

KEPIC WEEK Digital for Engineering

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Framatome at a glance

For over 60 years, Framatome's teams have been involved in developing safe, competitive, clean, low-carbon nuclear energy worldwide by:

- designing nuclear power plants,
- · supplying nuclear steam supply systems,
- designing and manufacturing components and fuel assemblies,
- integrating automation systems,
- and servicing all types of nuclear reactors.

Framatome is the original equipment manufacturer of:

92 nuclear power plants

€3.3 billion revenue in 2020

Our worldwide presence





Our activities in a nutshell



Engineering & Design Authority:

Development, design and licensing of Nuclear Steam Supply System and associated services, including worldwide Technical Centers



Projects and Components Manufacturing:

Design and manufacturing of heavy and mobile components for nuclear islands. Management and execution of nuclear reactor new build projects, as well as component replacement projects



Instrumentation & Control (I&C):

Design and fabrication of safety I&C and automation systems for nuclear power plants



Fuel:

Development, design, licensing and fabrication of fuel assemblies and core components for power reactors (PWR, VVER, BWR) and research reactors. Development of zirconium products



Installed Base:

Products, maintenance and engineering services for existing nuclear fleets and reactors under construction



Our Digital Expertise and Services

Digital Expertise from Nuclear

Where Nuclear gives us a competitive edge

Computing & Engineering



Computing codes, simulation and engineering solutions for complex physics systems

Industrial Control Systems



Digital solutions, equipment and services dedicated to instrumentation & control

Field Operator solutions



Supporting field operators to be more efficient and safer on their job

Services

Consulting Services from Framatome digital experts

Industrial Data Science



Leverage our & EDF R&D data scientists to extract value from industrial data

Cybersecurity advisory services



Risk assessment advisory services, on regulatory compliance or I&C protection

Industrial performance expertise



Improve your industrial performance with our senior lean consultants

Simulation

End-to-end simulators for operators' training or engineering





Engineering Digital Thread relies on several types of Digital Twins to address Nuclear use cases

Types of Digital Twins

Relevant Nuclear use cases

- Design & As-Built Twin with
 Building Information Modeling (BIM)
- Planning & coordination of on-site activities

Operation Twin with

Data Analytics solutions
(Metroscope, Cadis & L'Usine)

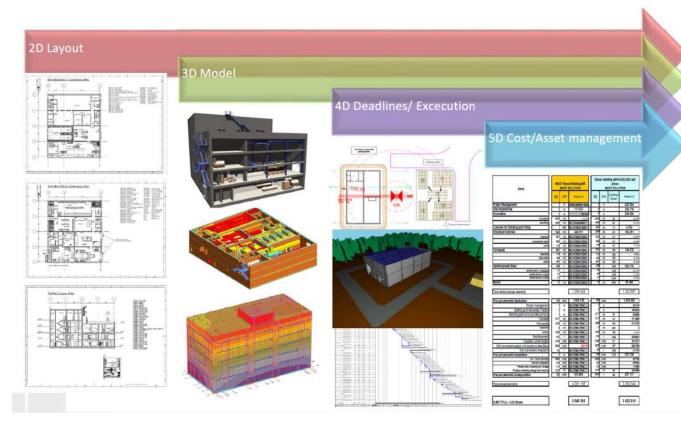
Optimize asset management and reduce costs

Simulation Twin with Digital reactor & Corys

Operator training
Design & safety studies



1 BIM - Introduction



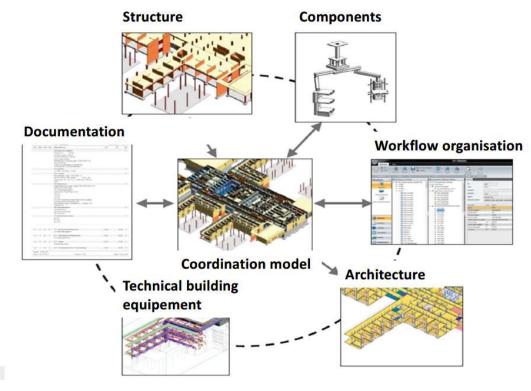
What is BIM?

BIM is a digital representation of the physical and functional characteristics of a building. As such, it serves as a shared knowledge resource for information about a building, forming a reliable basis for decisions during its life cycle from inception onward.



1 Planning & coordination of on-site activities

For BIM to become a reality, the main challenge is to centralize data for many different sources where data is represented in very different ways.



We use BIM internally to increase our productivity and reliability



2 Data Analytics Solutions

NPP operators need to stay competitive in the long-term, while facing growing maintenance and repair costs and electricity low-price pressure.

To find new models enabling costs optimization with short-term ROI, **Data Analytics solutions** can be deployed with the following challenges:

- Difficulty to manage, store and analyze the continuously growing data volume and variety to justify maintenance optimization
- Capability to generate value from the collected data because of lack of:
 - Data Science Resources & Skills
 - Ability to turn component and failure-mode expertise into operational solution (generate new insights...)



2 Data Analytics Solutions

- CADIS Central Asset Data Intelligence System to store, manage and analyze huge amount of asset data in a centralized data management system:
 - CADIS-Hardware modules
 - CADIS-Software
 - Framatome Expertise
- L'USINE Dedicated Lab service to deliver operational solutions with agile methodology in 3 to 6 months:
 - Advanced tools to produce new models of component behavior
 - Coupling of unstructured and heterogeneous data (sensors, images and texts)
 - · Analytics library: from report to industrial application
- Metroscope Live diagnostics software
 - Stand-alone startup created in early 2018
 - · Monitoring of operations through Digital Twins

For whom?

For NPP operators needing a full or a scalable HW / SW system with consolidation of data, analytics and Nuclear Expertise. « From bottomup » solution

One example of application

Optimize the maintenance of pumps

For NPP operators needing a quick diagnosis and predictive solution for a very specific case. Analyze and get the best value for all types and unexplored data

Predict & reduce clogging of steam generators

For Power Generation Monitoring and Diagnostics centers (NPP and fossils plants) Protect plant availability with detection of early stage feed water heater tube rupture

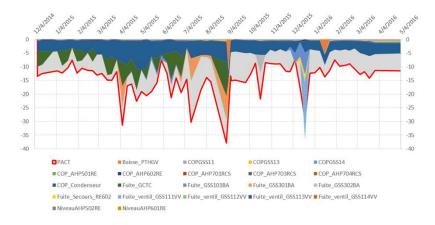
Knowing and Treating data through nuclear expertise

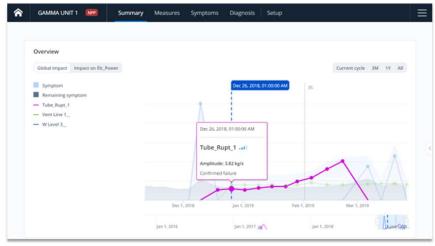


2 Metroscope Success Story

Feed water heater tube rupture detection 10 weeks before typical modeling would have detected

- Allow better maintenance planning
- Avoid severity of unplanned shutdowns







One EDF site historical analysis:

- 50 GWh of recoverable power over 1 year
- 20 detections by Metroscope

58 units implemented with 87% reliability of detection



2 Digital Solutions and technology building blocks

Together in the data journey

Category	Examples from Framatome original catalog	The data Journey
Expertise (tech/eng. Support, org, numerical twin, Smart troubleshooting)	Consultancy Services	Data Enrichment
Data Analytics (advanced, data science)	CADIS, L'Usine, Metroscope	
Data Treatment (conventional, signal treatment)	CADIS, DIROM, LPMS, ADAM, COMSY, FAMOSi, UltraCheckC, ADRIA, EMPATH	
Data collection (incl. edge comp.)	CADIS, DIROM, COMSY, DAW4, SULIVAN, MRMS, FOXGUARD	
Networks	IBN network, MRMS	
Industrial Sensors (enhanced sensors)	SIPLUG-C, SULIVAN, MRMS, FOXGUARD	
Instrumentation (traditional sensors)	LPMS, FLÜS, SIPLUG, FAMOSi, UltraCheckC, SULIVAN	Added value

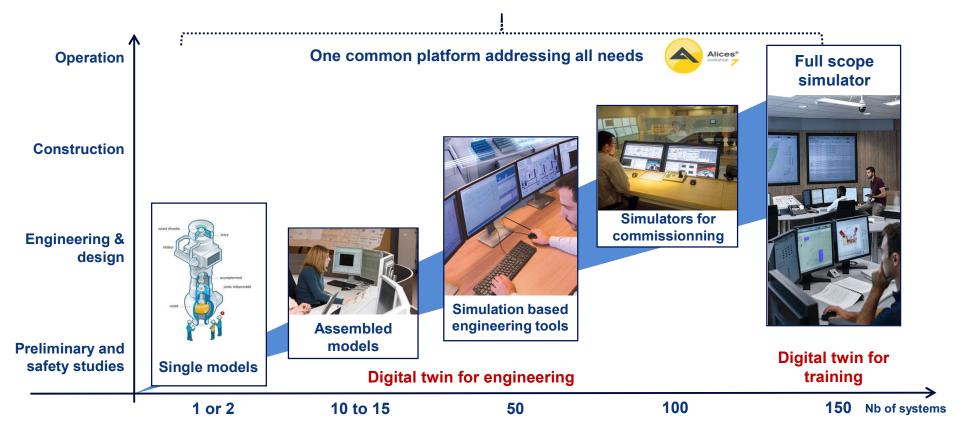


2 Detailed on digital solutions use cases

Solutions		lloT	Net.	Data coll.	Data treat.	Data sc.	Expert.
		Î		*	.		
CADIS - Condition Monitoring Platform				X	X	X	X
COMSY - Condition Oriented Ageing and Plant Life Software				х	x		x
ADAM/SIPLUG - Valve and Drive Online Diagnostics		X*		x	x		x
LPMS - Acoustic Loose Parts Monitoring System				х	х	X	X
VMS - Vibration monitoring system of primary and secondary circuit components				х	x	X	х
LPMS-VMS - Combined Loose Parts & Vibration Monitoring System				х	х	X	X
DIROM - Monitoring System for Rotating Machinery				х	х	X	х
FLÜS - Leakage and Humidity Detection System				х	X		х
FAMOSi - Fatigue Monitoring System				х	х		х
Industrial solutions							
iLPMS - Industrial acoustic loose parts monitoring system -				X	X		X
LEOS - Leakage Detection and Localization applicable to pipelines, tank farms and chemical sites	x			x	x		x
FAMOS-V – Vibration Fatigue Monitoring System				x	X	X	X



3 Simulation for nuclear reactor







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