

USA's **ARM** extends a hand in preserving nuclear competitiveness

By Clinton Carter



It is no secret that the nuclear power industry is enduring an economic crisis. Brought about largely by the impact of technological disruption across the larger energy market, a number of utilities have had no option but to prematurely shut down some nuclear plants because they could no longer compete in the regions they serve. Many others are similarly at risk.

In the midst of today's economic realities, the Utilities Service Alliance (USA) has launched an ambitious initiative: the Advanced Remote Monitoring and Diagnostics Services Project (ARM). ARM is a multi-million-dollar research and development initiative funded through a cooperative agreement with the Department of Energy Office of Nuclear Energy's Advanced Reactor Development Projects pathway. ARM promotes a vision that our nation's nuclear energy supply can be preserved by transforming core business processes through the application of advanced technologies. John Christensen, USA president and chief executive officer, noted, "USA is in a unique position to not only help our member utilities, but we are making a commitment to share our learnings and opportunities with everyone in the nuclear industry. For any of us to succeed we must all succeed."

USA is a not-for-profit cooperative whose mission is to reduce operating and maintenance costs, improve safety and performance, and provide innovation and leadership within the nuclear power industry. Membership includes eight nuclear utilities operating 14 reactors with a combined generating capacity of over 15,000 MWe.

As a part of the ARM industry demonstration, four of USA's member utilities are working alongside national laboratories, academic researchers, and leading technologists to research, develop, and deploy advanced monitoring solutions across a number of their facilities. This work will enable automation of data collection, analytics, and anomalies detection through intelligent machine learning algorithms. The project also aims to demonstrate the value of integrating all of these new capabilities into a centralized, 24-7 remote monitoring and diagnostics (M&D) center.

Idaho National Laboratory is a key partner in this initiative. INL's team is leading research activities associated with developing intelligent software tools that will aid in the analysis of plant telemetry and recognize the emergence of unusual conditions warranting human attention. INL also coordinates and oversees project-related research activities going on at selected universities. Bruce Halbert, director of the DOE's Light Water Reactor Sustainability Program, said, "Enhancing the economic competitiveness of operating nuclear power plants is vital to ensure their long-term operation. These projects led by USA will enable the domestic nuclear fleet to employ advanced technologies to be and remain competitive in current and future energy markets."

ARM is all about industry transformation and modernization of practices. Many long-standing nuclear programs such as plant health monitoring, equipment inspections, and compliance-related activities were designed many years ago before the proliferation of the Internet, wireless telecommunications, and intelligent software systems. These legacy processes, while highly effective, are complex and require a large investment of costly human resources to manage. Transformation of these processes through the application of modern technologies offers an opportunity to improve efficiencies, eliminate human error, and reduce operating costs.

With the mission of demonstrating how technological transformation can be achieved, ARM's research, design, and development activities are aligned with three foundational principles—standardization, automation, and centralization. The following discussion describes the complementary application of these principles in the various ARM project deliverables.

Continued

Shared Services Platform

Benefits:

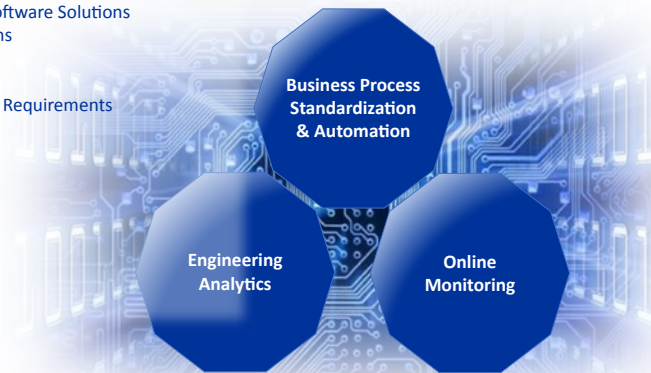
- Managed by Participating Utilities Through USA Membership
- Independence from 3rd Party Software Solutions
- Transparency into all Transactions

Features:

- Scales Organically with Business Requirements
- Integrated Social Media
- Knowledge Sharing Repository

Capabilities:

- ✓ Integrated Field Sensing
- ✓ Intelligent Pattern Recognition
- ✓ Continuous Learning



Architecture:

- Open Source Ecosystem
- Blockchain Architecture
- Modular Component Design

Interfaces:

- Legacy Data Historians & Applications
- Telecommunications Infrastructure
- Expanded Monitoring Systems

Business Process Transformation:

- ✓ Automated Inspections
- ✓ Remote Personnel & Plant Monitoring
- ✓ Continuous Performance Analyses

Fig. 1. NuSuite features and functionality. (Source: USA Inc.)

NuSuite

Operating cost reductions will be realized through standardization, modernization, and codification of nuclear plant activities. NuSuite is a shared services software platform capable of hosting various technologically redesigned business processes. The ARM project is developing a foundational prototype of this platform. Within the platform will reside a suite of standardized business applications, called modules. Every sub-tier project being developed within the ARM scope will be hosted in its own unique module. Each module will be composed of the user interface, record management system, calculational algorithms, and analytics based upon first principles and intelligent prognostics. The platform is envisioned to be structured as open source, wherever practical; inherently scalable; and owned by the participating utilities through USA membership. Figure 1 provides an overview of NuSuite's targeted functionality.

Business process transformation

Business processes will be transformed through the expansion of plant monitoring and analytical capabilities. This involves the deployment of various field-sensing technologies, telecommunications systems, and advanced algorithms in support of eight pilot projects. These projects were originally selected based upon an industry working group evaluating the potential economic benefits of remote monitoring technologies as a part of the Delivering the Nuclear Promise initiative being sponsored by the Nuclear Energy Institute. The ARM project is designed to demonstrate these technologies, develop an integrated approach to scale, and evaluate potential return on investment. Table 1 provides a listing of projects and the associated participating utilities. The projects listed in Table 1 and their related NuSuite modules capabilities are further detailed below.

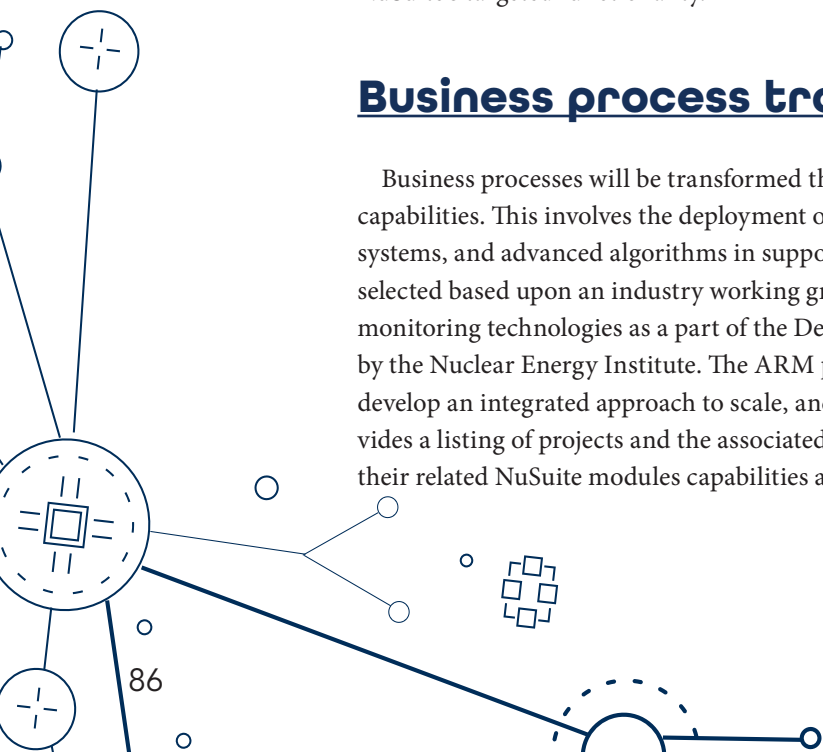






Table 1 - ARM Pilot Projects and Participants

Project Participants				
	Utility Station	Energy Northwest Columbia	Talen Energy Susquehanna	Xcel Energy Prairie Island, Monticello
Operator Rounds Reduction				✓
Technical Spec Shiftly Surveillances				✓
Fire Protection Compensatory Measures		✓		
Centralized Radiological Monitoring				✓
Thermal Efficiencies and Cycle Losses	✓	✓		✓
Process Anomalies Detection			✓	
Transformer Health Monitoring	✓			
24-7 M&D Services	✓	✓		✓

Operator rounds reduction

Operating staffs spend an extraordinary amount of time performing various plant tours and inspections, the primary goal of which is to simply verify that plant conditions are as expected. Technology holds the key to accomplishing such tasks, enabling operators to invest their time in more valuable activities. This project targets reducing the operator’s burden through the deployment of advanced field-sensing technologies throughout the plant. These sensors include video, acoustic, temperature, humidity, radiation, vibration, smoke, and gas. Telemetry will be gathered through existing plant networks combined with broadband wireless. When something in the plant environment exceeds established thresholds, this NuSuite module will generate alarms alerting a monitoring station to the need to investigate and dispatch the necessary personnel.



Compliance automation—shiftly surveillances

This project demonstrates the ability to improve efficiencies by eliminating the need for deploying plant operators to manually walk into more than 100 rooms and areas each shift to read local analog gauges and perform inspections as required by plant technical specifications. Wireless sensors will be installed in these areas, eliminating the need for manual collection of readings. Telemetry will be transmitted through the in-plant wireless network. The surveillance will be initiated on demand by control room personnel. When activated, this NuSuite module will trigger data collection, perform analysis to verify acceptance criteria are satisfied, and then generate surveillance reports ready for supervisory review and approval.



Continued

Fire protection compensatory measures

This project targets the elimination of costly manual roving and dedicated fire watch processes in favor of an automated detection system. Using advanced sensing technologies combined with artificial intelligence, this mobile system will enable the recognition of an emerging fire in areas monitored as a part of compensatory measures when required. The system's artificial intelligence algorithm, being developed through INL, will discriminate between an actual fire and certain routine activities, such as maintenance activities involving welding or grinding. Once a potential fire is recognized by the NuSuite module, the system will generate and transmit alarms and notifications over an in-plant wireless system to a dedicated monitoring center.



Centralized radiological monitoring

Environmental monitoring of radiological areas and radiation worker oversight from a centralized facility will be automated as a part of this scope with the goal of reducing manual radiation surveys, inspections, and personnel monitoring. This approach also reduces occupational radiation exposure of plant personnel. The NuSuite module will display conditions in areas monitored and generate alarm notifications when thresholds are exceeded.



Thermal efficiencies and cycle losses

This new capability replaces periodic walkdowns and testing to identify, quantify, and correct thermal losses in a near-real-time format. Wireless sensing technologies are being installed throughout balance-of-plant systems along drain lines and other possible leakage pathways. This in combination with online thermal efficiency calculations will be encoded in this project's NuSuite module, enabling near-real-time identification of energy losses, including location, severity, and economic impact information. When efficiency losses are detected, alarms will be transmitted to a remote monitoring center for evaluation and initiation of corrective action.



Process anomalies detection

This NuSuite module will utilize artificial intelligence being developed by INL to detect emerging anomalies in nuclear plant operations. The system will discriminate between instrumentation issues and actual plant process changes, enabling early assessment of plant asset health conditions or any potential sensor drift issues. Alarms will be generated and transmitted to a remote monitoring center.



Transformer health monitoring

Using online dissolved gas analyzers combined with intelligent algorithms developed by INL, the health of large power transformers will be continuously monitored through this NuSuite module with prognostic alarms being transmitted to a remote monitoring center when adverse transformer conditions are recognized. This particular project offers a view as to how component and system health programs can be transformed through the application of technology and centralization of technical services through the use of advanced M&D.





Fig. 2. Luminant's Power Optimization Center.
(Photo: Luminant)

24-7 M&D services

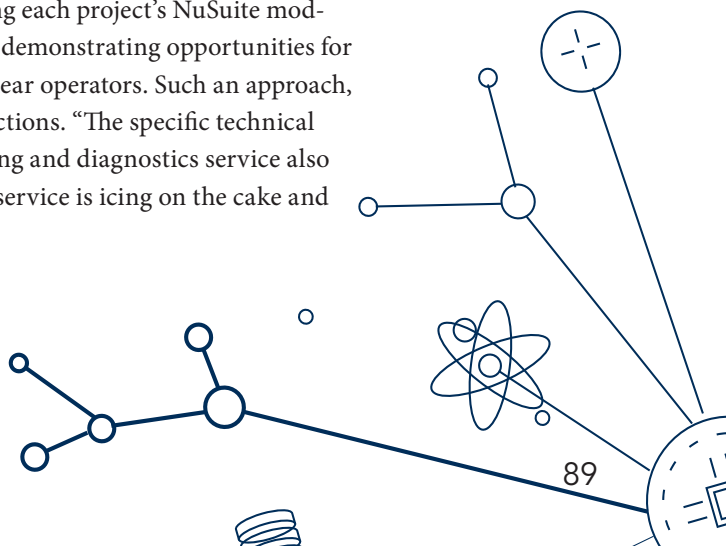
With the goal of demonstrating how centralized M&D services can assist in improving power plant safety, generation, and reliability while reducing a plant's overall operating expense, Luminant's Power Optimization Center (POC) is providing 24-7 advanced M&D services to Columbia, Susquehanna, and Comanche Peak as a part of the ARM project.



The POC is also expanding capabilities to accommodate the additional plant-level projects previously referenced and providing consultation in support of developing each project's NuSuite modules. This aspect of the project represents a breakthrough benefit by demonstrating opportunities for centralizing engineering and technical services across a fleet of nuclear operators. Such an approach, when expanded to scale, equates to meaningful operating cost reductions. "The specific technical pilots are at the heart of this project, but it is clear that the monitoring and diagnostics service also provides a value that is significant to our members. We believe this service is icing on the cake and pays for itself in short order," Christensen said.

The POC has been in operation for over 15 years and is presently servicing more than 50 generating assets, including coal, natural gas, nuclear, solar, and battery storage facilities across the nation.

Continued



Value capture and sharing experience

In order to share project learnings with the larger industry, an objective review of the value contributions realized by ARM will be performed. This includes the development of a proposed strategy, industry roadmap, and supporting business case for scaling the solution to full production levels.

Progress thus far

As the ARM project enters its second year, engineering modifications are progressing, equipment is being installed in the plants, and meetings with potential technology suppliers are underway. At INL, research and development activities are in full gear with data scientists evaluating best approaches for developing intelligent algorithms in support of the NuSuite modules.

A prototyping laboratory has been erected at Comanche Peak, where field sensors of all types, telecommunications equipment, and expert technologists and plant personnel are constructing systems to be deployed. The POC has successfully implemented full-scale, 24-7 M&D services for Columbia Generating Station. The POC is also working on systems setup, advanced pattern recognition models, and cyber-secure networking interfaces in preparation for onboarding Susquehanna Steam Electric Station in the very near term.

Path forward

The early success of ARM is capturing the attention of others across the industry, including potential research partners, suppliers, and various industry organizations. Back at USA, during the most recent board of directors meeting, all eight utility members agreed to collaborate in the development of a proposal for a phase 2 DOE grant application. Phase 2's scope includes expanding the tools originally developed through ARM, further business process automation, including the utilization of drones and robotics, and expansion of the capabilities inherent in the NuSuite platform. "The early success and value of phase 1 of this ARM project has demonstrated to our board that we can be successful in managing and implementing a large, coordinated effort like this. That confidence has energized the group around phase 2 of the project, which will further drive value for our members and ultimately for others in the industry," Christensen said.

As so often is the case in challenging times, the teamwork and collaboration being demonstrated as a part of the ARM project represents the nuclear power industry at its best. Through ARM and other such industry efforts, we will succeed in maintaining our economic competitiveness as well as preserving the inherent benefits of nuclear power for our nation and all of humankind. ☒

Clinton Carter (ccarter@usainc.org) is the director of fleet modernization for the Utilities Service Alliance.

