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02-16 Digital Engineering

March 2024

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Changing the World's Energy Future

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NRIC National Reactor Innovation Center

Digital Engineering

2024 NRIC Program Review

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5/1/2024

Agenda

- Digital Engineering Overview
- FY24 NRIC Digital Engineering Review
- Other NRIC Digital Engineering Updates at INL
- Funding & FY25 Look Ahead

Digital Engineering Overview

Why Digital Engineering

- 48% of large projects finish on budget
- 8.5% of large projects finish on budget and on schedule
- 0.5% finish on budget and schedule, while delivering the expected benefits/promises
- Nuclear related infrastructure is one of the worst offenders

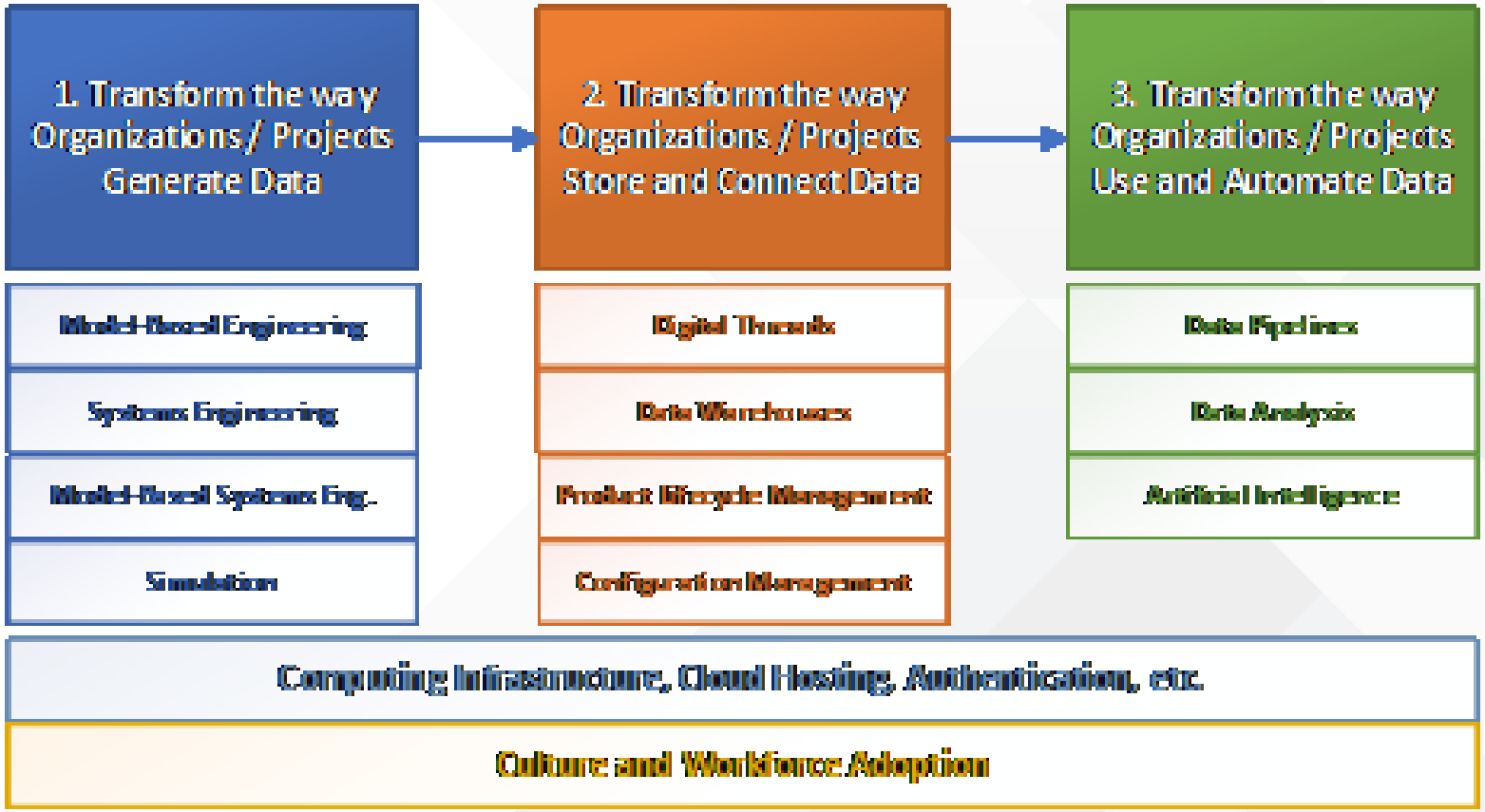
How Big Projects Performed

Source: Flyvbjerg Database

Project type	Mean cost overrun (%)	Projects (A) with ≥50% overruns (%)	Mean overruns of A projects (%)
Nuclear storage	238	48	427
Olympic Games	157	76	200
Nuclear power	120	55	204
Hydroelectric dams	75	37	186
IT	73	18	447
Nonhydroelectric dams	71	33	202
Buildings	62	39	206
Aerospace	60	42	119
Defence	53	21	253
Bus rapid transit	40	43	69
Rail	39	28	116
Airports	39	43	88
Tunnels	37	28	103
Oil and gas	34	19	121
Ports	32	17	183
Hospitals, health	29	13	167
Mining	27	17	129
Bridges	26	21	107
Water	20	13	124
Fossil thermal power	16	14	109
Roads	16	11	102

Digital Engineering Overview

- Digital engineering provides for the most secure, highest quality, most accessible, fastest execution of large scale and complex projects
- NRIC expects to "Do it right" every time and provide the most advanced look at reactor and testbed integration and designs



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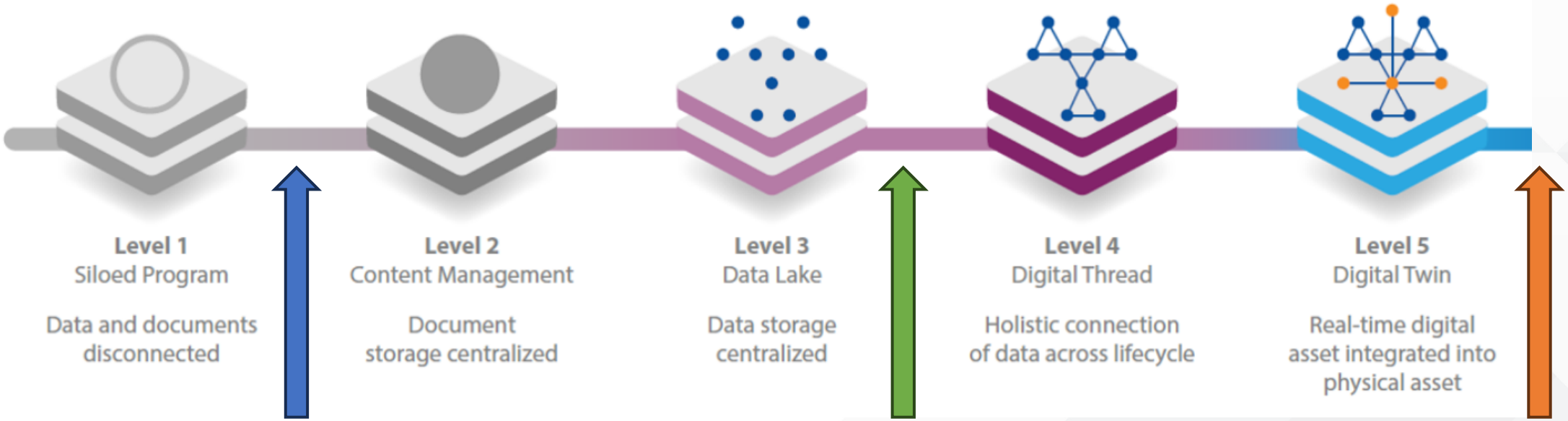
INL Digital Engineering Program Progress



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FY24 Digital Engineering Review

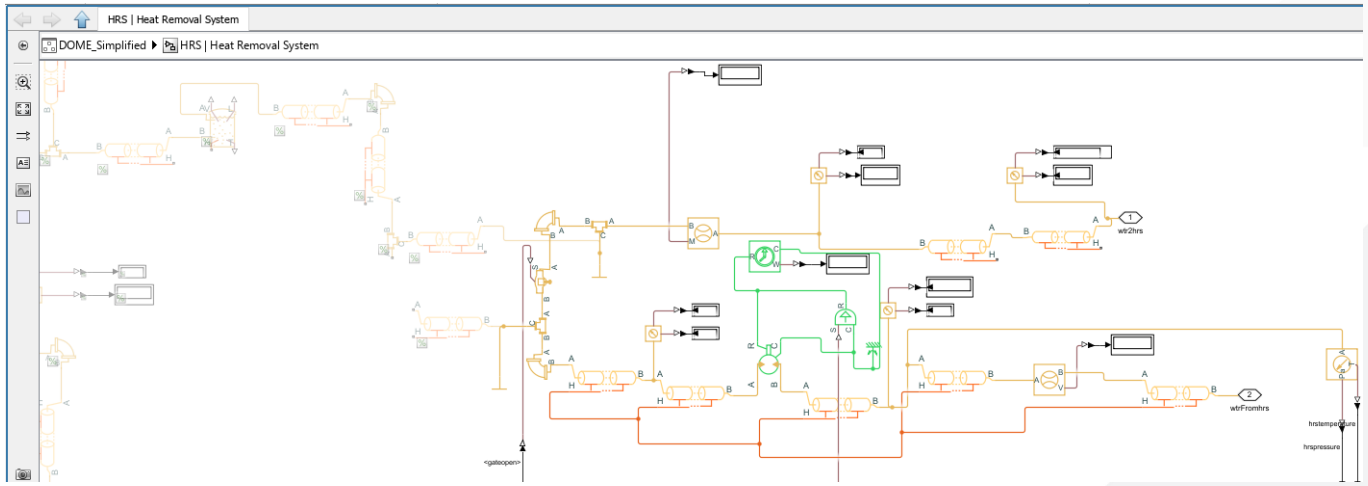
DOME Facility-Level Modeling

Why?

- Operational digital twins need some concept of how a facility or system is “supposed to work”
- Our INL engineering practices suffer from not incorporating system-level modeling

What?

- Use Matlab/Simulink tool suite to replace drawings with models and demonstrate how DOME is designed to work
- Systems are complete to model the high-level function of the physical assets and control logic associated with facility thermal management.
- Will be able to transfer this model to operations and leverage for the predictive side of the facility digital twin



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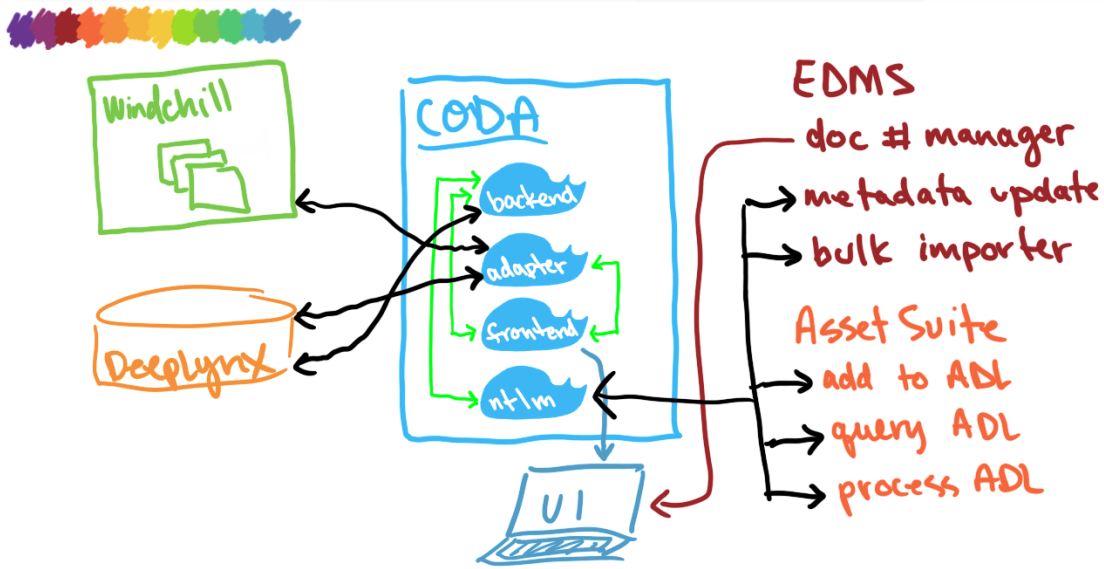
Windchill & Document Automation

Why?

- INL does not have a product lifecycle management (PLM) tool
- At the end of the design phase, engineers manually copy documents from multiple sources into our legacy systems

What?

- Deploy Windchill as an INL production system
- Automatically transfer completed engineering outputs from Windchill to INL Legacy Systems and Record Repositories



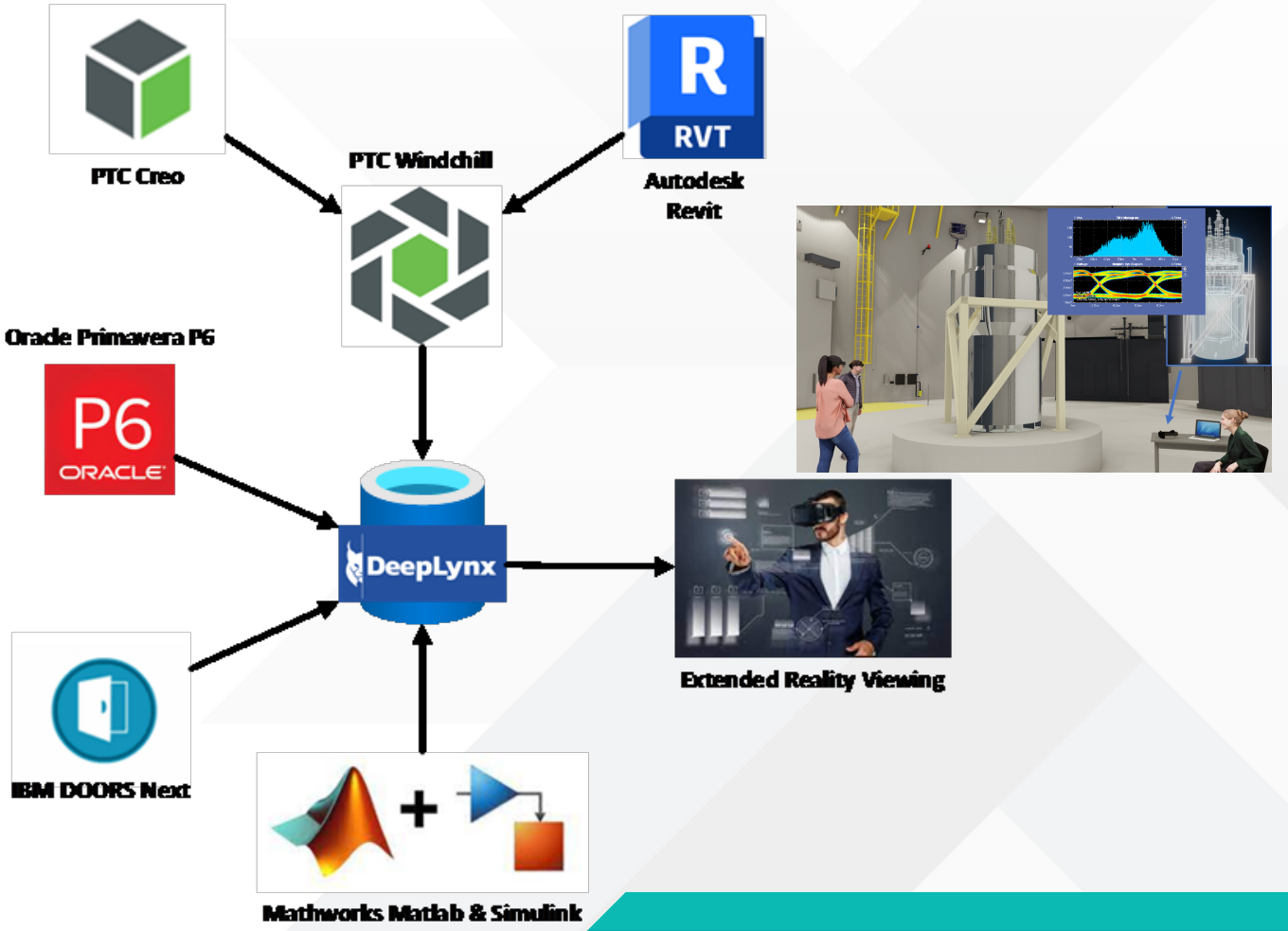
DOME Informational Digital Twin

Why?

- Digital Threads (connected data) is incredibly useful, but the mechanism by which we review it is outdated
- Review of a design is always "static" and never real-time from the source of truth

What?

- Connect requirements, P6 Schedule, Creo models, simulation results into a single "Viewing" platform that is real-time and leverages Deep Lynx
- Users will be able to inspect the model, move objects, traverse through the design using their computer or holographic glasses



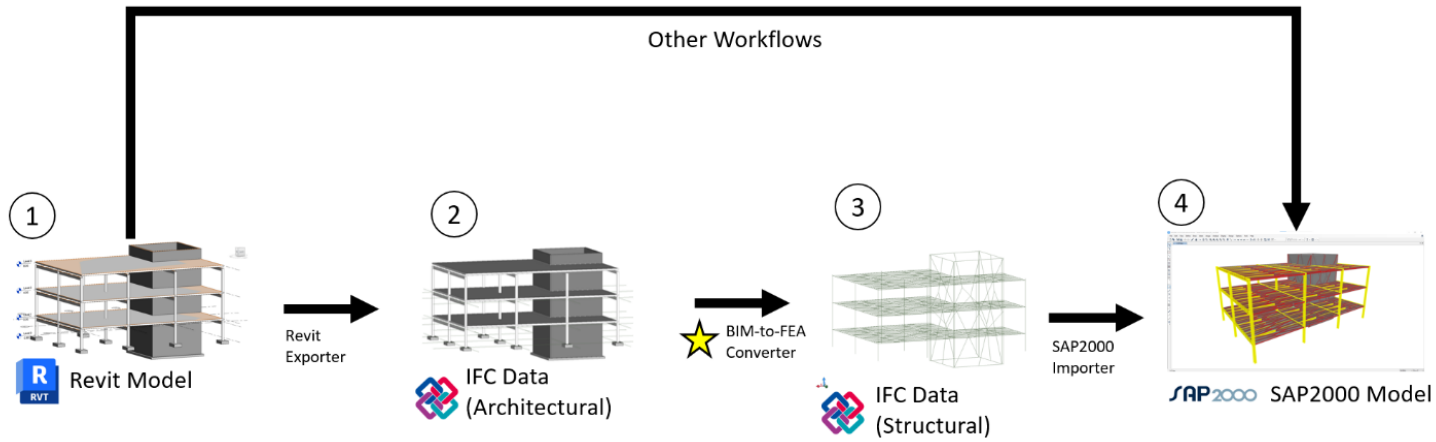
BIM to FEA Data Conversion

Why?

- Engineering design and analysis are historically siloed domains in nuclear
- One engineer spends time creating a model in Building Information Modeling (BIM) software and then another engineer recreates the exact same model in a structural analysis tool like SAP-2000

What?

- Automatically convert engineering design models (BIM) into compliant analysis models (FEA)
- Eliminate ~50% of the time it takes to generate a model for seismic analysis
- Currently working with several industry partners



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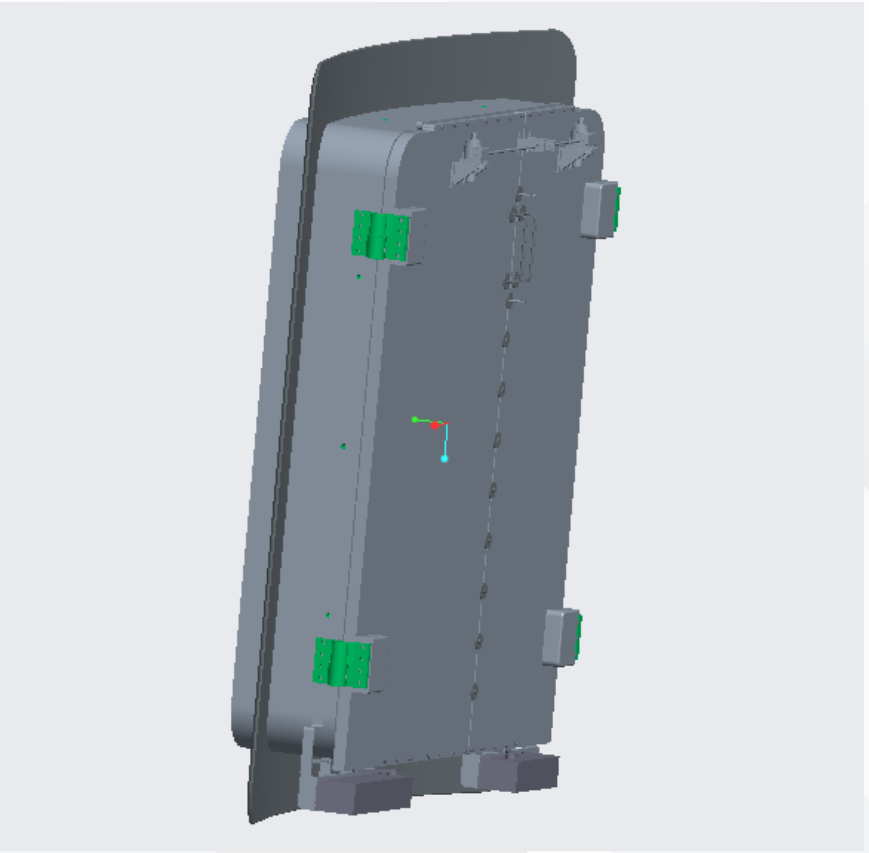
Other NRIC Digital Engineering Updates

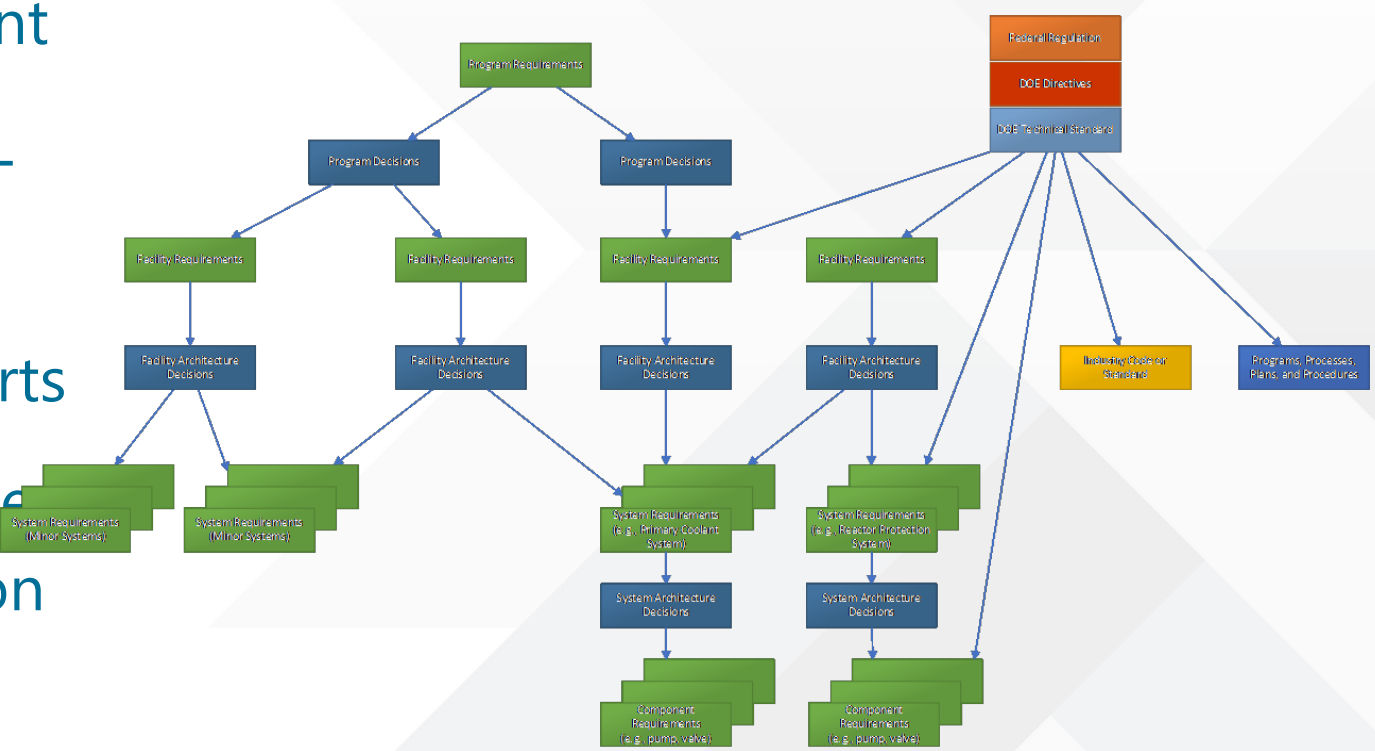
Model-Based Definition (MBD)

- Reworked DOME models to implement rigorous MBD and integrate with Windchill
- Mapping parameters embedded in the model to Windchill so that all bill of material (BOM) data is available to the user without access to CAD
- Instituting best practices with regard to identification (numbering), parameters, vendor/supplier collaboration, redlining, RFIs, etc.



Model-Based Requirements Engineering (MBRE)

- Continued adoption of IBM Engineering Lifecycle Management (ELM) [a.k.a. DOORS Next] for requirements management at INL
- Templatized a generic requirements structure
- Able to generate Word/PDF reports and documents conforming to almost any formatting or template
- 20+ NRIC projects using for Action Tracking
- Piloted use for field/construction V&V



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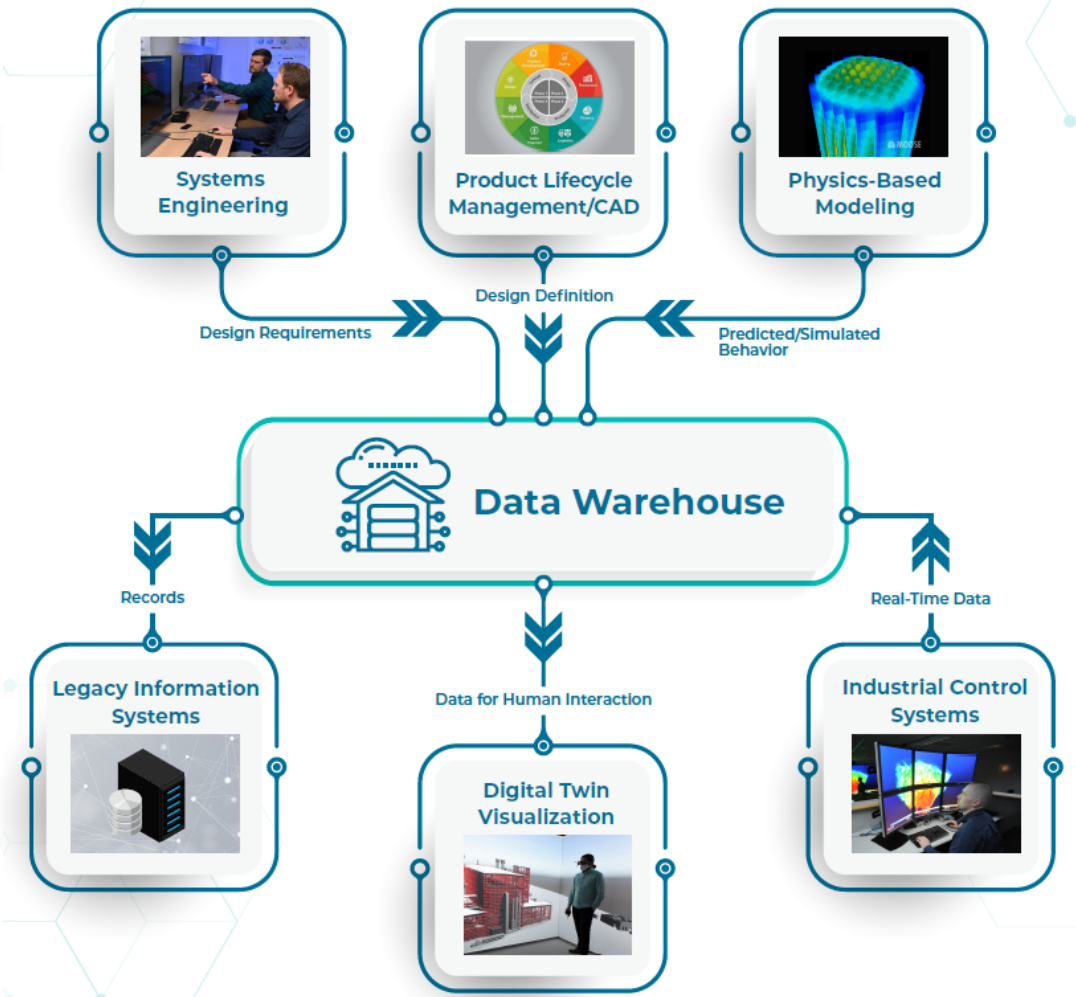
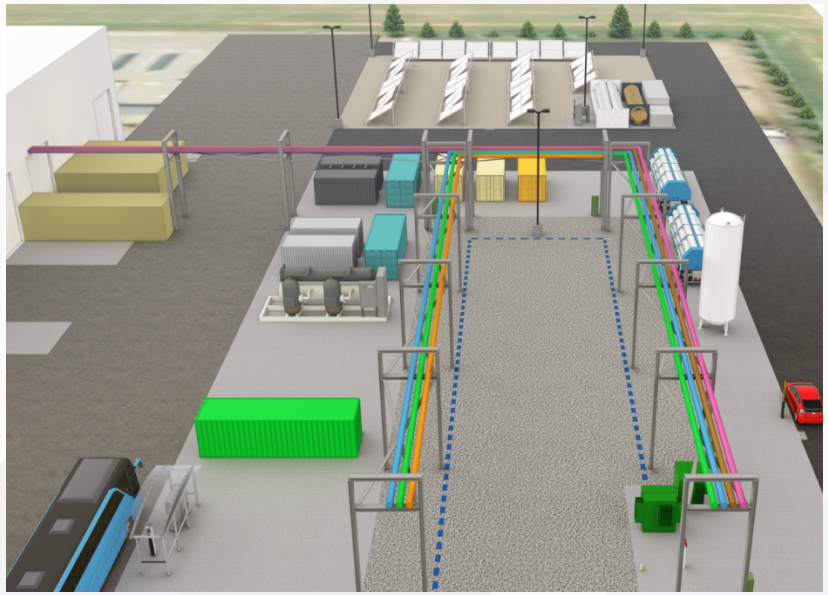
Deep Lynx

- INL is investing more in Digital Thread technology and the Deep Lynx data warehouse
- INL has R&D mission, meaning that software typically gets funded to TRL 6 without a path towards TRL 9
- Working with stakeholders and partners to stabilize the product and progress to TRL 9 and the standards expected of a commercial product
- Starting taking an internal SE approach to the M&O of the platform, established roles and responsibilities, enhanced documentation
- Some industry support and engagement



Artificial Intelligence

- Submitted two Digital Engineering-led LDRDs to Nuclear Call
  - AI for Regulatory Process Transformation
  - AI for Microreactor Operations
- AI Chat Deployed on the INL HPC and Ready for Use Cases: https://chat.hpc.inl.gov/
- Prototype MBSE -> CAD Generator (Auto Plant Design)

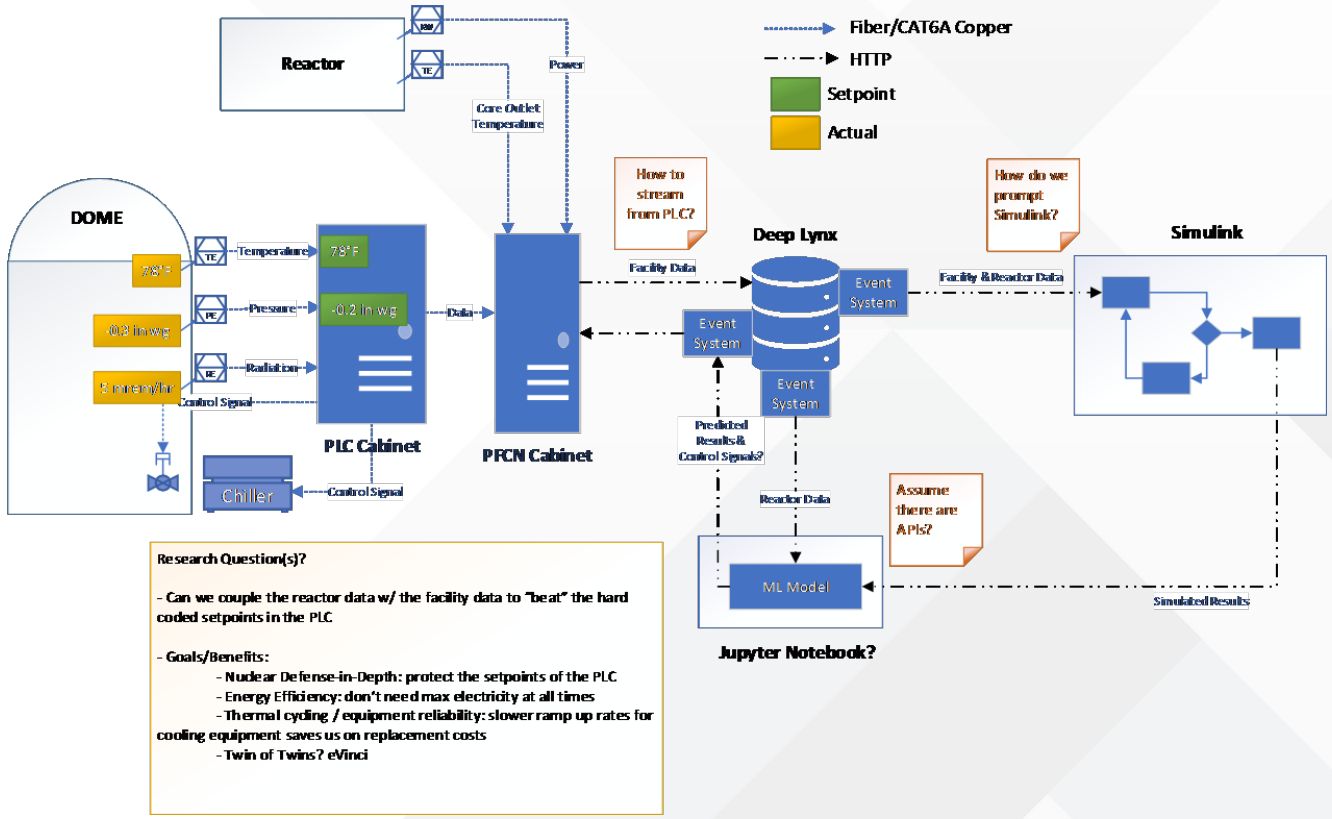


Funding & FY25 Look Ahead

FY25

FY20	FY21	FY22	FY23	FY24
$600K	$989K	$742K	$500K	$1.1M

- Release Beta Version of Auto Plant Design Application using AI
- Continued Development of DOME Digital Twin, incorporating hardware feedback
- Release Deep Lynx 2.0 at TRL 9 Level



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