Digital Twin Workflow and Applications

Bernard Dion
CTO, ANSYS Systems Business Unit
bernard.dion@ansys.com
Agenda

• Simulation-Based Digital Twin

• Digital Twin Workflow and Key Benefits
  – Build
  – Validate
  – Deploy

• Digital Twin Application Examples
  – Wind Turbine (GE)
  – Pumping system (Flowserve)
  – Relays (Phoenix Contact)
What is a Simulation-Based Digital Twin?

• Connected, virtual replica of an in-service physical asset in the form of an integrated multi-domain system simulation that mirrors the life and experience of the asset.

• Enables predictive and prescriptive maintenance and optimizes industrial asset management.
ANSYS Digital Twin Workflow and Key Benefits

**BUILD**
Reduce Engineering time 2X thru model reuse and easy composition

**Keywords:** System Simulation, ROM, FMI, Libraries

**DEPLOY**
Improved operations with 10-20% reduction in maintenance costs

**Keywords:** IoT, Virtual Sensors, Predictive Maintenance

**VALIDATE**
Optimize product performance 25% while lowering warranty costs

**Keywords:** Optimization, Statistical Analysis, Robust Design, HiL
ANSYS Twin Builder
Technical Capabilities
Twin Builder

Build Phase
Build Phase Benefits and Capabilities

Benefits
• Easily assemble virtual replica from a variety of sources
• Multi-domain, multi-fidelity, multi-language

Capabilities
• Support for multiple modeling domains and languages
• Extensive 0D Application Specific Libraries
• 3rd Party Tool (incl. 1D) Integration
• 3D Reduced Order Model Creation and Integration
• Embedded Software Integration
Multi-Domain Systems Modeler

Compose your system using multiple domains and languages

Multi-Domain Systems

Block Diagrams

State Machines

Circuit Diagrams

Co-simulation

Data-Driven / Look-up Tables

C-Code, FMUs

Reduced-Order Models

Digital/Mixed-Signal

Circuits

Modelica

Multi-Domain, Mechanics, Fluids

ANSYS Maxwell

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April 24, 2018
Extensive 0D Application Specific Libraries
3rd Party Tool Integration through Standards

FMI for Integrated System Simulation

Enabling:
MODEL PORTABILITY
TOOL INTEROPERABILITY
ENTERPRISE DEPLOYABILITY

Standards-Based Interoperability

Functional Mockup Interface
3D Reduced-Order Modeling Interfaces

- Transforms 3D simulation results into system-level models
- Preserves essential accuracy
- Simulates in a fraction of the time required by 3D
- Techniques for all ANSYS physics
Embedded Software Integration

Seamlessly integrate Embedded Software for Control and Display
Twin Builder

Validate Phase
Validate Phase Benefits and Capabilities

Benefits:
- Ensure Reliability and Robustness
- Optimize Product Design

Capabilities:
- Multi-Domain Simulation with Integrated Post Processing
- Rapid HMI Prototyping
- System Optimization
- XIL Integration
Multi-Domain System Simulation with Integrated Post Processing

Time-Domain  
Steady-State  
Frequency-Domain  
Multi-Simulations

\[
\begin{align*}
R1 & \quad RC \\
L1 & = 25 \text{mH} \\
C1 & = 1 \times 10^{-6} \text{farad} \\
R_{\text{load}} & = 1000 \text{ohm} \\
E1 & = + V \\
V_{\text{M1}} & \\
\end{align*}
\]
Rapid HMI Prototyping

- Rapid Prototyper enhances the simulation experience with powerful, easy-to-design, and interactive graphical panels.
System Optimization

Parameter Sweeps

Sensitivity

Optimization

Statistical

Built in Optimizers + Connections with ANSYS OptiSlang and ANSYS DX
XiL Integration

Tight Integration with Embedded Control & SW

MiL Design/Tuning
Co-simulation

SiL Validation
Code Import

Code Generation

Physical Model

Power Source

Power Electronics: inverter

Traction Motor (PMSM)

Power Cables

Mechanical Dynamics & Loads

Physical Model
Twin Builder

Deploy Phase
Deploy Phase Value and Capabilities

Benefits:
- Optimize Operations
- Deploy for Preventive Maintenance

Capabilities:
- Quickly Connect to supported IoT Platforms
- Export and Deploy Generated Models
Quickly Connect to IoT Platforms

Easily create simulation data connectors
Special callout to PTC ThingWorx, GE Predix, ...
Export and Deploy Generated Models

Twin Builder

Digital Twin

Digital Twin Runtime

IOT Platform
Digital Twin Application Examples
Fluid Pumping System Digital Twin
Relay Digital Twin

Controller

IoT

System Model