International Council on Systems Engineering
A better world through a systems approach

Authoritative Broker of Truth (ABoT)

Synchronizing Model-Based System Engineering with Cross-Disciplinary Simulation to Create Digital Twins

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Pat Meharg

Senior Fellow – Digital Engineering

Professional experience

- More than 20 years ‘creating cool things’ as a System Engineer.
- Teaching “Analog-to-Digital (ADC) Conversion” for the past 10 years.
- Master of Science in System Engineering (MSSE), MBA, PMP, OCSMP MBSE Modeler. Certified Software Architect

Scott James

Fellow – Simulation and Modelling

Professional experience

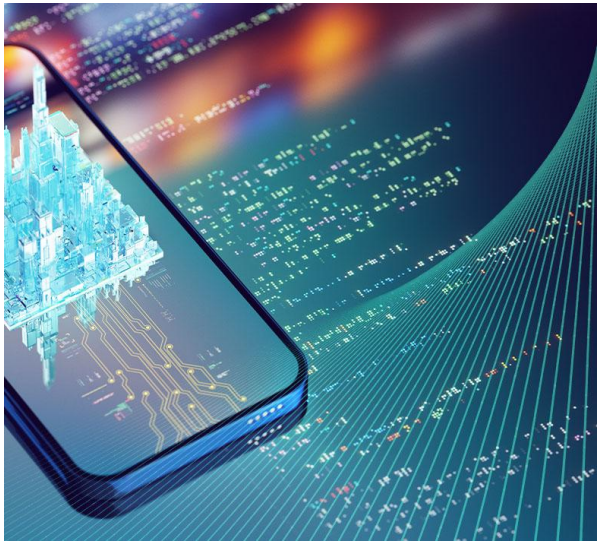
- Specializing in Large System Simulation and Visualization
- Mentoring smarter people than me for most of my career
- Doctor of Applied Mathematics, PMP, ACP

What is a Digital Twin?

Digital Twin Consortium Definition:

A digital twin is an integrated data-driven virtual representation of real-world entities and processes, with synchronized interaction at a specified frequency and fidelity.

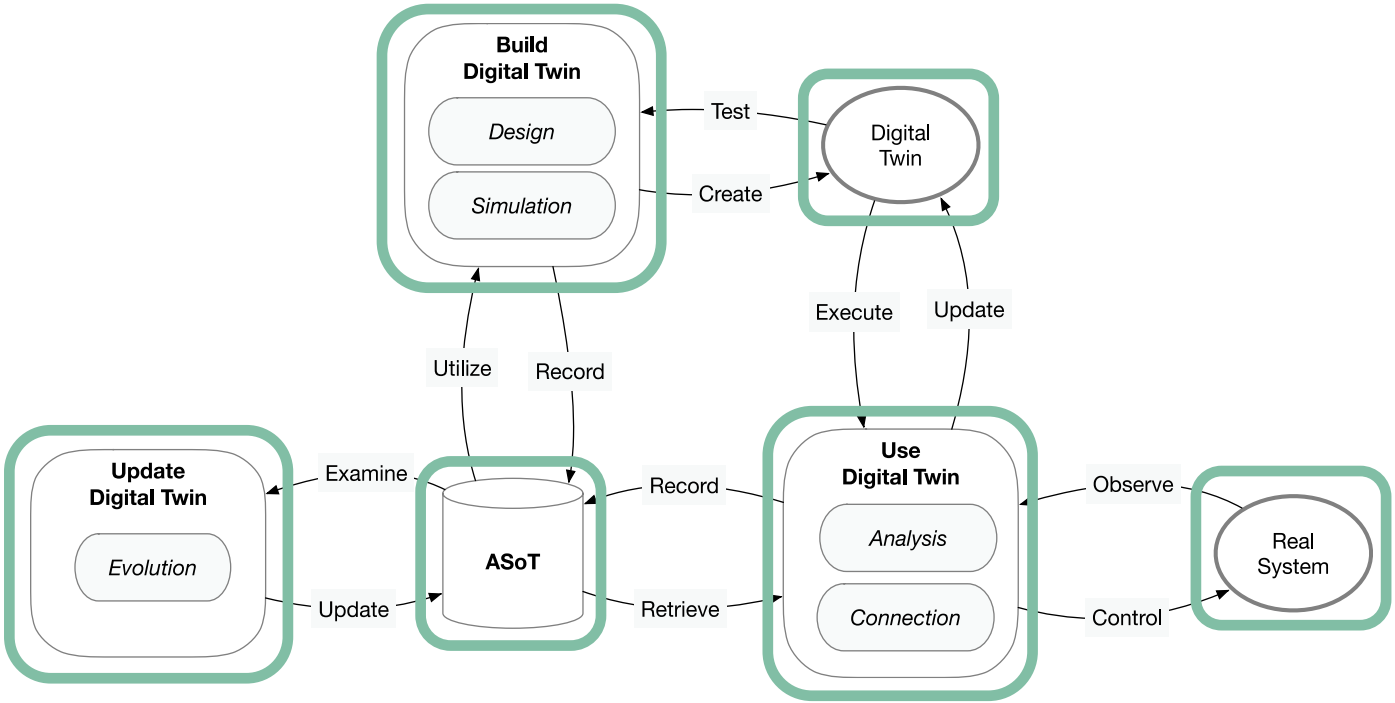
Digital Twin Consortium Definition:
https://www.digitaltwinconsortium.org/initiatives/the-definition-of-a-digital-twin/



Rephrased: Digital Twins are **living companions** to real systems whose primary purpose is to **answer meaningful questions** about the past, current and future functioning of their twinned, real-world system.

What is ABoT

The Authoritative Broker of Truth (ABoT) is a tool agnostic paradigm for building, maintaining, utilizing and evolving a Digital Twin

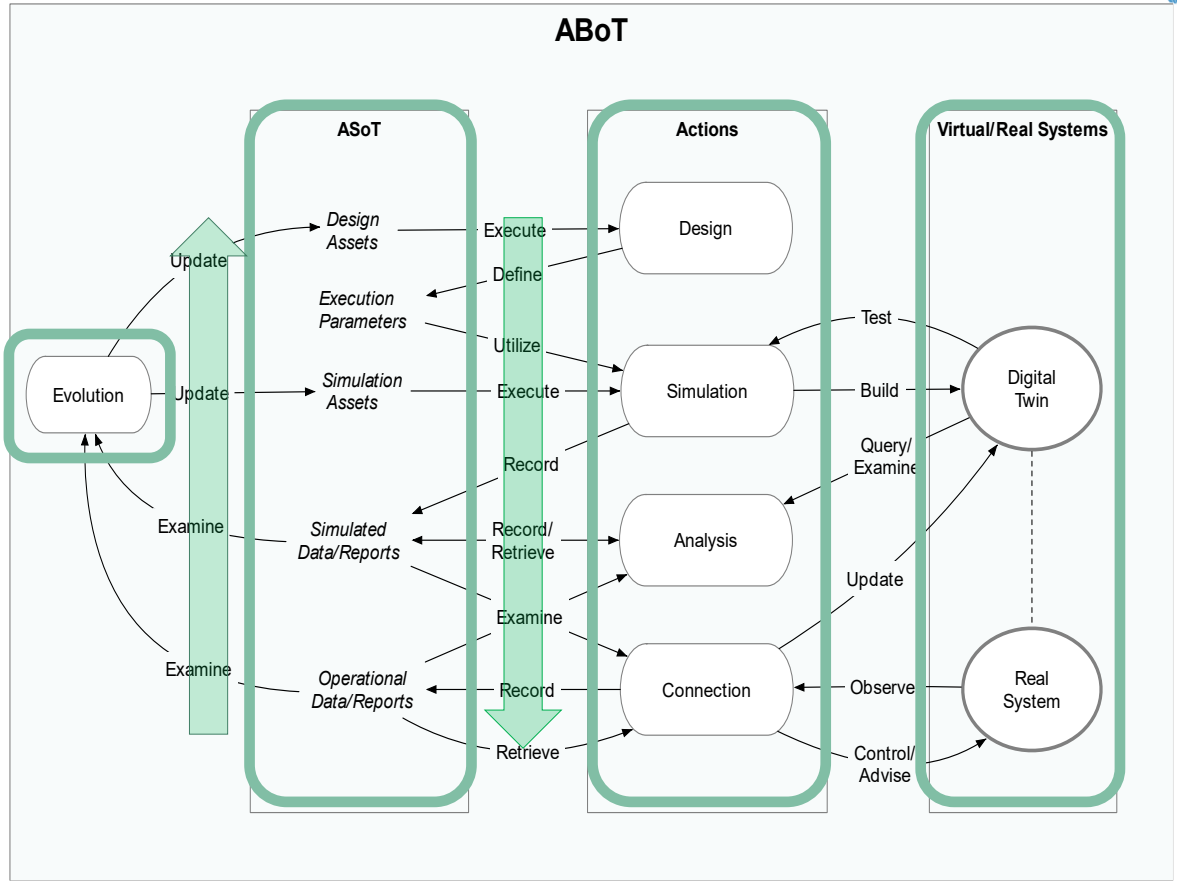


Why ABoT

Wanted a paradigm which is

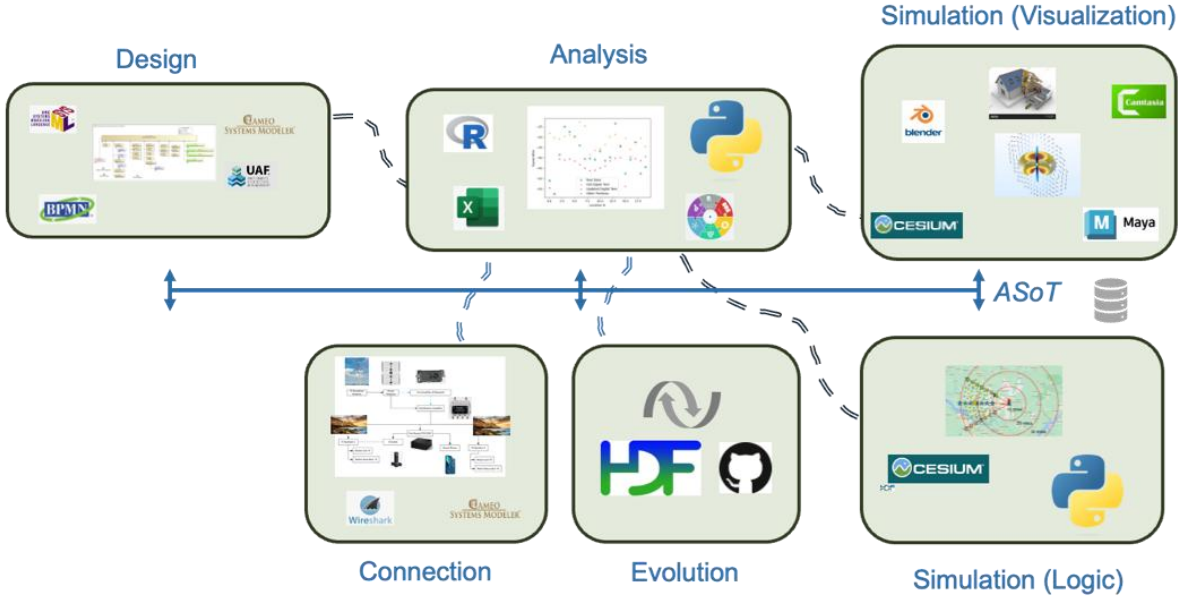
- Simple
- Tool Agnostic
- Cross SME Domain
- Used throughout full life cycle

… and by that we mean with a time horizon of forever, or at least as long lasting as the Real System



Use Case: ‘Cutting the Cord’

- Over-the-air television is available in most areas of the United States, providing free television through antennas.
- Use ABoT to create a Digital Twin tracking RF reception for these OTA channels within a selected area



Tools & Tool Chain

Model Based System Engineering - MBSE
- Cameo System Modeler
- Cameo Enterprise Architecture
- Cameo Teamwork Cloud
- UAF modeling language
- SysML modeling language
- Business Process Model Notation (BPMN)
- Excel
- XML

Verification & Validation
- Python
- Excel
- Cameo
- TS Reader
- HD Home Run

Simulation
- Cesium
- Google Earth
- NVIDIA Omniverse
- Blender
- Python

Visualization
- Blender
- Unity
- Camtasia
- Maya
- Adobe Photoshop
- Adobe Substance Painter
- Adobe Substance Designer
- Cesium
- HTML

System Prototype
- Excel
- Cameo

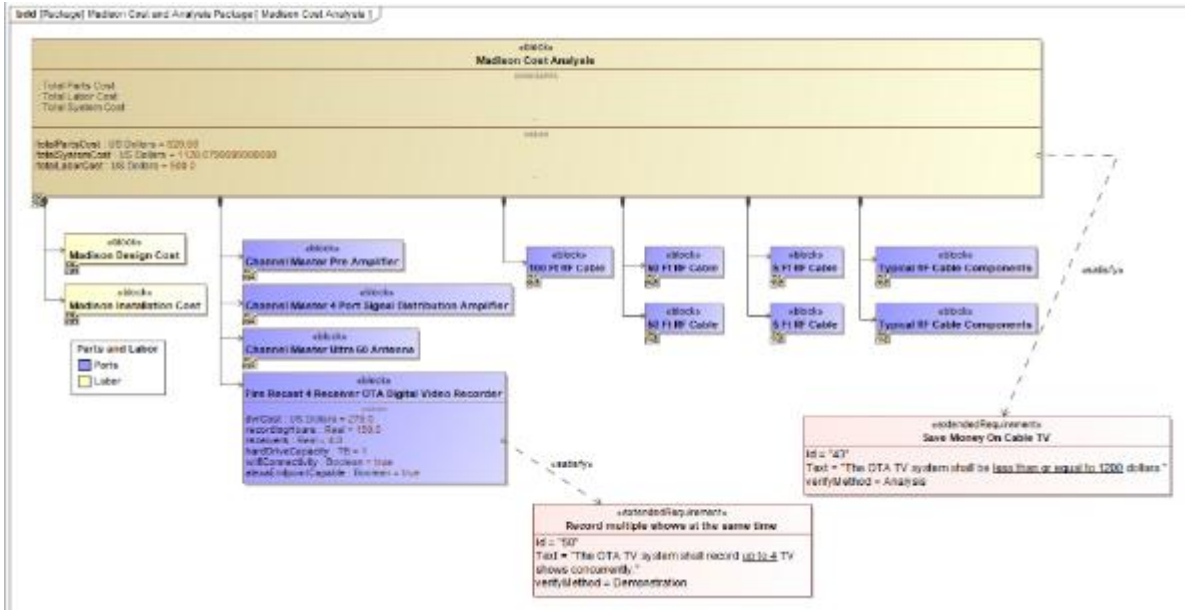
3-D CAD
- Solidworks
- Excel
- Cameo
- Bambu Lab

General & Administrative
- Outlook
- PowerPoint
- Visio
- Excel
- Word
- Teams
- Google
- Edge

Authoritative Source of Truth
- Software language R
- Hierarchical Data Format v5 (HDF5)
- Excel
- XML
- Python

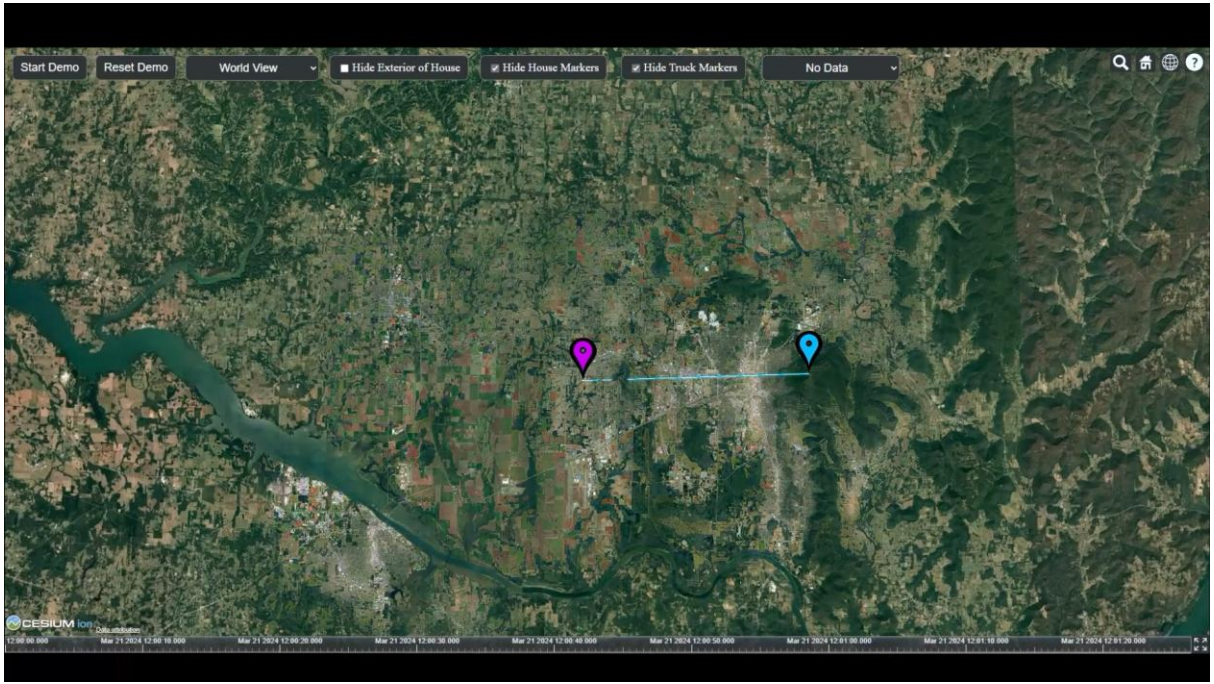
Design

- Design incorporated all nine diagrams of the SysML modeling language, including:
  - REQ: capture reason why the customer may be interested in an over-the-air TV antenna system
  - BDD: identify the components of the system, including antennas
  - PAR: predict the RF energy levels at geographical locations within the TV viewing area
- Design provides parameters for the Simulation



Simulation

- From Design parameters generate signal strength map
- Leverage Cesium to create an interactive display capable of browsing 2D/3D environment and filtering by reception channel



Analysis

- A stakeholder in Huntsville, AL wants to determine if they can replace their cable television with television transmission
- Entering their home coordinates, the stakeholder finds that the signal strength at their house is borderline
- Exploring the area with the simulation application they discover that a mountain (Rainbow Mountain) blocked the line of sight between the transmitter and house
- … but they would like to be convinced they really need extra hardware

Connection

- Collect additional RF data using
  - Mobile antenna platform
  - Hand-held GPS
  - Pickup truck
- Drive test rig to different locations to obtain new measurements

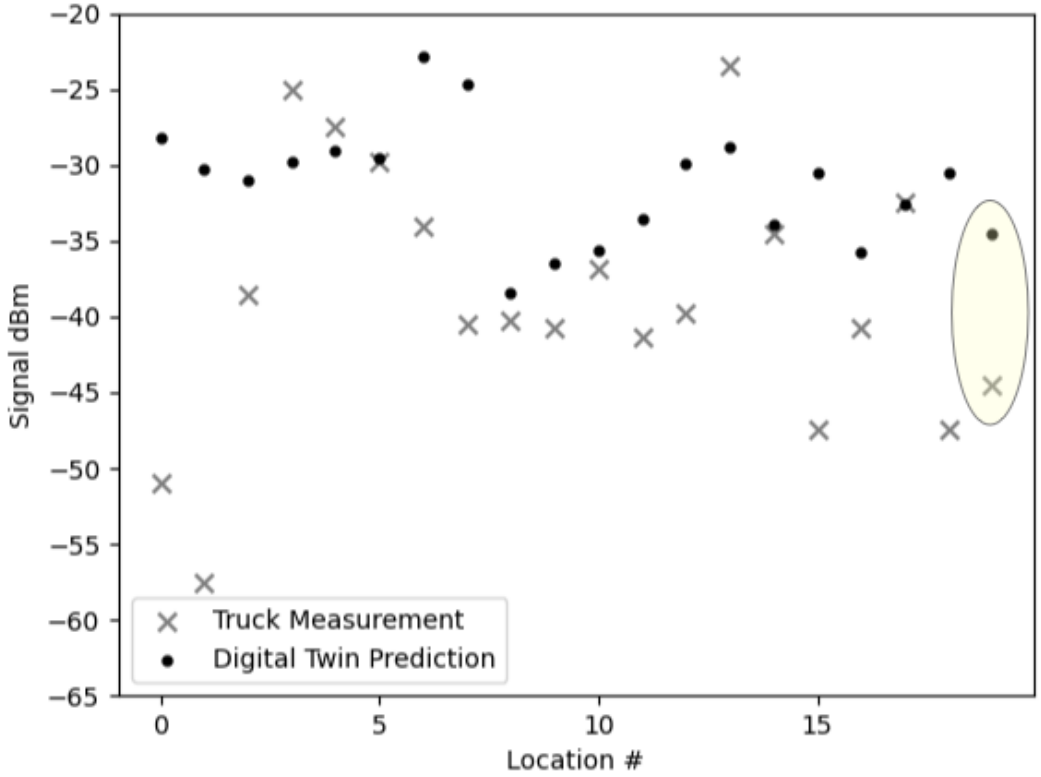
A

B

C

Evolution

- Examining the physical RF measurement at the stakeholder's house (yellow was lower than predicted, highlight) we see that the actual measurement thus confirming the need for an amplifier
- The new physical measurements are added to the ASoT and incorporated as the basis for the simulation and the next version of the digital twin



Let's connect

Visit **noblis.org**

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