From The Earthquake

Posted: 05/07/2015 12:39 pm EDT | Updated: 05/07/2015 12:59 pm EDT

MEASURE
a 32 Advisors Company

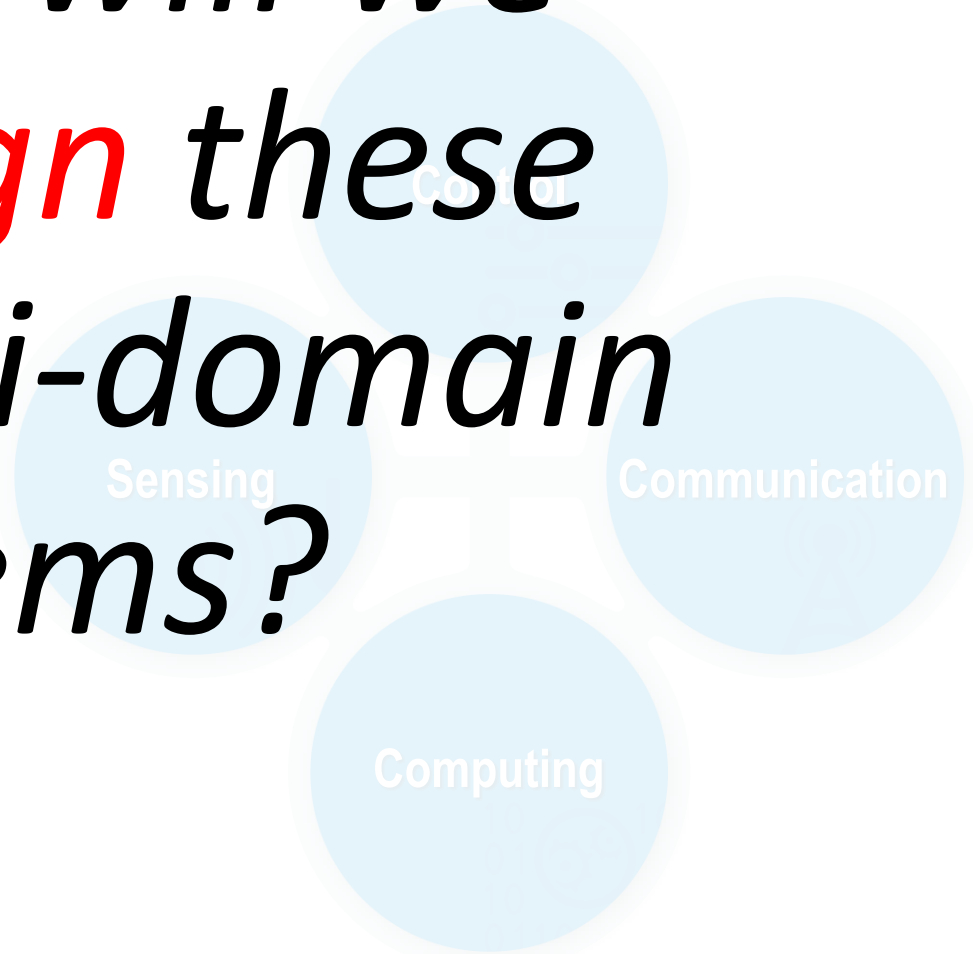
American Red Cross

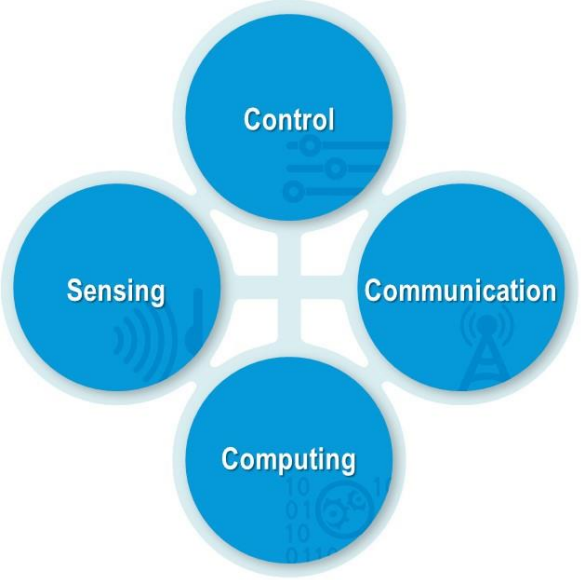
Drones for Disaster Response and Relief Operations

APRIL 2015

- **Situational awareness**
- **Survivor location**
- **Structural analysis**
- **Supply delivery**
- **Fire extinguishment**

How will we design these multi-domain systems?

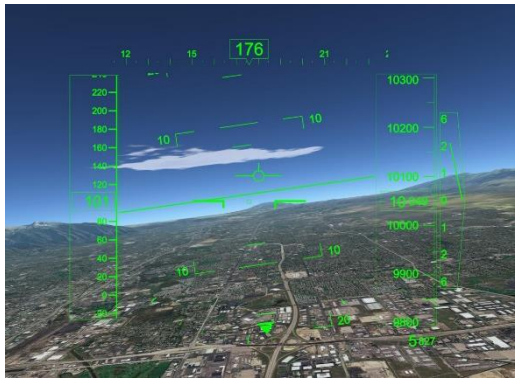




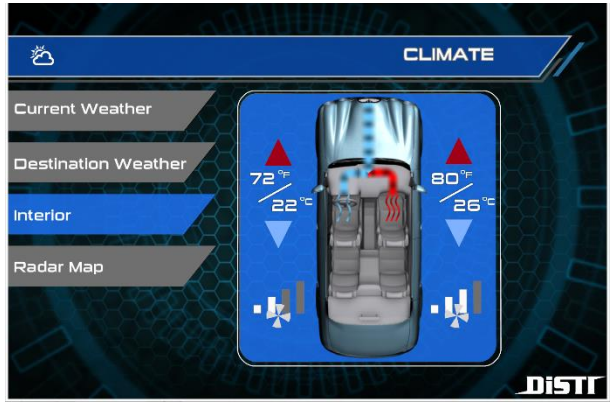
Human Machine Interface (HMI) Is Transformed

Primary Flight Display

Instrument Cluster

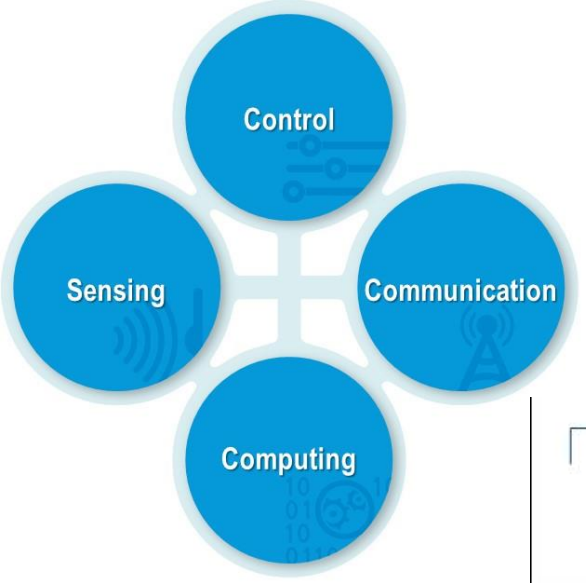


Heads-up Display



Center Stack

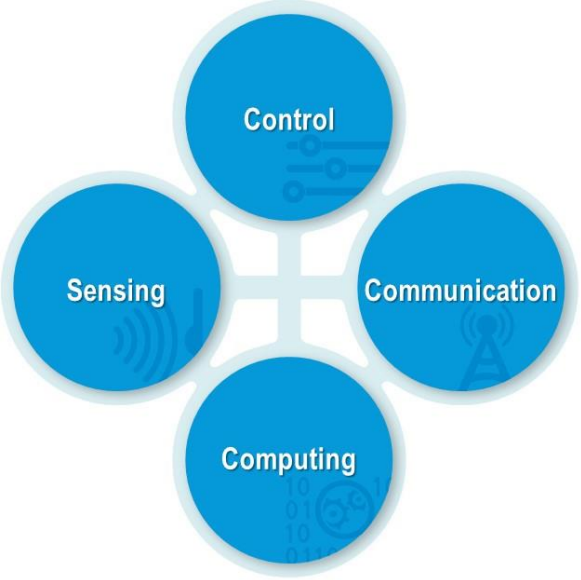
Images provided by DiSTI Corp. Reused with permission.
Images provided by Presagis Corp. Reused with permission.



Model-Based Design for HMI Development

Complete design modeled and tested with MATLAB, Simulink, and Stateflow

MathWorks



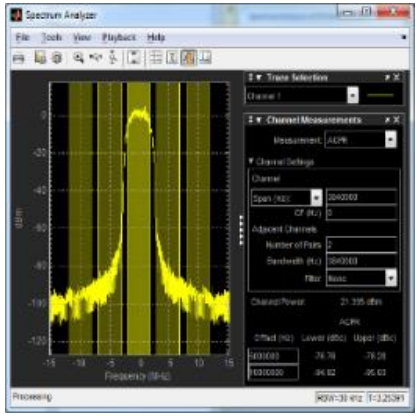
Design tools for wireless communications

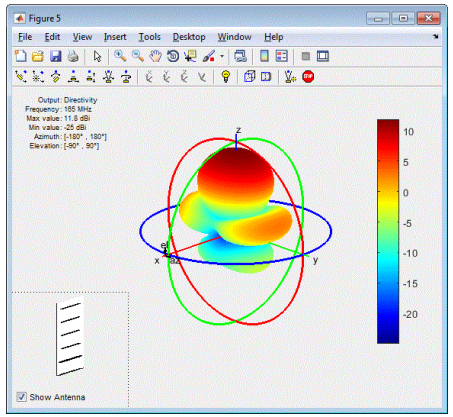
NEW in **R2015a**

Antenna Toolbox

NEW releases in **R2015a**

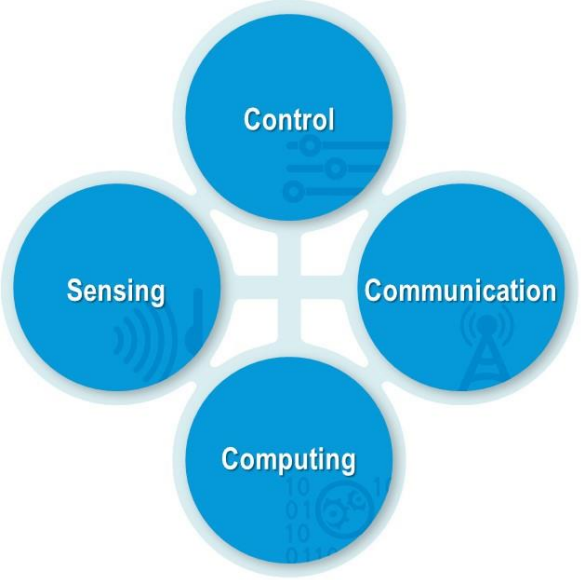
Communications System Toolbox
LTE System Toolbox
Phased Array System Toolbox





MathWorks

How will we test and verify them?



Certification standards for safety & reliability . . .

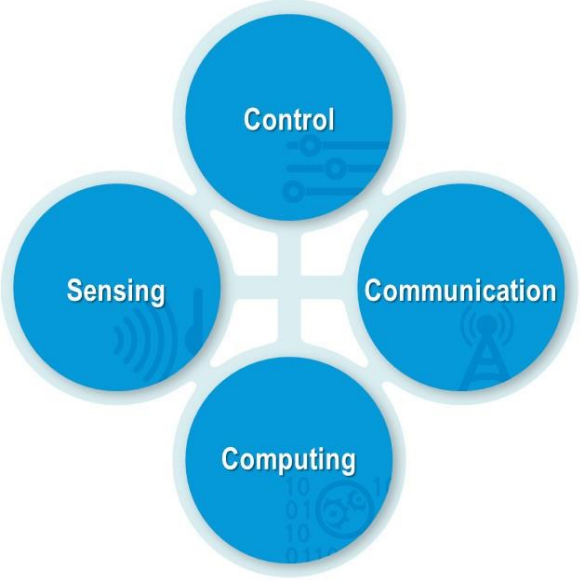
DO-178

Eurocopter France
Air Conditioning

System design in Simulink

Simulink Verification and Validation to check compliance

Embedded Coder for C code for software verification



. . . appearing

ISO 26262

GM USA
Hybrid Powertrain

Alstom France
Propulsion Control Systems

IEC 62304

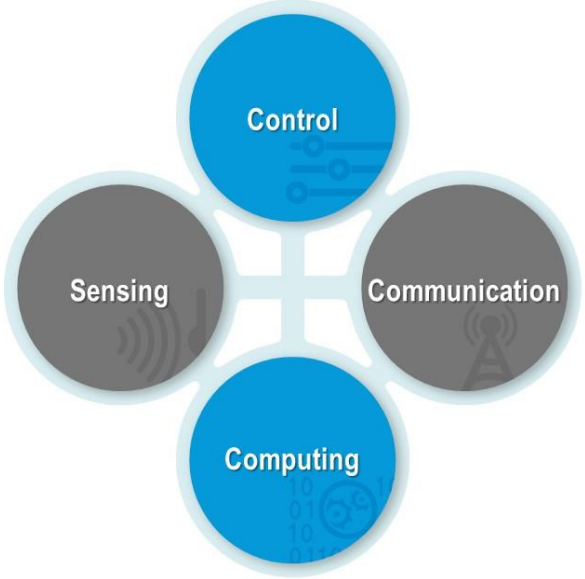
Weinmann Medical DE
Transport ventilator

IEC 61508

Alstom Grid UK
HDVC Power Systems

IEC-60880

MTU Germany
Nuclear Emergency Generators



Weichai Power: Fully-tested production ECU in 36 months

"Model-Based Design enabled us to reduce labor costs by 30%, cut testing costs by 20%, and increase productivity by more than 30%."

-Weichai Power

Checked compliance with modeling standards

Linked textual requirements to the model to **ensure traceability**

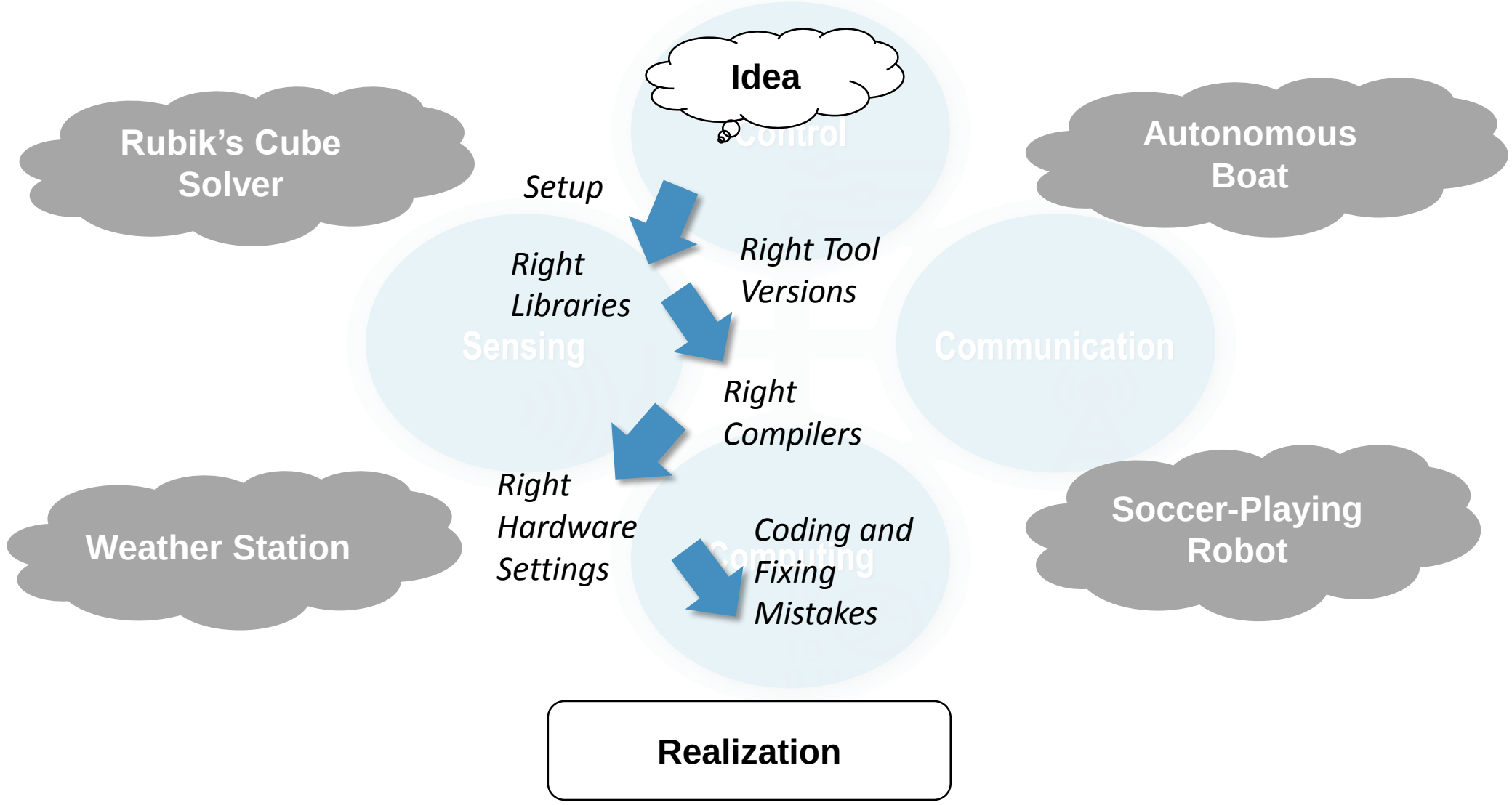
Verified control design through closed-loop simulation

Generated test vectors to achieve **complete model coverage**

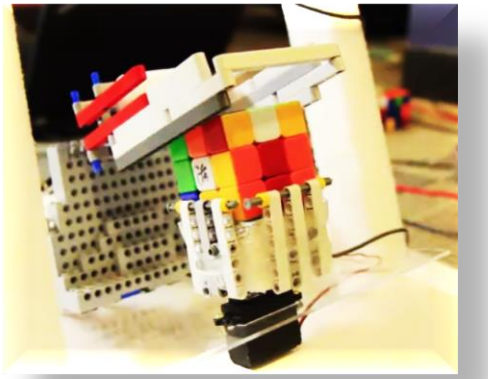
More than 340,000 effective lines of code for the production ECU

How will students prepare for transformative fusion?

By spending less time on HW/SW configuration …



And more time on systems using Project-Based Learning. . .



Control

Idea

Sensing

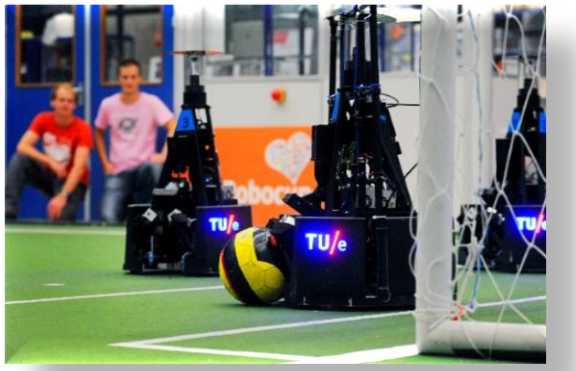
Setup

Communication

Tools

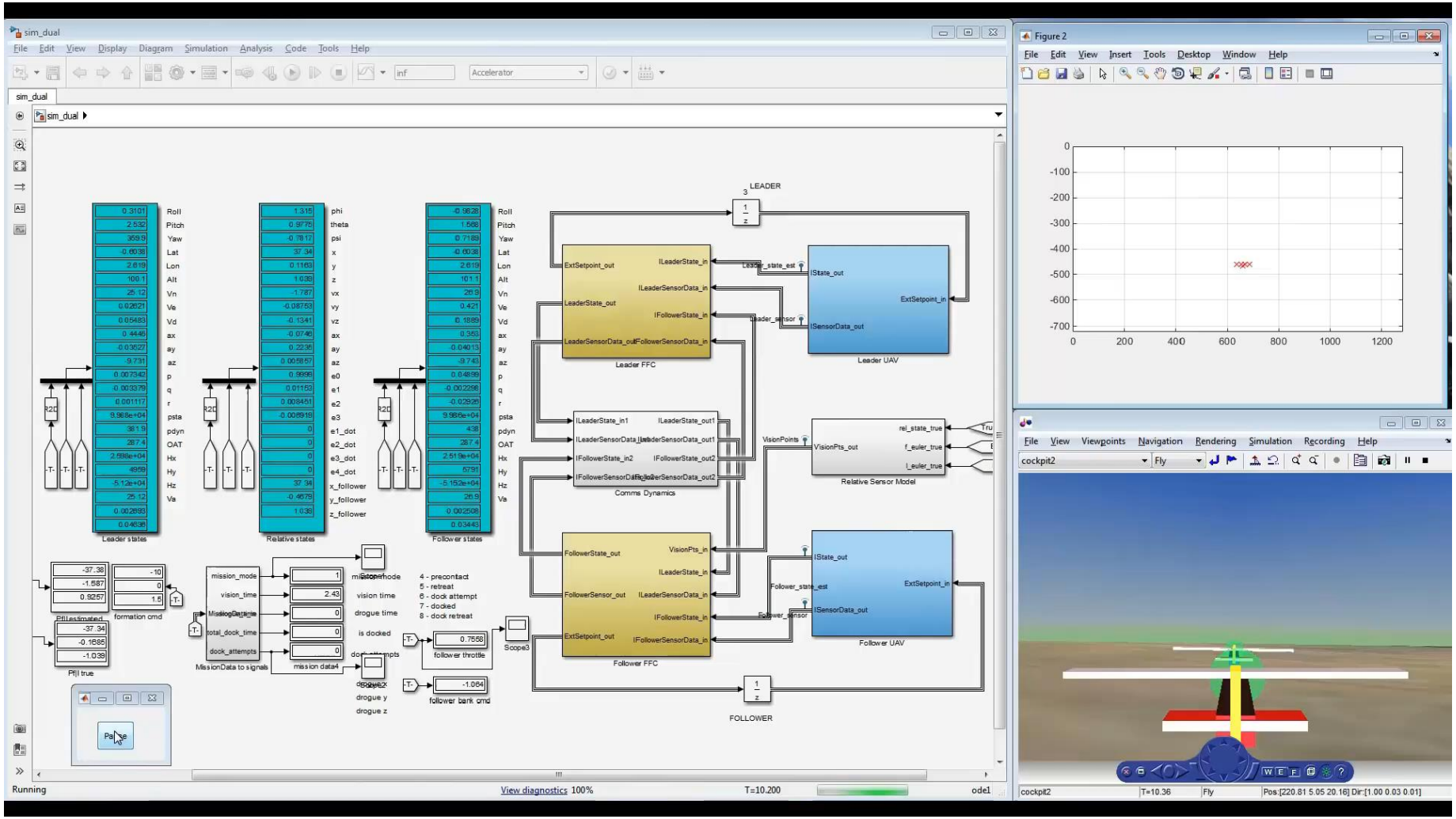
Computing

Realization



Student projects of sensing, computing, communication, and control - in action

Student projects of sensing, computing, communication, and control - in action



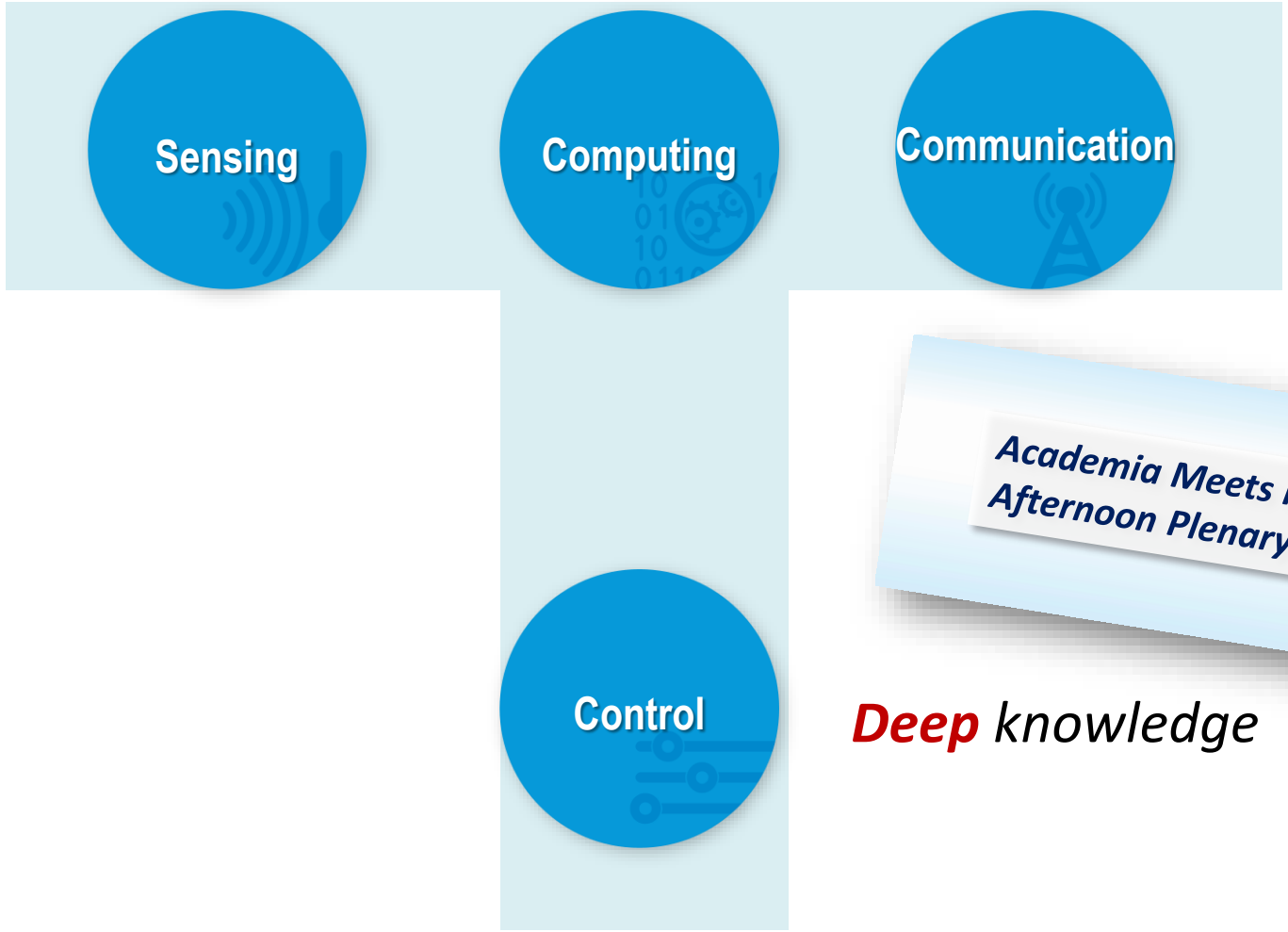
#1 *(tied)* Drone Formation Flying – University of Sydney

MathWorks

Student projects of sensing, computing, communication, and control - in action


WIJ ZIJN WÉL
WERELD
KAMPIOEN 2012!!!
TECH
UNITED
TURTLE-SK
TU/e

Demand for the T-shaped engineer...



Broad *knowledge*

Deep *knowledge*

...met with Project-Based Learning.

… in a world of distributed innovation.

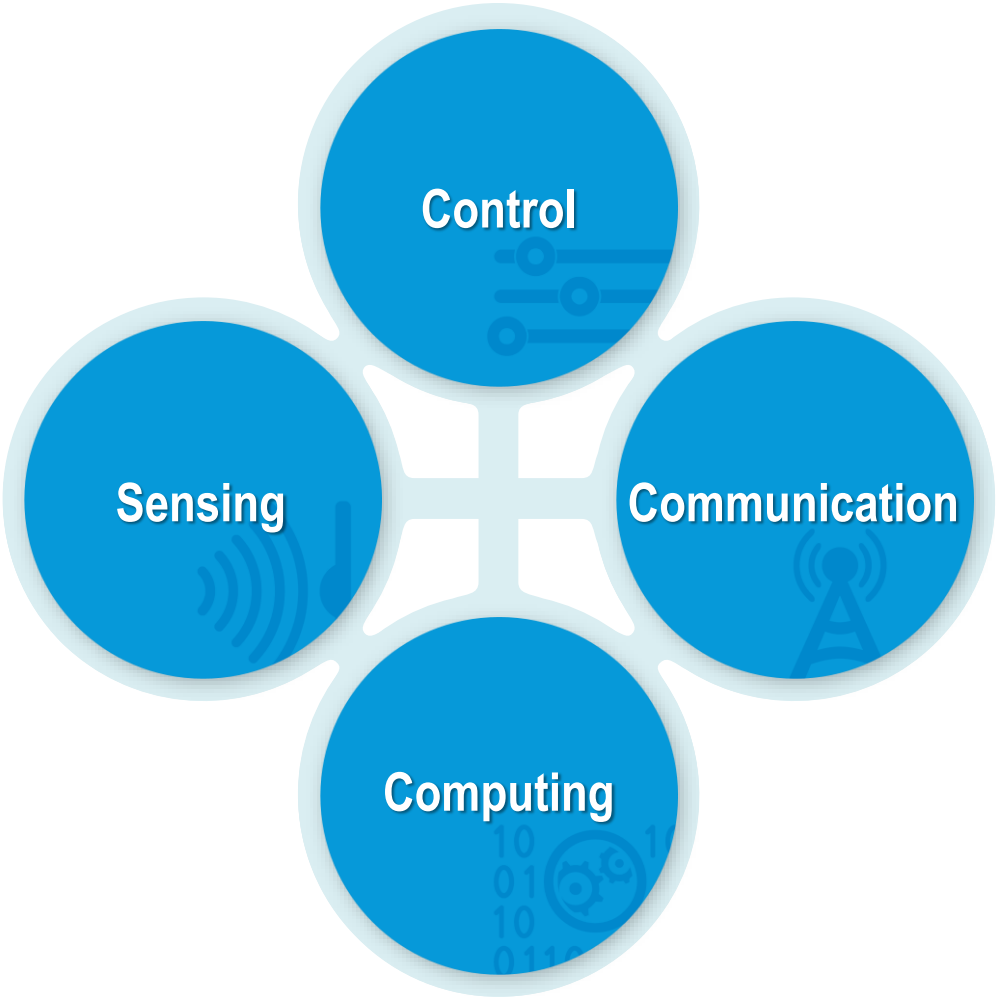
WELCOME TO THE MAKER-INDUSTRIAL REVOLUTION

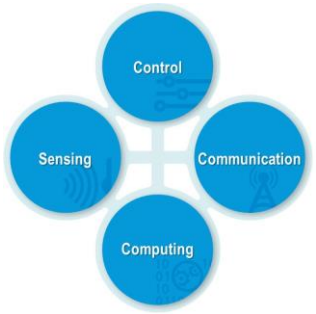
How GE, Local Motors, and an army of DIY inventors are rebuilding American manufacturing

Popular Science, 15 January 2015

*"**We're moving to distributed innovation processes**. The innovation going on in the rest of the world can probably overwhelm what companies can do internally."*

James Cash, Harvard Business School





Next Steps

- Attend the talks and exhibits
- Talk to your colleagues – from MathWorks and other companies and academies
- Learn from each other, share best practices across industries and applications
- Use these tools and methods to transform your application and industry!