Getting to Smart

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Getting to Smart

WHO
WHAT
HOW
…autonomous, responsive, multifunction, adaptive, transformable, and…
...and collaborative and....
getting to smart

- Experimentation system that is:
  - easy to use
  - transparent in operation
  - and flexible

- Finite-state machine execution with interfaces to C++, ROS, and MATLAB®

- MATLAB:
  - quadrotor modeling, control design, trajectory planning, simulation
  - interface for experiment definition and execution

- Continual development of increasingly complex behaviors

Courtesy: Daniel Mellinger, Vijay Kumar, et al. GRASP Lab, University of Pennsylvania
getting to smart – What’s New?
getting to smart – MATLAB Coder™

Generates C code from MATLAB functions
• Embedded
• Integration
• Acceleration
getting to smart – MATLAB Coder
getting to smart – MATLAB Coder
smart systems of systems
Chevrolet Volt – Opel Ampera

Credit: General Motors LLC 2011
Creating and Choosing

Engine Generator

Control Strategies

Electric Drive Unit

Li-ion Battery
“We’re using the same models to control different systems. It benefits us to use these [models], single sources that people can understand; it allows us to go faster.”

Greg Hubbard
Senior Manager of Hybrid and Electric Drive Controls, GM
Collaborative Team Development

GM Electronic Controls & Software

Includes 16 development and application centers across the globe.

Responsible for Powertrain, HVAC and other in-house hardware.

 Creates a global software-use across the GM vehicles.

1000+ creators and users produces, globally.

(2) Applied Software Product Line Globally

Large-scale Influences our Results

- Models with millions of blocks,
- Released every 6 weeks,
- Created by hundreds of engineers,
- Consumed by hundreds more,
- Geographically dispersed,
- Across product domains

Keynote: The Hope and Reality of Global Model-Based Development
Kent Helfrich, Executive Director, Electronic Controls & Software, General Motors
MathWorks Automotive Conference, May 4, 2011, Novi, MI, USA
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Concurrently tackling
- what is possible (the science)
- what is feasible and optimal (the engineering)

Leveraging Model-Based Design
- across development centers around the world
- across engineering teams
- across development phases
- across vehicles with the same design platform
getting to smart – What’s New?

- Simulink® Projects
- Simulink Variants

Connectivity through adapter

- Local Source Control
- Subversion (SVN)
- Other Source Control Tools
• Over 500 measurement sites in five continents

• Over 900 site-years of data, measured at 30-minute intervals (>15 Msamples)

• Time span over eight orders of magnitude, from hours to decades
Process Networks to model ecosystems

Derived using advanced statistics based on Shannon’s information entropy, chaos theory, and communication theory.
getting to smart

Lateral thinking: Adapting techniques from unrelated fields of research to model ecosystem dynamics

High performance computing:
- Two months’ data from one site → Several hours on a dedicated workstation
- Ten years’ data from seven sites → About a month on one machine (estimated)
- Enabled algorithm to run on 32-core cluster by changing one line of MATLAB code → A calculation with millions of iterations that required 176 hours on one core executed in under 6 hours using 32 cores
getting to smart – What’s New?

- **Parallel Computing and GPU support**
  - The number of GPU-enabled MATLAB functions continues to grow in Parallel Computing Toolbox™
  - GPU-enabled functions can be deployed using MATLAB Compiler™

- **MATLAB Mobile – iPhone and iPad**
  - Access ‘in the field’
Donor Matching  Skåne University Hospital
getting to smart

- The domain expert created the tool
- Decision-support tool based on data
- Performance improves as more data is provided
getting to smart – What’s New?

- Statistics and Curve Fitting
  - Unified Interactive curve fitting in Curve Fitting Toolbox™
Banc Sabadell algorithms at work

1,300 branches - 10,000 employees
Our goals

- Provide automated tools for the sales team to quickly generate product ideas
  - Interest rates, foreign exchange, commodities and inflation hedges and investments

- Provide tools for the traders to find and execute trading strategies as well as disseminate "market parameters" to the sales team
Banc Sabadell MATLAB in production

In MATLAB

Curve descriptor

Deployed with Java front end

Deployed with Excel front end

for Analysts to create and explore

for Sales to use

for Traders to integrate

smart | organization
Banc Sabadell  MATLAB in production

Deployment environment

- Branch users
- Corporate Intranet
- Departmental Server
- Managed by Corporate IT
- Managed by the Treasury
- .NET Executable
- MATLAB Code
- .NET DLL
- EXE
- Java JAR
- Swing Front End
- XL DLL
- XLS Front Ends
- Nightly batch
- Sophisticated users

smart | organization
getting to smart

- Put ideas in the hands of the people who can leverage them as quickly and robustly as possible

- Multiple formats for different user communities

- For prototyping ideas and 24/7 number-crunching

- Partnering with enterprise IT for deployment and support
getting to smart – What’s New?

- Service offerings for Financial customers - business critical application of MATLAB (MATLAB in Production)
Semtech transitioning from analog to digital

- To improve performance and decrease power consumption

- Want to evaluate multiple design ideas during the study phase

- Want to improve the development workflow, especially between study phase and implementation
getting to smart

- Two engineers
- System-level model, including channel noise and demodulation schemes
- Digital filters, converters, PLLs designed to integrate together
- Multiple designs explored, analyzed, and optimized
- Automatic HDL generation meant FPGA prototypes 50% faster
- “We used the time we saved to improve the design”
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Modeling different abstractions, multiple purposes

- System simulation and analysis
- Component design exploration
- System integration
- Automatic HDL code generation
- Test benches

The Semtech SX1231 wireless transceiver.
getting to smart – What’s New?

- HDL Coder™ and HDL Verifier™

- Prototype and implement algorithms on FPGAs or ASICs
- Verify HDL code using HDL co-simulation or FPGA-based simulation
- Support for DSP and Communications algorithms
TU MUNICH engineering education
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- Combining classroom instruction and hands-on work

- From basic concepts of kinematics and control design, to the implementation and certification of flight code

- Attracting, engaging, and retaining students, and equipping them to succeed in industry
getting to smart – What’s New?

- Simulink support for Lego, Arduino, and Beagle Board
- Real-Time Windows Target™
- xPC Target™ Turnkey
MEDUMAT Transport ventilator

- Designed for emergency transport and care
  - damage to lungs or chest wall?
  - can patient breathe?
  - using mask or tube?

- Multiple operating modes, ranging from assistive to full control

- Must be portable and exceptionally reliable

- Requires certification to ISO/IEC 62304, ISO 10651-3, DIN EN ISO 13485, DIN EN ISO 14971
MEDUMAT Transport ventilator

Simulink Verification and Validation™ – model coverage analysis for unit tests

Embedded Coder™ – targets code to Infineon MCU and TI DSP

Simulink® and Stateflow® – model of controller and state machines

Simulink – plant model includes hardware components and a mechanical model of human lungs

Embedded Coder™ – production code for control system and sensor signal processing

DSP System Toolbox™ – digital filters and algorithms to calculate gas flow velocity

Image © Weinmann Medical Technology.
50% faster code development and reviews

100% automatically generated embedded software

50% less time on internal reviews

Over 40 design alternatives explored

60% reuse of core design in next-generation ventilator, which uses a different processor

smart in many ways
**getting to smart**

- components
- systems
- systems of systems
- development processes
- understanding
- decisions
- people
- organizations
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MATLAB Coder
Simulink Projects
Parallel Computing & GPU
MATLAB in Production
HDL Code Generation
Connecting to Hardware

Technical Computing
Design & Simulation
Implementation & Verification
Looking inside Demo
Partner Presentation
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<td>Design and Simulation</td>
<td>Implementation and Verification</td>
<td>Looking inside Demo</td>
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<td>데일리코에 컴퓨터 터,gpu 등 클러스터 운영체제의 MATLAB Parallel Computing 가능 MathWorks, 성호현 과장</td>
<td>Simulink에서의 딥 러닝 활용 MathWorks, Chris Pfitsch</td>
<td>MATAVI 및 HDI 자동 코드 생성 및 헬드립니다 MATLAB, 문순철, 이동수</td>
<td>AUTOSAR 작업을 위한 MATLAB &amp; Vector Tool Interface 및 CANopen Interface</td>
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1. Technical Computing
2. Design and Simulation
3. Implementation and Verification
4. Looking inside Demo
5. Partner Presentation
Enjoy the conference!