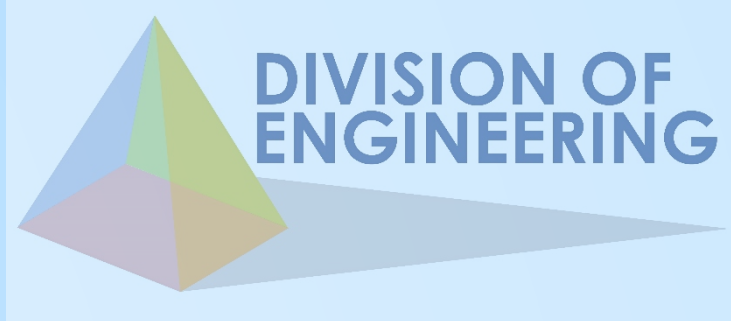
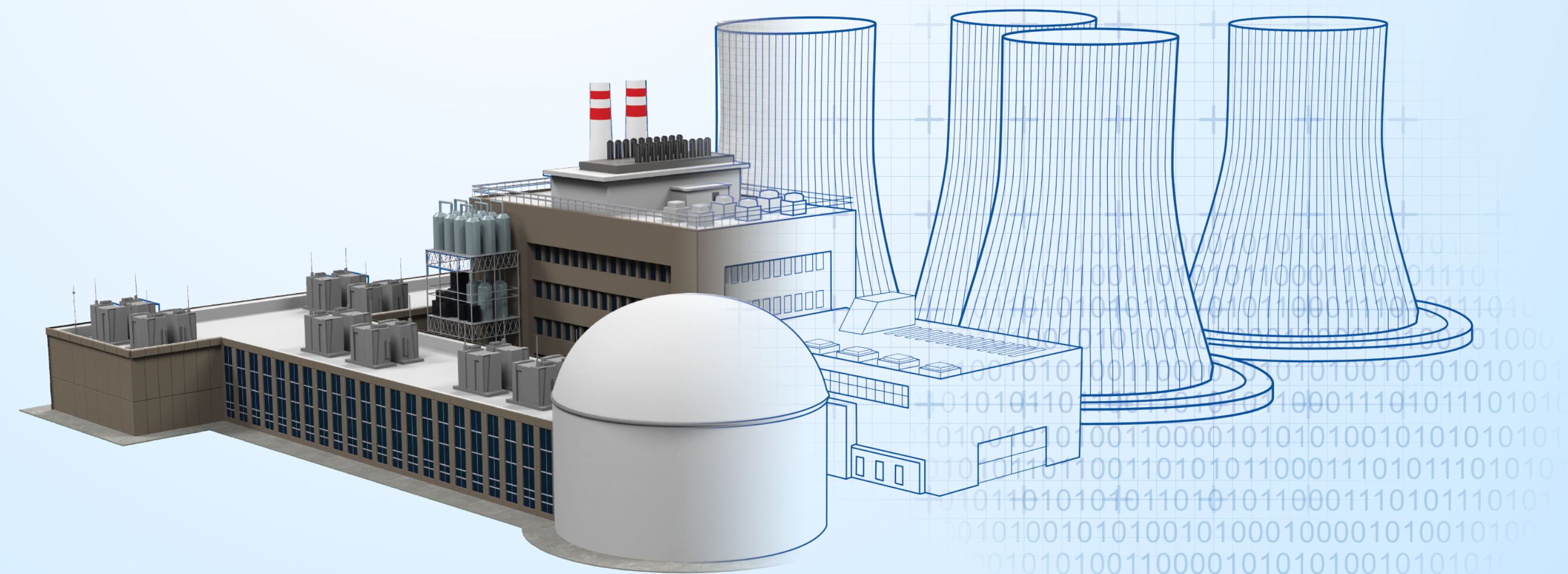


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Digital Twins - Regulatory Viability

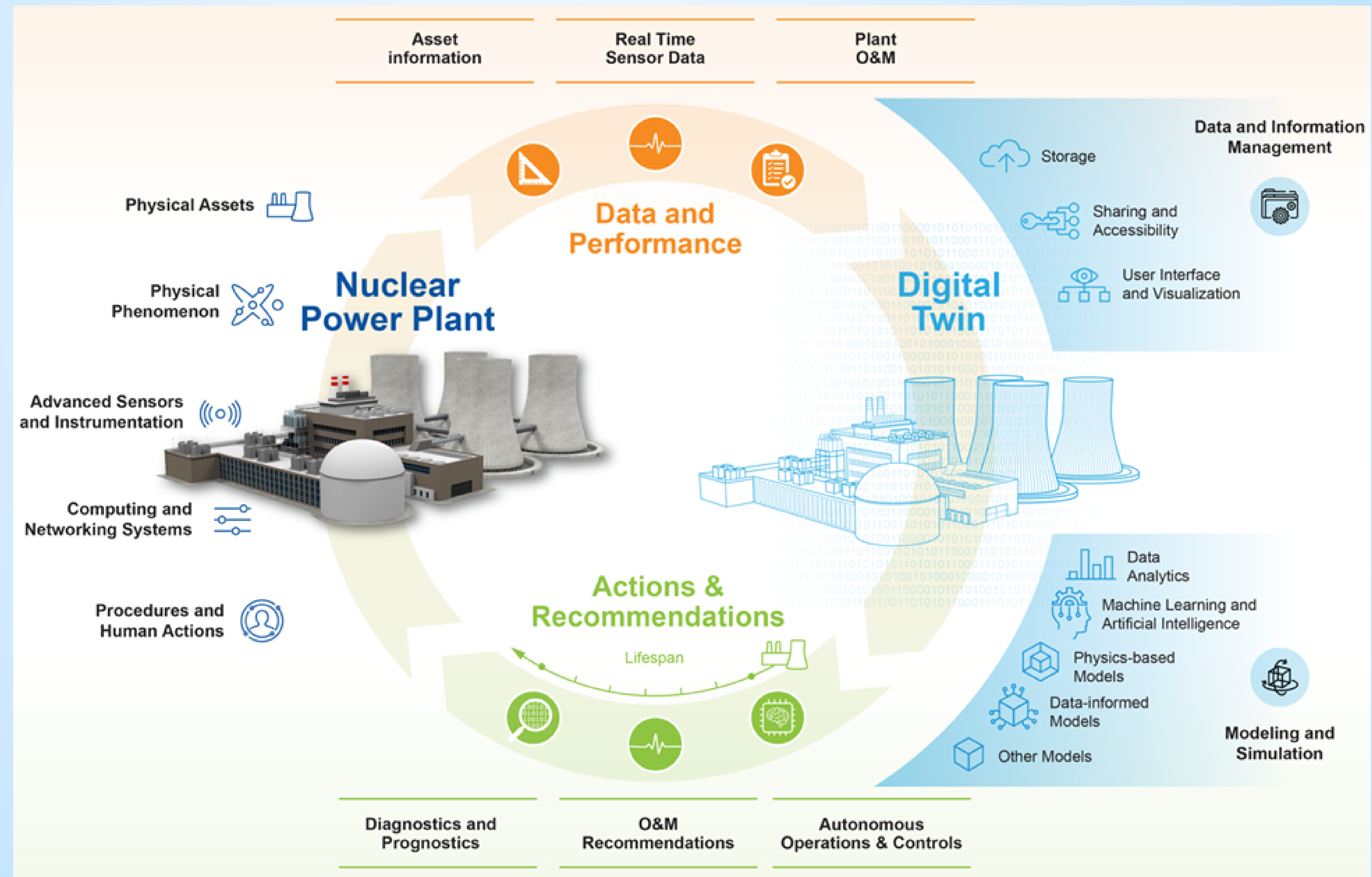
Digital Twins Project Staff Team
Reactor Engineering Branch
Division of Engineering
Office of Nuclear Regulatory Research
US Nuclear Regulatory Commission



Public Meeting on the Regulatory Considerations
and Opportunities for Digital Twin Technology
March 1, 2022

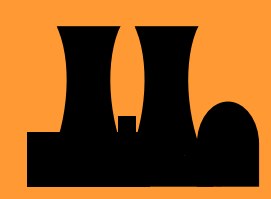
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What is a Digital Twin?



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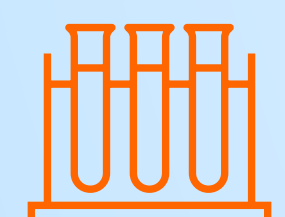
Opportunities & Applications



Plant Opportunities



Design



Testing



Operations



Maintenance



Regulatory Applications



Common trusted information



Shared acceptance framework



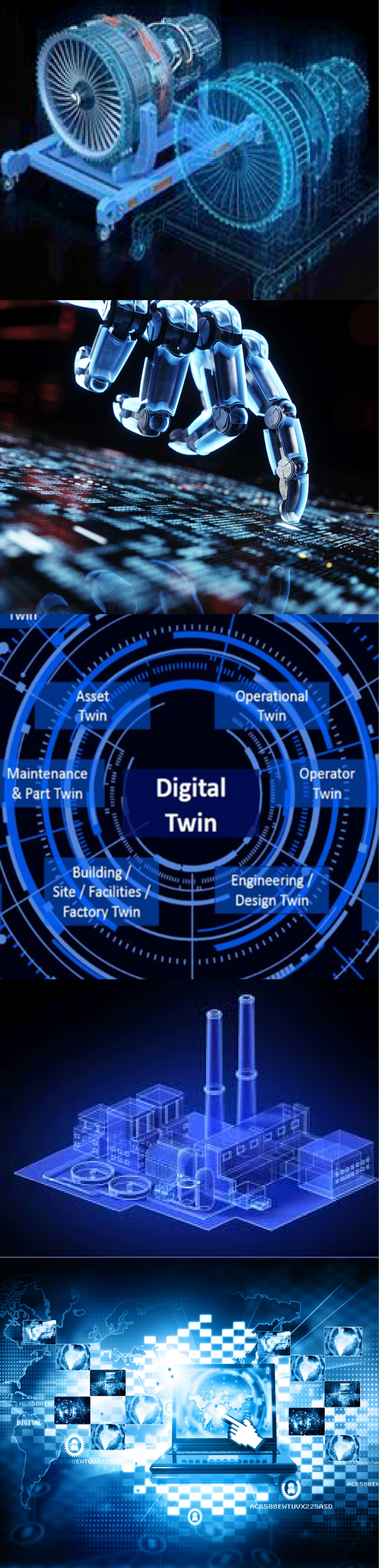
More efficient communication



Improved regulatory agility

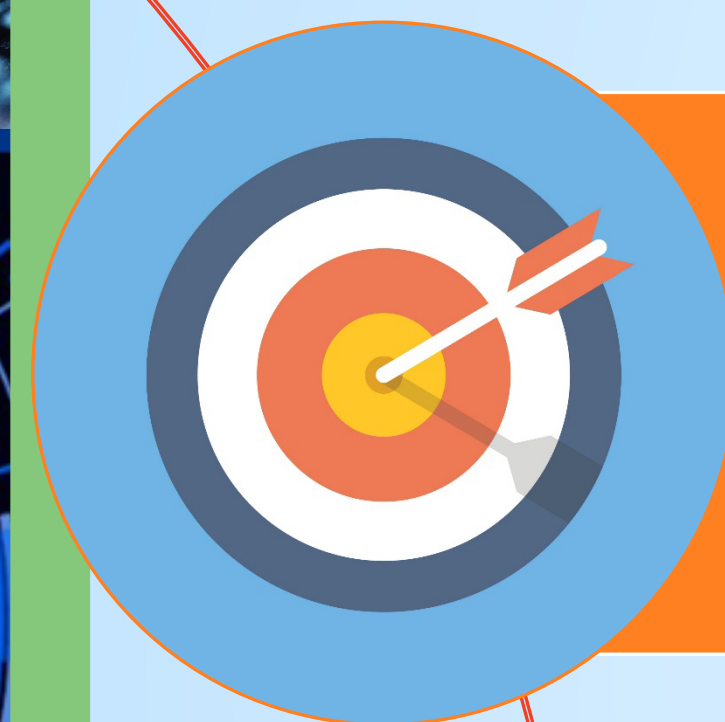


Enhanced on-site inspection



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Digital Twin FFR Project



Main Goals



Technical Letter Report*



Research Information Letter**



* ML21160A074, ML21361A261 ** ML2108A132, ML21348A020

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Workshop Participants

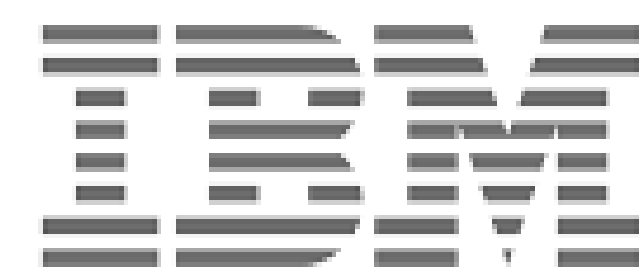
 **OAK RIDGE**
National Laboratory

 **INL**
Idaho National Laboratory

 **U.S. NRC**
United States Nuclear Regulatory Commission
Protecting People and the Environment

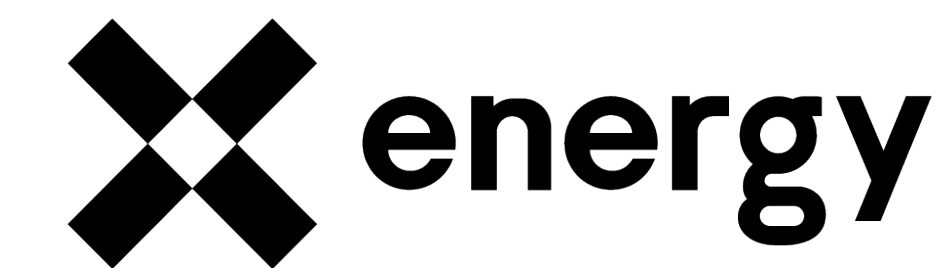
 **arpa-e**
CHANGING WHAT'S POSSIBLE

 **EPRI**
ELECTRIC POWER
RESEARCH INSTITUTE

 **IBM**

 **MIT**

 **Westinghouse**

 **X energy**

 **Kairos Power**  **edf** 

 **AMS**

 **BWXT**

 **UNIVERSITY OF
ILLINOIS**
URBANA-CHAMPAIGN



**ONTARIO POWER
GENERATION**

 **JACOBS** **Pitt**

 **tecnatom**

 **OASIS**

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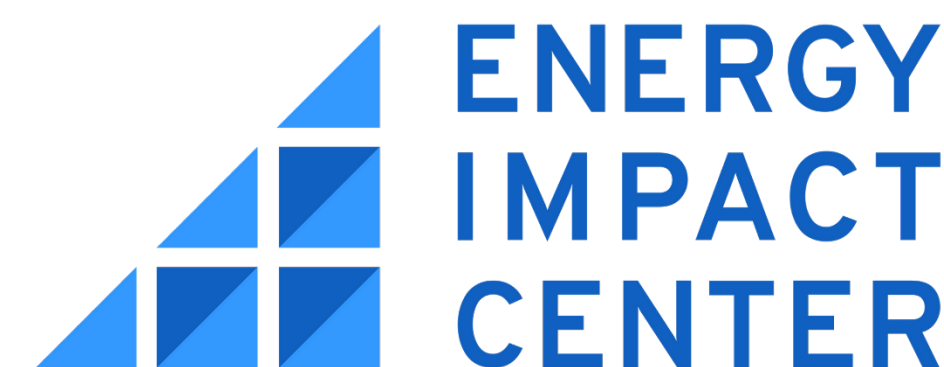
 **framatome**

 **ZACHRY**

 **Argonne**
NATIONAL LABORATORY

 **UMASS
DARTMOUTH**

 **NC STATE
UNIVERSITY**

 **ENERGY
IMPACT
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Aalto University

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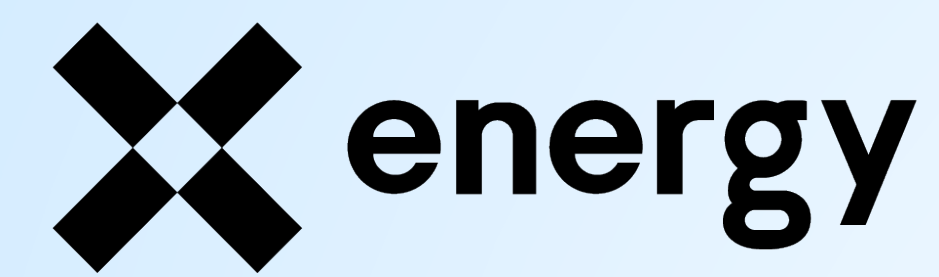
 **NATIONAL
ENERGY
TECHNOLOGY
LABORATORY**

 **NEI** **NUCLEAR
ENERGY
INSTITUTE**

 **FLORIDA TECH**

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State of Digital Twin Technology



Optimized O&M



Hardware-In-The-Loop



Additive Manufacturing



Condition-Based Maintenance



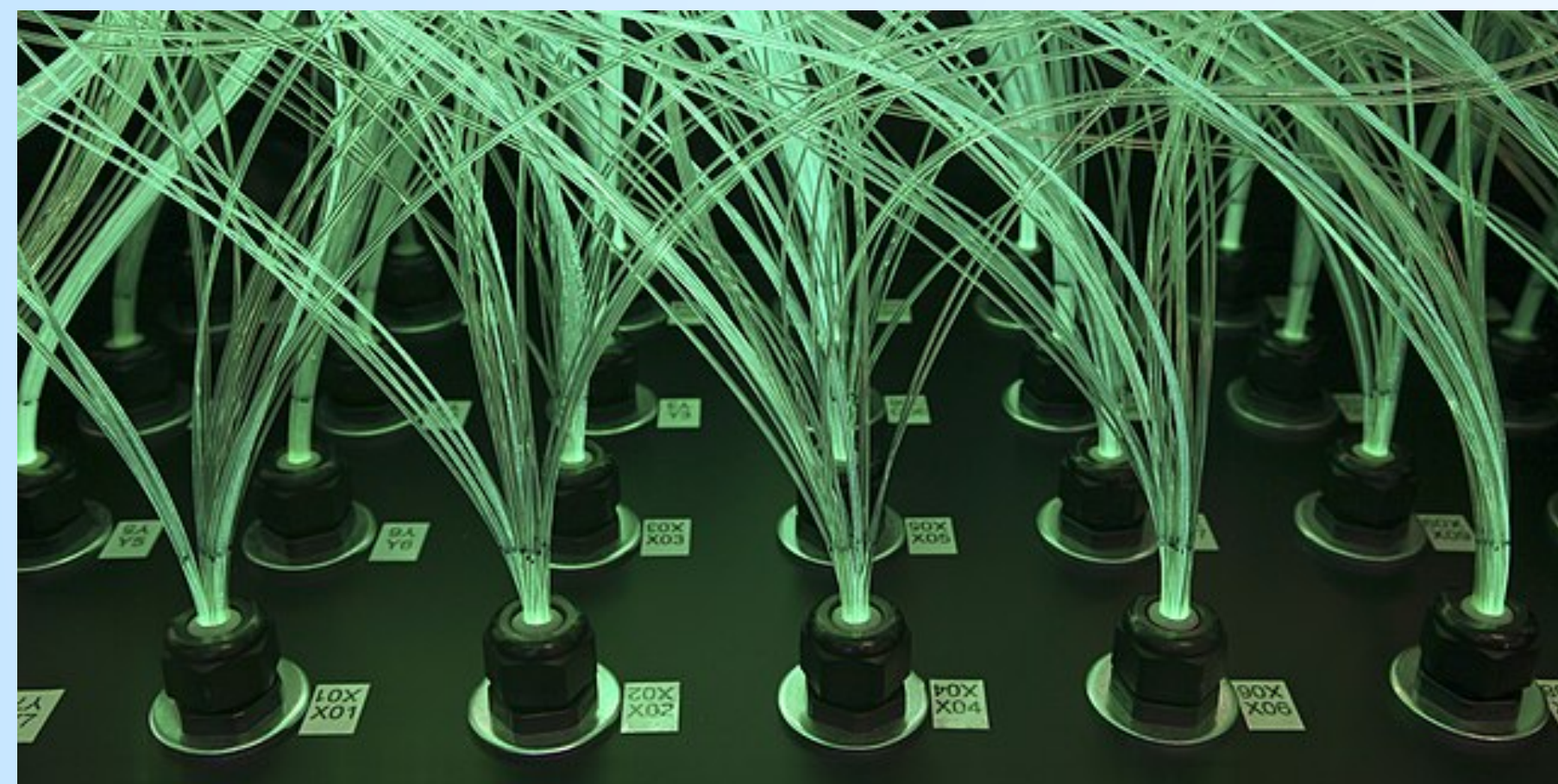
Humble AI



Iterative Prototyping

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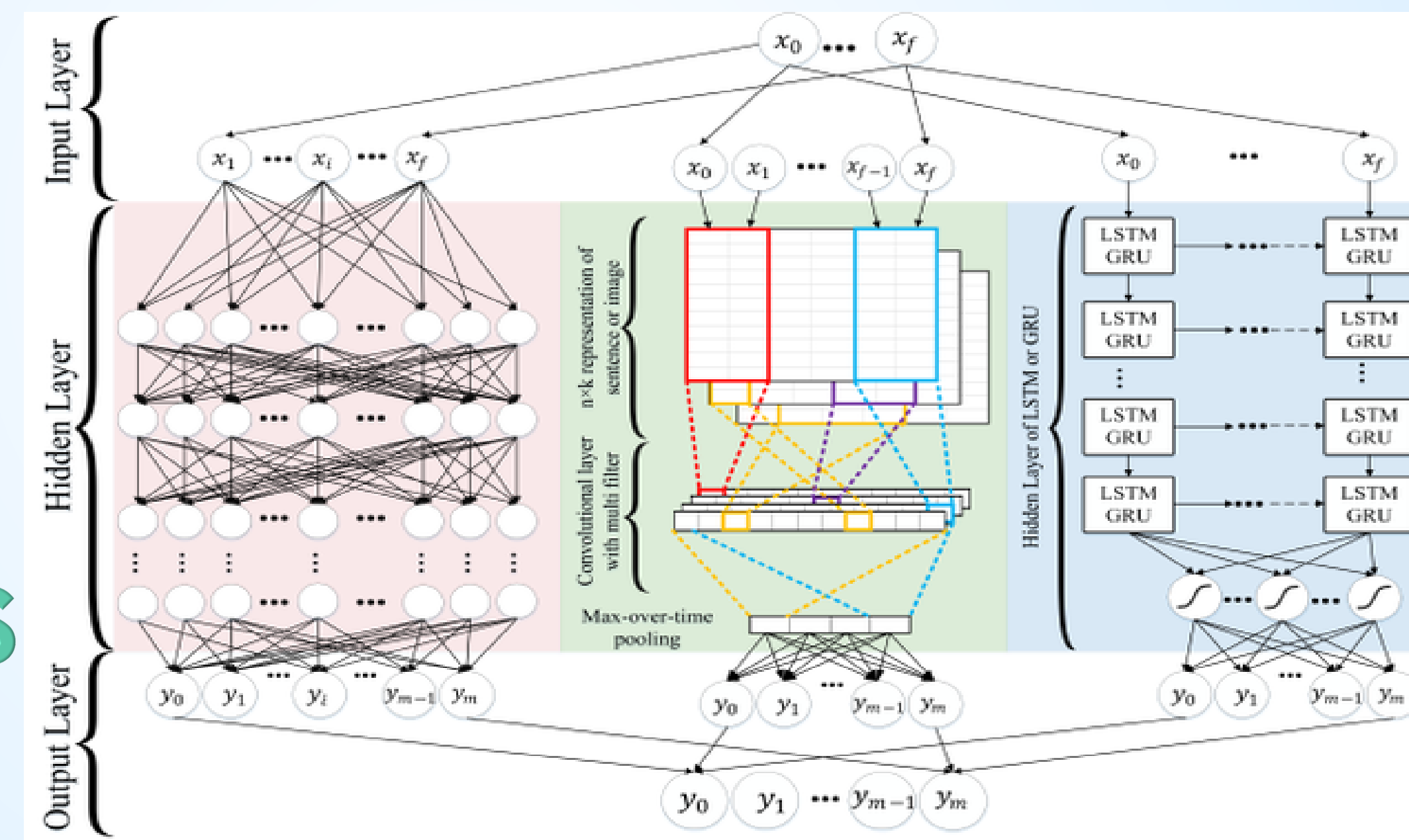
Enabling Technologies



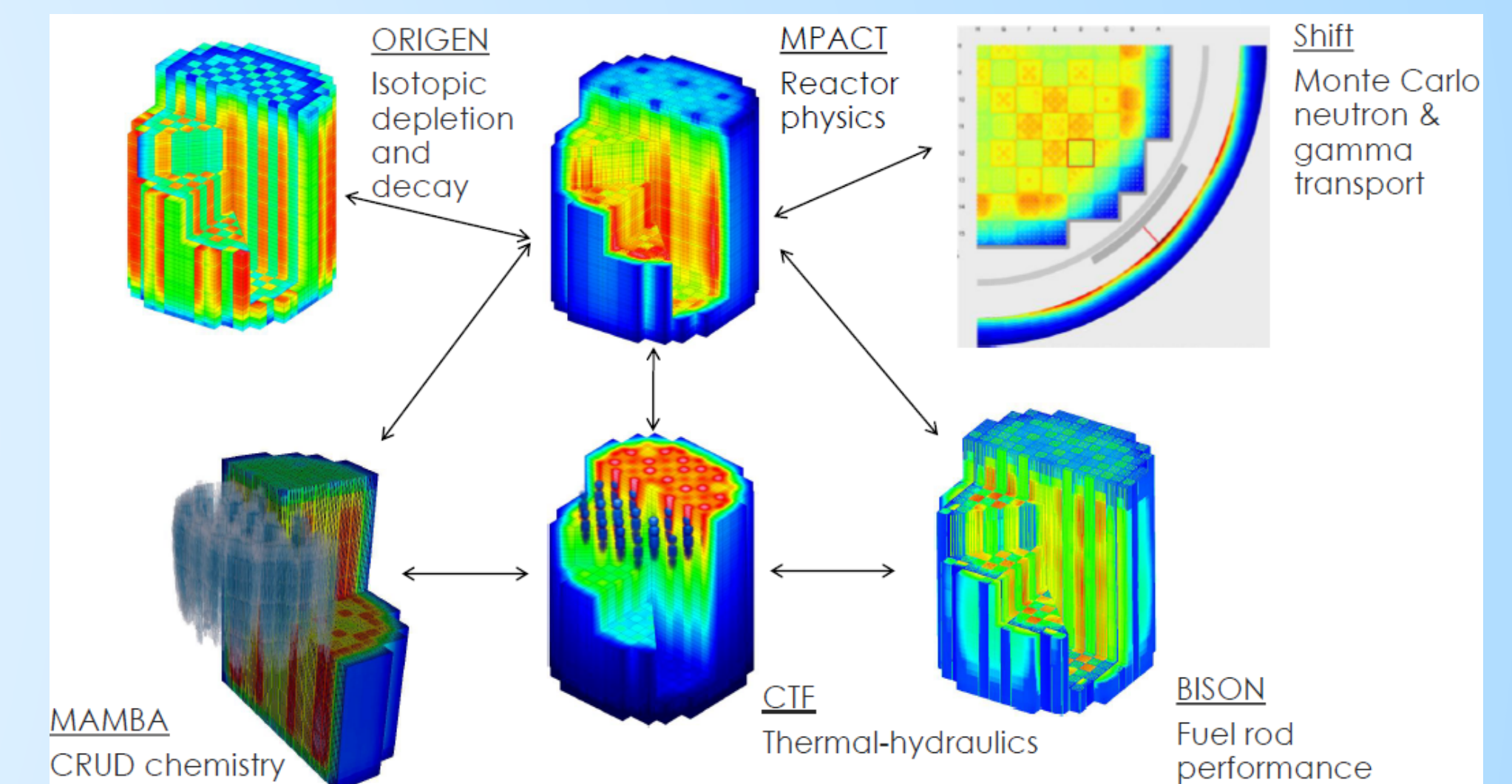
Advanced Sensors



Data Analytics



Machine Learning & Artificial Intelligence



Multi-Physics Models



Data-Informed Models

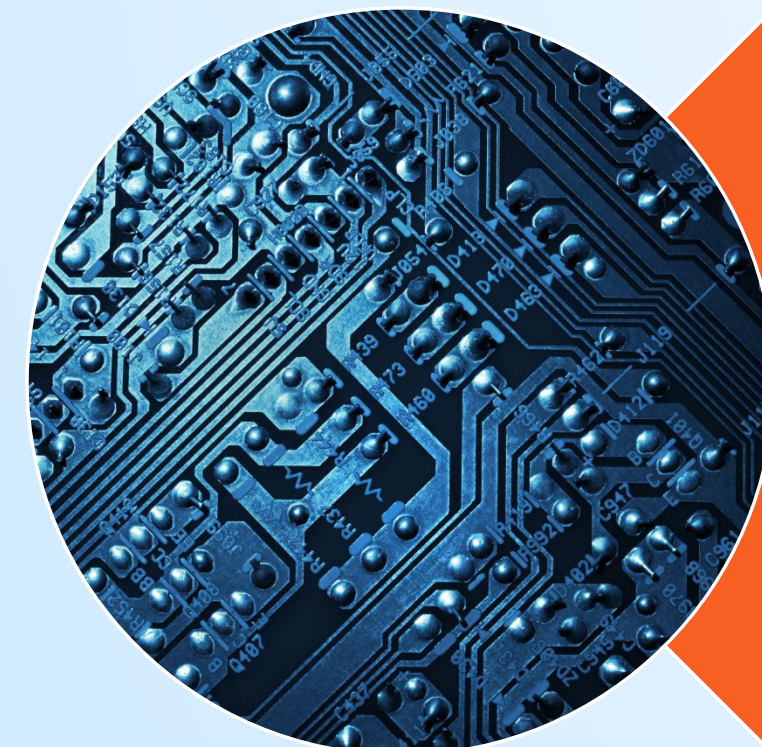
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Challenges & Gaps



Advanced Sensors and Instrumentation

- More sensors and with new modalities
- Real-time data collection and integration



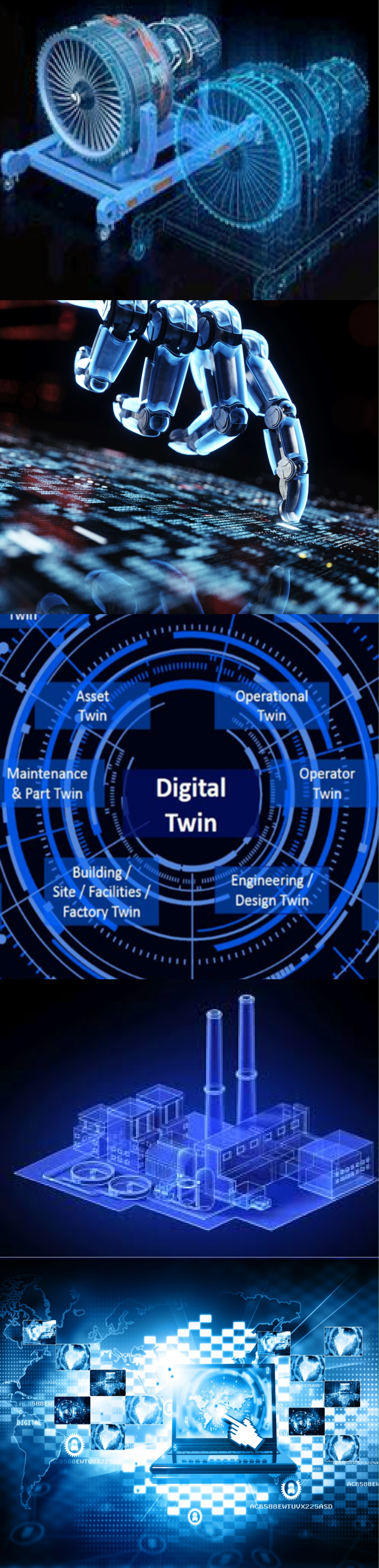
Modeling and Simulation

- Concurrent, high-fidelity models
- Uncertainty quantification



Data and Information Management

- Computational and data storage infrastructure
- Cybersecurity and data integrity

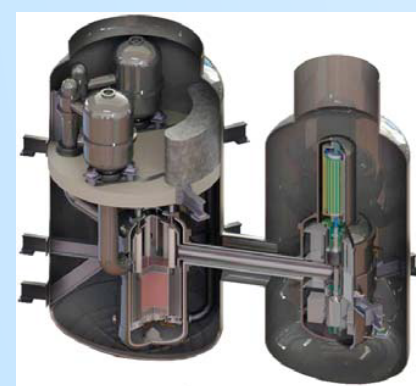


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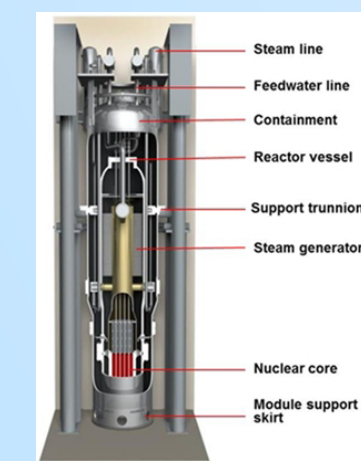
Regulatory Considerations and Opportunities



Intersection of digital twin technologies & NRC regulatory activities



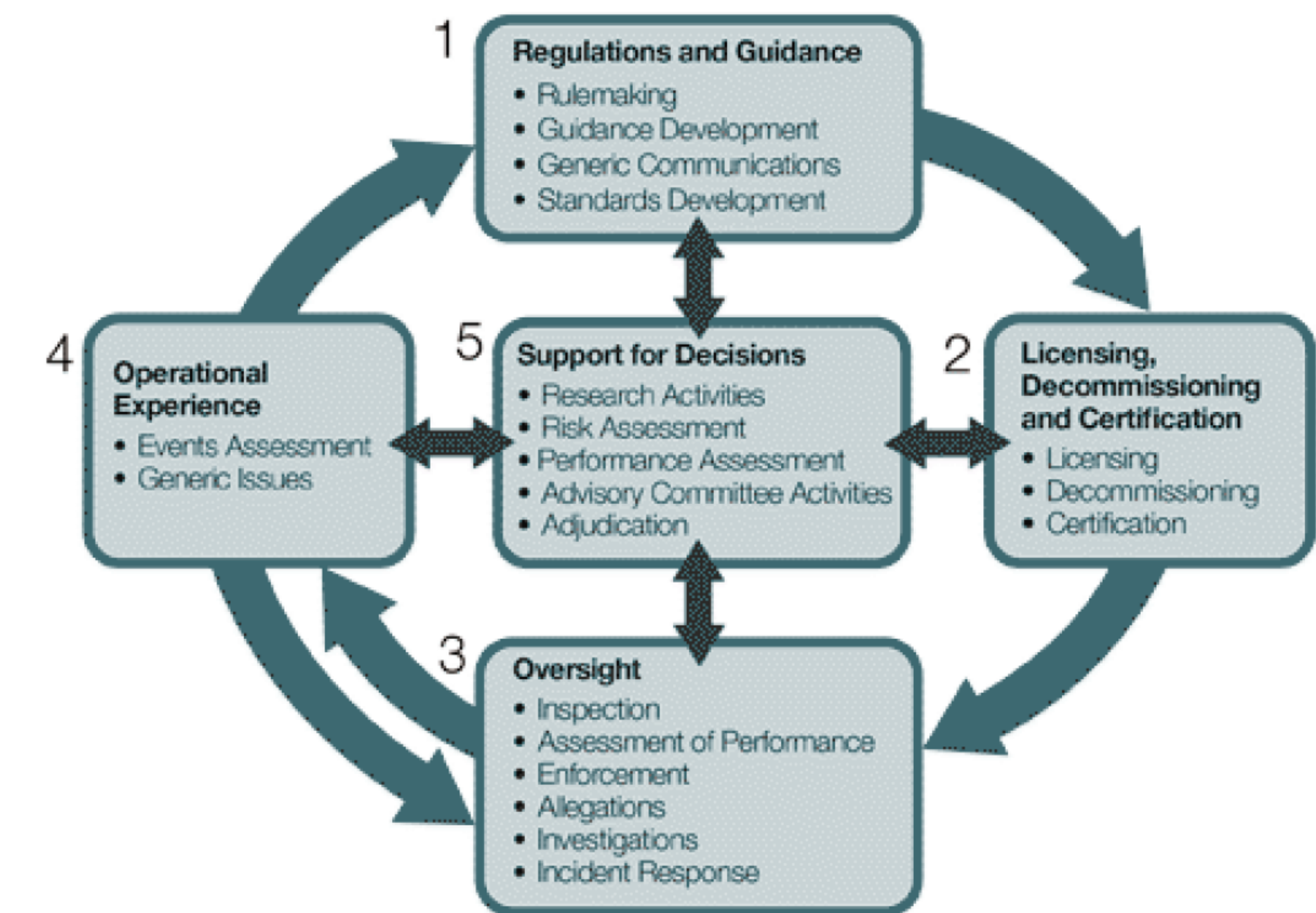
Adv Reactors: design and acceptance



New Reactors: O&M models



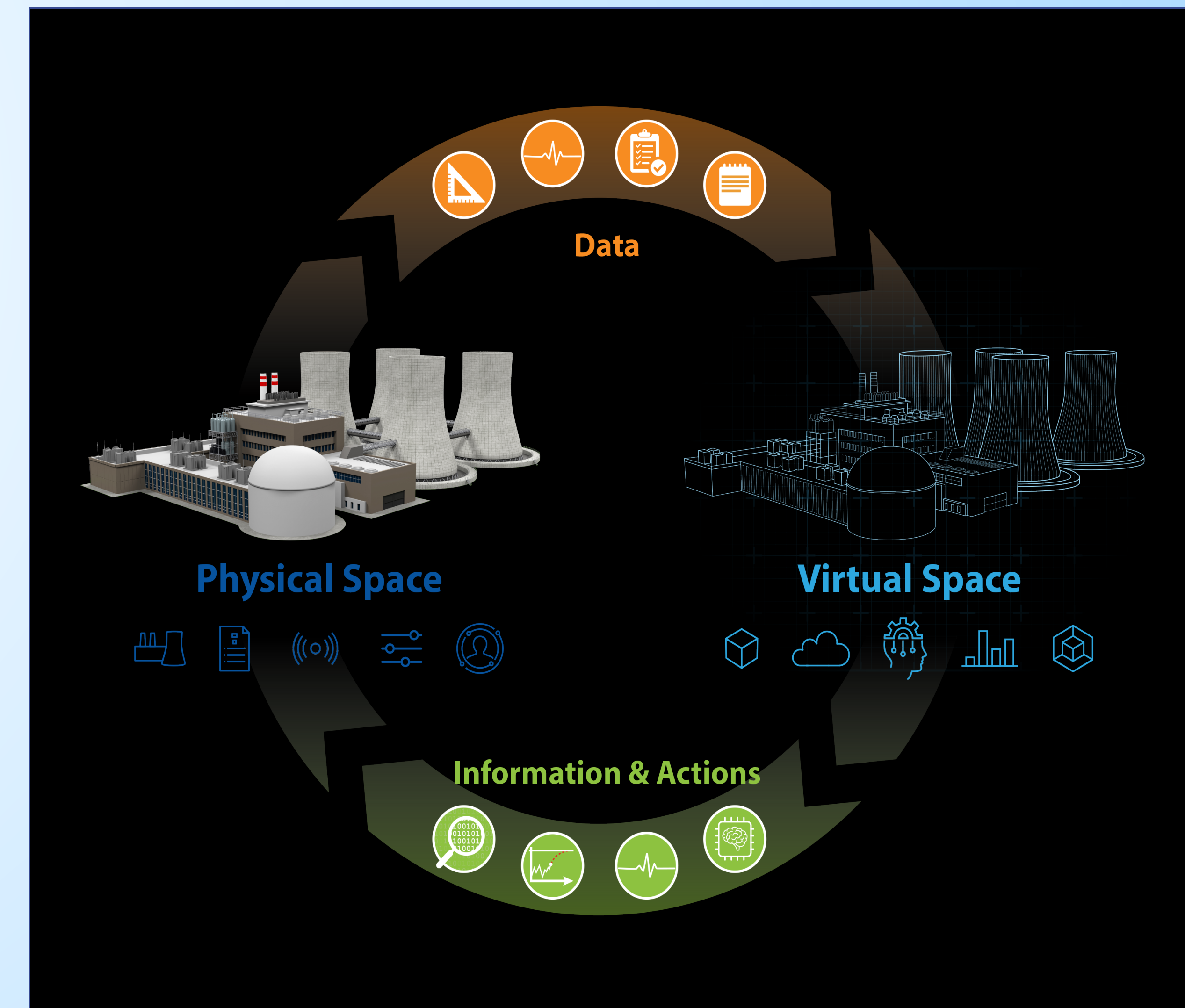
Op Reactors: condition-based monitoring and components/subsystems models



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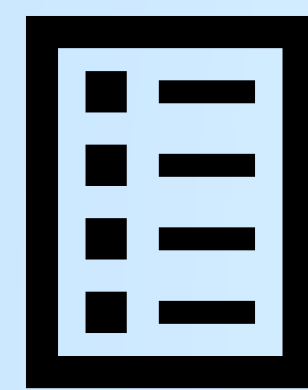
Project Takeaways

- Rapidly evolving/industry-wide interest
- Novel source of trusted information
- Need for common framework and community of practice
- Significant work needed in key enabling technologies
- This is just the beginning...



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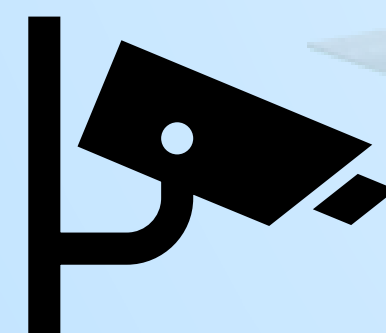
What's Next?



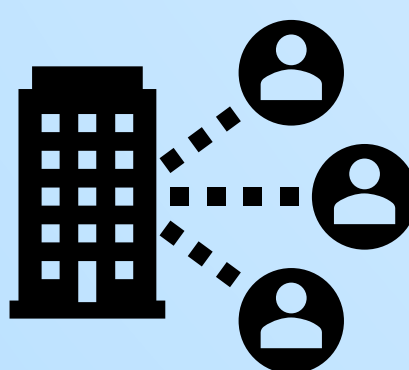
Regulatory Considerations and Opportunities & Project Summary Reports



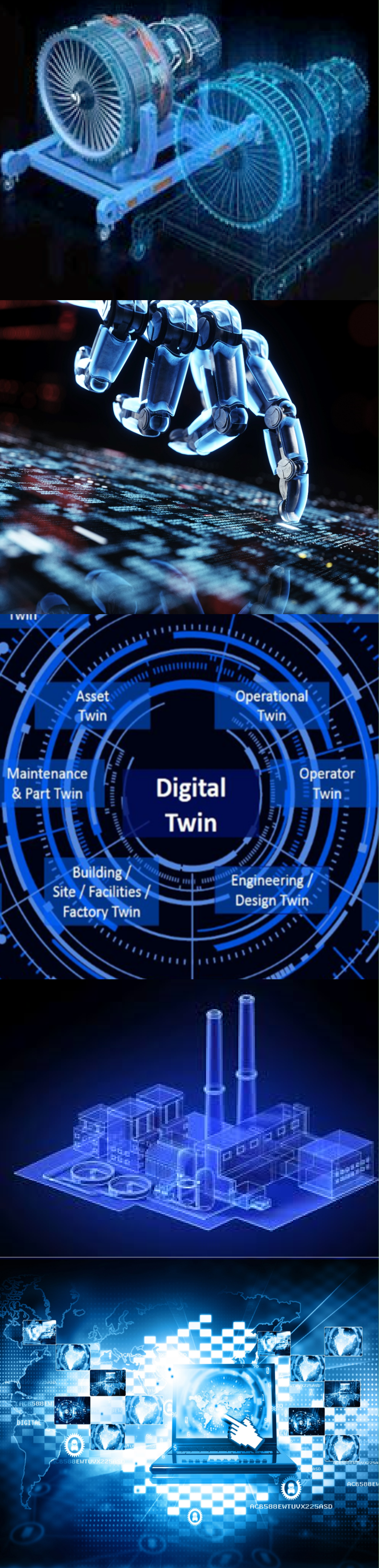
Online Monitoring for Enhanced Diagnostics and Prognostics



Safeguards and Security in Digital Twins



Continued Engagement with Nuclear Stakeholders



Digital Twins Project

Thank You

The project was supported by multiple NRC offices including:

- Nuclear Regulatory Research
- Nuclear Reactor Regulation
- Nuclear Security and Incident Response
- The Chief Information Officer
- The Chief Human Capital Officer

For further information, questions, or comments on the NRC Digital Twin Project, please contact:

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