MATLAB EXPO 2017
Simulink as Your Enterprise Simulation Platform

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Simulink as an Enterprise Simulation Platform

Simulating Spacecraft Communications for Deep-Space Missions
Dr. Deepak Mishra, Scientist/Engineer (SF)
Indian Space Research Organization

Challenge
- Integrating large multi-faceted project
- Simulation at multiple stages and in multiple domains to explore the problem

Solution
- Leverage Simulink as a platform
Enterprise Simulation Platform

- Enterprise - Any size business or project
- Simulation – Evaluating system behavior through computation
- Platform – Scalable environment for multi-disciplinary collaboration

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Enterprise Simulation Platform Enablers

- Multi-Domain Modeling
- Integration
- Scalability
Multi-Domain Modeling
Multi-Domain Modeling in Simulink

Dynamic Systems

State Machines

Discrete-Event Systems

Physical Modeling

Object-Oriented
Robot Arm Multi-Domain Simulation

Without Network Model

With Network Model
Multi-Domain Model

youBot Arm

1. Plot motor currents (code) and torques (code)
2. Plot joint angles (code) and forces (code)
3. Plot box trajectory (code)
4. Explore simulation results using gseeexplore
5. Plot optimization results: Friction, No Friction (code)
6. Compare optimization results (code)
7. Load model parameters (code)
8. Learn more about this example

Configure Test: Default (code)
Box Transfer only: Linear, Spines: Manual, Optim (friction), Optim (no friction)
Joint Tests: Pivot, Bicep, Forearm, Wrist, Max Torque, All 35
Run optimization: Friction, No Friction (code)
State Charts and System Dynamics

youBot Arm
1. Plot motor currents (code) and torques (code)
2. Plot joint angles (code) and forces (code)
3. Plot box trajectory (code)
4. Explore simulation results using `assemblle` (code)
5. Plot optimization results: Friction, No Friction (code)
6. Compare optimization results (code)
7. Load model parameters (code)
8. Learn more about this example

Configure Test Commands (Code)
Box Transfer only: Box In, Box Out, Manual, Op, Max
Joint Tests: Pivot, Bisection, Box In, Box Out, Max
Run optimization: Friction, No Friction

Select Arm Trajectory

Select Prong Position

Select Gripper Position

1. 1:1817_Put Gripper Position closed
2. 1:1817_Put Gripper Position open
3. 1:1817_Put Gripper Position right

Sensor

Home

Arm

Belt In

Belt Out

Belt

Input
Control
Network (CAN Bus)
Multi-Domain Model

youBot Arm
1. Plot motor currents (code) and torques (code)
2. Plot joint angles (code) and forces (code)
3. Plot box trajectory (code)
4. Explore simulation results using susexplor
5. Plot optimization results: Friction, No Friction (code)
6. Compare optimization results (code)
7. Load model parameters (code)
8. Learn more about this example

Configure Test: Default (code)
Box Transfer only: Linear, Spines, Manual, Optim (friction), Optim (no friction)
Joint Tests: Pivots, Bicep, Forearm, Wrist, Max Torque, All 36
Run optimization: Friction, No Friction (code)
Physical Modeling
Discrete-Event Modeling

youBot Arm
1. Plot motor current (code) and torque (code)
2. Plot joint angles (code) and forces (code)
3. Plot box trajectory (code)
4. Explore simulation results using gseeplor
5. Plot optimization results: Friction, No Friction (code)
6. Compare optimization results (code)
7. Load model parameters (code)
8. Learn more about this example

Configure Test: Default (code)
Box Transfer only: Linear, Splines
Joint Tests: Pivot, Bicp, Forearm
Run optimization: Friction, No Friction

Transmitter
Receiver

MathWorks
Domain-Specific Blocksets and Toolboxes

- Simulink has numerous domain-specific tools, for example:
  - Aerospace Blockset
  - Computer Vision System Toolbox
  - DSP System Toolbox
  - Powertrain Blockset
  - Robotics System Toolbox
Customer Success in Multidomain Modeling

ABB, Deltamarin, and VTT Simulate and Optimize Ship Energy Flows

Challenge
- Increase the energy efficiency of large vessels

Solution
- Use Simulink and Simscape to model, simulate, and optimize ship energy flow

Results
- Cost- and fuel-saving design improvements
- Testing costs reduced by tens of thousands of euros
Customer Success in Multidomain Modeling

“Simulink and Simscape enabled us to create a dynamic model of a complex energy system that spans several physical domains. By simulating this model, we can see how a new energy subsystem will perform before it is built, and provide customers with an accurate estimate of their return on investment.”

Juha Orivuori, ABB

Solution
- Use Simulink and Simscape to model, simulate, and optimize ship energy flow

Results
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Simulation Integration
Disconnected Component Intellectual Property (IP)

- Your IP exists in many forms and in many locations, making integration difficult
Integrating Your Code

- Multiple ways to reuse your legacy code with Simulink
Integrating Third-Party Simulation Tools

Mature and extensive APIs for third-party tool integration

- Vehicle dynamics modeling
- Tire behavior assessment
- Thermo-fluid system simulation
- 1D / 3D engine/exhaust simulation
- Virtual test driving
Partner Ecosystem

- Numerous partners provide interface to Simulink
Customer Success in Simulation Integration

Develop Integrated Vehicle Safety Applications
Siddharth D'Silva, Principal Engineer
Autoliv

Challenge
- Design and validate safety-critical algorithms before implementation

Solution
- Leverage Simulink as a platform by integrating third-party software
Customer Success in Simulation Integration

“Seamless integration with third party software solutions enables rigorous development in a safe environment. For application engineers or system engineers, it is very useful that you can export these complex third-party tool functionalities in the form of S-functions and run co-simulation.”

Siddharth D’Silva, Autoliv

Results

- Industry first integration of stability control inertial sensor into airbag control unit
- Restraint control module software development time reduced by 30%
Scalability
Scalability Challenges

- Performance
- Componentization
- Team Workflows
- Sharing
Performance Scalability

- Easy scalability to multicore or cluster/cloud computation environment
Performance Scalability

- Big data workflow
  - Processing large amount of simulation inputs / outputs
Complex Design Development through Componentization

- Supporting team workflows
  - Faster modular development
  - More effective verification
  - Increased reusability

- Improving performance
  - Incremental loading and code generation
  - Simulation speed
  - Memory usage
Capabilities Enabling Team Workflows

- Source control
- Design comparison and merging
- Dependency analysis
- Task automation
Source Control Integrations

- Microsoft Team Foundation Server (TFS) integration available now from MathWorks File Exchange
Integrating Work from Different Engineers via Merge

- Supports concurrent engineering
- Lets you concentrate on design
Dependency Analysis – Modular Development
Dependency Analysis – Modular Development

- Show model structure
- List products required
- Highlight issues
Task Automation – Configuring Project Environment

- Robustly configure the team environment
- For everyone
- Automatically
Sharing Outside Your Team

- Quick File Packaging
- Model Protection (IP Management)
- Reporting and Documentation
Simulink Addressing Scalability Challenges

Performance

Componentization

Team Workflows

Sharing
“There is no such tool, which gives the simulation environment as well as the hardware verification and validation. In a single environment, I am getting these together. That is why I use MATLAB and Simulink.”

Dr. Deepak Mishra,
Indian Space Research Organization