## **ANSYS**<sup>®</sup>

## **ANSYS Twin Builder Product Presentation**

2020 R1



### 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 system design and optimization, predictive maintenance and optimize industrial asset management



## **Key Capabilities of ANSYS Twin Builder**

Deploy



## **ANSYS Twin Builder Workflow for Digital Twins**



#### **Technical Capabilities Overview of ANSYS Twin Builder**



### **Technical Capabilities Overview:** Quickly Build Digital Twins using Twin Builder



#### Build Phase Benefits and Capabilities

Easily assemble virtual replica from a variety of sources

Multi-domain, multi-fidelity, multilanguage





#### Extensive 0D Application Specific Libraries

Electrical, Electronics, Std. Modelica Lib., Fluid Power, Thermal etc.



#### **3rd Party Tool (incl. 1D) Integration**

• Support for FMI/FMU, ANSYS 3D solvers and co-simulation



#### **3D Reduced Order Model Creation and Integration**

Support for multiple modeling domains and languages

Support for Modelica, VHDL-AMS, C/C++, SPICE and more

• Simplify 3D physics by use of ROM (Dynamic, Static and DX)



#### **Embedded Software Integration**

SCADE Suite, SCADE Display and more

## Multi-Domain Systems Modeler Compose your system using multiple domains and languages

- Model with standard languages and exchange formats including VHDL-AMS and Modelica.
- Combine conserved (acausal), signal-flow (causal), and discrete event system behaviors.
- Compose your system by including multiple physical domains including Electrical, Mechanical, Hydraulic and other domains.



#### Language-Based Modeling



**Multi-Domain Systems** 

## Extensive OD Application Specific Libraries Develop multi-domain system models using built-in and add-on libraries

- Develop multi-domain system models using built-in Modelica and specialized Twin Builder libraries.
- Build battery cell model with Twin Builder Modelica library that includes four templates for Equivalent Circuit Models(ECM) with SOC or SOC-Temperature dependency.
- Add-on library: Twin Builder Heating and Cooling library and Fluid Power Library



## Add-On Libraries (Modelica):

Heating and Cooling Library

Fluid Power Library



Built-in Multi-Domain System Libraries

## 3<sup>rd</sup> Party Tool Integration through standards Enhance productivity and interoperability by leveraging standards

- Compatible with the functional mock-up interface (FMI) for model exchange to import models from all FMI-compliant tools and export Modelica models as FMUs
- Create or reuse C/C++ models with the Twin Builder C interface.



Standard-Based Interoperability

## **3D Reduced-Order Modeling Interfaces Transforms 3D simulation results into system-level models**

- Use Reduced-Order Modeling (ROM) interfaces to generate accurate, compact models from detailed 2D and 3D physics simulations.
- Simulates in a fraction of the time required by 3D Techniques for all ANSYS physics
- Link to a variety of ANSYS tools to create high performing models.



Connections with 3D Physics

## **Introducing ANSYS Twin Builder Battery Wizard**

- Battery Wizard allows users to easily construct battery cells and assemble them into battery modules for use in electro-thermal simulations
- Streamlines the model creation and parametrization of Cell and Modules and allows export to multiple formats

TRANS TRANSPORT	Rell Configuration Tool	– 🗆 X		💀 Module Configuration Tool —
1	Select Cell Parameter Options Nurber of ECM parameters O 4 Parameters O 50C Only © 50C Only © 50C Conly © 50C Conl	Set Col Parameter Value Horo do you want to load the coll parameters? O From Fielder @ From File wit Hand-typed Vectors: O From HPPC Data Type in SQC vector for your tables: Example: [208.02.0.35] Type in Temperature vector for your tables: Example: [208.15.203.15] VOC RS R1 C1 R2 C2 Salect tor 556 for VI/C dischares table:	2	Select Cell Configuration File       BatteryCell ecm     ✓     Refresh     Ov       Module Size Configuration       Scaled     Discretized       (●
	Depart to Modelice Package:     Croose a focación to ergort Modelica package:     @ Add to Existing Package     Mex package Others Package     Nex package folder name: Betting/Cel_Package	Generate Close Help Detail	-7	Output Format: Twin Builder Component FMU Module Configuration File Export to Modelica Package:
Battery Cell			Battery Module	Choose a location to export Modelica package: Brows
			Configuration	Add to Exising Package     New Package

"A123 uses ANSYS Twin Builder to perform thermal simulation of their 48V battery pack development. A123 also utilizes Ansys Twin Builder's Reduced Order Model (ROM) technologies to simplify complex 3D thermal simulation to significantly reduce the simulation time from days to few seconds while keeping the required simulation accuracy."

- Shawn Zhang, Sr. Manager, Simulation Engineering, A123 System

## **Embedded Software Integration:** Use SCADE family products to develop embedded applications

 Fast track development of your control applications using SCADE Suite and Display and seamlessly perform system level integration in Twin Builder.



### **Technical Capabilities Overview:** Validate and Optimize the Digital Twin



#### Validate Phase Benefits and Capabilities

Ensure Product Reliability and Robustness

Optimize System Performance with built in Optimizers (or ANSYS DX and ANSYS OptiSLang)

Easily Integrate and validate with Test data



#### Multi-Domain Simulation with Integrated Post Processing

• Analyze and optimize the interactions among the multi-domain components in a system.



#### **Rapid HMI Prototyping**

• Enhances the simulation experience with powerful, easy-to-design, and interactive graphical panels. etc.



#### System Validation and Optimization

• Support for DoE, Parameter Sweep and Scripting (VBA/Iron Python)



#### **XIL Integration**

 Support for co-simulation for Model-in-the-Loop (MiL) and Software-in-the-Loop (SiL) validation workflow

### Multi-Domain System Simulation: Integrate, Validate and Optimize multi-domain systems



## Rapid HMI Prototyping Increase testing efficiency by integrating HMI

- Rapid Prototyper enhances the simulation experience with powerful, easy-to-design, and interactive graphical panels.
- Use Rapid Prototyper to create interactive panels using predefined widgets (buttons, sliders, etc.) to interact with the application under test.



**ANSYS** 

#### **Mission Profile** Outside air conditions EQU CONST EQU CONST -CONST V\_inter Easily Integrate and validate EQU Heat Generation with Test data. PackLeve 150.0 Wall\_Trmperature 125.0 QdotCoolantPack **Optimize System Performance** 100.0 75.0 and and with built in Optimizers (or 50.0 25.0 ANSYS DX and ANSYS OptiSlang) 0.0 CFD boundary 1250.0 2500.0 3600.0 Cabin ROM Cabin ROM Outputs conditions Battery Voltage HVBatisaVit ine S line W Pack Voltage Trace how ! Fill Syr 1.00 Symbol 44.0 Cartesian | Gen Attribie No. 42.0 40.0 -550 -1.00 1.60 25 00 50 60

#### **System Validation and Optimization**

© 2019 ANSYS, Inc.

۲

۲

ANSYS Confidential

# System Validation and Optimization XIL Integration

- Co-simulation for Model-in-the-Loop (MiL) design and tuning of control strategies.
- Code Import for Software-in-the-Loop (SiL) validation of the real embedded code in the virtual system.



### **Technical Capabilities Overview:** Deploy Digital Twins on leading IIoT platform



#### Deploy Phase Benefits and Capabilities

**Optimize Operations** 

Deploy for Preventive Maintenance



#### **Quickly Connect to supported IoT Platforms**

- Configure connector to connect to IIoT platform and send and receive operational data
- SAP Predictive Engineering Insights enabled by ANSYS



#### **Export and Deploy Generated Models**

 Export from Twin Builder to generate portable, cloud deployable Twin

# Twin Runtime SDK allows testing of exported Twin models and deployment to IIoT Platforms



#### Deploy Phase Benefits and Capabilities

SDK supports the testing and the deployment of Digital Twins on supported IIoT platforms, such as SAP Leonardo IoT, PTC ThingWorx, etc.



## Introducing new ANSYS Twin Builder packaging



Add-On Libraries	
ANSYS Twin Builder Heating and Cooling Library	
ANSYS Twin Builder Fluid Power Library	

## **Application Examples of Digital Twins with Twin Builder**



**Battery/Electrification** 



Structural



**Industrial Automation** 



**Electric Motors and Machines** 



**Heat Exchangers** 



**Rotating Machinery** 

## **Battery Modeling at A123 with Twin Builder Battery Wizard**



"A123 uses ANSYS Twin Builder to perform thermal simulation of their 48V battery pack development. A123 also utilizes Ansys Twin Builder's Reduced Order Model (ROM) technologies to simplify complex 3D thermal simulation to significantly reduce the simulation time from days to few seconds while keeping the required simulation accuracy."

- Shawn Zhang, Sr. Manager, Simulation Engineering, A123 System

#### Challenge:

An industry wide push towards electrification is forcing battery manufactures in Automotive industry to deliver higher density batteries with better thermal and aging performances in shorter time to market. A123 needed a tool for battery pack development that can simulate electrical and thermal behavior to determines the Electric performance, thermal Performance and battery aging quickly and without loss of accuracy.

#### Solution:

By using the Twin Builder's unique tool, Twin Builder Battery Wizard, A123 Systems was able to model and simulate 48V liquid cooled pack for accurate and efficient thermal simulations. A123 was able to reduce the simulation time from days to few seconds while keeping the required simulation accuracy.

#### **Results:**

There is a continued collaboration with A123 to improve battery models and there is joint marketing planned to highlight ANSYS and Twin Builder's unique Battery solutions.



elect .txt file for VOC discharge tal

Close

**ANSYS Twin Builder Battery Wizard** 

Export to Modelica Packa

New package folder name BatteryCell Packag

Help

Detail

## **Verbund Hydro: Digital Twin for Water Turbine**

## Verbund

**Challenge:** Predict the wear on the turbine under different loading conditions to optimize the turbine output as unplanned downtime can cost up to **\$60,000/h**.

**Solution:** A simulation based digital twin of the turbine and surrounding component is connected with physical sensor data to predict accurate current stresses at the hot spots.

**Results:** Optimized operations of the turbines can save **~\$100k/year** per turbine. Verbund operates more than 120 plants and can deploy up to 120 digital twins.







Verbund

in cooperation with CADFEM O ITficient

ANSYS Confidential ANSYS

## **Phoenix Contact: Creating a Fail-Safe Digital Twin**

### **PHŒNIX** CONTACT

**Challenge:** Unplanned downtime due to failure of a relay can cost tens of thousands of dollars per hour. It is very hard to predict relay failure as there is no wear sensor.

**Solution:** To predict component failure before it occurs, a simulation based digital twin was created that predicts the wear based on actual load and sensor data (temperature, switching frequency).

**Results:** By lowering unplanned downtime, Phoenix Contact's advanced relays can potentially save **tens of thousands of dollars per hour** for their customers.



ANSYS Maxwell simulation shows magnetic field at different armature positions.

# VWMS used the new ECM library and ROM techniques to model electro-thermal behavior of a battery pack

**Challenge:** Develop a fast electro-thermal model to optimize battery pack

**Solution:** Develop a Thermal LTI ROM, combine with new ECM library and simulate/optimize for complete drive cycles

**Results:** Won the race and beat the record by full 15 seconds on June 24, with help from ANSYS technology

7:57:148—Volkswagen makes racing history with record-breaking electric race car

Electric power beats the internal combustion engine fair and square in major motorsport.









