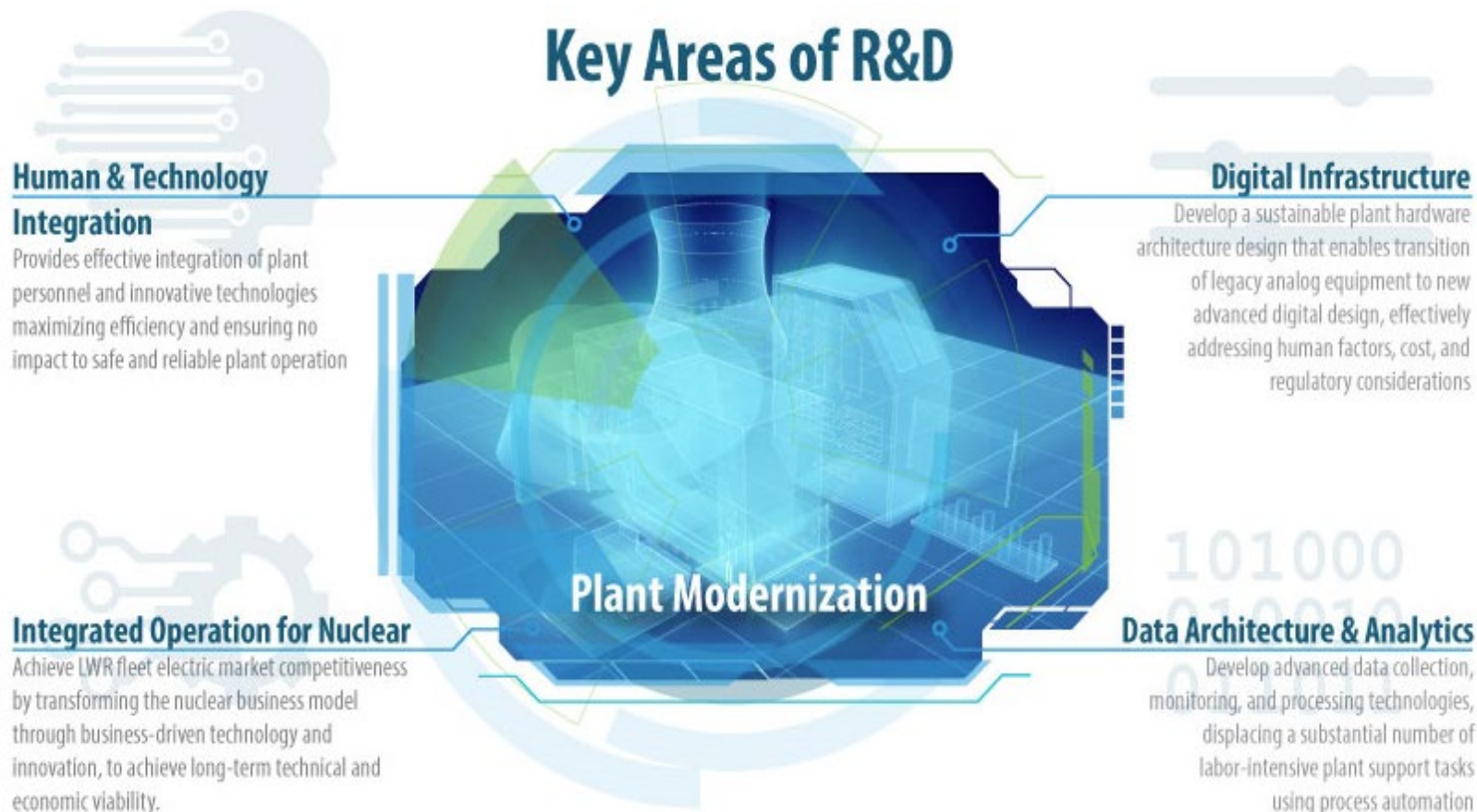**LWRS**
LIGHT WATER REACTOR
SUSTAINABILITY

Ahmad Al Rashdan Ph.D.
Plant Modernization Pathway Lead

12/3/2024

Plant Modernization Pathway Overview

Objectives

- **Extend the life and improve the performance** of the existing fleet through modernized technologies and improved processes for plant operation and power generation.

- Develop modernization solutions that **improve reliability and economic performance** while addressing the U.S. nuclear industry's aging and obsolescence challenges.

- Deliver a sustainable business model that enables the U.S. nuclear industry to **remain cost competitive**.

Key Areas of R&D

Human & Technology Integration
Provides effective integration of plant personnel and innovative technologies maximizing efficiency and ensuring no impact to safe and reliable plant operation

Digital Infrastructure
Develop a sustainable plant hardware architecture design that enables transition of legacy analog equipment to new advanced digital design, effectively addressing human factors, cost, and regulatory considerations

Integrated Operation for Nuclear
Achieve LWR fleet electric market competitiveness by transforming the nuclear business model through business-driven technology and innovation, to achieve long-term technical and economic viability.

Plant Modernization

Data Architecture & Analytics
Develop advanced data collection, monitoring, and processing technologies, displacing a substantial number of labor-intensive plant support tasks using process automation
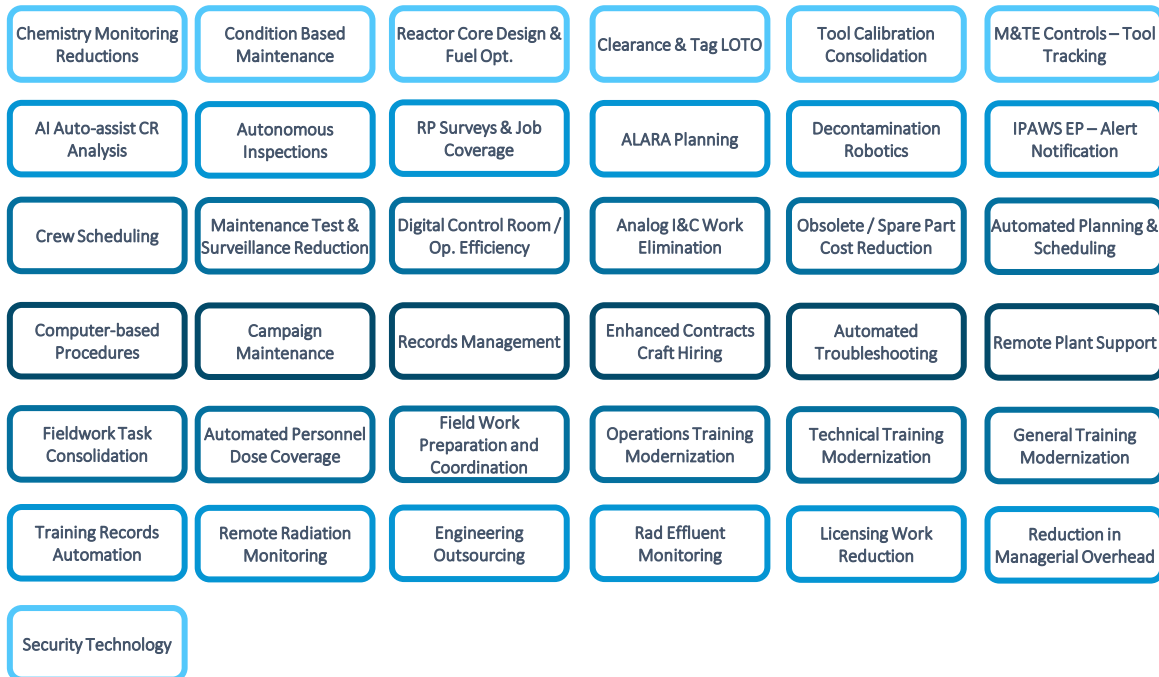
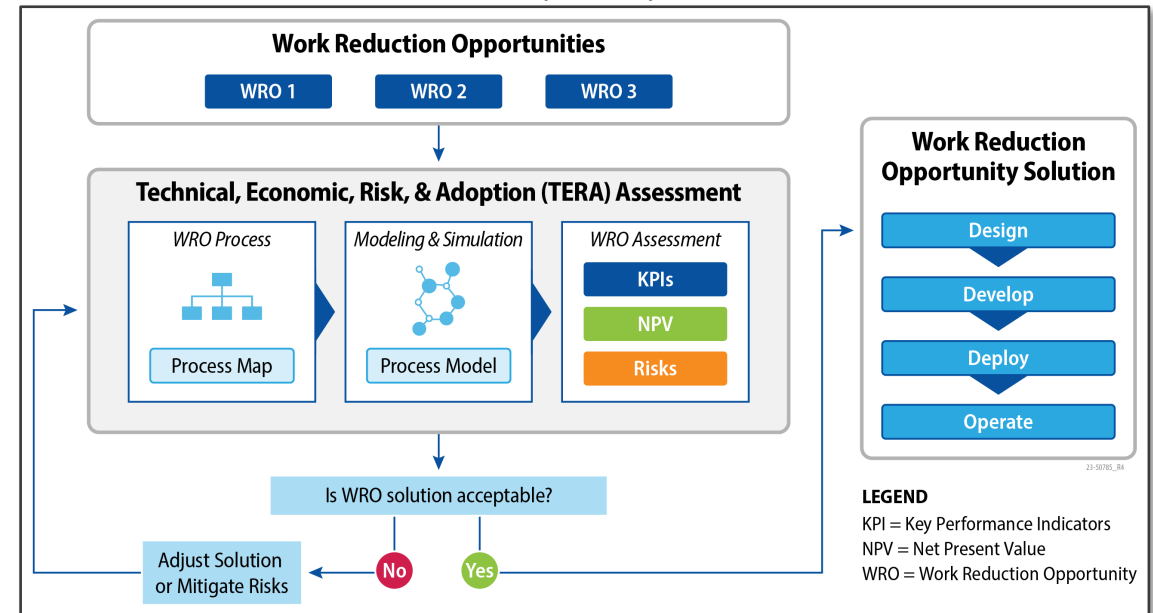# Integrated Operations for Nuclear (ION)

A methodology for developing a roadmap for the digital transformation of plants, and for demonstrating business cases for work-reduction opportunities to foster plant modernization and sustainability

Integration of people, organizations, work processes, and information technology to make smarter decisions by:
- Identifying strategic opportunities to develop as part of every incremental modernization effort
- Developing a methodology that tailors a roadmap for implementing work-reduction opportunities that are plant or utility specific.

Work-Reduction Opportunities

Chemistry Monitoring Reductions	Condition Based Maintenance	Reactor Core Design & Fuel Opt.	Clearance & Tag LOTO	Tool Calibration Consolidation	M&TE Controls – Tool Tracking
AI Auto-assist CR Analysis	Autonomous Inspections	RP Surveys & Job Coverage	ALARA Planning	Decontamination Robotics	IPAWS EP – Alert Notification
Crew Scheduling	Maintenance Test & Surveillance Reduction	Digital Control Room / Op. Efficiency	Analog I&C Work Elimination	Obsolete / Spare Part Cost Reduction	Automated Planning & Scheduling
Computer-based Procedures	Campaign Maintenance	Records Management	Enhanced Contracts Craft Hiring	Automated Troubleshooting	Remote Plant Support
Fieldwork Task Consolidation	Automated Personnel Dose Coverage	Field Work Preparation and Coordination	Operations Training Modernization	Technical Training Modernization	General Training Modernization
Training Records Automation	Remote Radiation Monitoring	Engineering Outsourcing	Rad Effluent Monitoring	Licensing Work Reduction	Reduction in Managerial Overhead
Security Technology					

The Technical, Economic, Risk, and Adoption Assessment (TERA) Framework

Work Reduction Opportunities

WRO 1   WRO 2   WRO 3

Technical, Economic, Risk, & Adoption (TERA) Assessment

WRO Process — Process Map

Modeling & Simulation — Process Model

WRO Assessment
- KPIs
- NPV
- Risks

Is WRO solution acceptable?

No → Adjust Solution or Mitigate Risks

Yes →

Work Reduction Opportunity Solution
- Design
- Develop
- Deploy
- Operate

23-00785_R4

LEGEND
KPI = Key Performance Indicators
NPV = Net Present Value
WRO = Work Reduction Opportunity

3

Data Architecture and Analytics

Advanced technologies and tools for data collection, management, and analysis to automate operations, maintenance, and support activities. These advanced technologies will reduce reliance on manual human activities and improve plant processes.
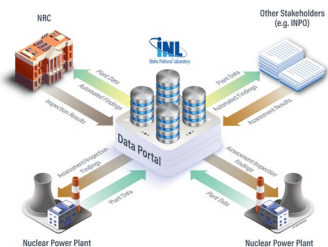
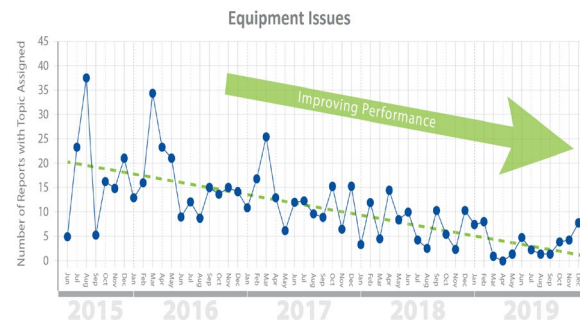*Work Management Automation*
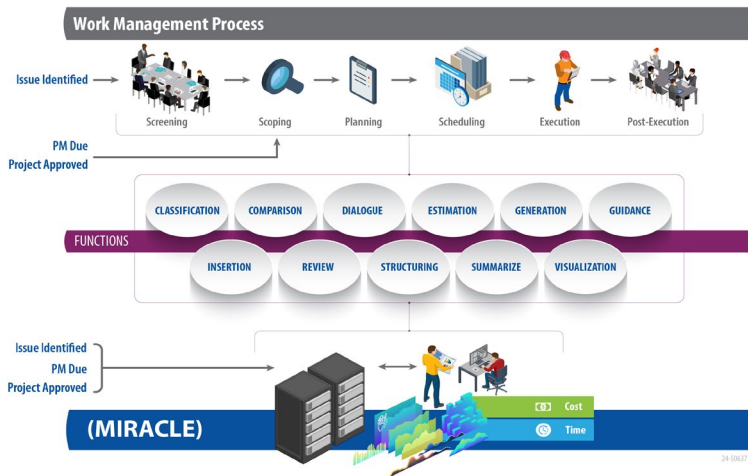
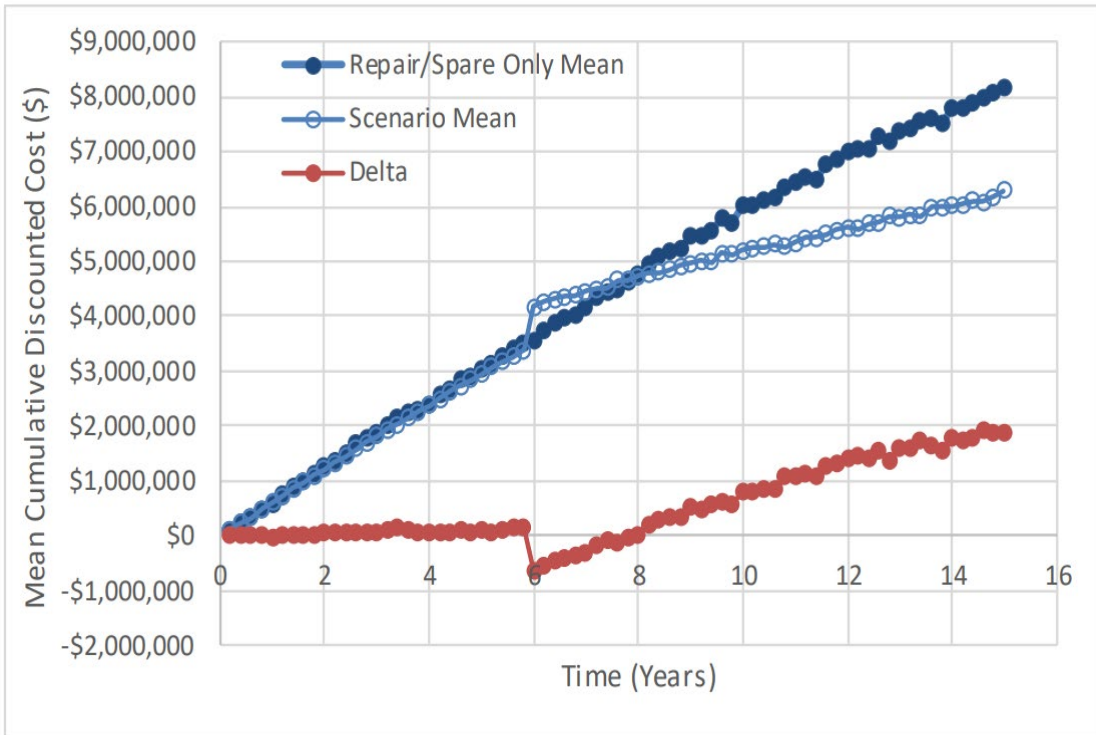*Online Condition Monitoring*
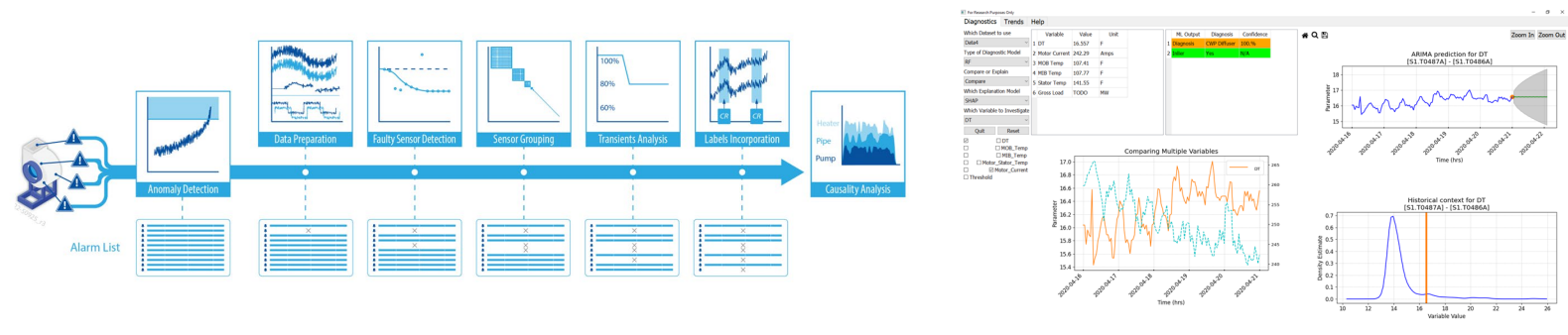
Automated Rounds and Monitoring

Performance Improvement

Inspections

Digital I&C Infrastructure

Guidance on digital instrumentation and control (I&C) infrastructure upgrades to modernize nuclear power plants, along with demonstrations of their technological and economic benefits.
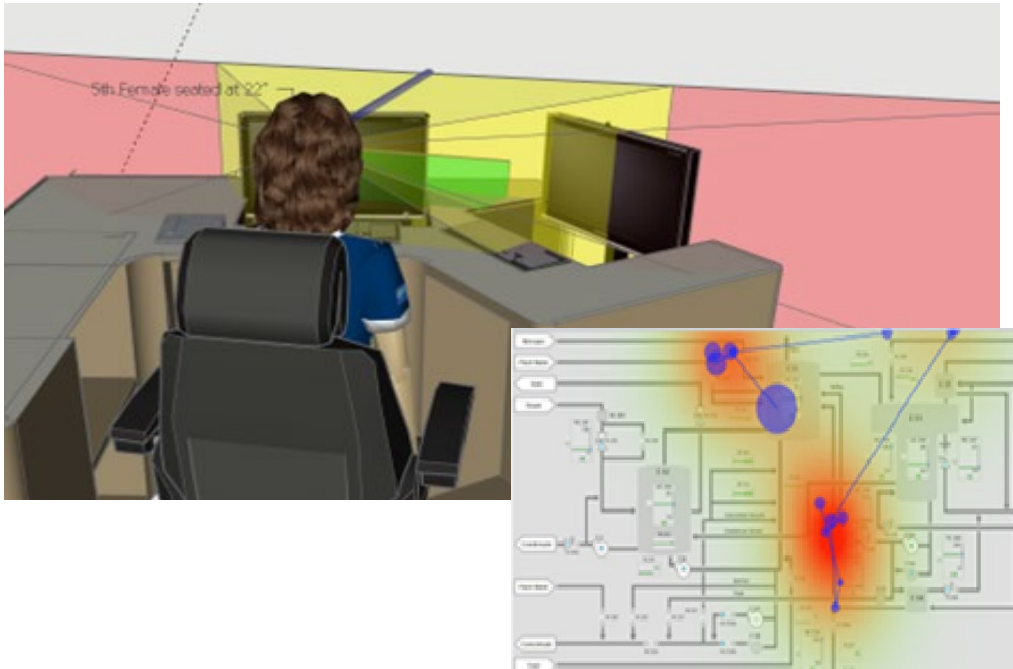
Obsolescence Analysis

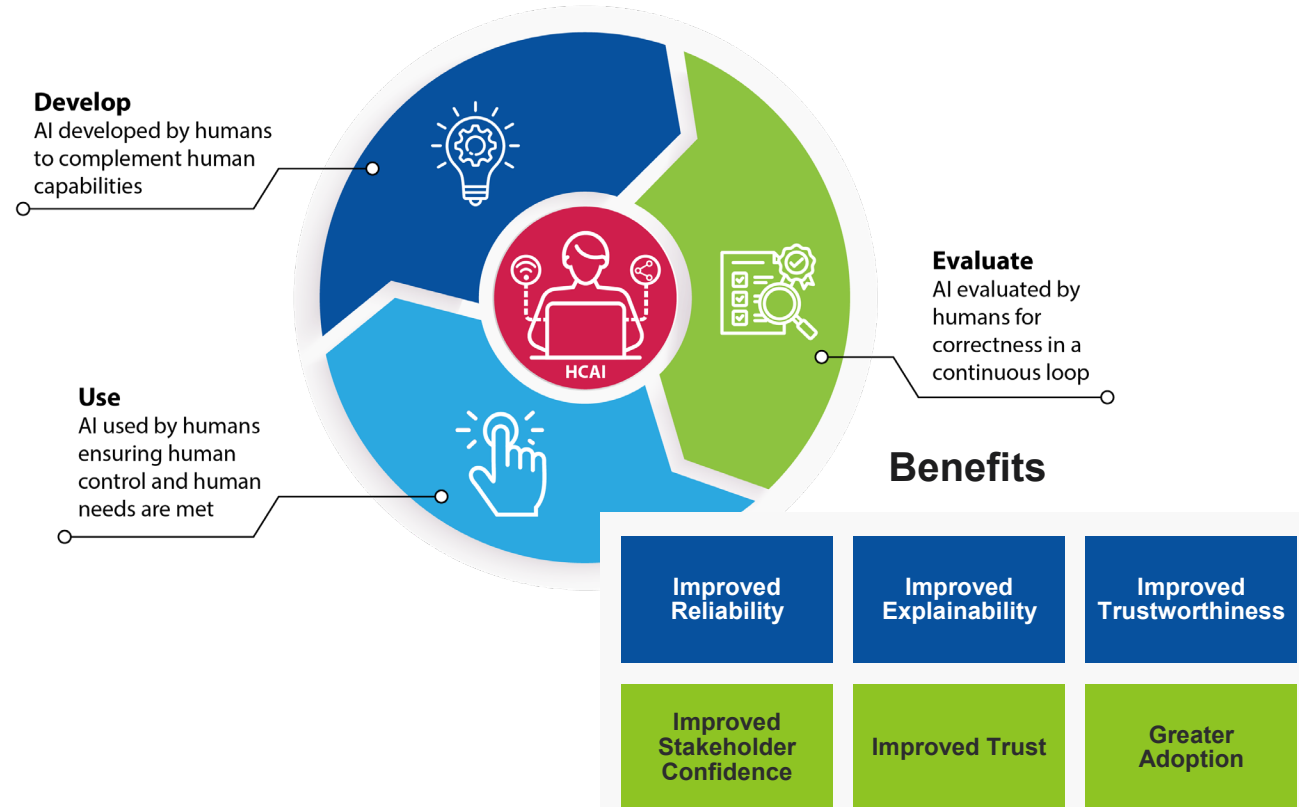*Digital Infrastructure Modernization*
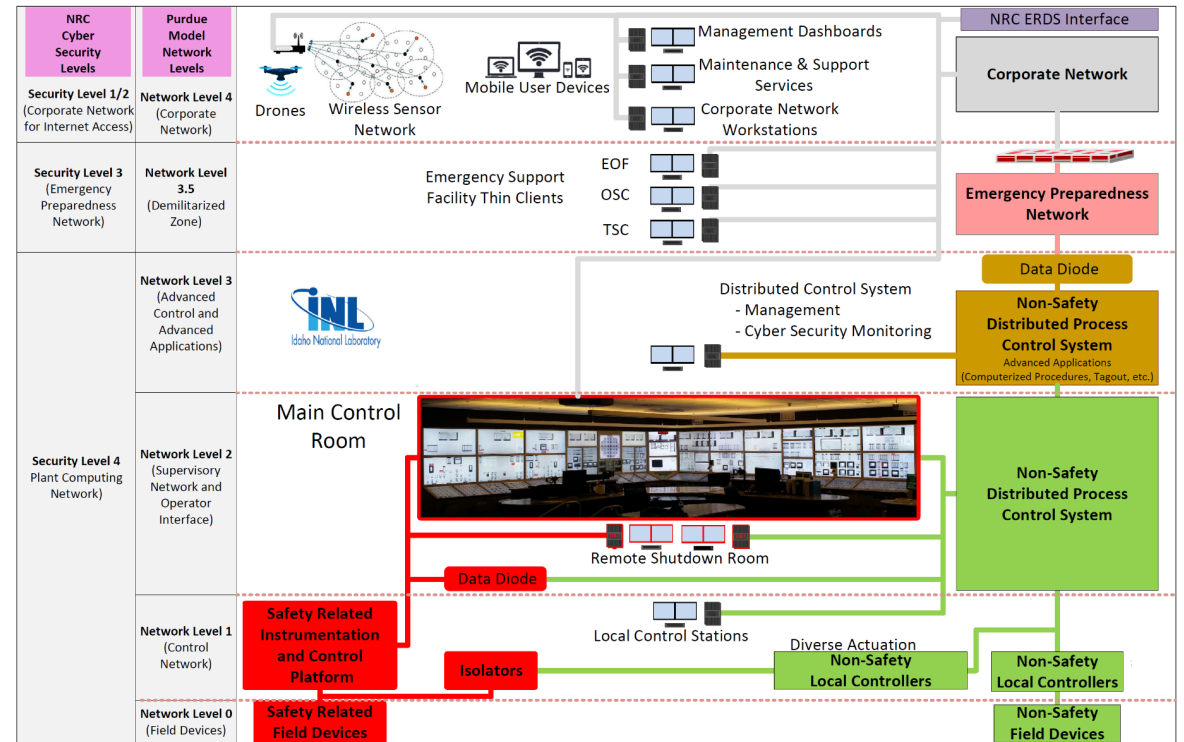
Technology Adoption Barriers

A methodology to evaluate business-case, technical, organizational, and human-factors aspects to overcome barriers to deploying and scaling automation technologies. This research will lead to a broader and more successful adoption of automation technologies.

Human-Centric Operations Optimization

Adoption of AI

Develop
AI developed by humans to complement human capabilities

Evaluate
AI evaluated by humans for correctness in a continuous loop

Use
AI used by humans ensuring human control and human needs are met

HCAI

Benefits

Improved Reliability	Improved Explainability	Improved Trustworthiness
Improved Stakeholder Confidence	Improved Trust	Greater Adoption

Collaborations with Stakeholders

Sustaining National Nuclear Assets

lwrs.inl.gov