FPoliSolutions RISA Technology Status and Path Forward

April 2019
Solidified the RISA Technology Stack

- FPoli-AAP for enterprise data management
  - Documents -> parameters -> simulation relationship
- Automation engines for preparing and post-processing physics simulations – enterprise knowledge
- High fidelity, 2-phase physics simulations
Business/Market Drivers

RSO1: Vendor Independent Safety Analysis Tools
RSO2: Vendor Independent Safety Analysis Methods
RSO3: Safety Analysis Automation
RSO4: RAVEN SOA Framework
RSO5: Data Mgmt for Safety Analysis Tools
RSO6: RAVEN RISMC Applications
RSO7: Integrated System Response + Configurable Scenarios

CT1: Vendor Independence in Safety Analysis
CT2: Reduced Safety Analysis Maintenance Cost
CT3: Reduce Required Component Surveillances

RAVEN Deployment to US Commercial Nuclear Market
FPoliSolutions RAVEN Services Platform

- Database Services
- Plant State Management
- Database Diagnostic
- Workflow – Automation
- Reporting Services
- Limit Optimization
- Component Declassification
- Simulations

RAVEN
- Containment Response
- Core Response
- System Response
FPoliSolutions Data Management Platform and Applications
FPoli-AAP made significant progress in fulfilling the vision for an enterprise data management platform with RAVEN as a key service for RISMC application

- FPoli-AAP is an enterprise system that can leverage multi-tiered software solutions such as web services, Fortran/C++/java/python backends, and interfaces to existing current nuclear technologies across various servers.
- Specifically architected for rapid implementation of applications using an agile development process.
- RAVEN is now an important component in FPoli-AAP technology stack.
FPoli-AAP is a full stack, enterprise grade, application platform

• Platform shares data between applications (or services)
• Data Management applications can be rapidly developed and deployed in an NQA-1 environment
• Applications can either perform calculations, track/store data, or manage other work processes
• The application platform uses a web browser interface which can be accessed anywhere
• FPoli-AAP designed so that FPoli and customers can create apps to manage data in a relational manner
• Architected to be rapidly customizable to customers (utilities) processes
Vision: A Data Management and Simulation Hub for the Nuclear Power Plant (NPP) Operating Fleet

Problem:
• Operation under financial stress, rely on data integrity and scrutability
• Managing data cost too much money and time
• Adoption of complex methods (D-PRA, RISMC) too cumbersome (training, specialized resources) and risky (regulatory uncertainty)
• Hard to prove financial benefit from RISMC applications
• Rigid regulatory framework of managing data: outdated

Solution:
• Tracked and searched data across apps
• Consumed data and learned from them
• Built event-driven SOA for extensive automation across disciplines
• Great emphasis on ‘ease-of-use’ and automation to minimize training, human resource requirements
FPoli-AAP offers generic plant management solutions, diagnostic services, automation of simulation workflows.

System services are use case driven focusing on NPP applications.
FPoli is developing several applications on the FPoli-AAP platform

FPoliDOX – for document management

FPoliDON - for research test facility data management and storage

NexHub - for simulation management
Plant Simulations Engine powered by RAVEN

- FPoli-AAP’s service oriented framework allows:
  - Extension of services to extract data
  - Collect simulation input files
  - Run physics simulations

- NexHub was designed to integrate data for a central database to run plant simulations

- NexHub has encapsulated data collection and workflow management in the simulation manager framework

- The simulation manager utilizes the content management services provided by FPoli-AAP to manage inputs and results while it automatically run complex analysis chains with multiple simulators.
• FPoli-AAP can be deployed to run on PC and interact with PC based application, while FPoli-AAP’s services can run in Windows, Linux, Unix, etc.
Example of Services Deployed or under Active Development for Early Deployment

- Various versions of FPoliDOX, FPoliDON and NexHub (Simulations) already used in house for processes automation, data sharing and security
- Extension to advanced data analytics and dynamic PRA services currently pursued
- Development of surrogates and optimization tools (Machine Learning algorithms) being approached
- Extension to deep learning tools (neural networks) with ability to leverage both CPU and GPU architectures or hybrids
INL Partnership for a Use Case: Plant Reload Process Optimization Project

- Explicit goal of reducing feed fuel/uranium enrichments
- Working with tools available to any us utility
- Use RISA methods to create new thermal limits to lower fresh fuel batch size
Three Phases

Phase I (FY2020) - DBA Methods Development
- Realistic Plant Model
- Analysis Framework
- DBA Simulations
- Create RISA Methods

Phase II (FY2021) - RISA Methods Development
- Create RISA Scenarios
- Update RISA Framework
- Simulate RISA Scenarios
- Thermal Limit Optimization

Phase III (FY2023) - Demonstrate RISMC Benefits
- Regenerate Original Fuel Management
- Optimize Fuel Management
- Equilibrium Cycle Analysis

- Classic Thermal Limits
- RISA Thermal Limits
- Optimized Fuel Management

New Fuel Cycle Economics
Plant Reload Process Optimization

• **FY19 Activities:**
  • Identification of a coherent and feasible development/deployment plan
  • Early demonstration of the tool infrastructure on a selected accident sequence

• **Working Group**
  • INL
  • FPoliSolutions, LLC
  • Future possible partnerships: Exelon and Sothern
FPoli has been actively looking for near/mid-term deployment opportunities to interested customers.

High-level APIs for Deep Neural Networks:
- FNNs
- CNNs
- RNNs
- Other DNNs