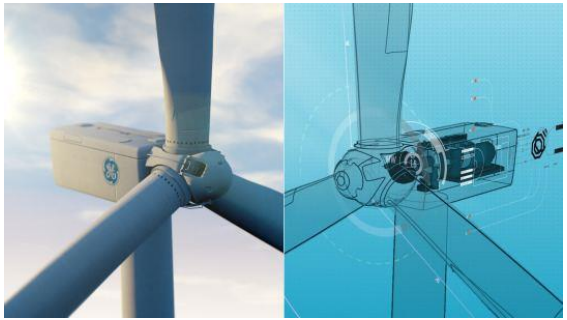
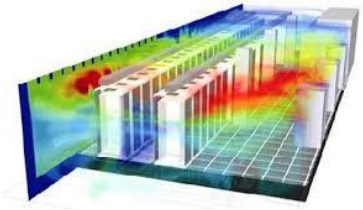
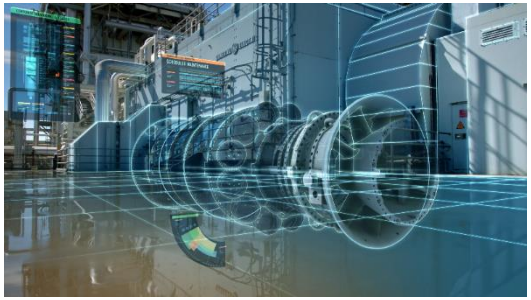
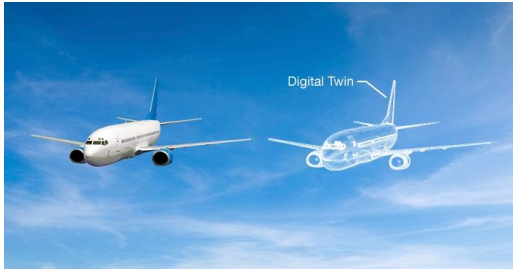

# IoTwins

# Digital Twins










- A **digital twin** is a digital replica of a living or non-living physical entity

- Digital twins integrate **internet of things, artificial intelligence, machine learning and software analytics** with spatial network graphs to create **living digital simulation models** that update and change as their physical counterparts change
- Particularly useful to detect, diagnose and predict anomalies

# IoTwins

- IoTwins will design a reference architecture for distributed and edge-enabled digital twins, to allow:
  - the description of the system itself and its dynamics
  - the prediction of its evolution
  - the optimization of its operation, management and maintenance
    - **predictive maintenance**

- IoTwins will work to lower the barriers to building edge-enabled and cloud-assisted intelligent systems and services based on big data for the domains of manufacturing and facility management

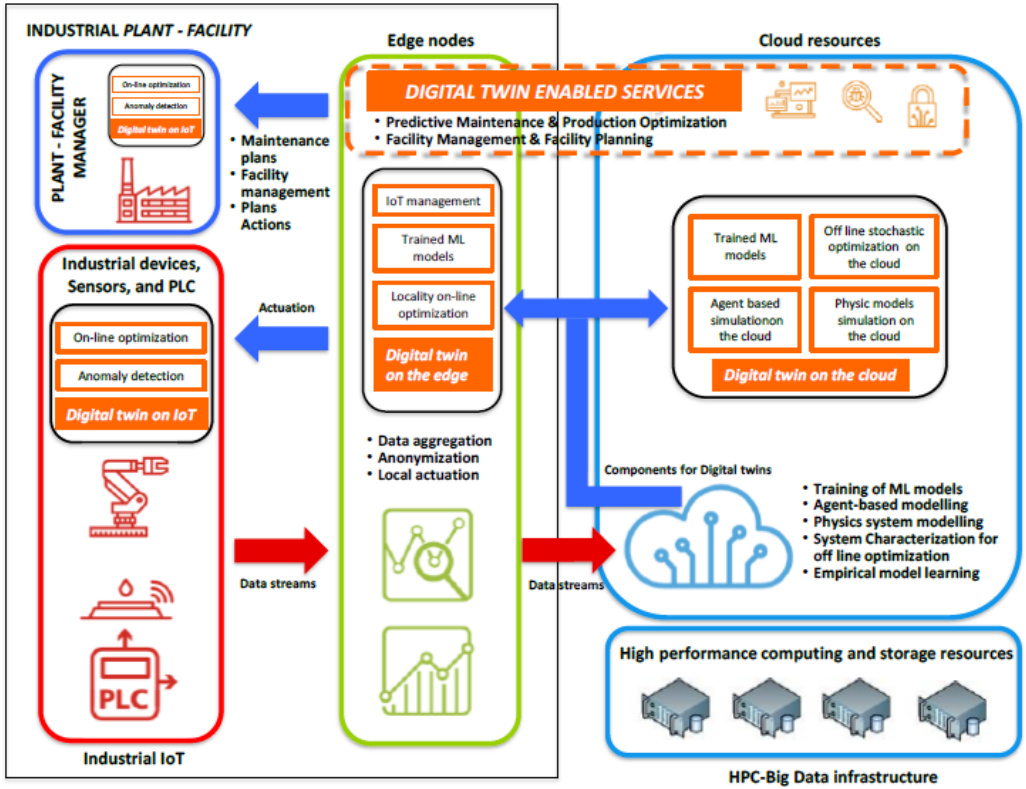
# Industrial testbeds

- **Twelve industrial test-beds**, grouped into three classes:
  1) test-beds in the manufacturing sector with the goal of optimizing production quality and plant maintenance
  2) test-beds for the optimization of facility/infrastructure management
  3) test-beds for the in-the-field verification of the replicability, scalability, and standardization of the proposed approach, as well as the generation of new business models

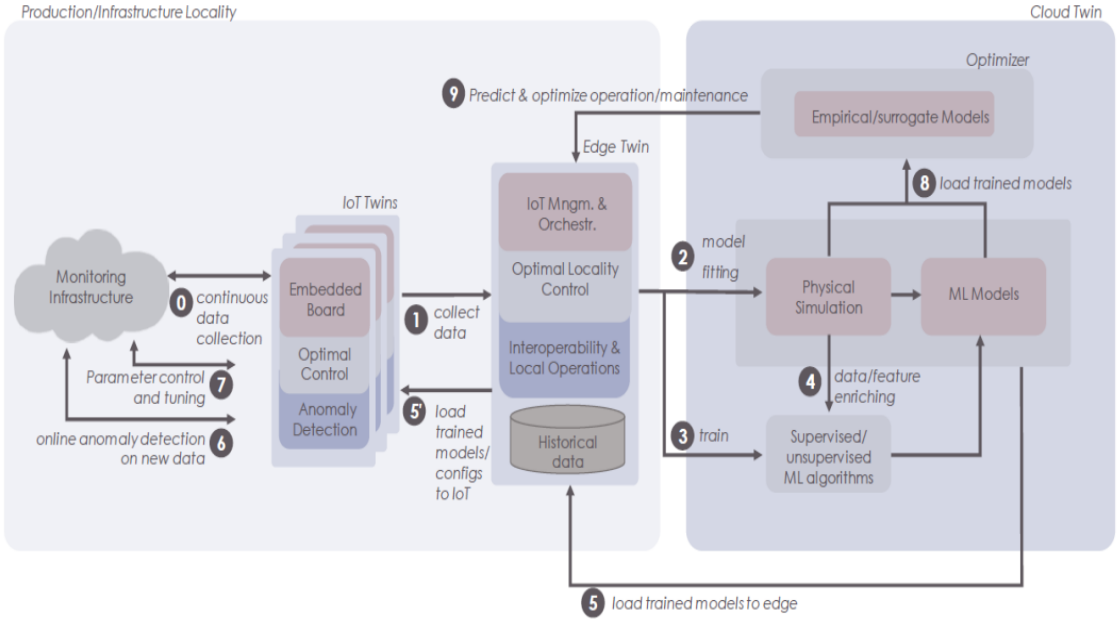
# Testbeds

1) RI-KKWS – Wind turbine predictive maintenance
2) FILL-TTT – Machine tool spindle predictive behaviour
3) Predictive maintenance for a crankshaft manufacturing system
4) GCL - Predictive maintenance and production optimization for closure manufacturing
5) NOUCAMPNOU – Sport facility management and maintenance
6) Examon (CINECA) – Holistic supercomputer facility management
7) SAG-SAGOE - Smart Grid facility management for power quality monitoring
8) Patterns for smart manufacturing for SMEs
9) Examon replication to INFN/BSC datacentres
10) Standardization/homogenization of manufacturing performance
11) FCB - Replicability towards smaller scale sport facilities
12) MARP - Innovative business models for IoTwins PaaS in manufacturing

# Digital Twins architecture



# The high-level Platform architecture




- The primary elements of the IoTwins PaaS infrastructure **at the cloud side** will be provided using state-of-the-art technologies, such those developed in H2020 initiatives like the INDIGO-, XDC-, and DEEP-DataCloud projects.
- At the PaaS level, INDIGO and DEEP provide solutions for automatically instantiate and orchestrate virtual resources to run ML applications as soon as new data appears.
- Storage events notifications are used to trigger new models training or new analysis/inference.
- Multiple Authorization and Authentication mechanisms are also provided, based on X509 certificates, tokens (openIDConnect) or plain username/ password.

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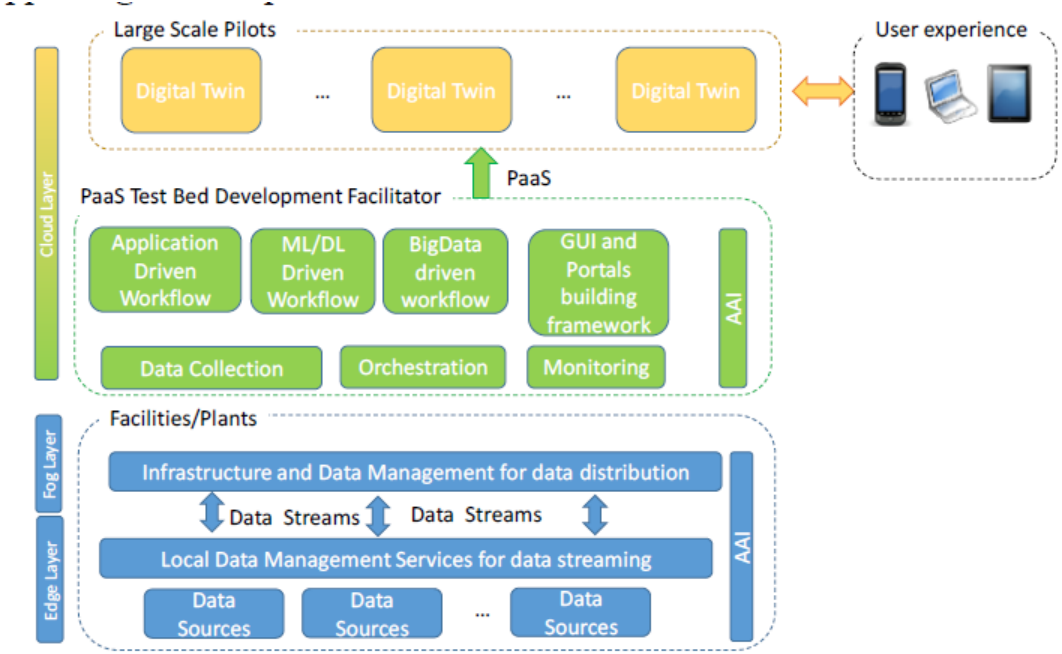
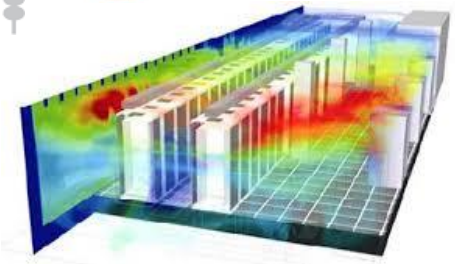



**Figure 5**: Cloud-based IoTwins infrastructure

# WP6 Testbed 10: INFN and BSC test-bed on EXAMON deployment for Large IT infrastructure management

- Demonstrating the re-usability of the IoTwins platform for Large IT Infrastructure management
- Datacentre AI-driven optimization
- Data center predictive management
- Operation cost reduction achievable by energy minimization

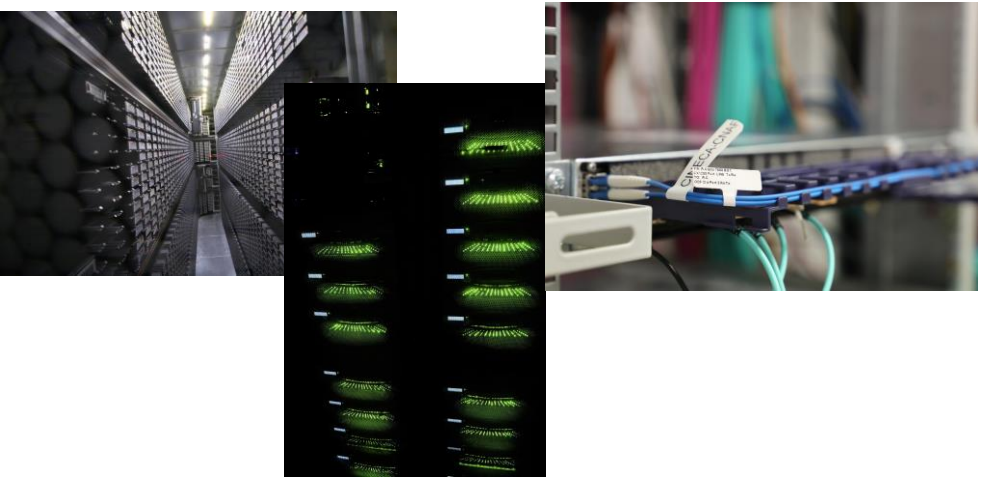


# WP6 Testbed 10: INFN and BSC test-bed on EXAMON deployment for Large IT infrastructure management

- The EXAMON solution developed in WP5 TB6 will be deployed in two different infrastructures

**The INFN-CNAF datacenter**

A large production datacenter used by scientific communities



**Unconventional clusters at BSC**

Based on pure embedded-processor technology

# Implementation - 1

| WP No | Work Package Title | Lead Part. No | Lead Part. acronym | PM | Start M | End M |
|---|---|---|---|---|---|---|
| 1 | Project management | 1 | BRI | 80 | 1 | 36 |
| 2 | IoT-Edge-Cloud infrastructure and big data services for SMEs | 4 | FOKUS | 493 | 1 | 36 |
| 3 | AI services for distributed digital twins | 8 | UNIBO | 153 | 1 | 30 |
| 4 | Manufacturing test-beds | 17 | GCL | 580 | 1 | 36 |
| 5 | Facility management test-beds | 6 | FCB | 263 | 1 | 36 |
| 6 | Platform replicability, scalability, and business models | 3 | ESI | 258 | 1 | 36 |
| 7 | Exploitation of the project developments and knowledge management | 12 | WST | 181 | 1 | 36 |
| 8 | Outreach activities – dissemination and communication | 11 | ASTER | 150 | 1 | 36 |
| | | | | 2158 | | |

- INFN
  - WP1: 1PM
  - WP2: 61PM
    - Leader of **T2.1: Technology Requirements**
    - Leader of **Task 2.6: Service Orchestration and Security**
    - Leader of **Task 2.8: Cloud-side Data Services Development**
      - management of massive streams of data in order to analyse them as they are produced, so as to exploit their "freshness", by possibly using approximate techniques for low power computing and/or for reducing time computation
      - data management services will provide capabilities for managing the entire data lifecycle, allowing policy definition to control it. Policies will allow to request and enforce attributes such as:
        - » replica multiplicity
        - » storage Quality-of-Service (i.e. fast vs glacier-like resources)
        - » access control evolution over time (i.e. open availability after “embargo” periods characterized by limited access).
      - The data management system will integrate
      - the encrypting, anonymizing, and ACL enforcing

# Implementation - 2

| WP No | Work Package Title | Lead Part. No | Lead Part. acronym | PM | Start M | End M |
|---|---|---|---|---|---|---|
| 1 | Project management | 1 | BRI | 80 | 1 | 36 |
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- INFN
  - WP3: 6PM
  - WP4: 16PM
    - TB #1, #3, #4
  - WP5: 12PM
    - TB #6 (**Large IT infrastructure management (EXAMON)**
  - WP6: 44
    - TB #9/10, Leader di T6.4 (**Deployment of EXAMON on INFN and BSC plants (M20-M36)**
    - TB #12
  - WP7: 3PM
  - WP8: 2PM

**145PM Totali**

**5ke per PM + OH**

# Budget

| No | Participant | Country | (A) Direct personnel costs/€ | (B) Other direct costs/€ | (C) Direct costs of sub-contracting/€ | (D) Direct costs of providing financial support to third parties/€ | (E) Costs of inkind contributions not used on the beneficiary's premises/€ | (F) Indirect Costs / € (=0.25(A+B-E)) | (G) Special unit costs covering direct & indirect costs / € | (H) Total estimated eligible costs / € (=A+B+C+D+F+G) BENEFICIARY | (I) Reimburse-ment rate (%) BENEFICIARY | (J) Max.EU Contribution / € (=H*I) BENEFICIARY | (K) Costs of third parties linked to participant THIRD PARTIES | (L) Max.EU Contribution / € THIRD PARTIES | (M) Total Costs for BENEFICIARY & THIRD PARTIES (=H+K) | (N) Max.EU Contribution / € BENEFICIARY & THIRD PARTIES (=J+L) | (O) Requested EU Contribution / € BENEFICIARY & THIRD PARTIES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bri | IT | 1144000 | 411100 | 0 | 0 | 0 | 388775,00 | 0 | 1943875,00 | 70 | 1360712,50 | 0 | 0 | 1943875,00 | 1360712,50 | 1360712,50 |
| 9 | Infn | IT | 725000 | 321800 | 0 | 0 | 0 | 261700,00 | 0 | 1308500,00 | 100 | 1308500,00 | 0 | 0 | 1308500,00 | 1308500,00 | 1308500,00 |
| | Total | | 13639194 | 2136661 | 100000 | 0 | 0 | 3943963,75 | 0 | 19819818,75 | | 16212552,01 | 210000,00 | 210000,00 | 20029818,75 | 16422552,01 | 16422552,01 |

1PB raw, ancillary services - disk servers and high bandwidth network connections, 100.000€ for 2 dual socket nodes each equipped with 4 last generation GPUs

Altri 21 partner…..

# Cloud Layer Resources @ CNAF

- Tender already assigned

2x
Dual Xeon 28-Core 8276 2,2Ghz 38.5MB
Quad NVIDIA V100 SXM2
384 GB DDR4-2933

1x Mellanox FDR 18 port 56Gb/s
1x Eth 10Gb/s BaseT 48 port

2x
Dual Xeon 24-Core 8260 2,4Ghz 35.75MB
45 x 14TB HDD
2 x 2TB SAS SSD
2 X 460 SATA SSD
384 GB DDR4-2933