

On the Use of Resilience Models as Digital Twins for Operational Support and In-time Decision Making

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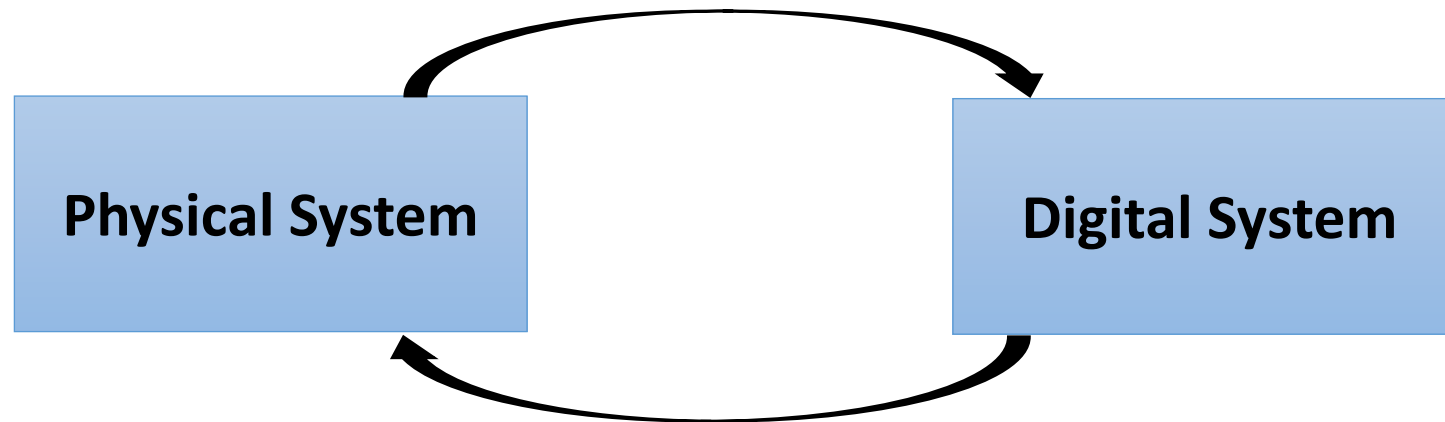
AIAA Aviation Forum 2023

June 12-16, 2023

DGE-02/DE-03, Digital Ecosystem, Digital Thread
and Digital Twin
San Diego, CA



What are Digital Twins?



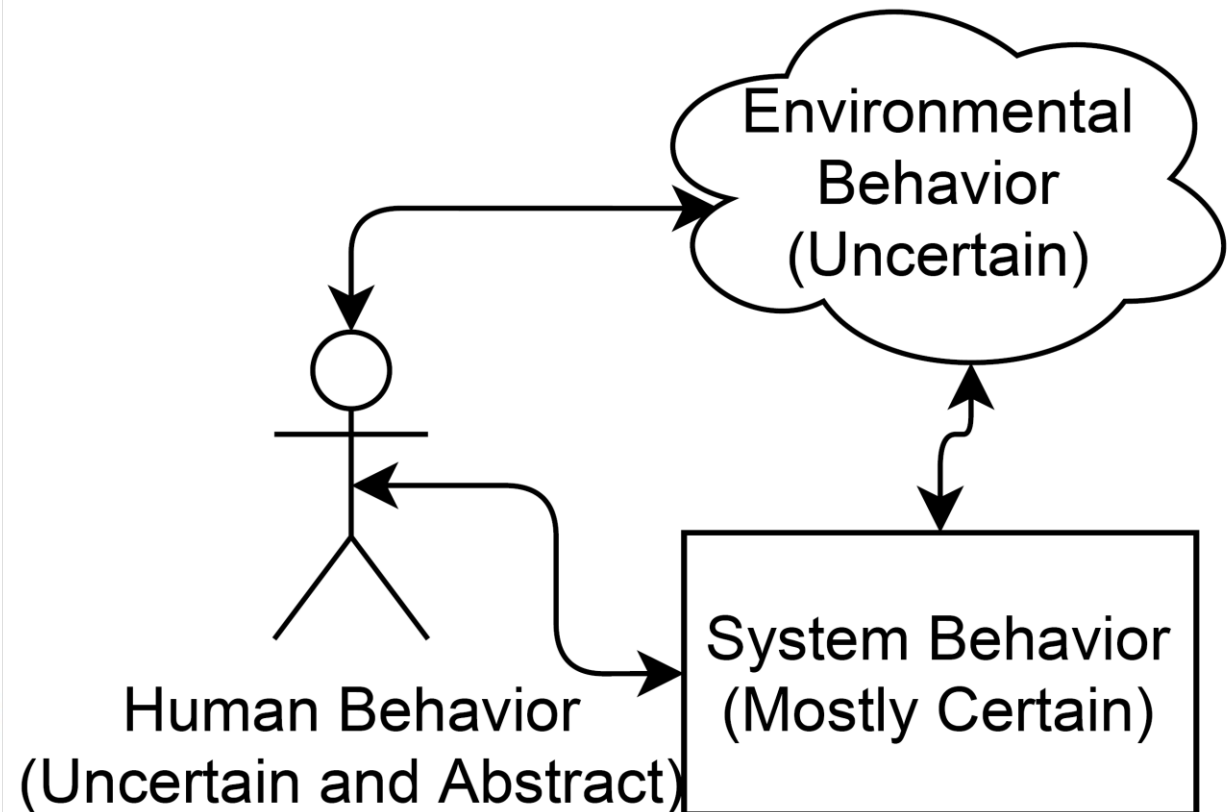
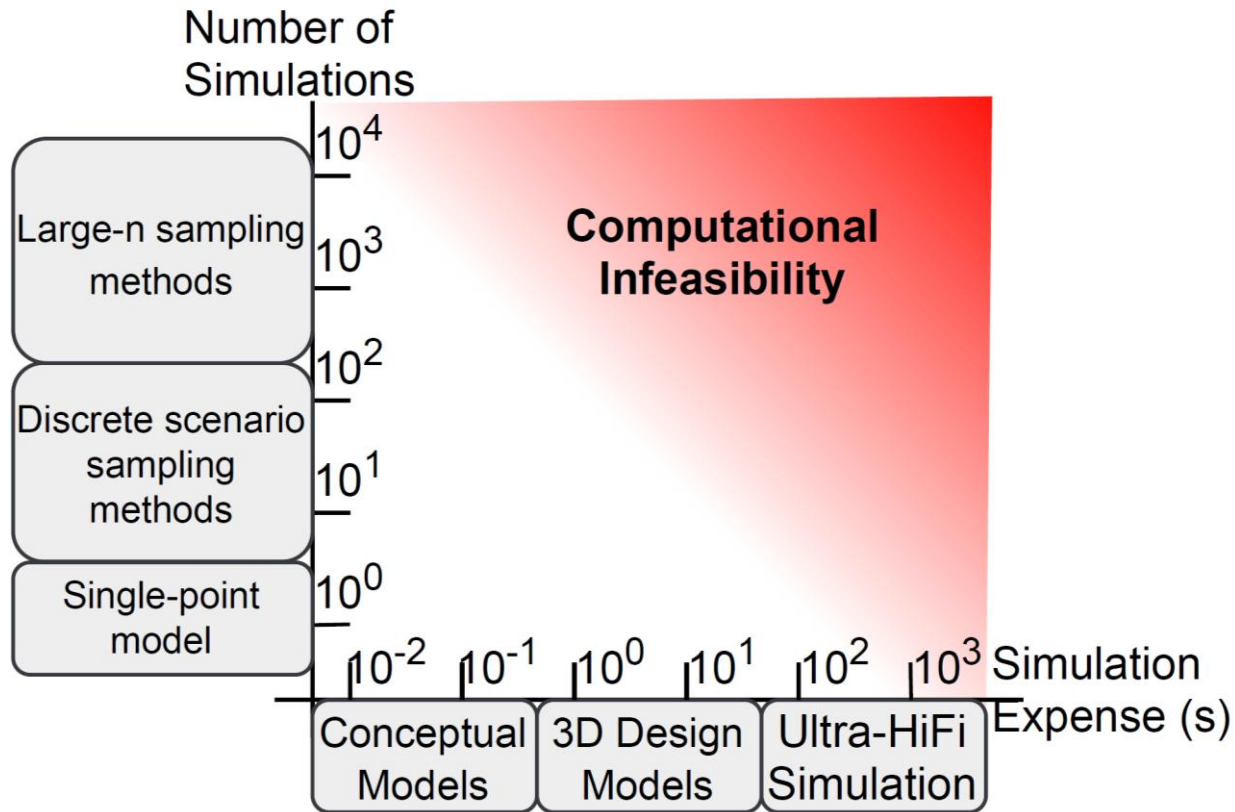
- “Ultra-realistic” – high-fidelity
- Real time interconnection – internet of things, sensors, webservices, etc.

Is High Fidelity Achievable?

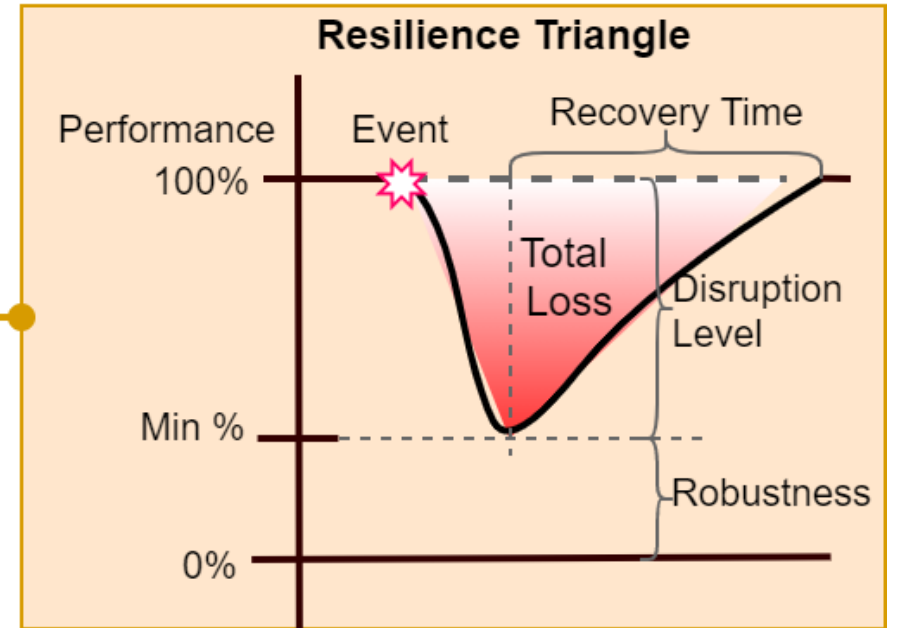
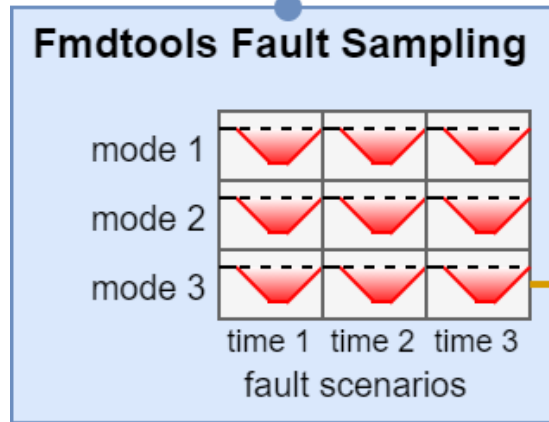
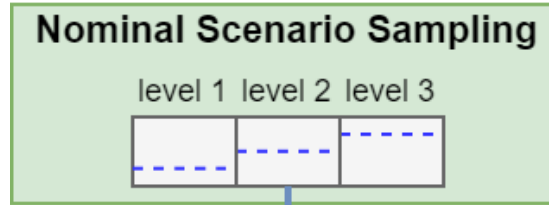
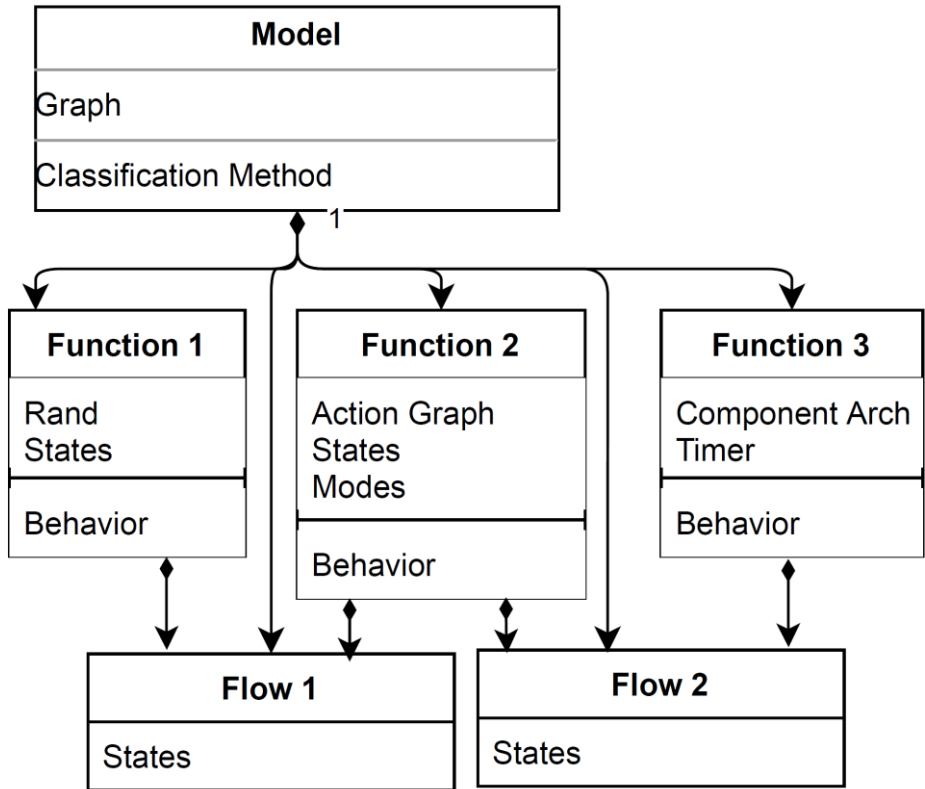
- None of the literature in DT have high-fidelity models
- Network speeds, lack of data, uncertainties, computational costs
- Real time data exchange – human-in-the-loop systems, varying data collection frequencies



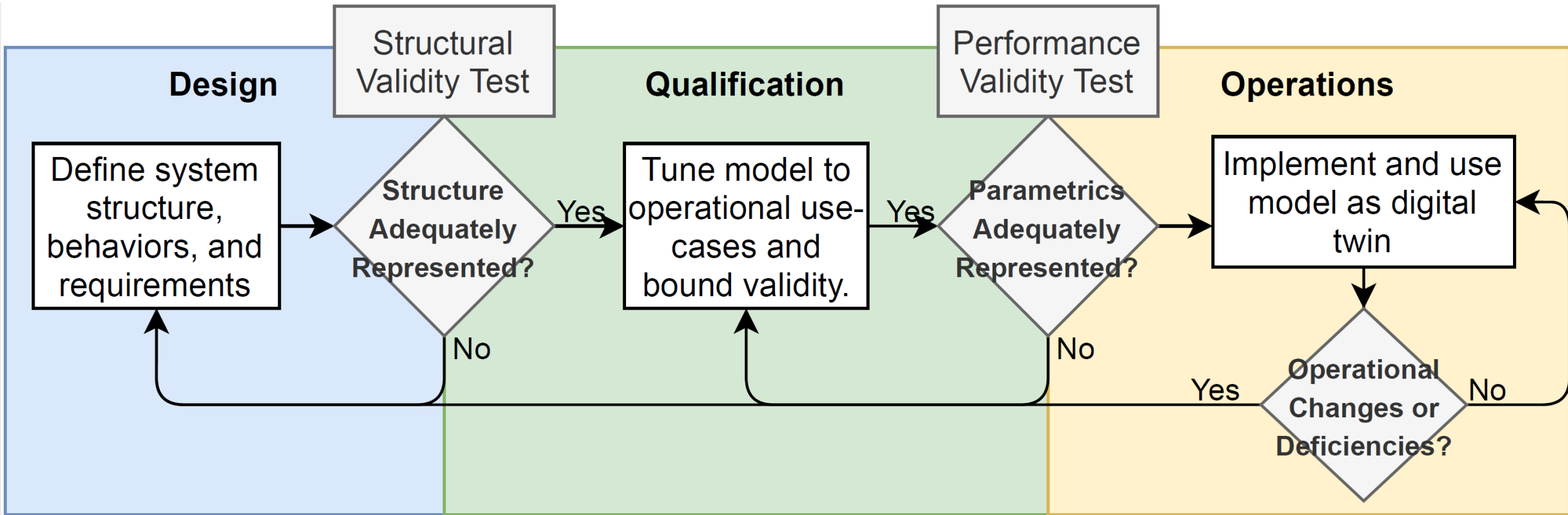
Is High Fidelity Achievable?



The fmdtools Toolkit



Methodology

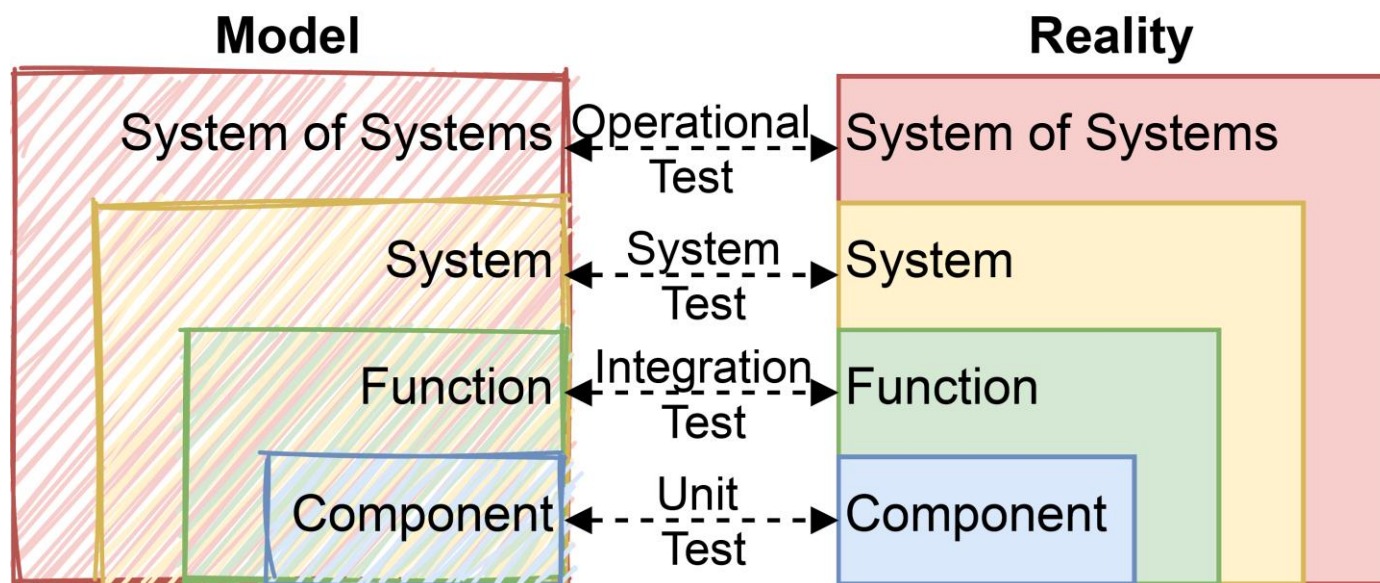
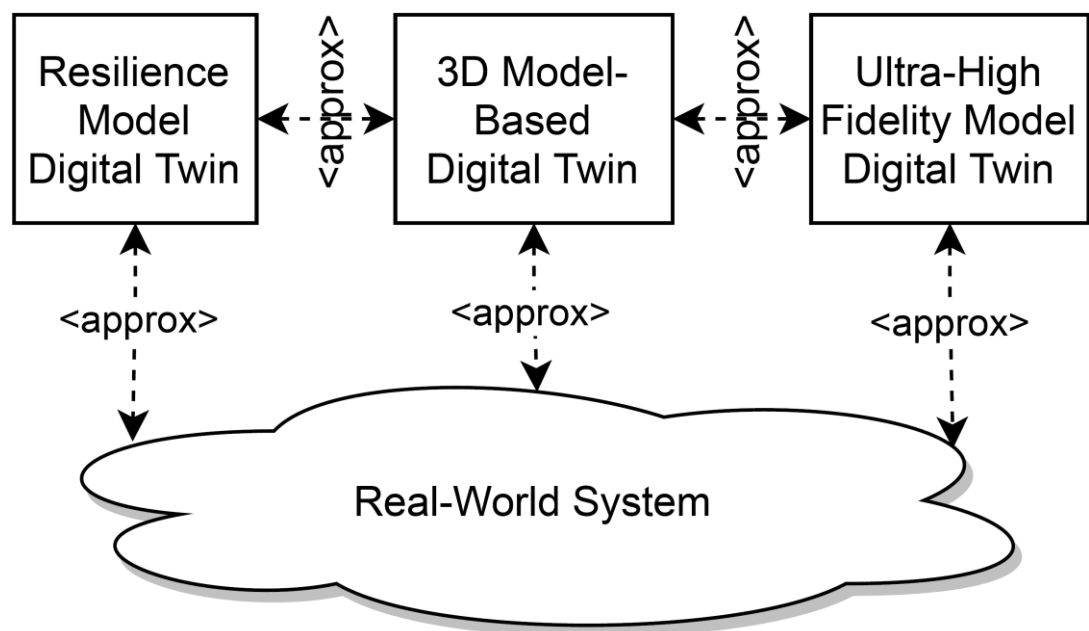


Digital Twin Development

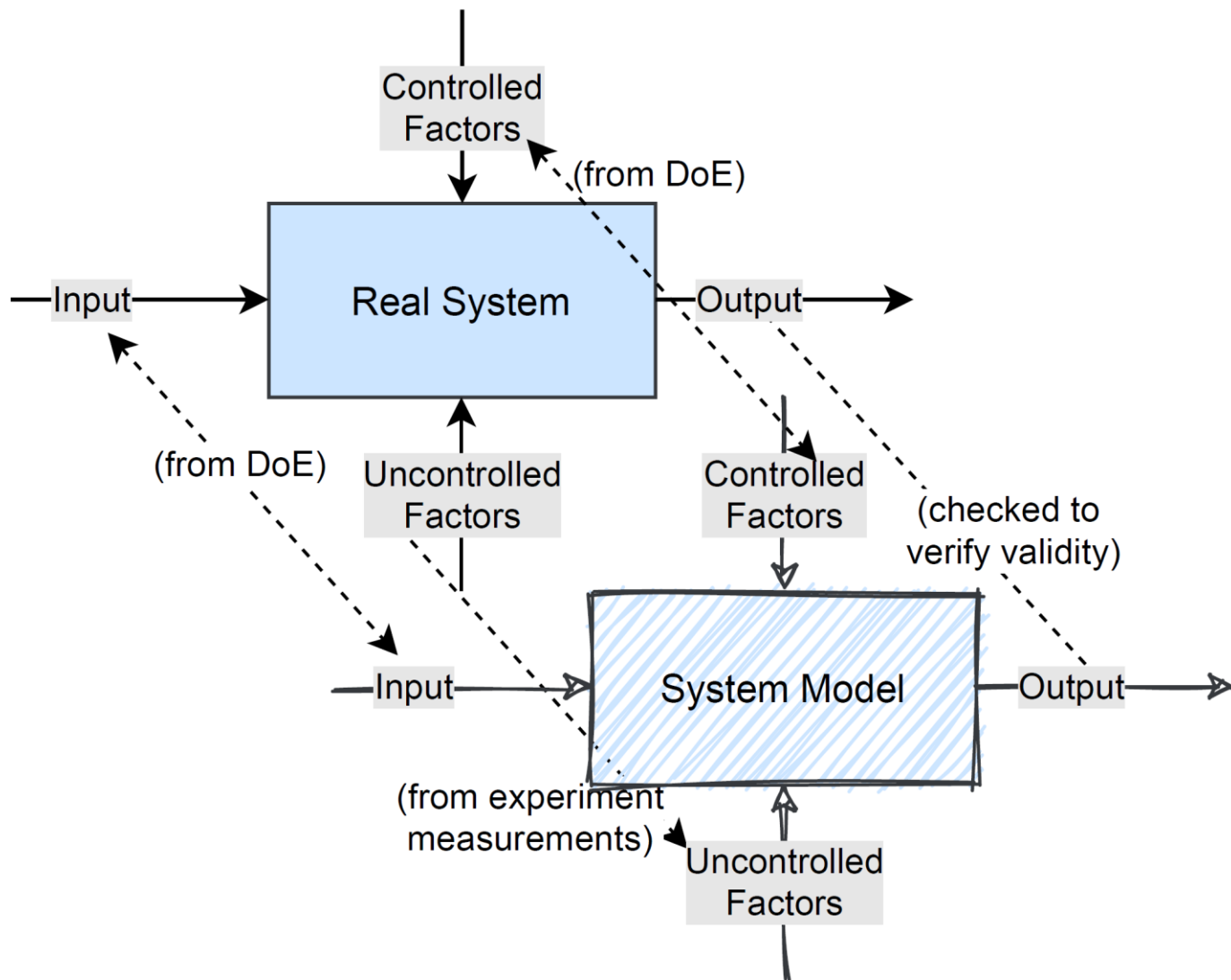
- Functions, Flows, Parameters, Behaviors, Actions, etc.
- Data Sharing Structure
- Data Sharing Frequency
- Representing the Human
 - Action Sequence Graphs
 - Performance Shaping Factors



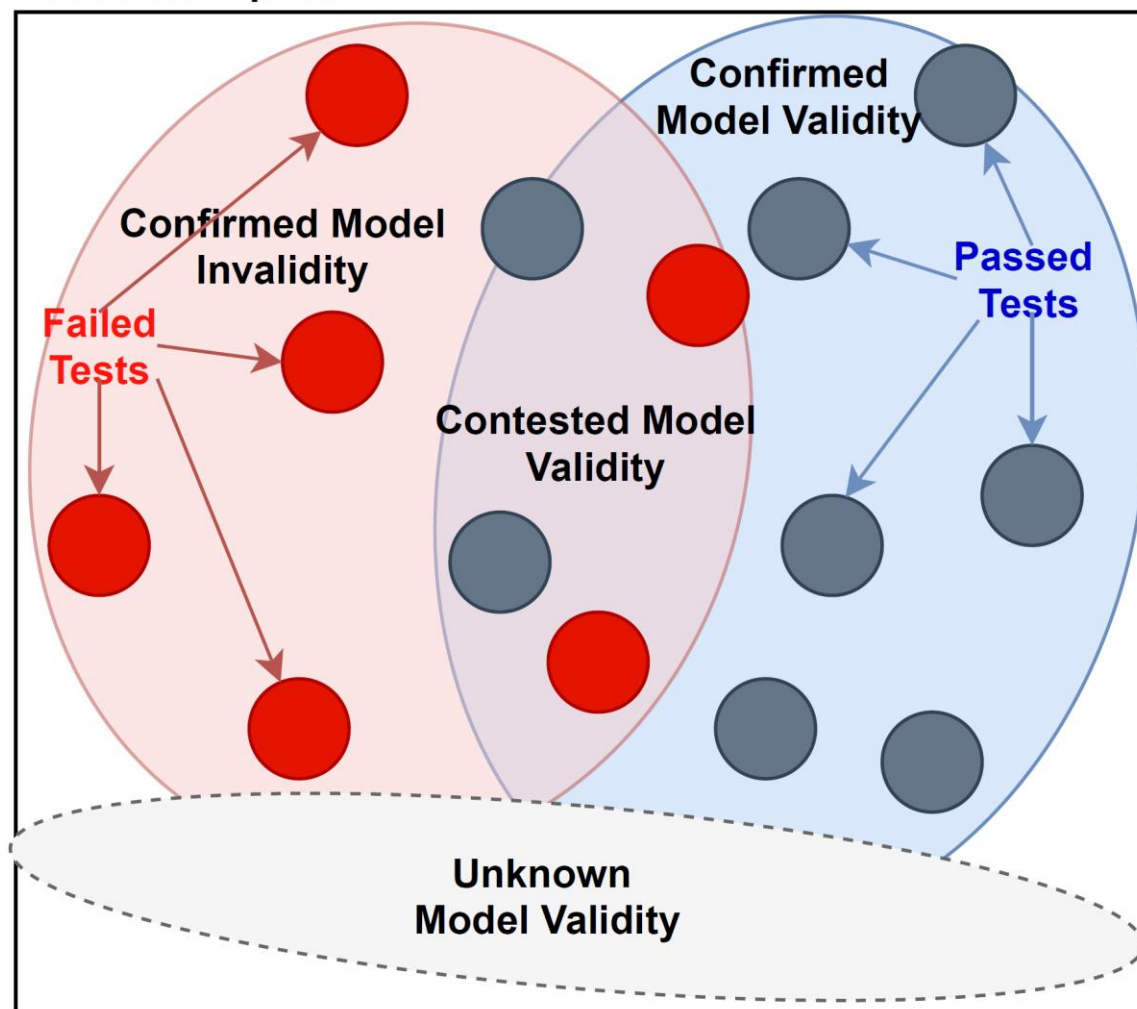
Digital Twin Qualification



Digital Twin Qualification



Test State-Space



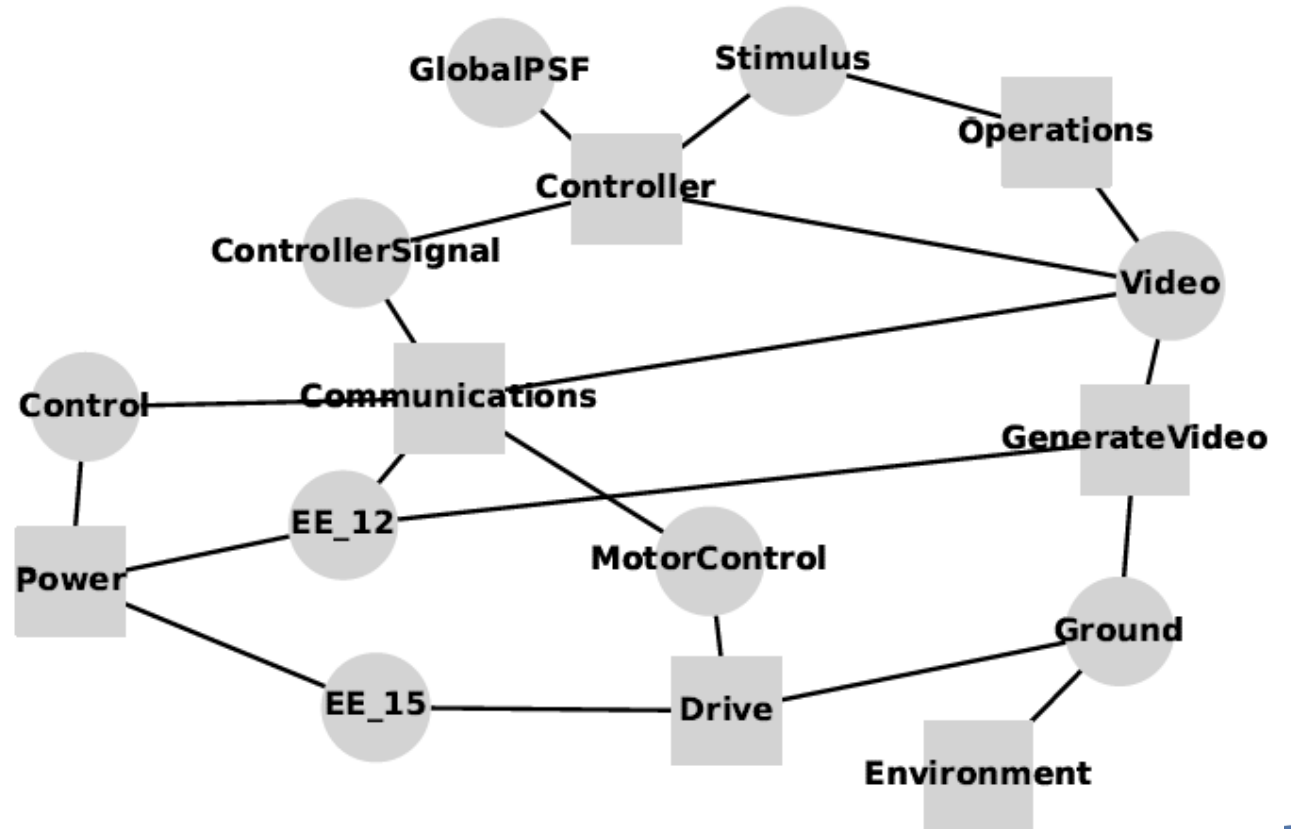
Digital Twin Operations Phase

- Operational Issues
- New Application or Data
- New Operations
- Deviations from the Norm

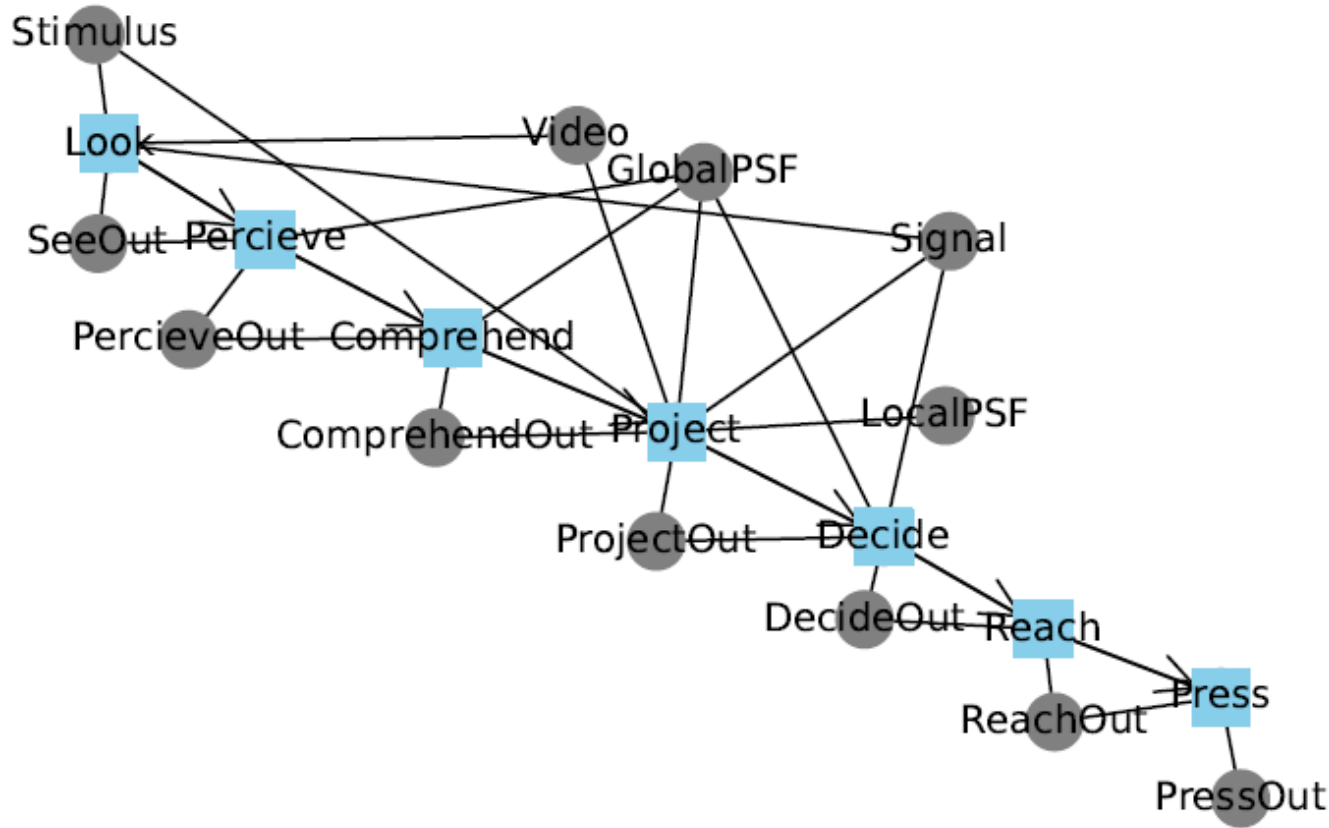


Demonstration

- Parameters
 - Map



Demonstration



- Performance Shaping Factors
 - Attention
 - Fatigue

Conclusions and Future Work

- A low fidelity digital twin using fmdtools models
- Human representation
- Easy to adapt, large number of simulations, computationally cheap
- As decision support for both diagnostic and prognostic applications in-time
- Design time usage
- Rover – currently under development
- Real time testing and validation of the framework



Questions?

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researchgate.net/profile/Daniel-Hulse-4

Resilience Analysis and Design Project

website:

ti.arc.nasa.gov/tech/rse/research/rad/

Fmdtools Simulation Package

repo:

documentation:

github.com/nasa/fmdtools

nasa.github.io/fmdtools/

