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LESSONS LEARNED FROM ARCADE

Advanced Reactor Cyber Analysis and Development Environment

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ANS®

NPIC HMIT 2023

PSA 2023
18th International Probabilistic Safety Assessment and Analysis

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U.S. DEPARTMENT OF ENERGY
NNSA

OUTLINE

- Nuclear Cybersecurity Research Needs
- ARCADE
  - System Description
  - Software Stack
  - Design Phase Interaction
- Current Progress
- Future Work

Solar tower at Sandia.

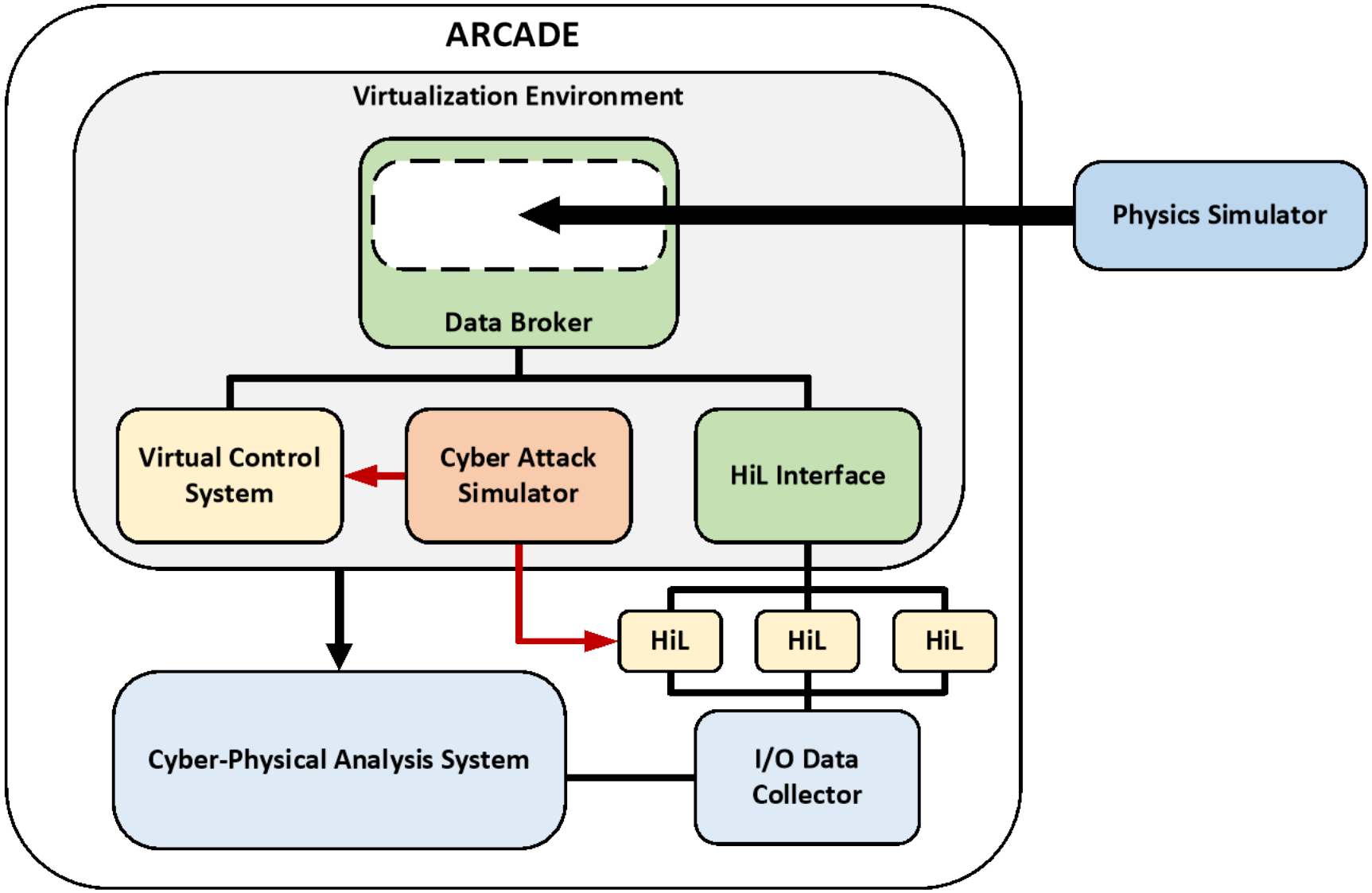
Rigorous, repeatable, and evidence-based cybersecurity analysis and evaluations require complex modeling and simulation platforms

An Advanced Reactor Cyber Analysis and Development Environment (ARCADE) is being developed to analyze advanced reactor (AR) systems

ARCADE will:

- Support System Level Design Analysis (SLDA)
- Simplify secure-by-design (SeBD) analysis
- Allow evaluation of Defensive Computer Security Architecture (DCSA) implementations
- Enable analysis of cyber-attack impacts

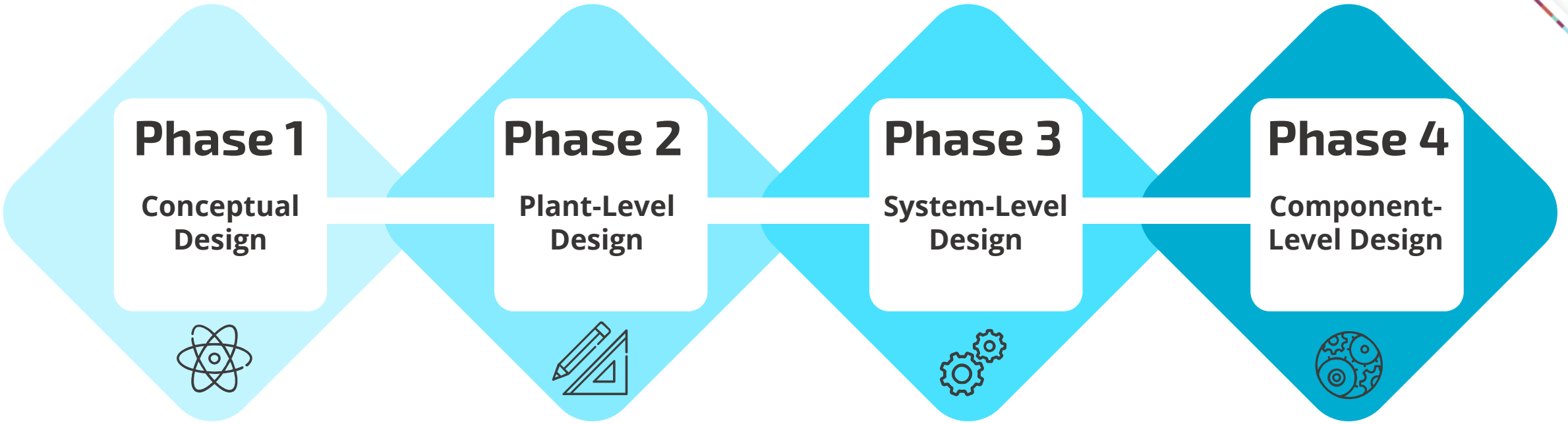
ARCADE | SYSTEM DESCRIPTION



ARCADE | SOFTWARE STACK

Components	Technology
Virtualization Environment	minimega
Physics Integrator	Sandia DataBroker
Cyber Attack Simulator	ManiPIO & Kali Linux
PLC Runtime Environment	OpenPLC
SCADA Interface	scada-LTS
Physics Simulation	Not Included

ARCADE | SMR DESIGN MATURITY PHASE INTERACTION



- Preliminary I&C Evaluation
- Detection or elimination of low level attack vectors

- Evaluation of DCSA efficacy
- Identify sequences not mitigated by SeBD

- Testing integration of ICS devices
- Evaluate denial of task features

Citation: Design Maturity and Regulatory Expectations for Small Modular Reactors, World Nuclear Association, 2021

CURRENT PROGRESS | INTEGRATIONS

MathWorks®

Simulink S-Function

C/C++ Generic API

C# Generic API

FLOWNEX®
SIMULATION ENVIRONMENT

Flownex Integration

FUTURE WORK

- **Incorporate more models and simulators**
  - Increase the sample size of designs and further develop API
- **Advanced automated analysis**
  - Develop more powerful automated analysis systems to provide deeper and repeatable analysis
- **Expand emulation technology and Hardware-in-the-Loop**
  - Provide greater analysis on technology dependent problems
- **Increase the control network fidelity**
  - Larger network component library (firewalls, diodes, SIEMs)

QUESTIONS?