Case Study: Leveraging Digital Twins for the next generation of Energy Performance Certificates in the building sector

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SmartWins

Projects' Information

Project Information

D^2EPC

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DOI

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Funded under

SOCIETAL CHALLENGES - Secure, clean and efficient energy

Overall budget

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EU contribution

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Coordinated by

ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS

Greece

Project Information

SmartLivingEPC

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Coordinated by

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Greece

Introduction on EPCs

Energy performance (of a building)

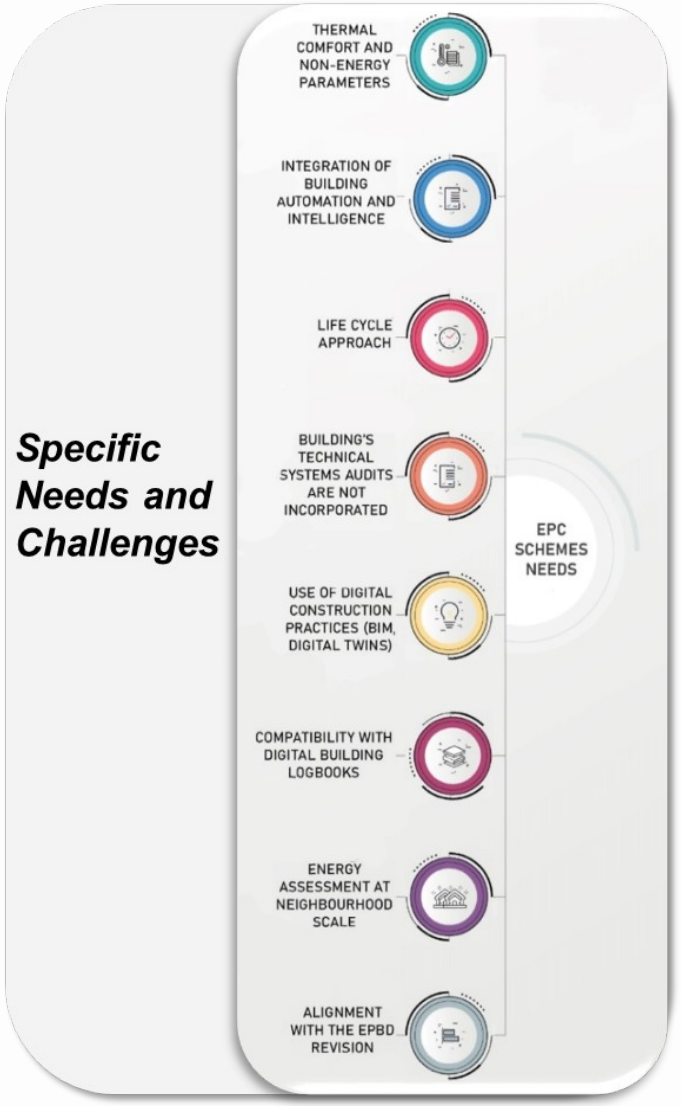
The calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes energy used for specific services (i.e., heating, cooling, ventilation, hot water and lighting).

Energy performance certificate of a building

A certificate recognized by a Member State or by a legal person designated by it, which indicates the energy performance of a building or building unit, calculated according to a methodology adopted at national or regional level.
Member States shall apply a methodology for calculating the energy performance of buildings in accordance with the common general framework as described in EPBD standards.

Reference: **EN** ISO 52000-1

Current Situation – EPC challenges



D2EPC

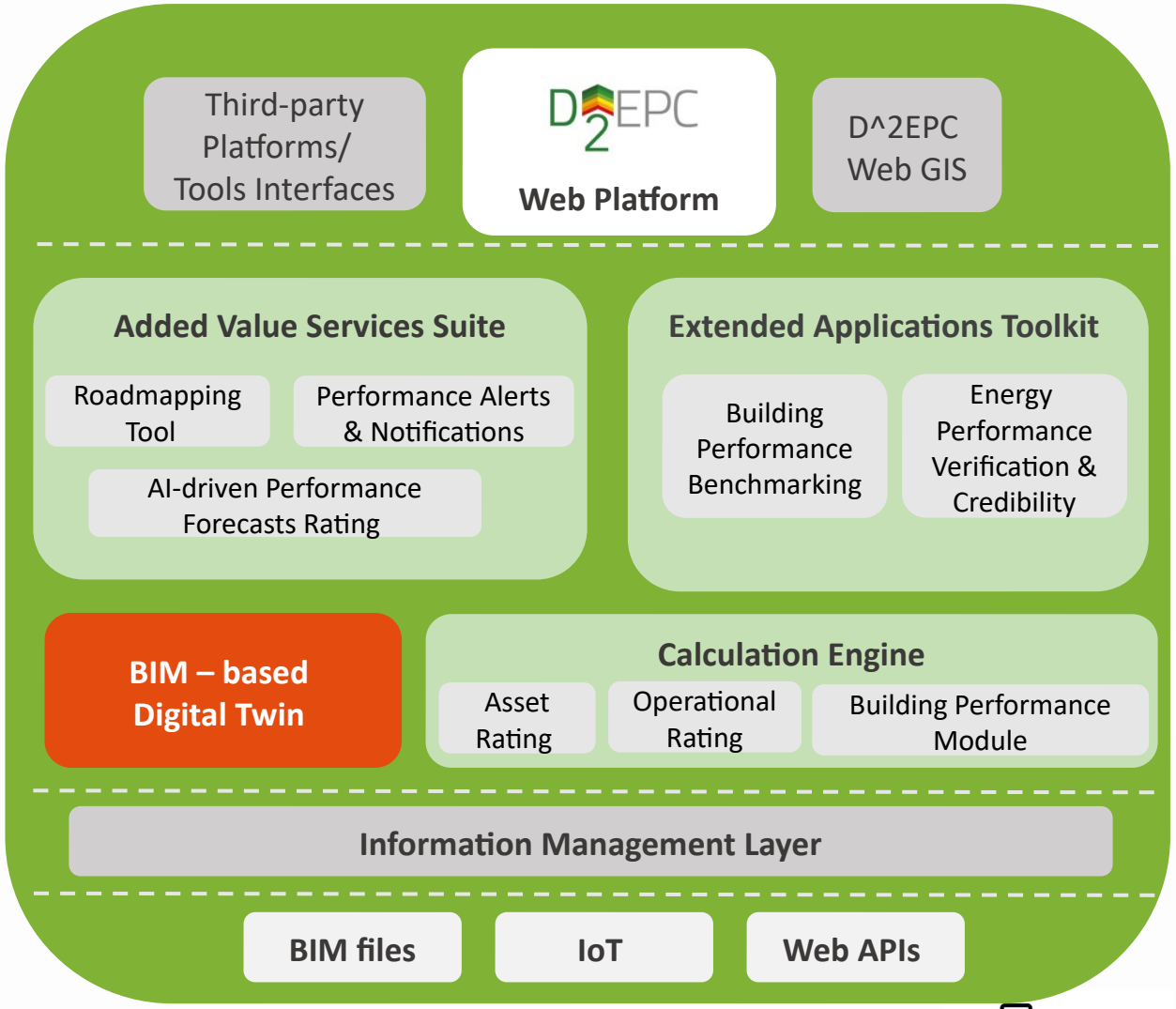
Smart living EPC

Next generation of Energy Performance Certificates

- Provision of an informative user-friendly tool for all the involved stakeholders in the building's lifecycle
- Use of digitized tools and retrieve assessment information from BIM literacy and Digital Twins
- Operational and regular assessment of buildings energy performance
- Digital design and monitoring tools and services
- Customized energy saving and renovation recommendations with the utilization of machine learning and AI-driven algorithms
- Introduction of new informative indicators at the aspects
- Provide information on building operational behavior based on life cycle performance, smartness, and technical system performance
- Expand to cover water consumption, noise pollution, and acoustics, and be compatible with digital logbooks and building renovation passports
- Expand the certification process to building complex level

D^2EPC at a glance

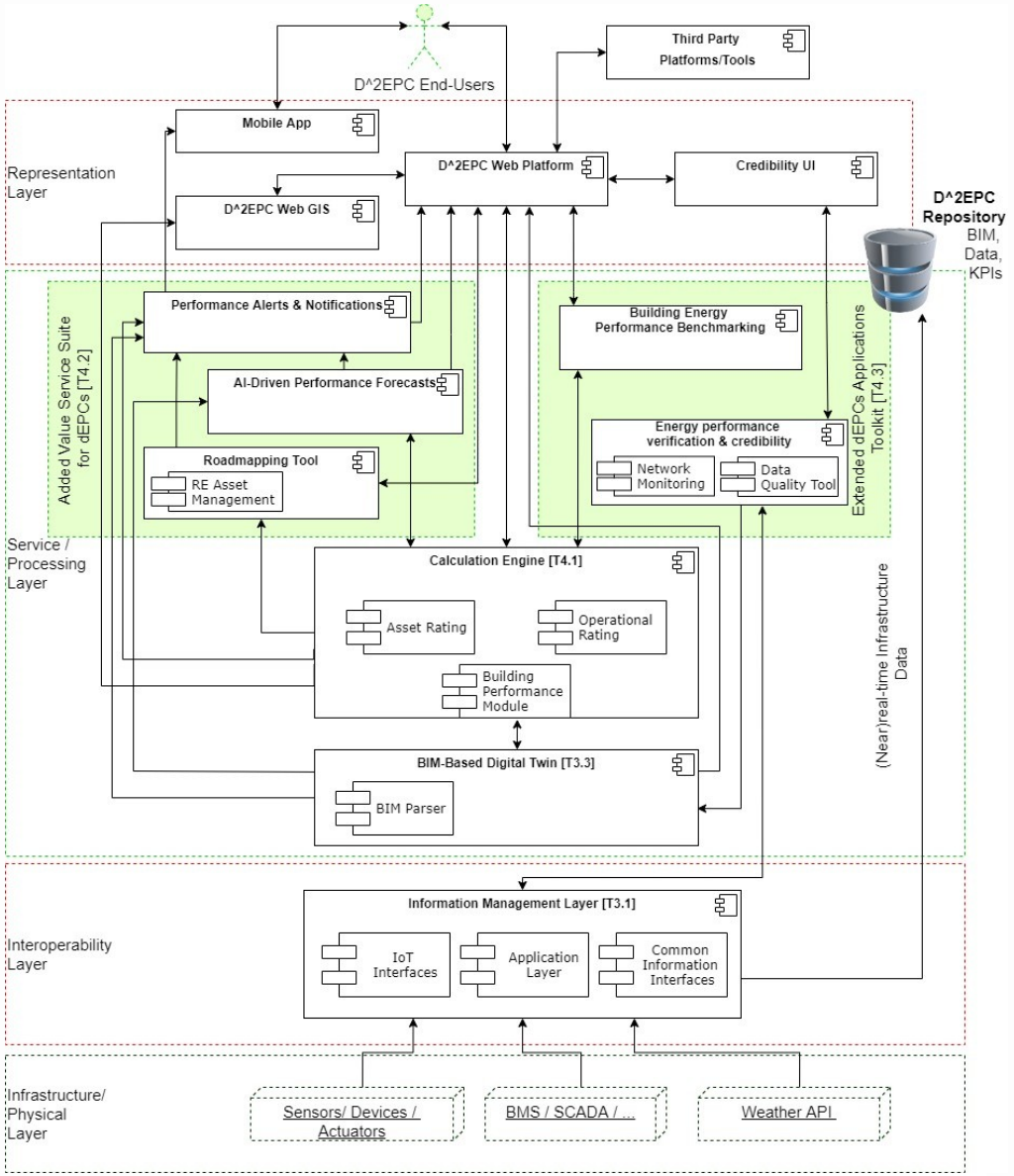
- Building Documentation
  - BIM / IoT / Web APIs
- BIM-based Digital Twin
  - Near real time asset monitoring
  - Building info integration
- Enhanced multi-parameter assessment
  - As-designed/ As-Operated energy rating
  - Extended KPIs (smartness, sustainability, human comfort, financial)
- Improved AI-driven assessment recommendations and services
- Delivery of Dynamic Energy Performance Certificates
  - Added value district/ neighborhood information through GIS



D^2EPC Architecture Overview

The proposed scheme consists of:

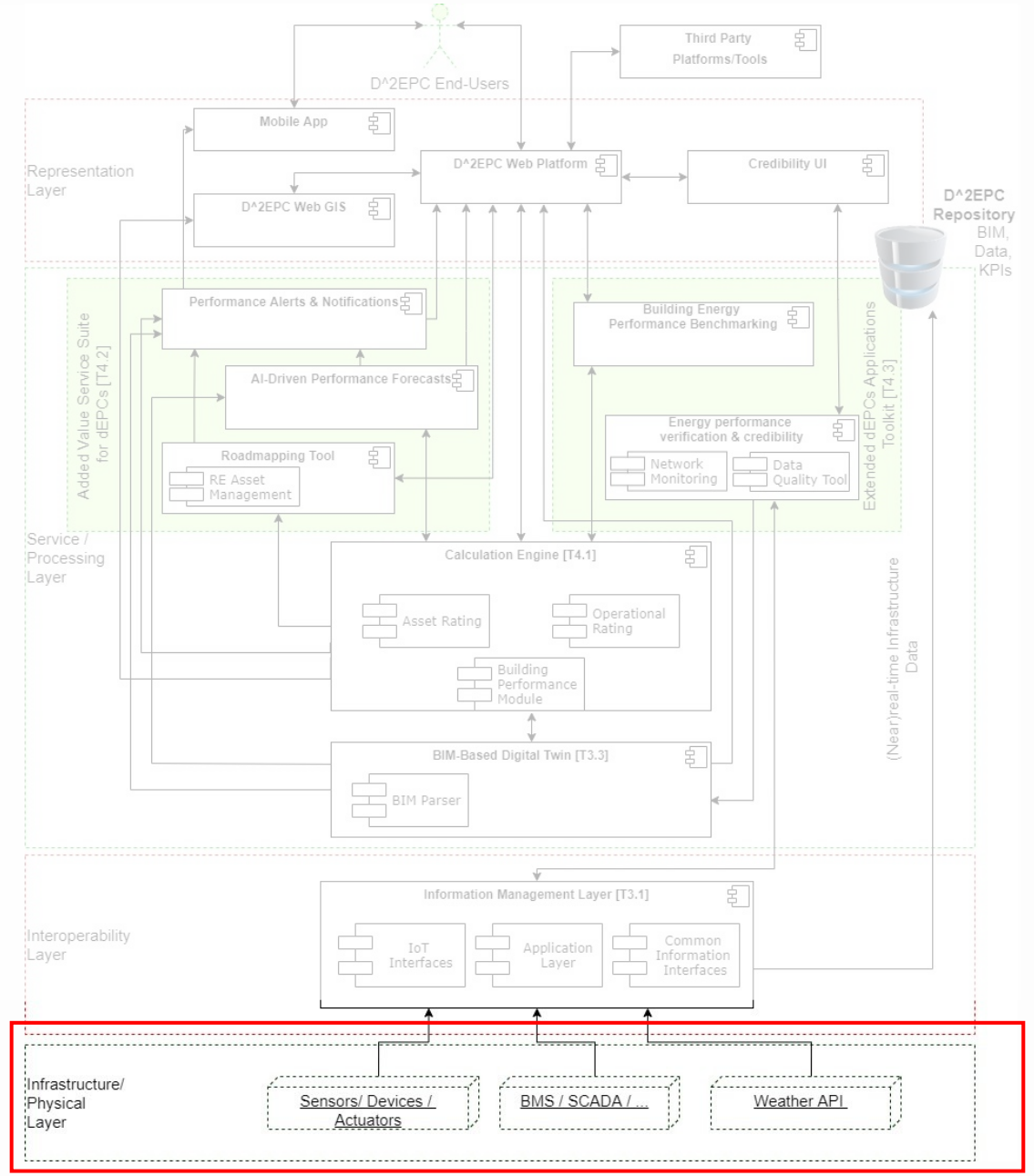
- 4 layers
  - Infrastructure/ Physical Layer
  - Interoperability Layer
  - Service/ Processing Layer
  - Representation Layer
- 13 components



D^2EPC Architecture Overview

Infrastructure/ Physical Layer

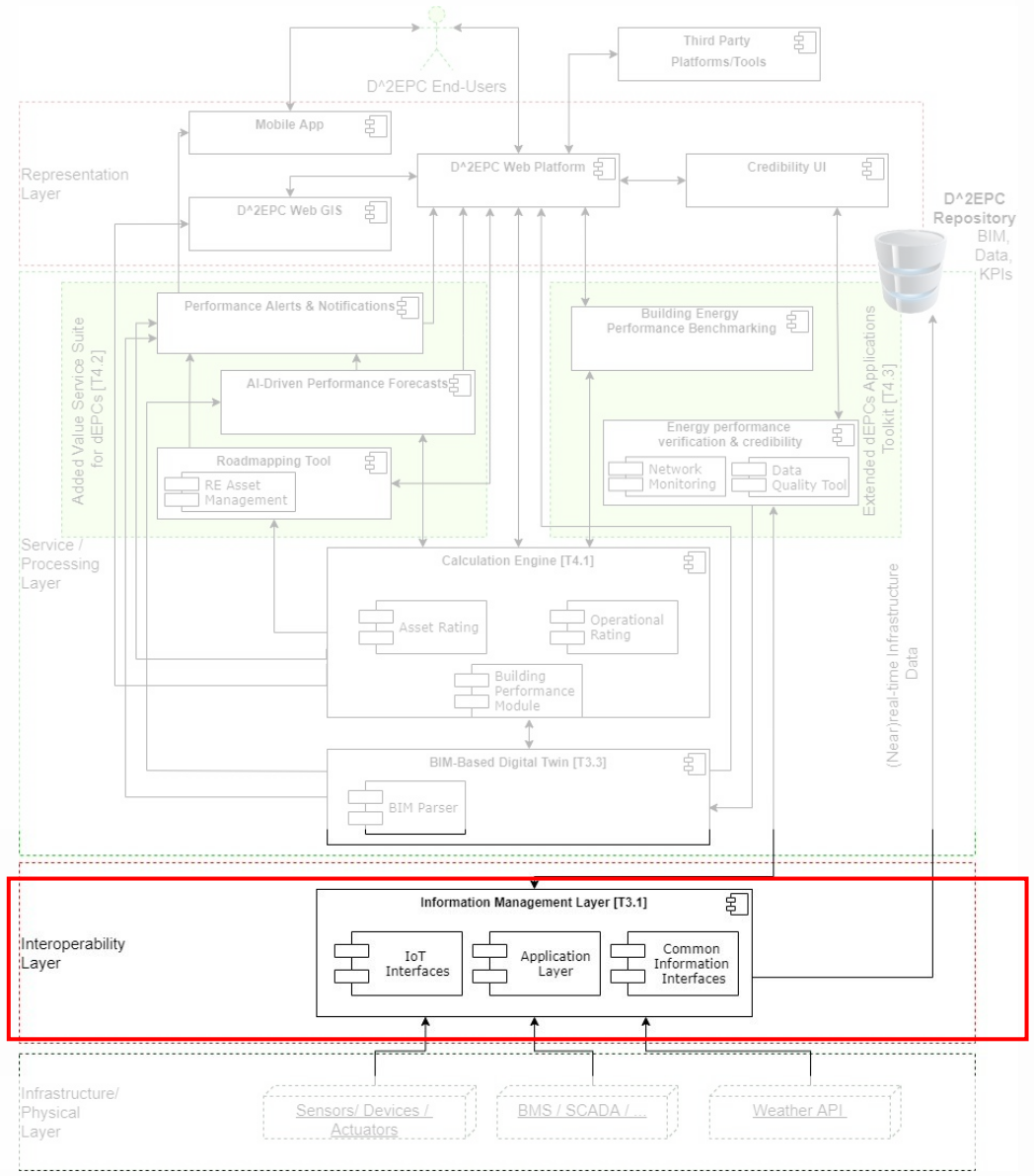
- Sensors / Energy Monitoring Devices/ Systems (BMS, EMS, SCADA)
- Data collection trough external APIs (weather data)



D^2EPC Architecture Overview

Interoperability Layer - Information Management Layer

- Building measurements translation into a common data format
- Data streaming to D^2EPC Repository
- Introduction of an information model that extends current standards and incorporates all required aspects for delivering both asset and operational assessment

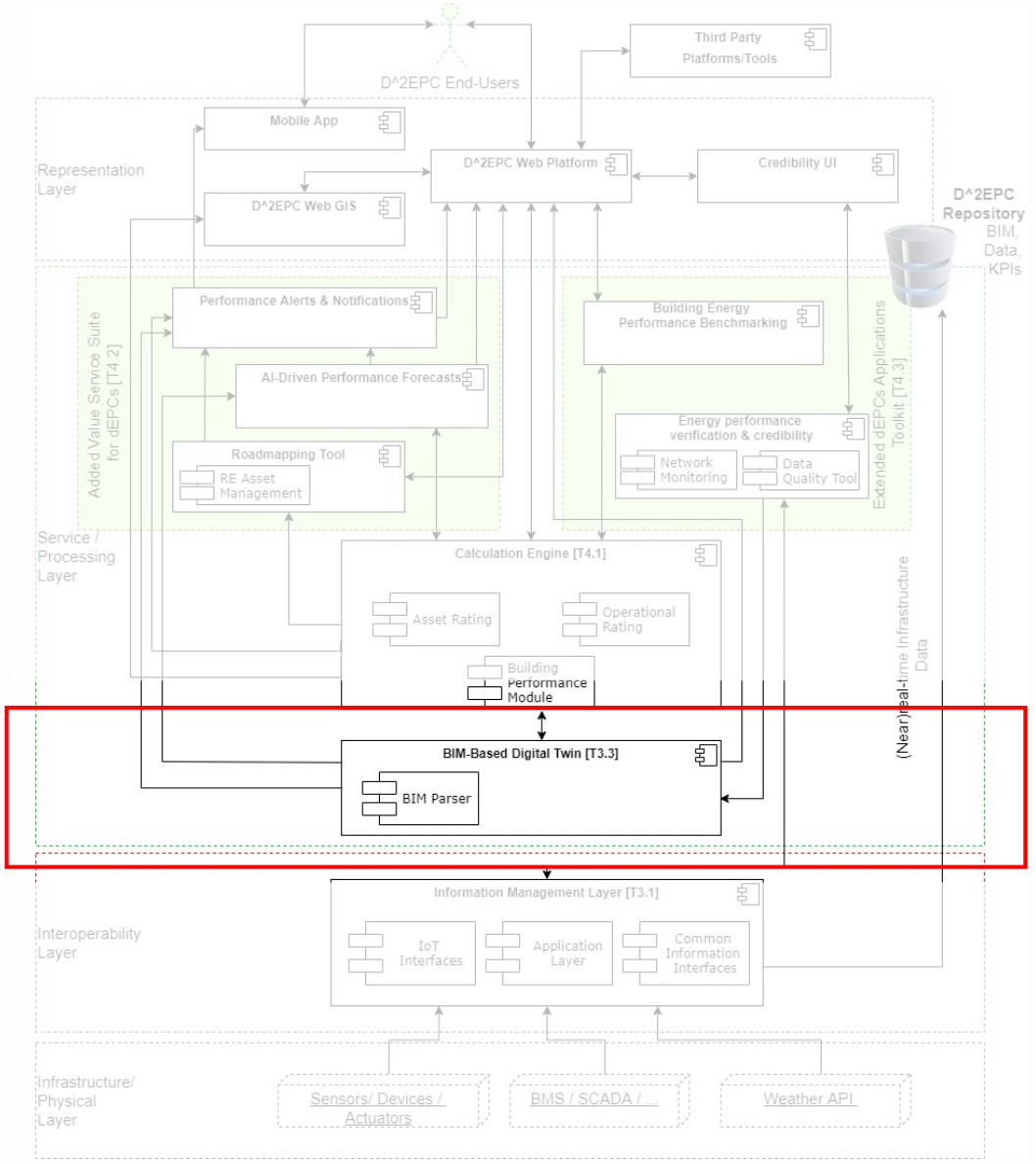


D^2EPC Architecture Overview

Service/ Processing/ Decision Making Layer

BIM – based Digital Twin

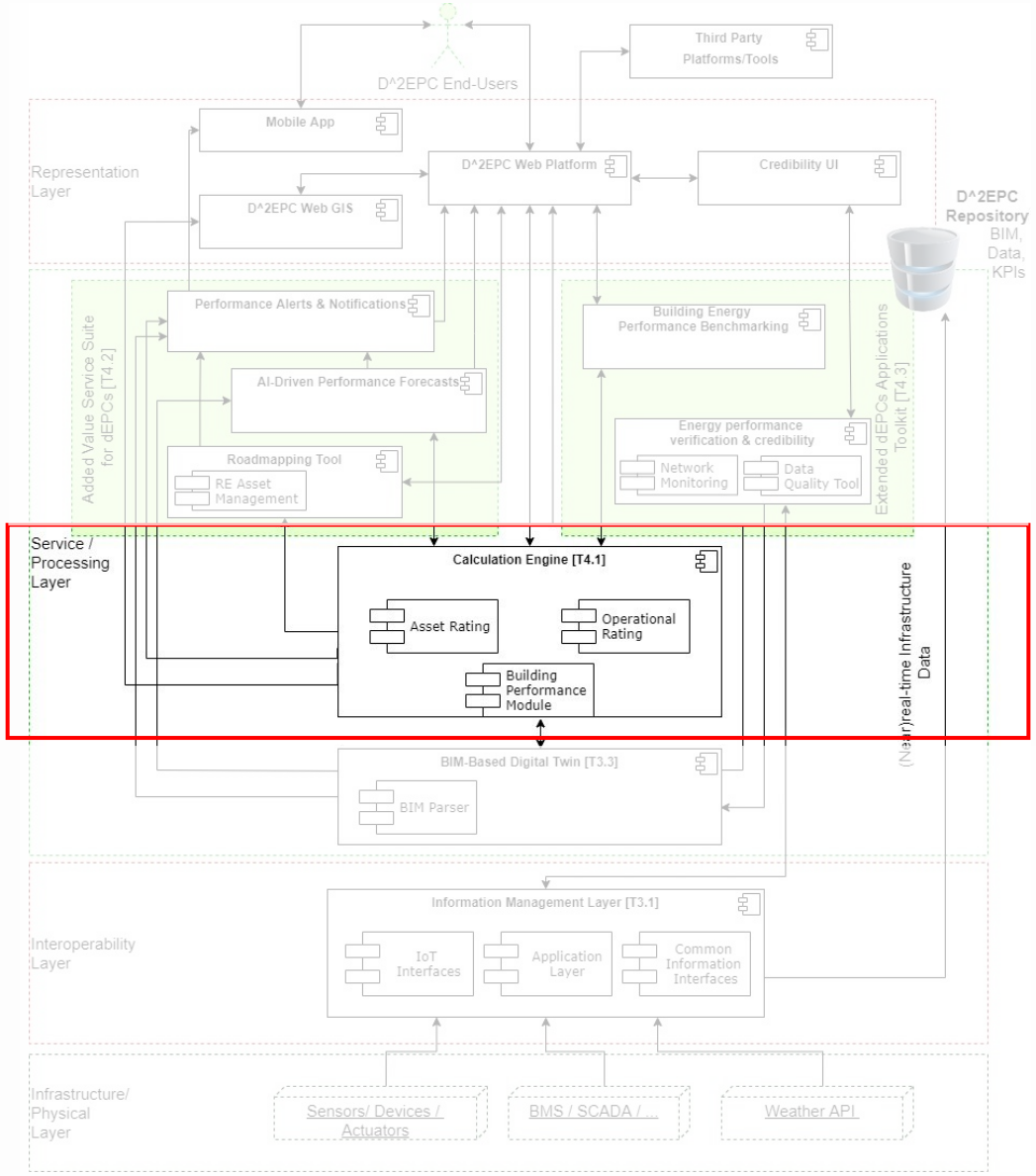
- 3D Building representation
- combination of BIM file with real-time building data
- automated and dynamic assessment process
- ad-hoc certificate issuing, monitoring and verification



D^2EPC Architecture Overview

Calculation Engine

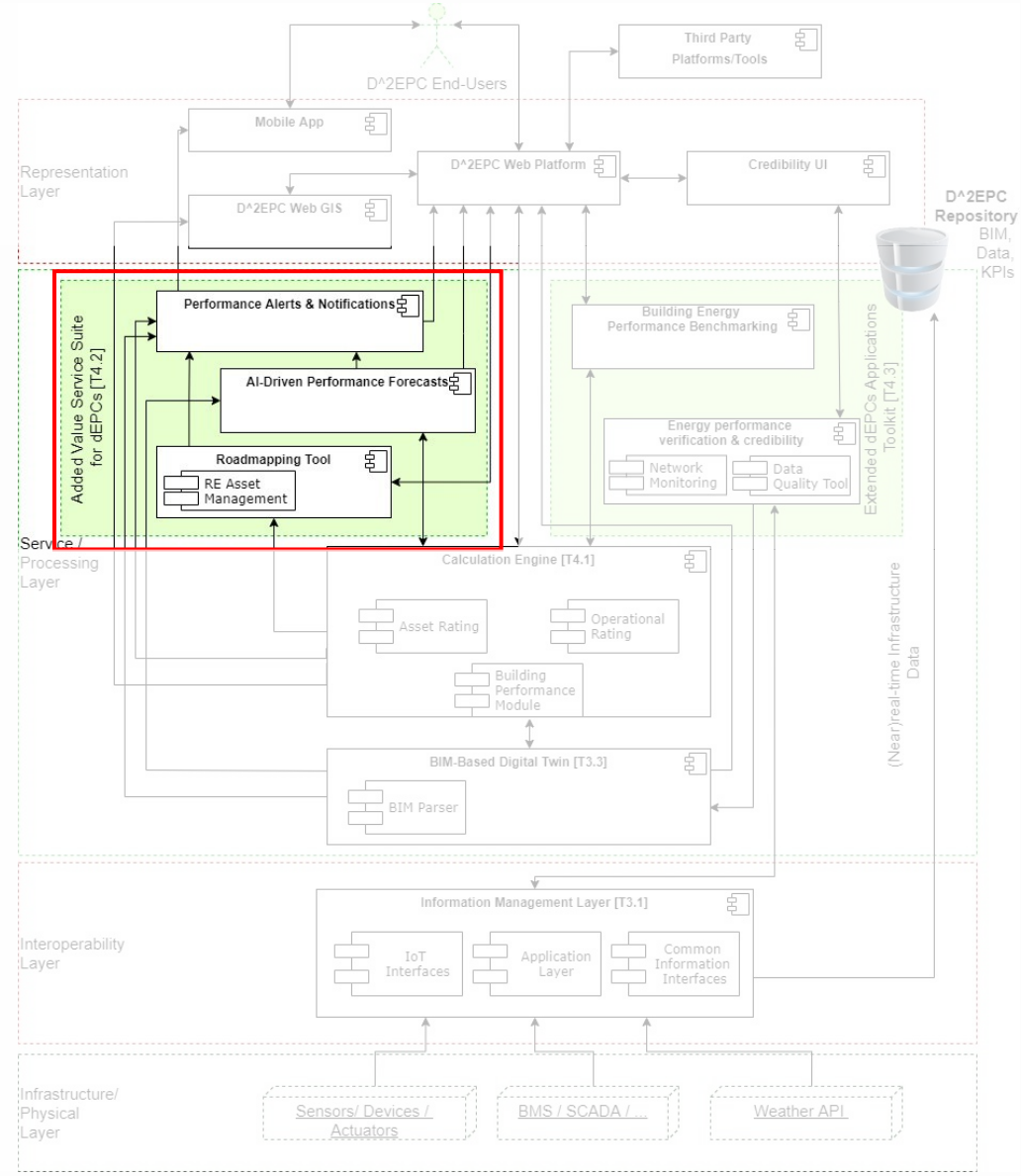
- Asset & Operational Rating Calculations implementation
- Building Performance Module: calculation of indicators that will enrich the EPC procedure



D^2EPC Architecture Overview

Added Value Services Suit

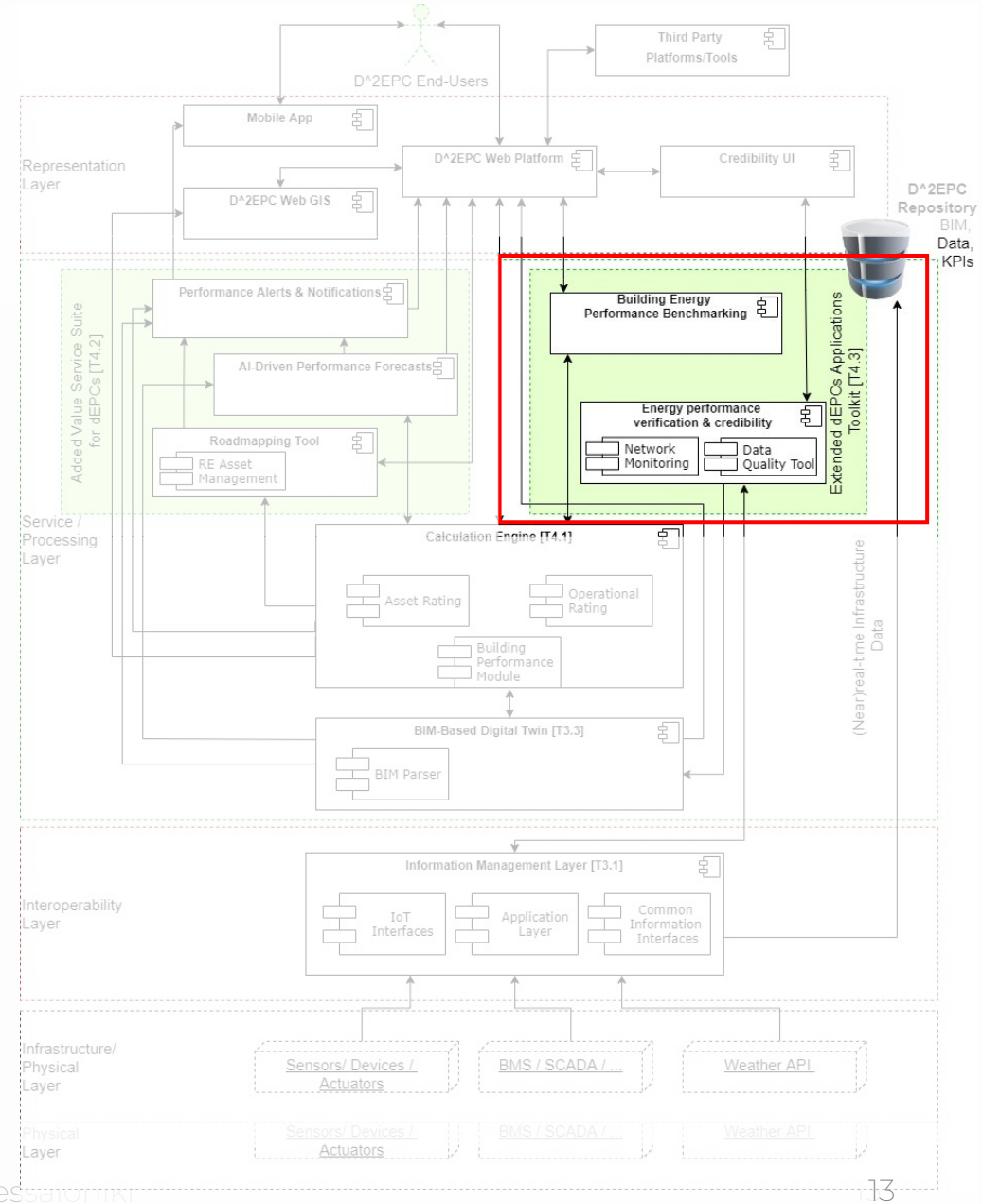
- Roadmapping Tool
  - Provision of customized recommendations for energy performance enhancement taking into account the building and the user
- AI-Driven Performance Forecasts
  - Forecast building operational conditions and the impact that specific changes can have in the building's energy performance
- Performance Alerts and Notifications
  - Provide recommendations during building's actual operation



D^2EPC Architecture Overview

Extended D2EPC Applications Toolkit

- *Building Energy performance Benchmarking*
  - Classification Engine: indicate paths for performance improvements
- *Energy Performance Verification and Credibility*
  - Ensures the reliability of collected data streams

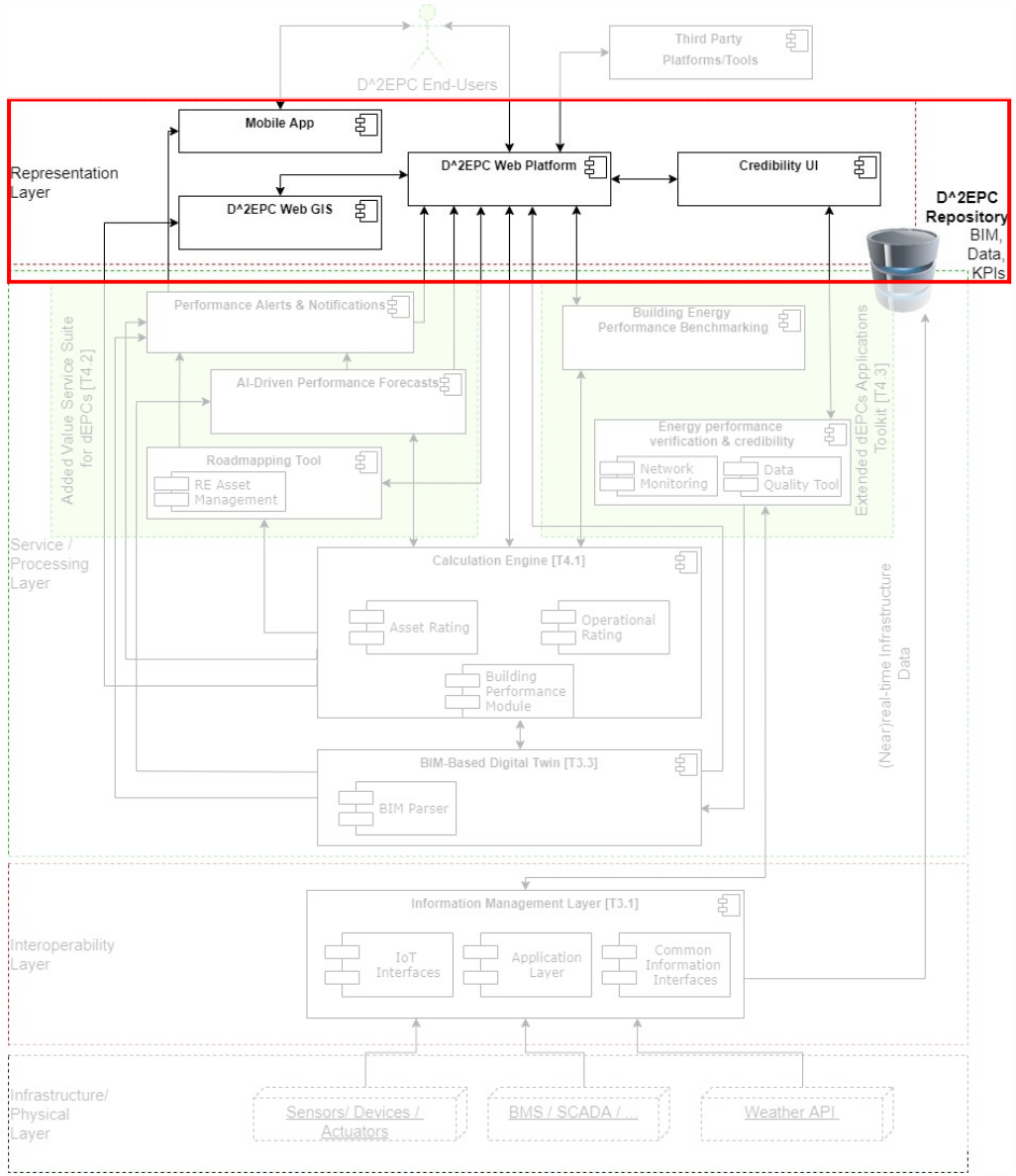


D^2EPC Architecture Overview

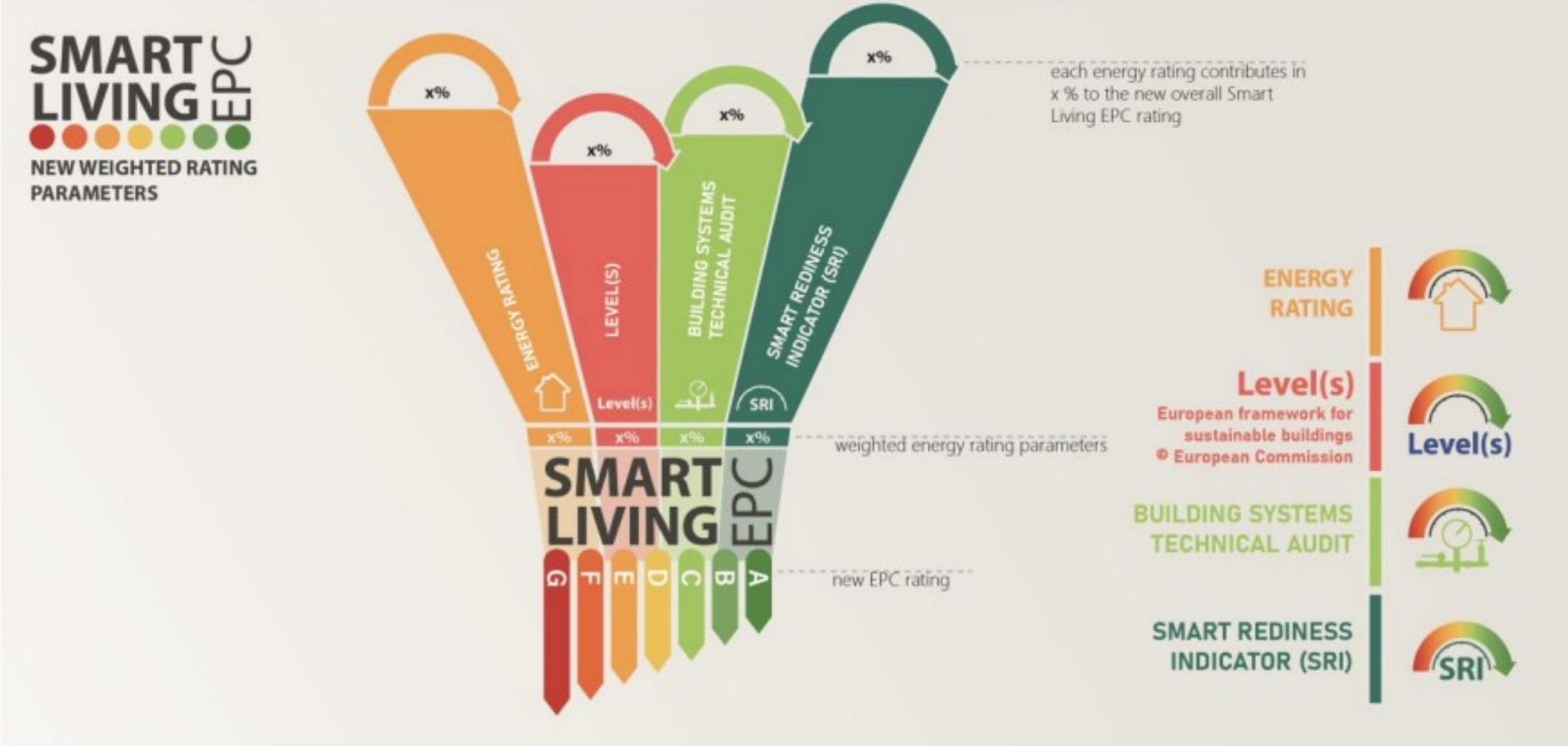
Representation Layer

Web Platform

- Results representation from the various components:
  - EPCs, KPIS, recommendations, notifications etc.
- *Web – GIS Tool*
  - Spatial representation of buildings' energy performance data



SmartLivignEPC at a glance



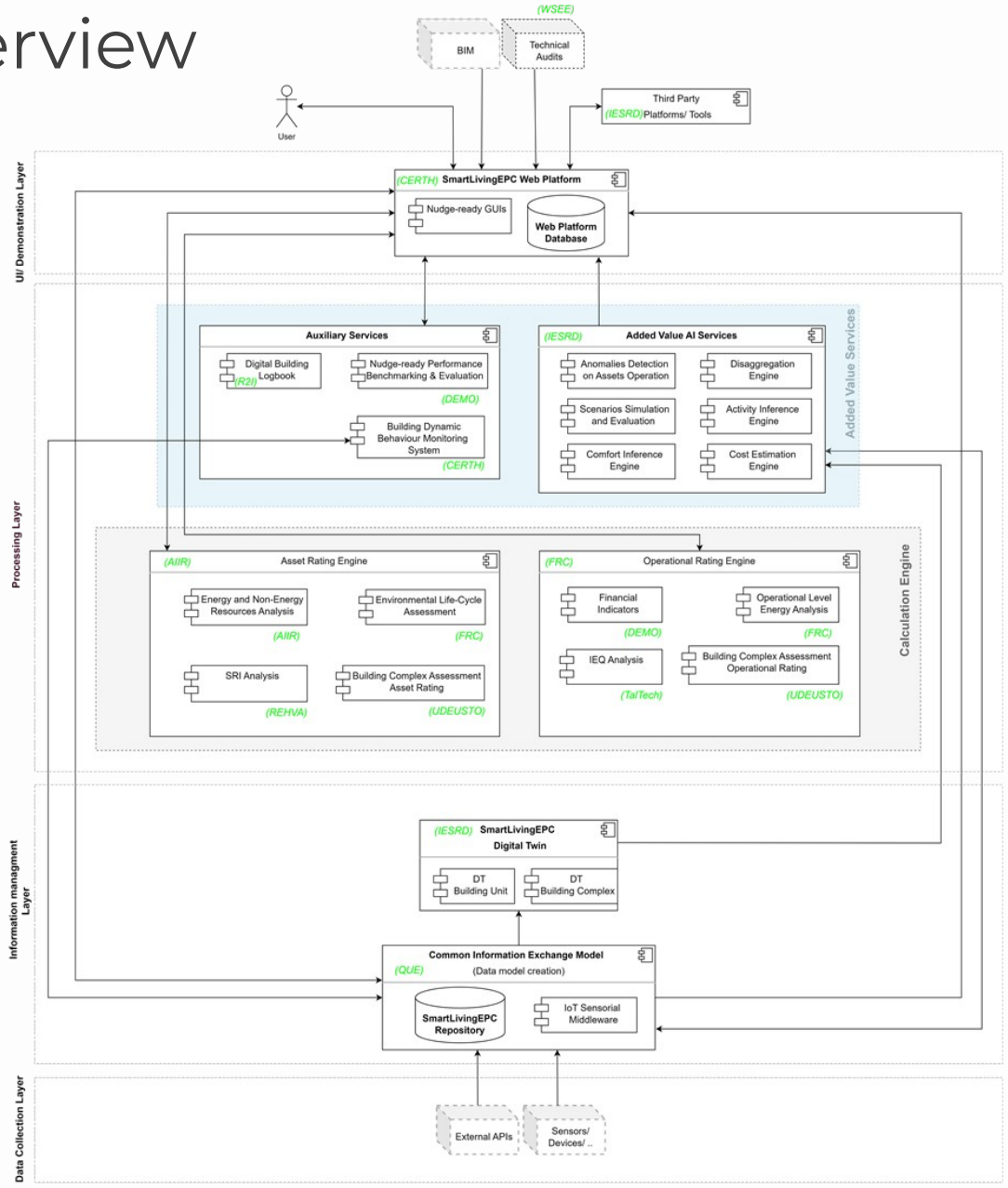
SmartLivignEPC Architecture Overview

Layers

- Data collection Layer
- Information Management Layer
- Processing Layer
- UI/ Demonstration layer

Components

- 7 main components
- 22 sub-components



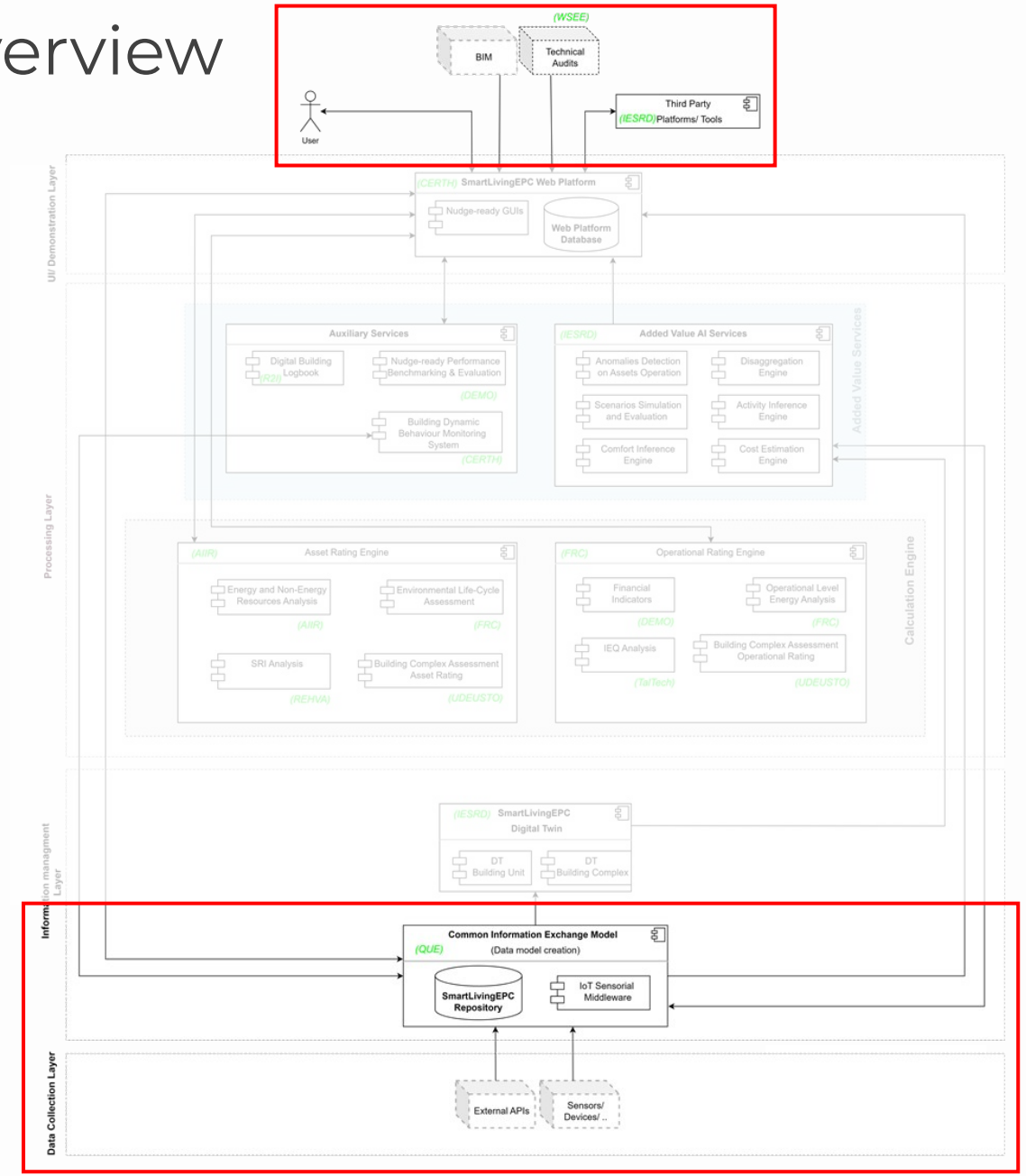
SmartLivignEPC Architecture Overview

Data collection from devices

- Sensors
- Meters
- Internet of Things
- BMS/ BEMS

Building documentation provided by end-users

- BIM models
- Technical Audits
- other documentation sources



SmartLivignEPC Architecture Overview

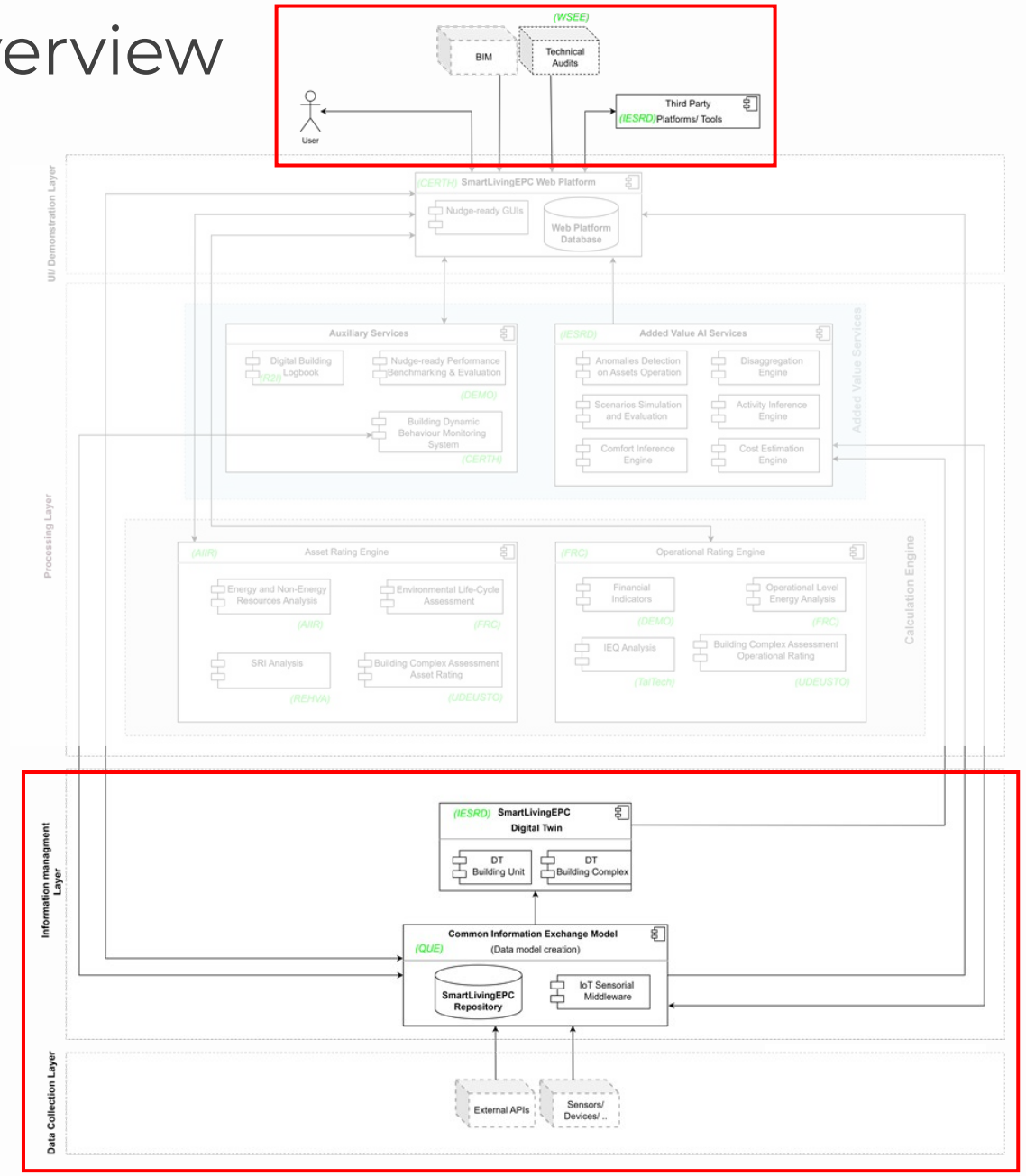
Information management Layer

Common Information Exchange Model

- Repository and middleware for the collected dynamic data
  - Data management, cleansing, normalization, and quality checks
  - Combination of BIM file with real-time building data
  - Data model creation

Digital Twin

- Conceptualized 3D Buidling Viewer of building Units (aim to be extended to building complexes)
- Near real time asset monitoring
- Additional insights for the building operation



SmartLivignEPC Architecture Overview

Processing Layer

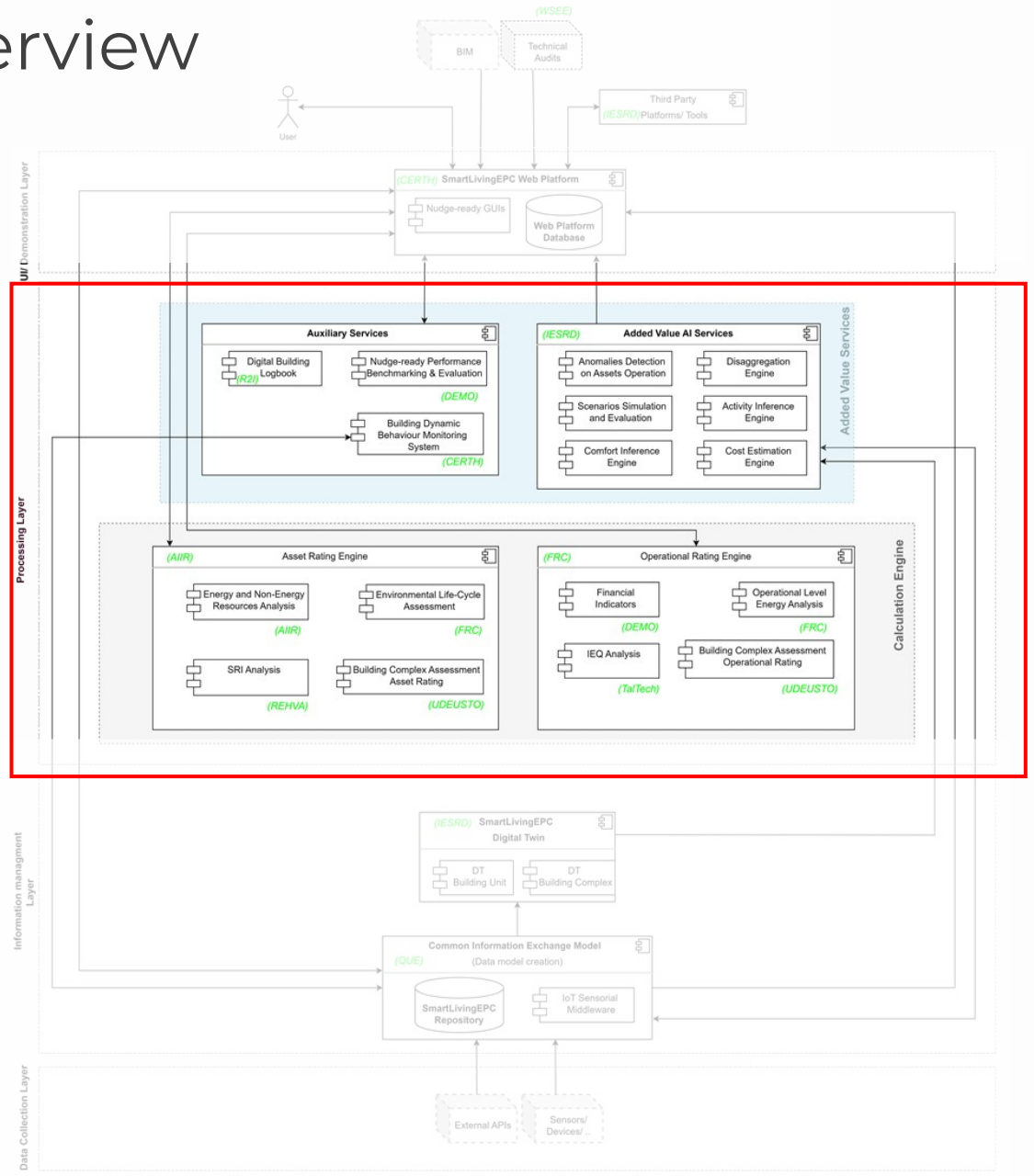
- includes all the calculation modules for building performance assessment and optimization

Asset Rating Engine
- as-designed energy and environmental performance

Operational Rating Engine
- as-operated performance metrics

Added Value Services
- benchmarking and building dynamic behaviour monitoring, DBL functionalities

Added Value AI
- Additional services base on Artificial Intelligence



SmartLivignEPC Architecture Overview

Processing Layer

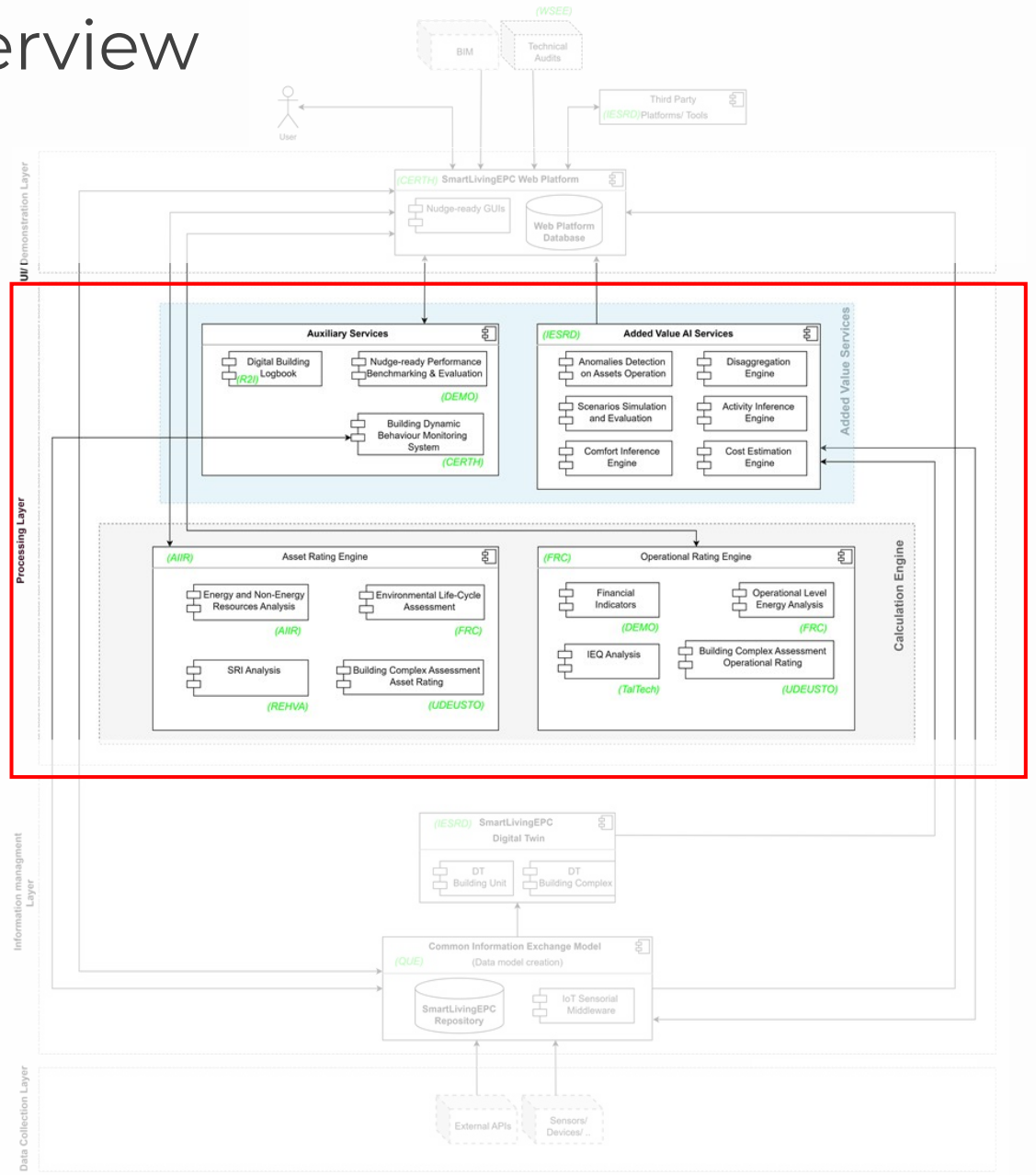
- includes all the calculation modules for building performance assessment and optimization

Digital Building Logbook

- document traceability and versioning track modifications and access different document versions, focusing on historically significant building data

Nudge-ready Performance Benchmarking & Evaluation

- collect and normalize data from all available buildings
- compare the theoretical / design data calculated by the EPCs with the actual operational data for the same building
- provide specific recommendations for energy efficiency practices, energy upgrades, optimal operation, maintenance, etc.



SmartLivignEPC Architecture Overview

Processing Layer

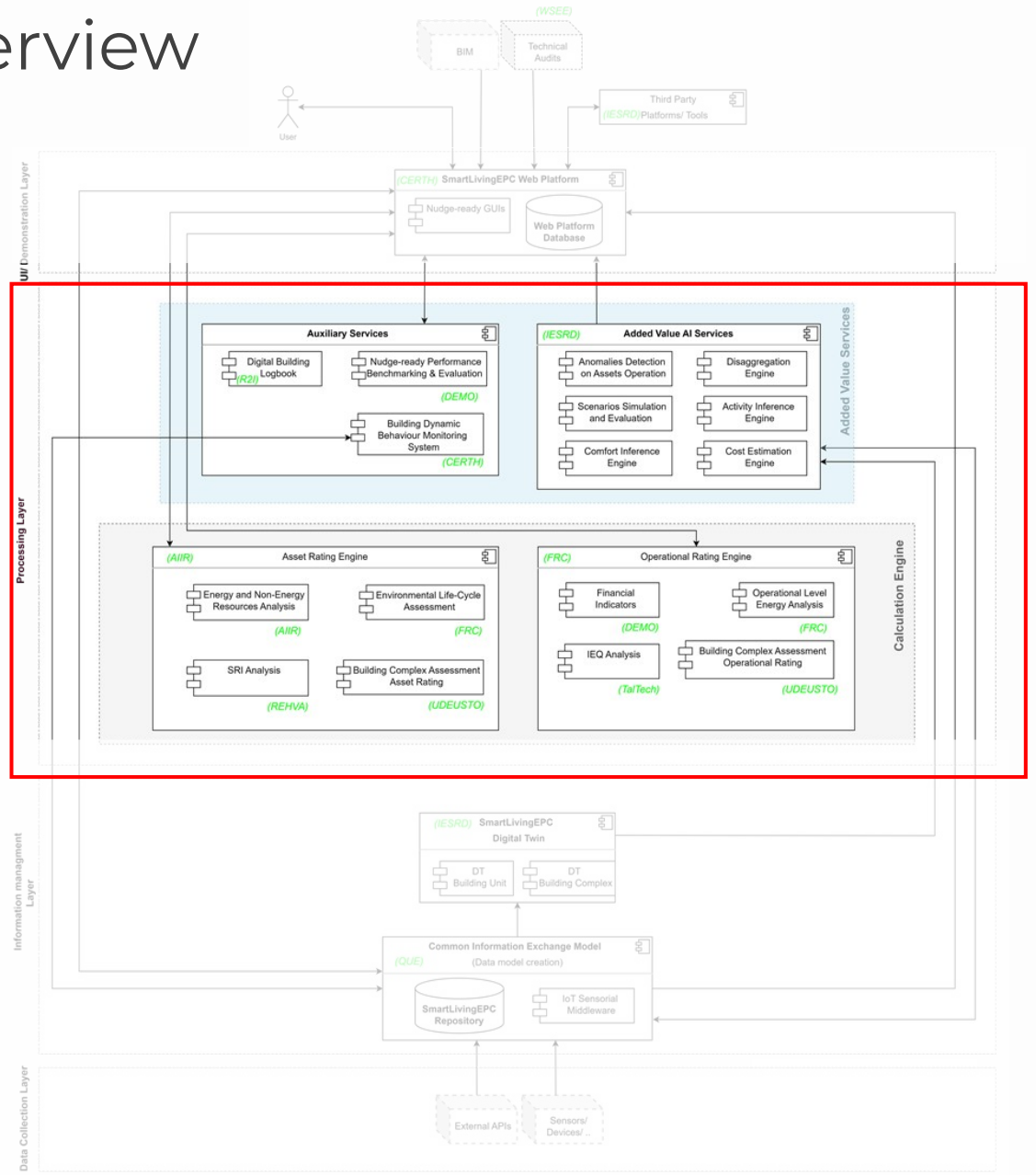
- includes all the calculation modules for building performance assessment and optimization

Building Dynamic Behaviour Monitoring System

- Occupancy presence estimation
- Energy consumption forecasting
- Occupancy profiling
- Alert system provision of insights for the state of the building

Added Value AI Tools

- Anomalies Detection
- Disaggregation Engine
- Cost Estimation Engine
- Scenario simulations and evaluation
- Activity inference engine
- Comfort inference engine

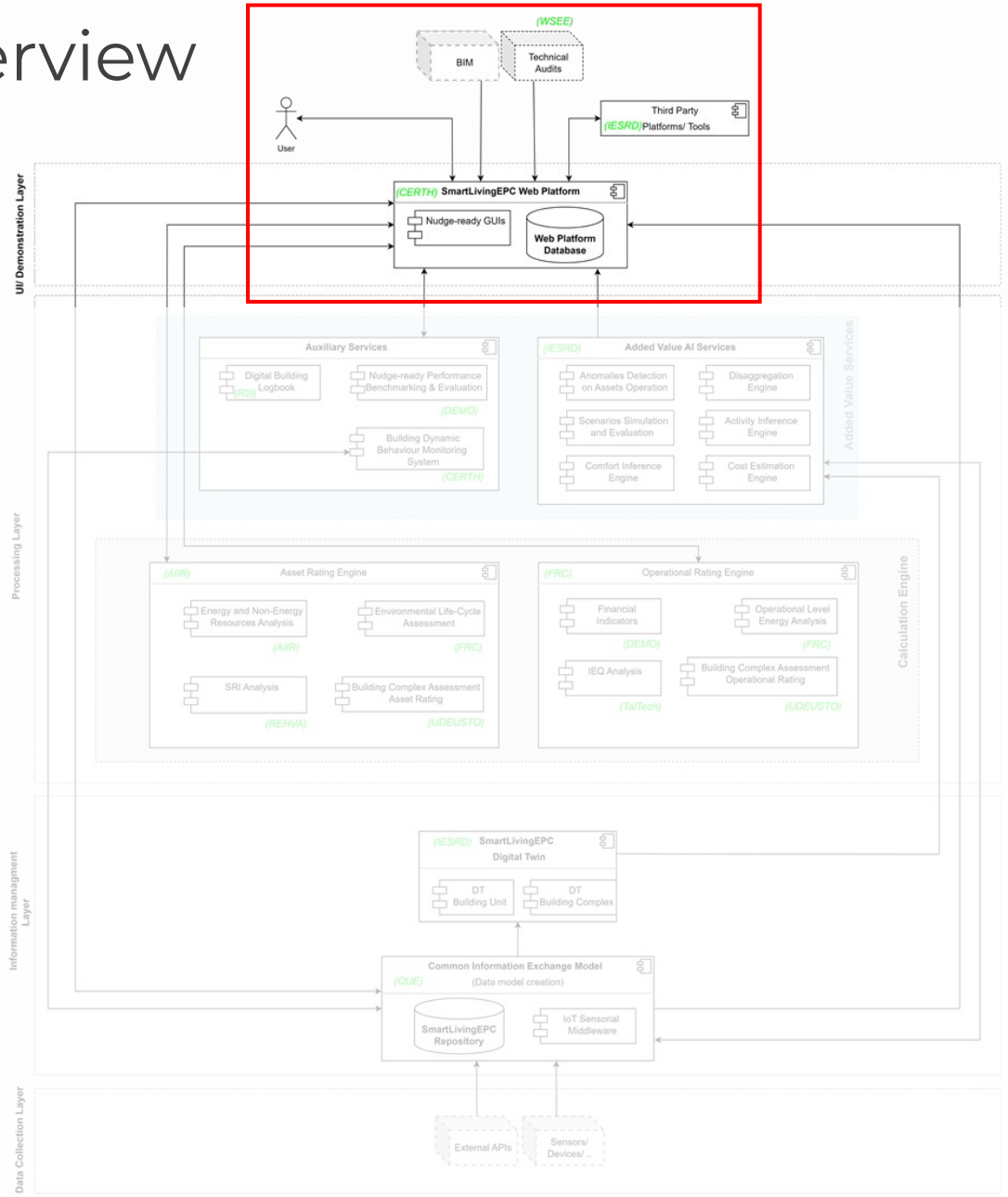


SmartLivignEPC Architecture Overview

UI/ Demonstration Layer

SmartLivingEPC Web Platform

- access real-time building performance statistics,
- upload and update the building related information (e.g., BIM files) and
- receive actionable insights for an efficient operation of their assets.



Digital Twin Differences : D2EPC vs SmartLivingEPC

D2EPC Digital Twin

- 3D Building representation
- Combination of BIM file with real-time building data
- Data model creation

SmartLivingEPC Digital Twin

- Conceptualized 3D Buidling Viewer of building Units (aim to be extended to building complexes)
- Near real time asset monitoring
- Additional insights for the building operation

CIEM component

* The SmartLivingEPC Digital Twin is under development, so alterations may occur during the project.

Boosting Research for a Smart and Carbon Neutral Built Environment with Digital Twins – **SmartWins**

Project Partners

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