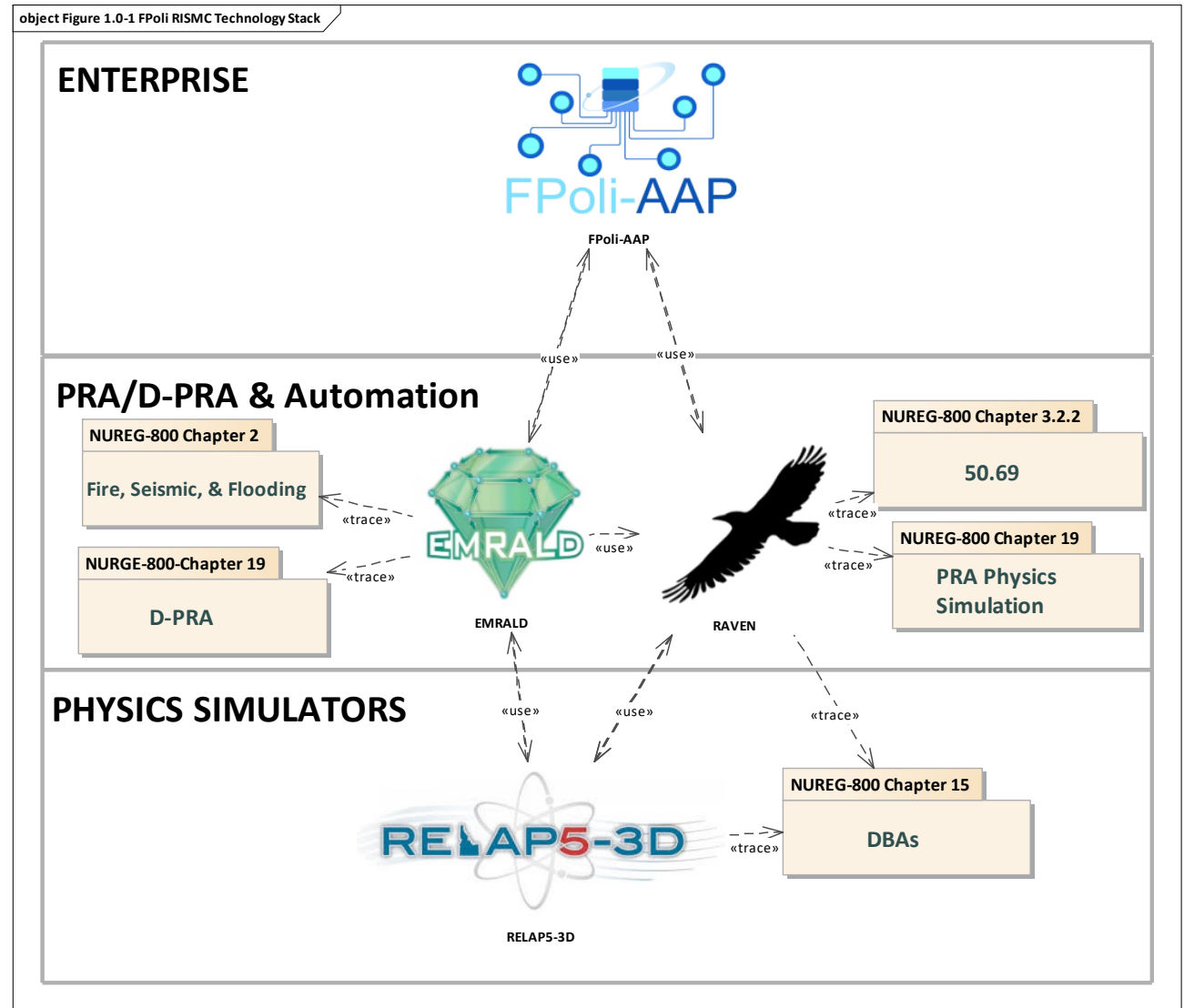# FPoliSolutions RISA Technology Status and Path Forward
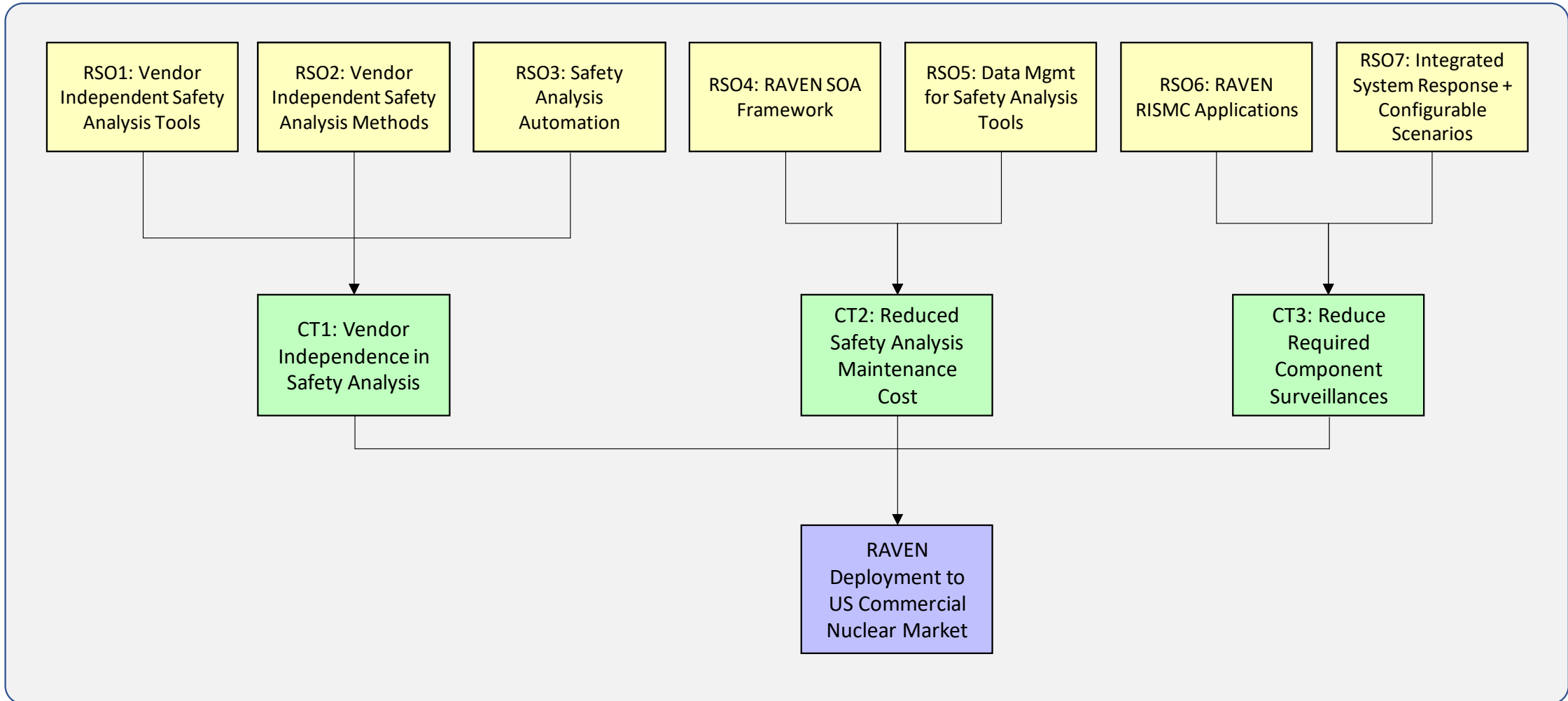
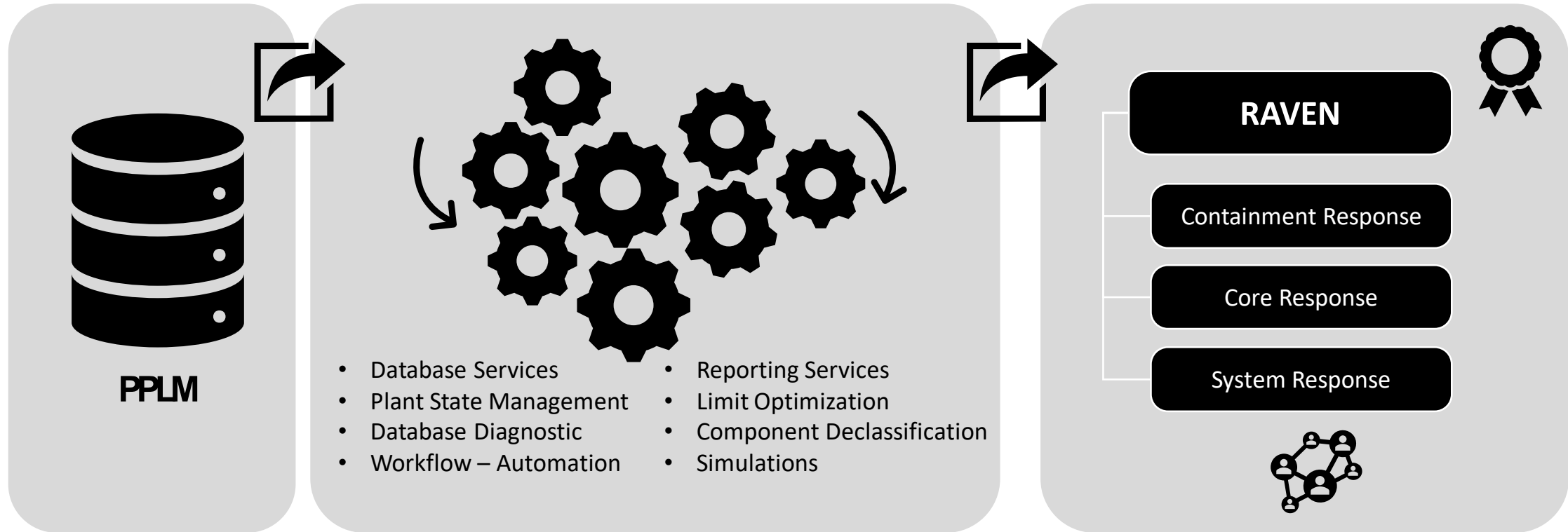April 2019

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

object Figure 1.0-1 FPoli RISMC Technology Stack

ENTERPRISE

FPoli-AAP

«use»   «use»

PRA/D-PRA & Automation

NUREG-800 Chapter 2

Fire, Seismic, & Flooding

«trace»

NURGE-800-Chapter 19

«trace»

D-PRA

EMRALD   «use»   RAVEN

NUREG-800 Chapter 3.2.2

50.69

«trace»

NUREG-800 Chapter 19

«trace»   PRA Physics Simulation

PHYSICS SIMULATORS

«use»   «use»   «trace»

RELAP5-3D

«trace»   NUREG-800 Chapter 15

DBAs

Business/Market Drivers

FPoliSolutions RAVEN Services Platform

PPLM

- 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
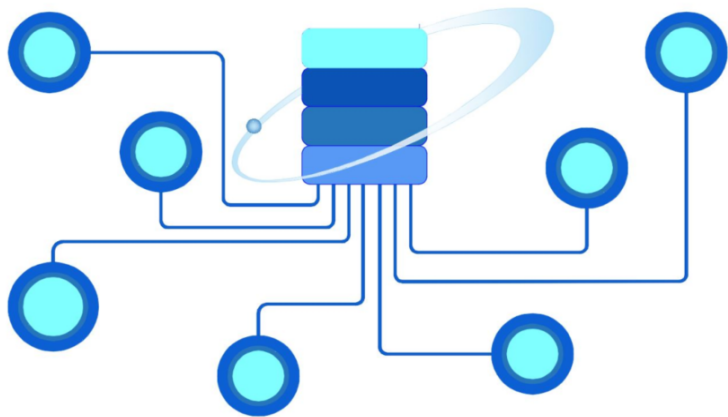
FPoli-AAP

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
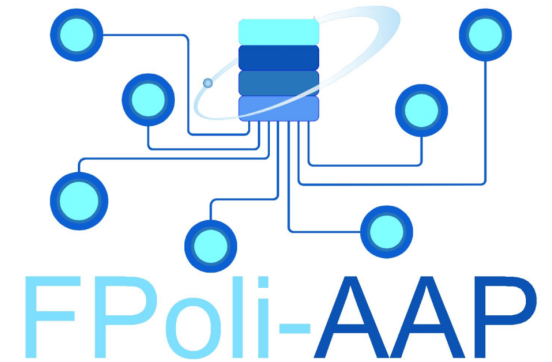
**FPoli- APP (Agile Application Platform)**

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
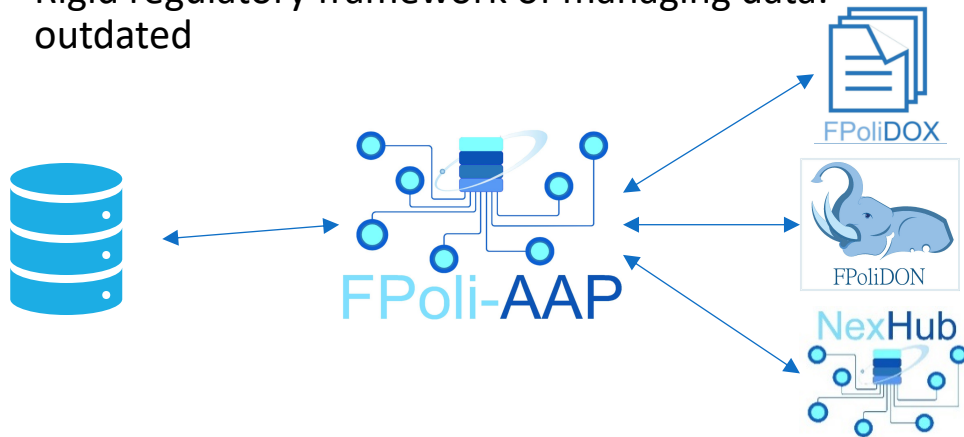
Solution:

- 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
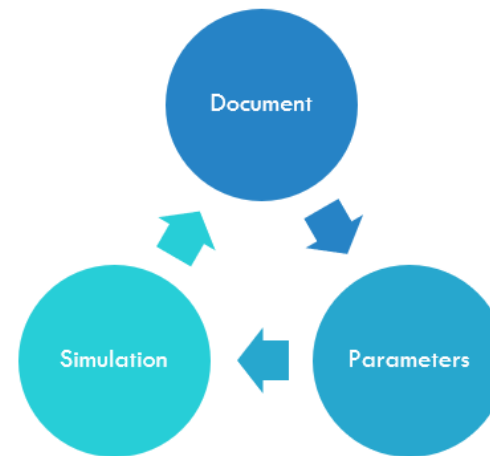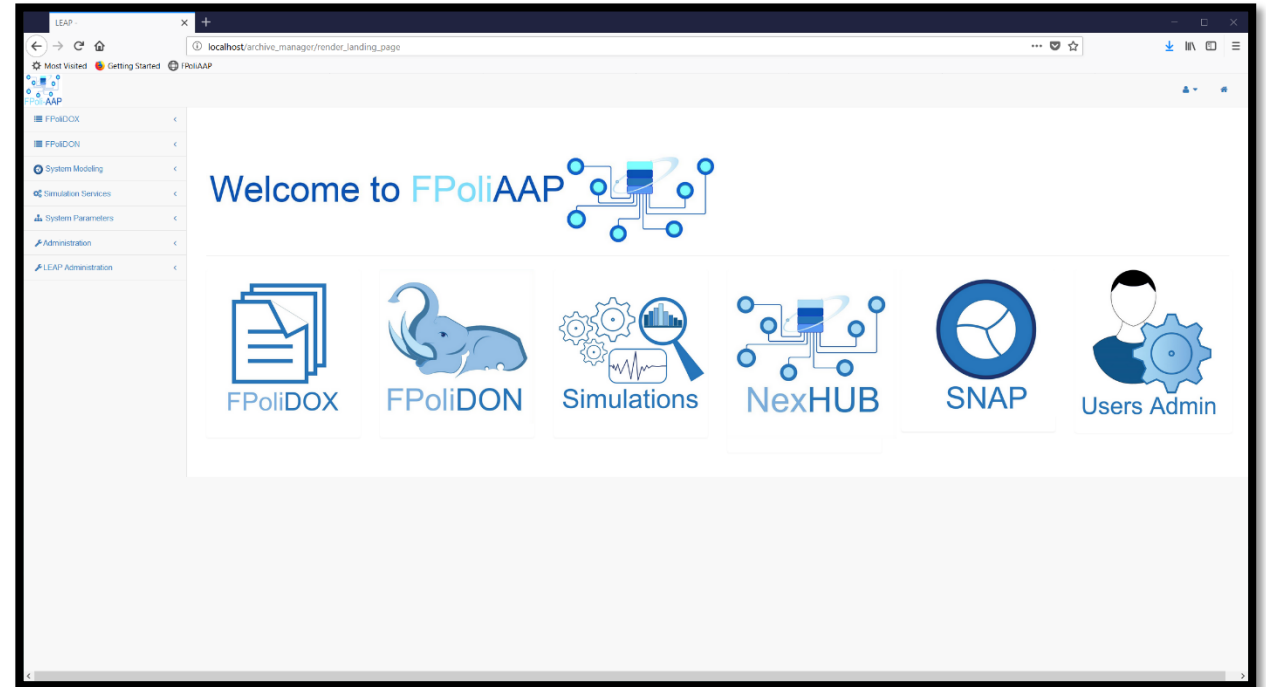
FPoli-AAP offers generic plant management solutions, diagnostic services, automation of simulation workflows
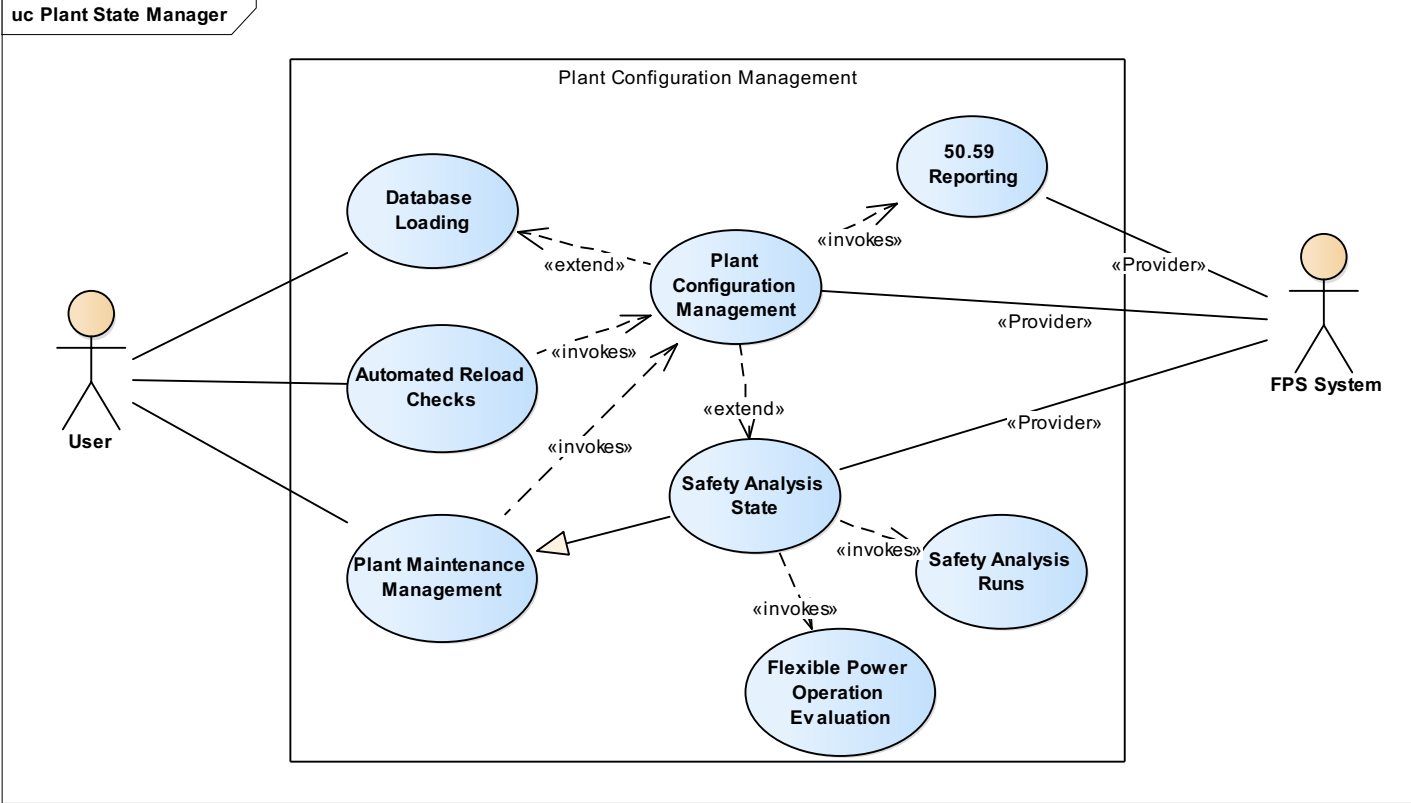
System services are use case driven focusing on NPP applications.

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
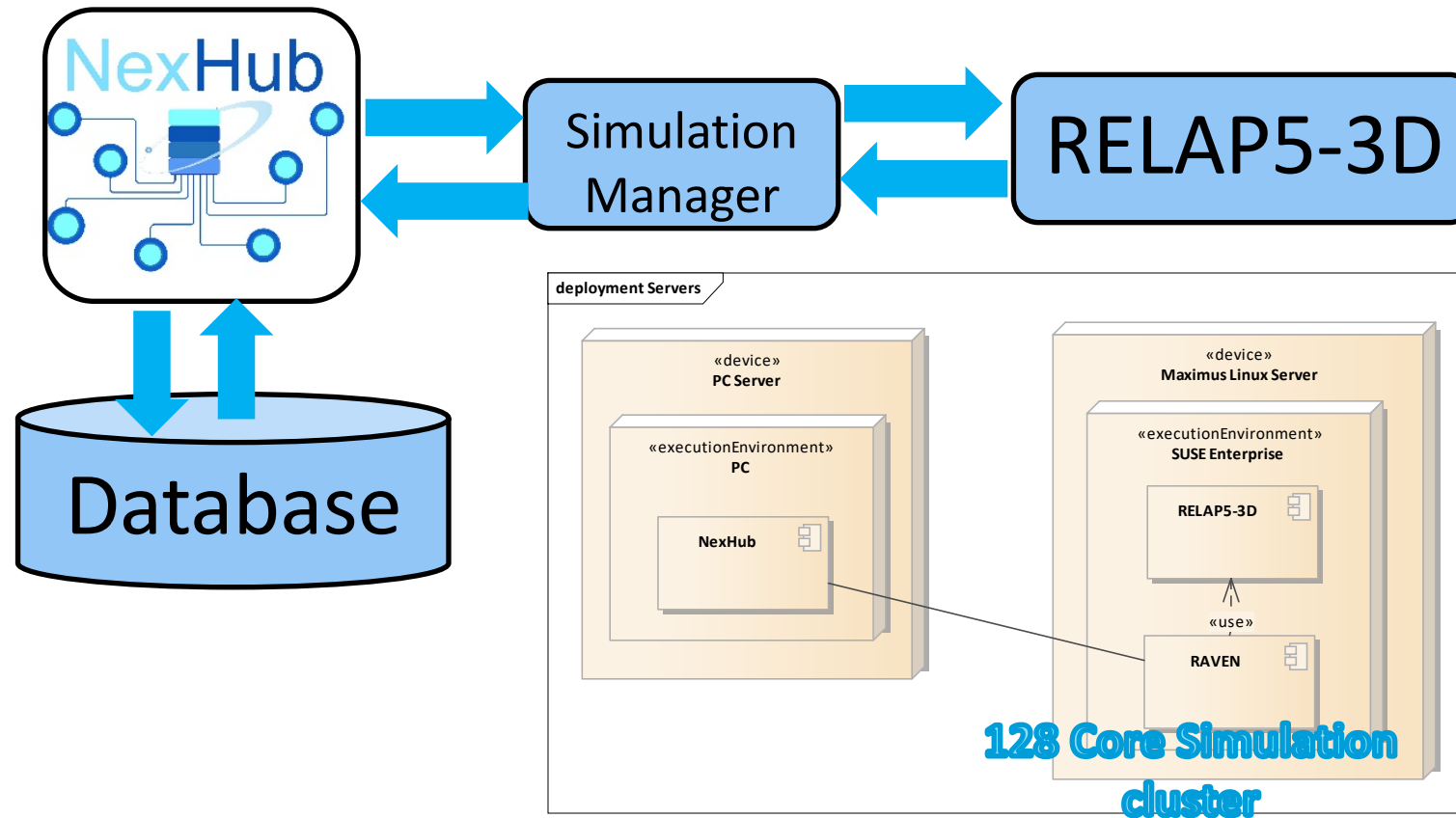
Example of Services Deployed or under Active Development for Early Deployment

- 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

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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

strategy map Figure 2.0-1 PROJECT GOALS

Reload Optimization Vision
Commoditize the nuclear fuel market through deploying vendor independent tools and RISA Methods

Goal1- Reduce the feed batch sizes through optimization of fuel thermal limits using RISMC methods

Goal2- Vendor In-Dependent Methods and Tools

Goal3- An automation framework with tools and methods for reload analysis

Three Phases

strategy map Figure 2.0-2 PROJECT OBJECTIVES

Phase I (FY2020) - DBA Methods Development

- Realistic Plant Model
- Analysis Framework
- DBA Simulations
- Create RISA Methods
- Classic Thermal Limits

Phase II (FY2021)- RISA Methods Development

- Create RISA Scenarios
- Update RISA Framework
- Simulate RISA Scenarios
- Thermal Limit Optimization
- RISA Thermal Limits

Phase III (FY2023)- Demonstrate RISMC Benefits

- Regenerate Original Fuel Management
- Optimize Fuel Management
- Equilibrium Cycle Analysis
- Optimized Fuel Managment
- New Fuel Cycle Economics

- **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

FPoliDOX

FPoliSolutions LLC

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

FPoliDON

NexHub

ROM

External Models

External Codes Interface

Models

External storage (database, files)

Run 1

Run 2

Run ..

Run ...

Run N

Steps & JobHandler

Data structures

Data Mining Statistical analysis

Samplers

Distributions