

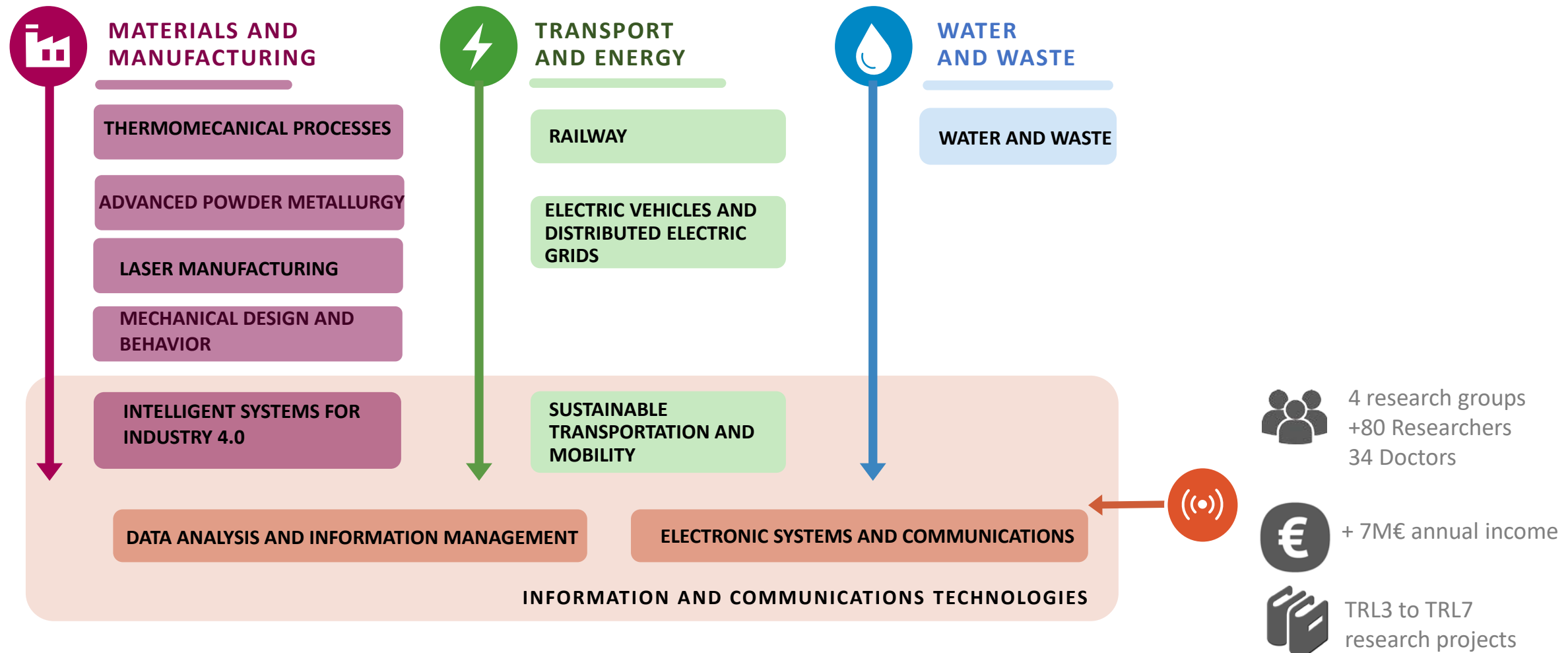


MEMBER OF
BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

ICT Division

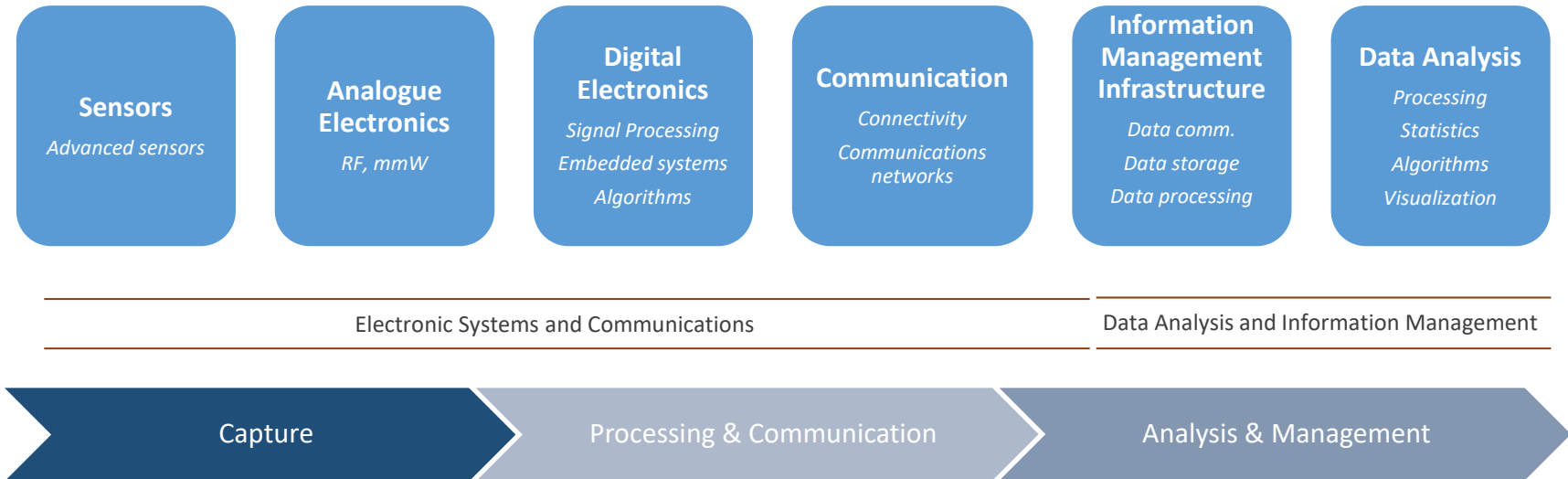
24-06-2026

Organization





Complete value chain of monitoring devices and communication systems applied to communications, manufacturing, transport, energy and water domain.



ICT Division

 +80 research staff

 Industry

 Energy

 Transport

Research lines:

Advanced
Instrumentation

Data analysis

Robotics and
Mechatronics

Cyber-secure
Communications

Indoor & Outdoor Positioning
Technologies

Extended reality

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Advanced sensors

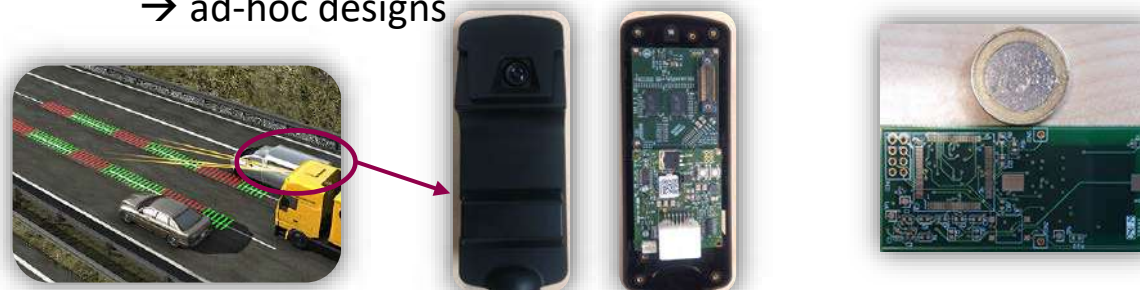
- Optical sensors
- Electromagnetic signals
- Ultrasound signals



Monitoring of oil dielectric constant in Transformers

Electronics for Cyber-Physical Systems

- **High-performance platforms**
 - Embedded systems for signal and video processing
 - FPGA and ASIC
 - Microcontrollers and DSP
 - Microprocessors with embedded Linux (Zynq, ARM, etc)
 - PCB design
 - signal integrity for high speed signals
 - low power consumption
- **Smart components**
 - Analog and digital processing for application-specific sensing
 - Miniaturization for low cost and low power consumption
→ ad-hoc designs



Advanced instrumentation – Application of electromagnetic techniques to the Non-destructive characterization of mechanical properties / microstructure in steels

- ✓ Microstructural characterization in steels.
 - ✓ Quality control in production processes.
 - ✓ Surface integrity control in manufactured components.
- Characterization of metallic materials
 - Defect detection

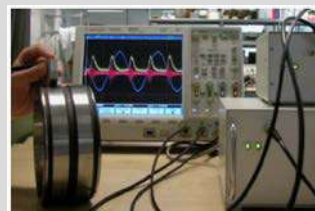
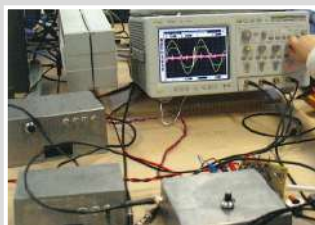
**Design and
development of
sensor heads and
measurement
equipment**

**Gauges -
Systems for Manual
measurements**

**Robotized
solutions**

Non-Destructive Techniques

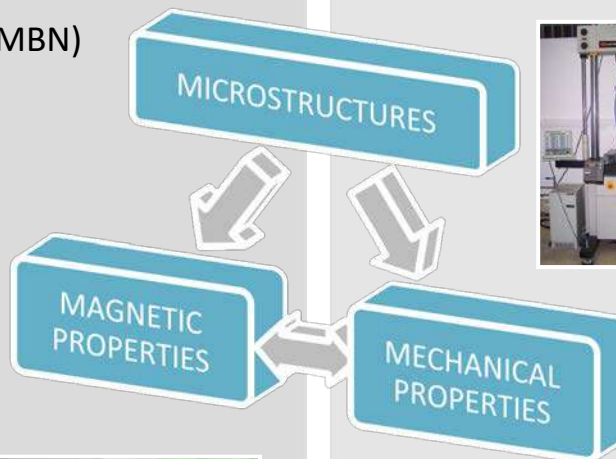
- Magnetic Barkhausen Noise (MBN)
- Hysteresis loops (BH)
- Magnetic flux leakage (MFL)
- Eddy currents (EC)



Destructive Techniques



- Tensile testing
(Micro and nano-hardness)
- Optical and electronic
microscopy (FEG-SEM,
EBSD, STEM, FIB)
- X-ray diffraction
(residual stresses)



**Multidisciplinary
knowledge**

Implemented NDT inspection systems – R & D projects

Steel- Manufactured parts

1. Determination of **mechanical properties** (HR, Rp, YS) / **microstructure** / **thermal treatments**
 - Hot stamping
 - Wind turbine bolts – product/process property control
2. Determination of **hardened layer thickness** - **induction/laser/carburisation treatments** // Nitrogen case-hardening (nitriding/nitrocarburizing)
 - Ball screws - threaded shafts - induction
 - Gear teeth – carburisation
 - Crankshafts – induction / laser
 - Hardness, hardening layer, distance to crankwebs
3. Grinding Burn Detection
 - Camshafts
 - Gears / Bearings
 - Ball screws - threaded shafts
4. Material discrimination- forged parts
5. Monitoring of residual stresses
 - Surface – Shot blasting - shot peening
 - Depth profile (estimation from surface to different depths)



Steel- In-service applications (MFL)

1. **Degradation monitoring** in steel wire ropes (broken wires, fatigue)
2. Railway tracks – **defects, cracks**



Implemented NDT inspection systems – R & D projects

Aluminium – By indirect measurement of conductivity (Inductive impedance)

- Forged Al – hardness variation after various heat treatments
 - T6- Solubilization quenching + ageing (artificial maturing)
- Cast Al – variations in Hardness, SDAS, grain size, eutectic Si type



Impedance measurements for other non-metallic media (Capacitive impedance)

- Oils (Transformer oils), (bearing oils)
- Monitoring of degradation of oils used during grinding



Insulating oils

Electric parameters → *Oil properties*



Lubricating greases

Electric parameters → *Grease condition*



Cutting fluids

Electric parameters → *Fluid condition*

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► Safeloc system

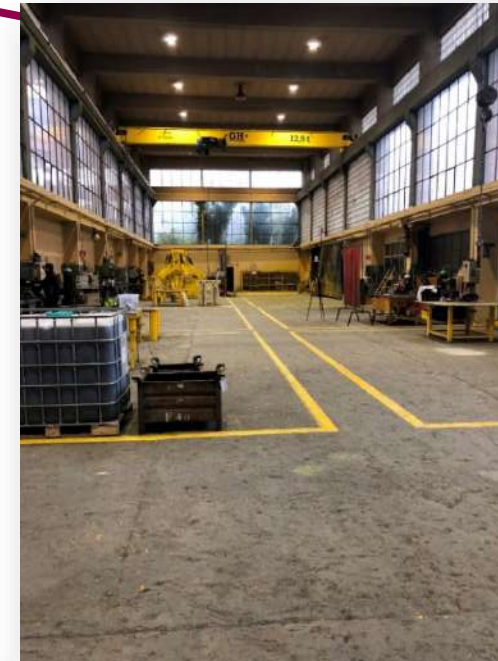
- HW based on UWB (IEEE 802.15.4a-2011)



- Proprietary positioning algorithms



	μ_r (m)	σ_r (m)	RMSE _r (m)
Test environment 1	0.24	0.05	0.25
Test environment 2	0.18	0.09	0.20



Test environment 1



Test environment 2

Tecnologías de Posicionamiento Real Time Location Systems (RTLS)

Fusión Inteligente Multitecnología

- **Doble Tecnología:** Fusión de UWB (gran precisión en entornos metálicos hostiles) + BLE-AOA (más sensible a la ubicación de las anclas y tags, pero menor consumo que UWB).
- **Conectividad 5G:** Aumento de capacidad de cómputo en nodo y reducción extrema de latencia en tiempo real.
- **Algoritmos IA para NLOS:** Procesamiento inteligente para detectar y corregir señales sin línea de visión directa.

Resultados de Validación en Laboratorio:

TECNOLOGÍA	ERROR MEDIO (m)	DESV. EST. (m)	RMSE (m)
BLE-AOA	0.344	0.266	0.435
UWB	0.155	0.103	0.187
Algoritmo de Fusión Ceit	0.165	0.127	0.209



Ancla BLE-AOA



Ancla UWB



Tag BLE-AOA + UWB

Navegación Multisensorial

Fusión Kalman Multisensor

Diseño y validación de algoritmos de alta fidelidad integrando GNSS, UWB, IMU y comunicaciones.

Filtros Kalman *Loosely Coupled* y *Tightly Coupled*.

Filtros de partículas de alta robustez.

Fiabilidad y Anti-Spoofing

Algoritmos robustos de seguridad que protegen los sensores ante interferencias intencionadas.

FDE (Fault Detection & Exclusion) avanzado.

Autenticación GNSS robusta (OS-NMA).

Soporte de Hardware de Última Generación

Integración completa de hardware comercial con diseños propietarios de receptores y tags adaptables de CEIT.

Septentrio RX-Asterx U

u-blox Z9P / M8

EMLID Reach RTK

UWB Tag Qorvo & CEIT ad-hoc



watereye 

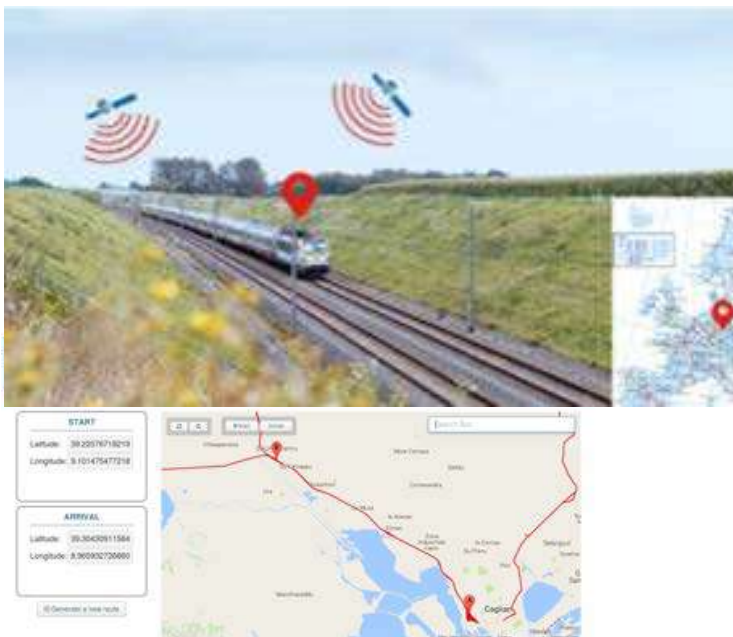


ALERION

ICT division

Localization systems for railway

- Positioning for ERTMS/ETCS level 3
- Multi-frequency & multi-constellation solutions
- Augmentation-based solutions (EGNOS/EDAS, RTK, etc.)
- Fusion algorithms (GNSS, IMU, UWB, etc.)



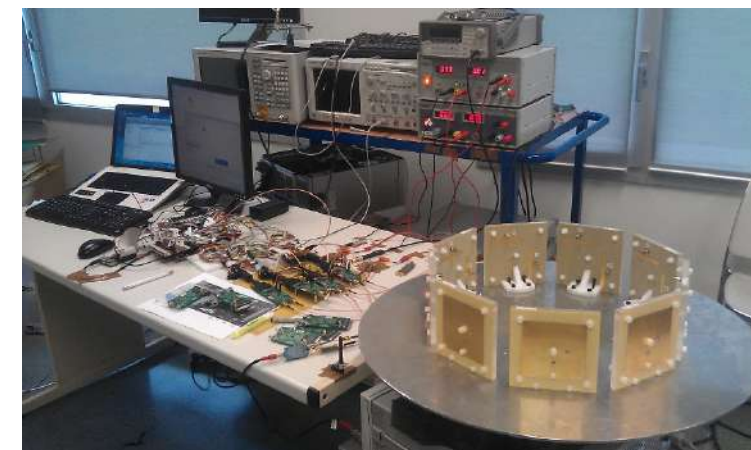
On-board communication and positioning system



On-board BTM-ETCS system



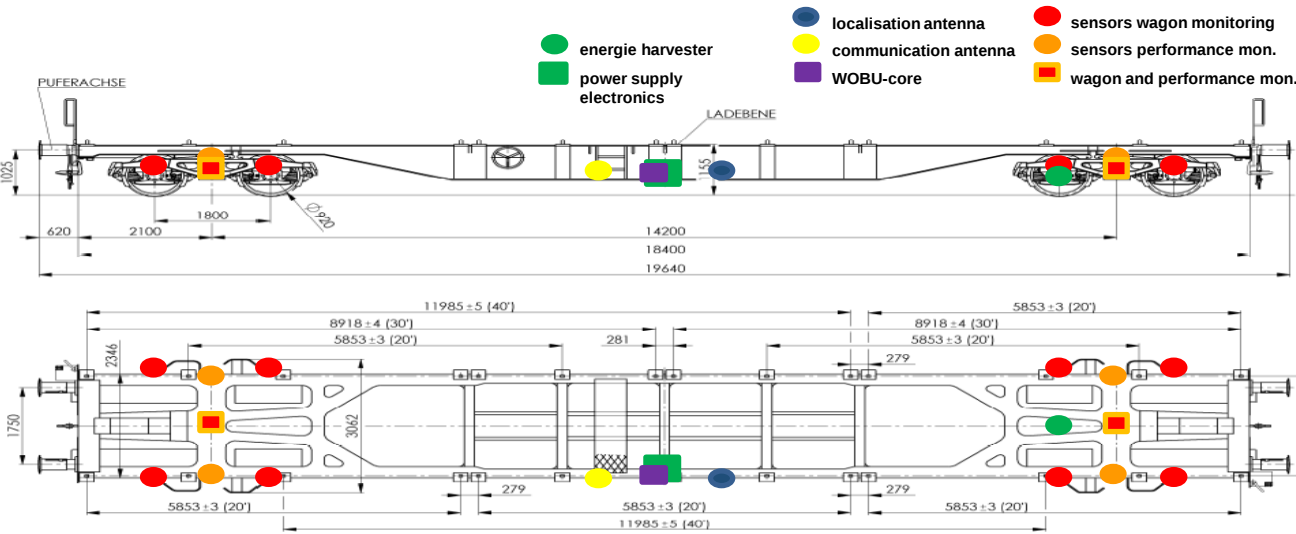
On-board positioning system



On-board positioning system

Examples of projects: Intelligent freight wagon

Wagon On-Board Unit (wOBU). Telematic system for railway freight wagons including positioning, communication and monitoring for logistics and vehicle Condition Based Maintenance (CBM)



Monitoring system architecture



Asset characterization for CBM



On-board System

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Hardware y Protocolos Propios

Capacidad completa para diseñar nodos propios (HW + FW) multi-tecnología capaces de funcionar de manera altamente fiable en los entornos industriales más hostiles.

- **Plataformas Soportadas:** Implementación ad-hoc en FPGAs, microcontroladores y System on Modules (SoM).
- **Integridad de Señal Máxima:** Diseño riguroso de PCBs de múltiples capas adaptados para señales de muy alta velocidad.
- **Bajo Consumo de Enlace:** Protocolos inteligentes diseñados a medida para maximizar los ciclos de vida útil de batería.

TECNOLOGÍAS INALÁMBRICAS PERSONALIZADAS:

subGHz

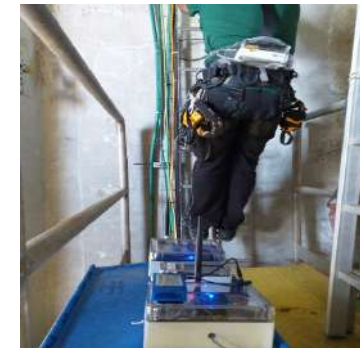
UWB

LoRa

ZigBee

Mioty

WiFi



- Despliegue experimental, análisis de RF y validación de la pila de protocolos 5G Standalone/No Standalone utilizando plataformas de Ettus Research (B210, X310).
- Ejecución de srsRAN gNB u OpenAirInterface (OAI) sobre servidores x86 estándar.
- Dispositivos clientes: móviles COTS y módems 5G.



HARDWARE SDR



Ettus USRP X310

Alto rendimiento con bus PCIe/Dual 10G SFP+ y FPGA Kintex-7 para emulación gNodeB de grado portador.



Ettus USRP B210

Plataforma MIMO 2x2 flexible para experimentación, desarrollo ágil de capas PHY/MAC y entornos de laboratorio.



PILAS ABIERTAS (OPEN-SOURCE)

OpenAirInterface (OAI)

srsRAN

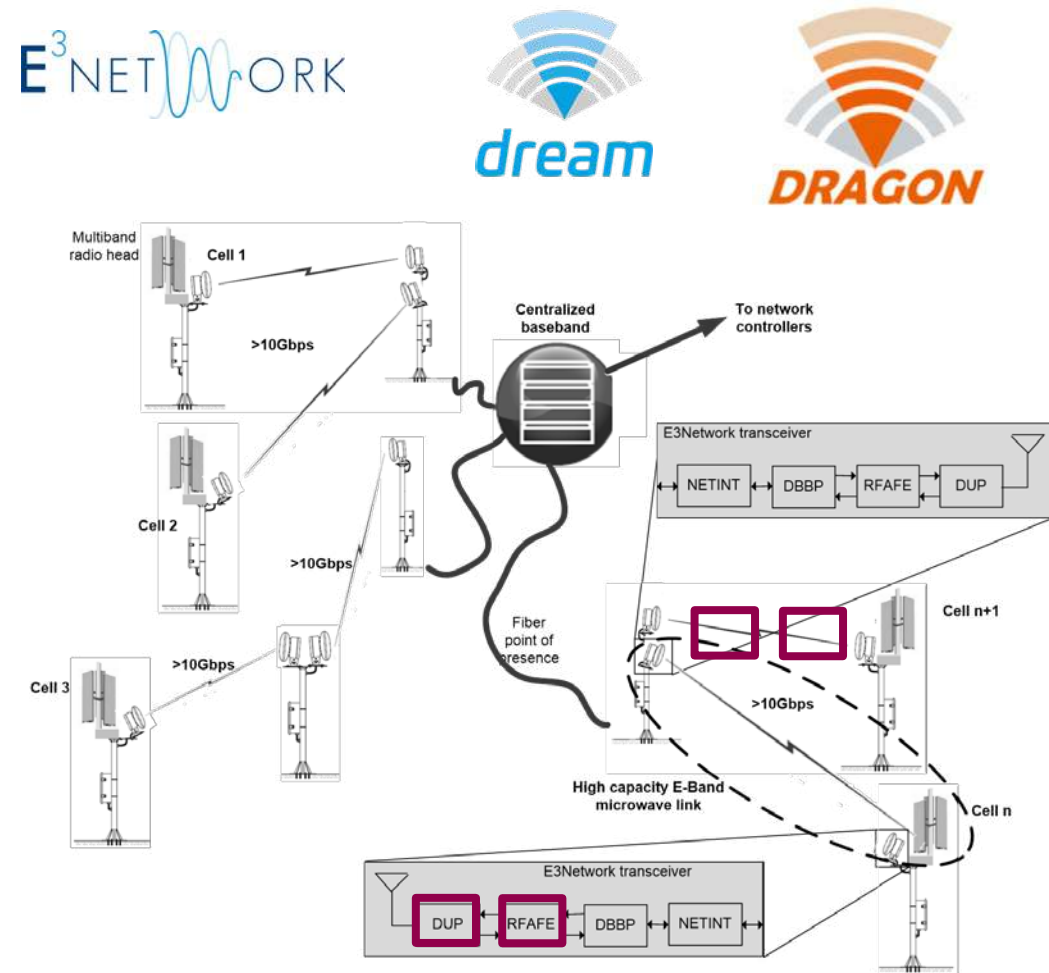
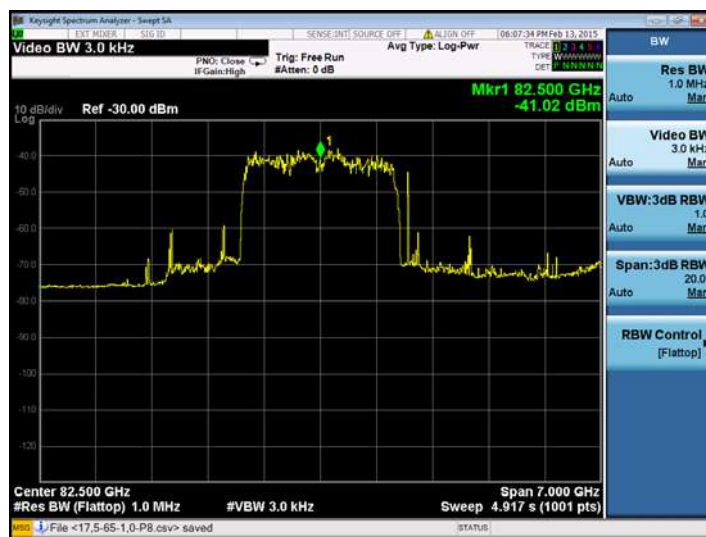
Open5GS

ENTORNO COMERCIAL Y DE VALIDACIÓN

Amarisoft Suite

Millimeter-wave transceiver for backhaul and fronthaul in 5G

- System modeling
- Analogue TX front-end design in SiGe for E-Band(71-76, 81-86) GHz and D-Band (130 GHz-174.8 GHz)
- Design of a 2 GHz-bandwidth modulator
- Design of mix-signal algorithms to compensate analogue impairments
- Implementation in an FPGA of the base-band processor



► 5G EUSKADI

- Application of 5G technology in different use cases:
 - Implementation of applications in MEC/Cloud
 - Embedded hardware with 5G connectivity



Augmented visualization and remote operator assistance

Energy

eMBB

MEC

uRLLC



Maintenance of vehicles in mobility
Mobility

eMBB

MEC

uRLLC



Fleet video surveillance and 5G broadband for passengers

Mobility

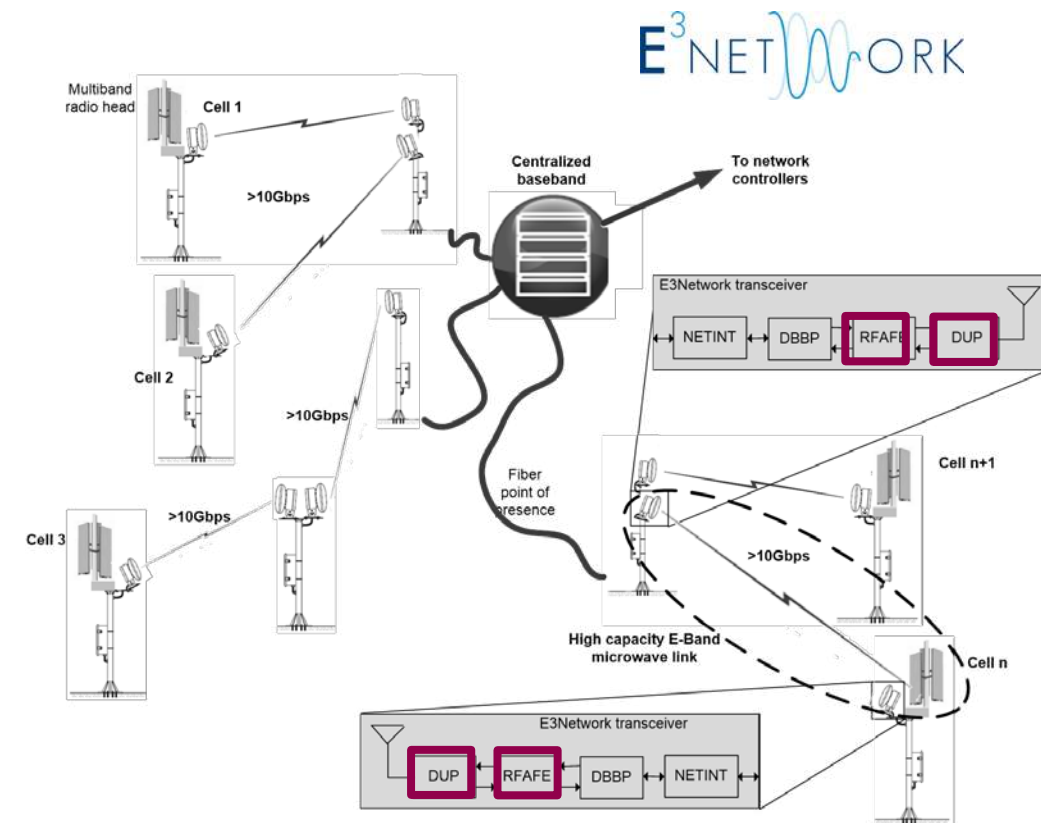
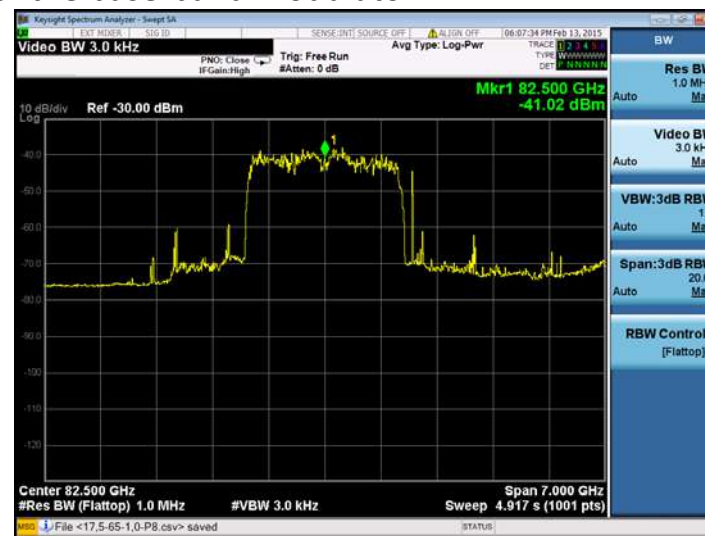
MEC

uRLLC



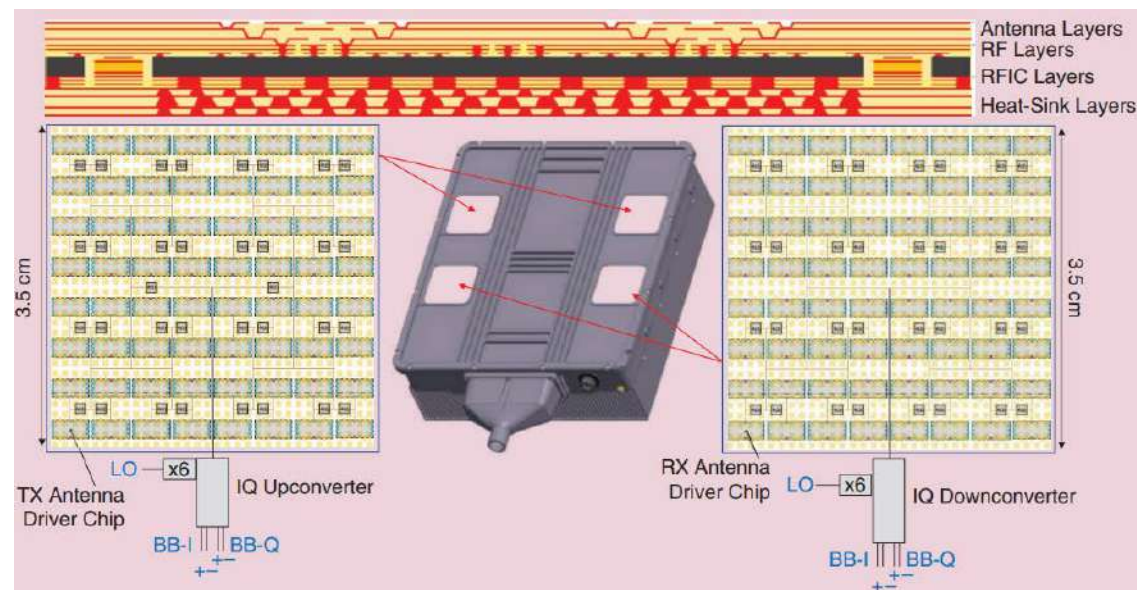
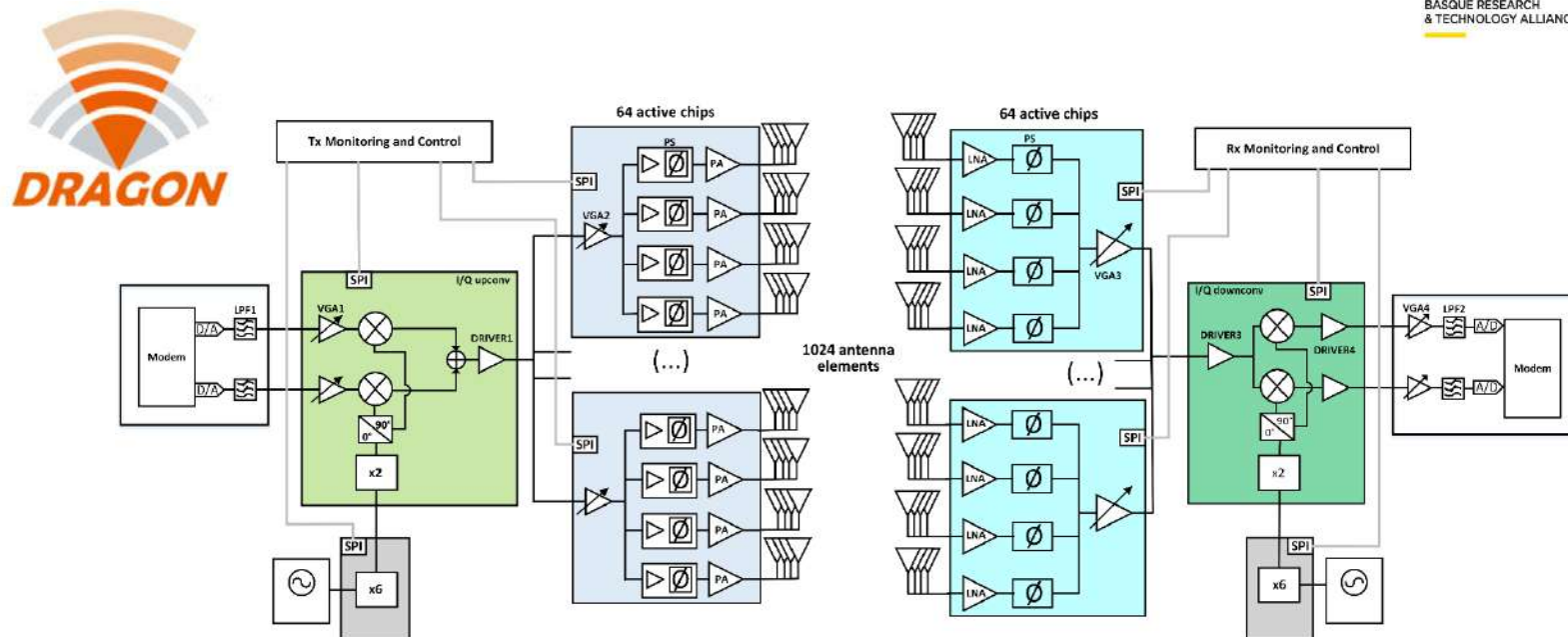
Energy Efficient E-Band transceiver for backhaul of Future Networks

- Backhaul networks
- High order modulation to increase spectrum efficiency in Gigabit transceivers
- Assess low-cost SiGe BiCMOS for Gigabit in E-Band (71-76, 81-86)
- System modeling and detailed specs.
- Analogue TX front-end IC (2 GHz bandwidth)
- Design of mix-signal algorithms to compensate analogue impairments
- Implementation in an FPGA of the base-band modulator



D-Band Radio 5G Network Technology

- Backhaul/fronthaul links
- Network reconfigurability: antenna beam steering (increment the number of antenna element)
- Build low-cost SiGe BiCMOS chipset for Gigabit in D-Band (130 GHz-174.8 GHz)
- Develop integration technology (multilayer antenna in-package) and manage thermal dissipation
- System modeling and detailed definition specs.
- Phase-shifter and tx/rx antenna driver IC integration (20 GHz bandwidth)
- Design of digital control for chipset (IC SPI slaves)



P. Chevalier and A. Pallotta, "Silicon Germanium Spins Cellular and Space Communication Networks," in *IEEE Microwave Magazine*, vol. 25, no. 10, pp. 54-67, Oct. 2024, doi: 10.1109/MMM.2024.3428192

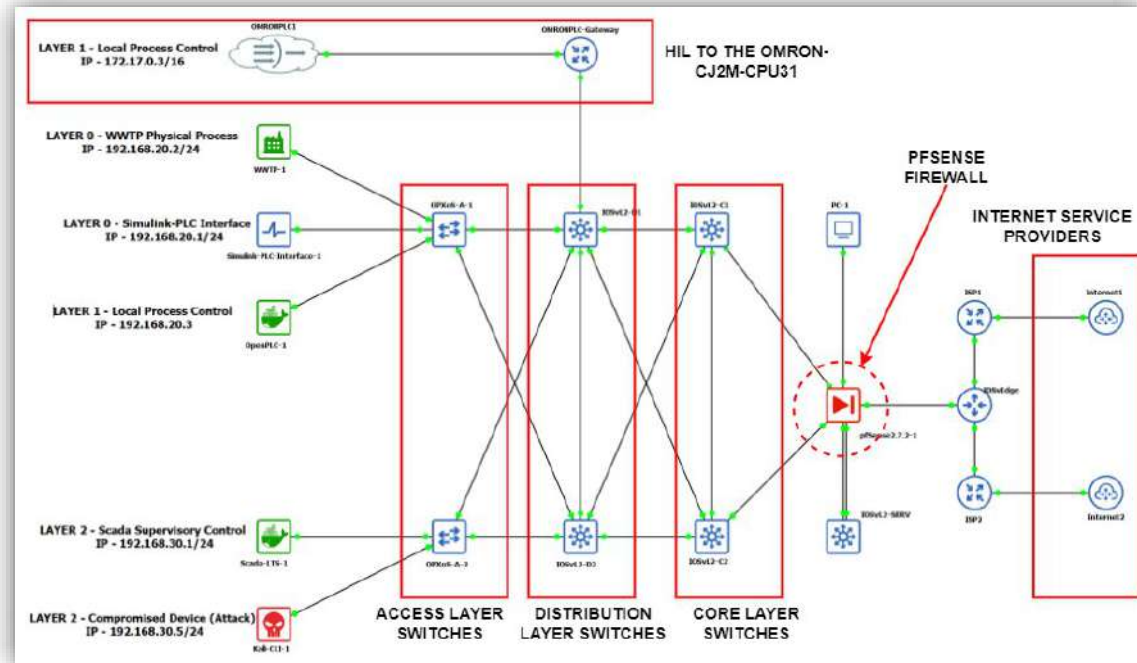
CICERO: Testbed híbrido

Banco de pruebas híbrido (virtual y físico) para entornos críticos, orientado a la evaluación de seguridad, rendimiento y segmentación de redes industriales.

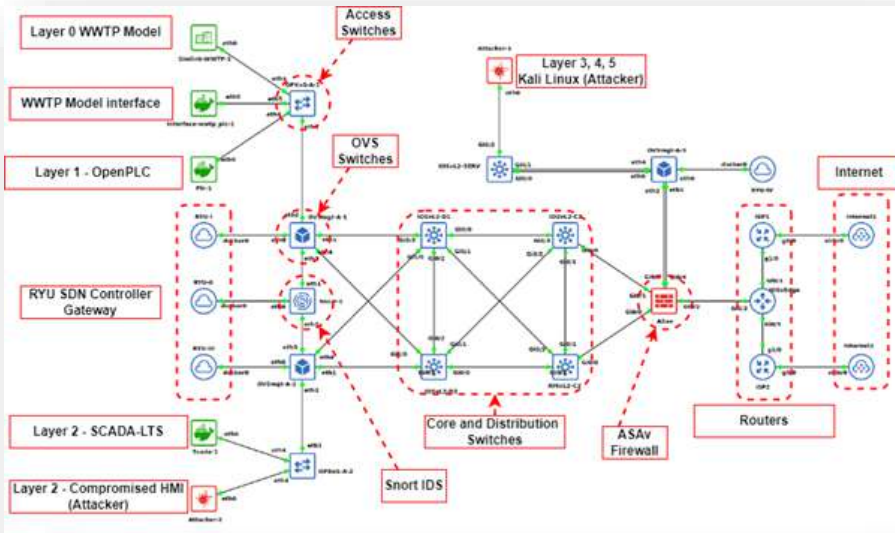
- Proceso simulado: planta industrial modelada en entorno virtual.
- Interfaz de comunicación: conecta simulación con controladores.
- Controladores: dispositivos físicos y virtuales en la red de control.
- Zona de supervisión: sistema SCADA para monitoreo y control.
- Atacante interno: equipo para pruebas de ciberseguridad.
- Capa de distribución y core: conectividad central y redundante.
- Firewall perimetral: control de tráfico entre red interna y exterior.

Automatización de testbed híbrido

- Orquestación automatizada (Ansible)
- Despliegues reproducibles y escalables
- Configuración de dispositivos de manera dinámica.
- Fácil adaptación del entorno a distintos escenarios de prueba con mínima intervención.
- Eficiencia operativa.



CICERO



Software defined network (SDN)

Sistema SDN desarrollado e integrado para el control centralizado y la gestión dinámica de la red en entornos OT.

Intrusion detection system (IDS)

Sistema IDS basado en Snort desplegado para detección avanzada de amenazas en coordinación con el sistema SDN para entornos industriales.

Advanced Moving Target Defense (AMTD)

AMTD integrado con SDN para modificar dinámicamente configuraciones de red, reduciendo la exposición y dificultando la explotación de la superficie de ataque en entornos OT.

Herramienta de análisis de riesgos

Plataforma dinámica de evaluación y mitigación de riesgos OT conforme a marcos normativos industriales.

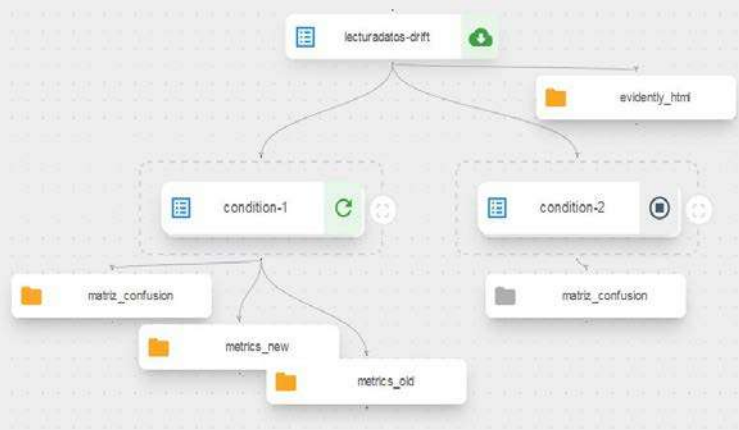
Monitorización

Sistema dinámico de monitorización OT basado en estándares industriales para la detección temprana de eventos y la trazabilidad de la actividad.

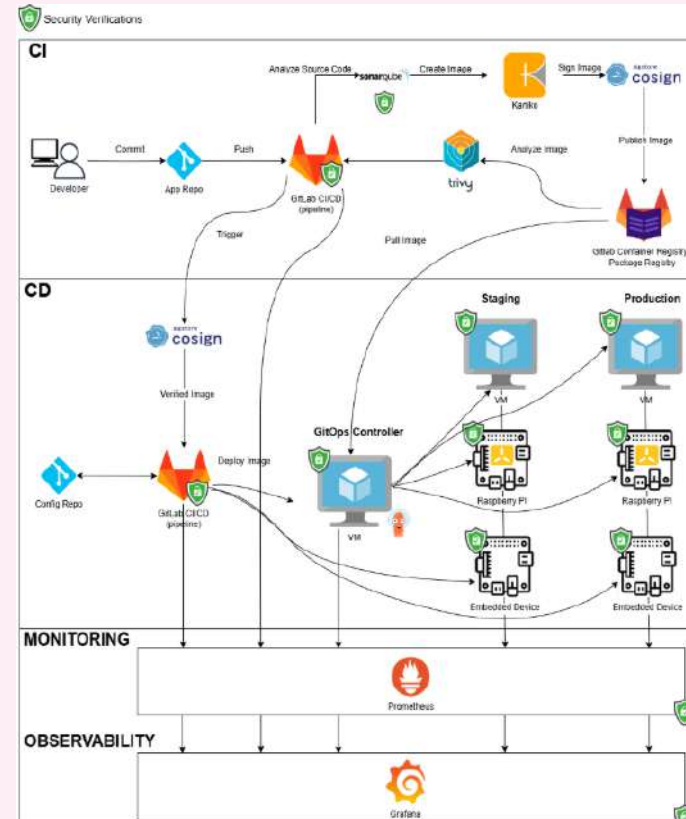
Desarrollo de entornos MLOps

Implementación de entornos automatizados y seguros para el ciclo de vida de modelos de IA.

- Orquestación con Kubeflow y GitLab
- Entrenamiento, validación y despliegue automatizados
- Monitorización con Prometheus y Grafana
- Evaluación de ataques y defensas en modelos



Pipeline CI/CD seguro para entornos críticos



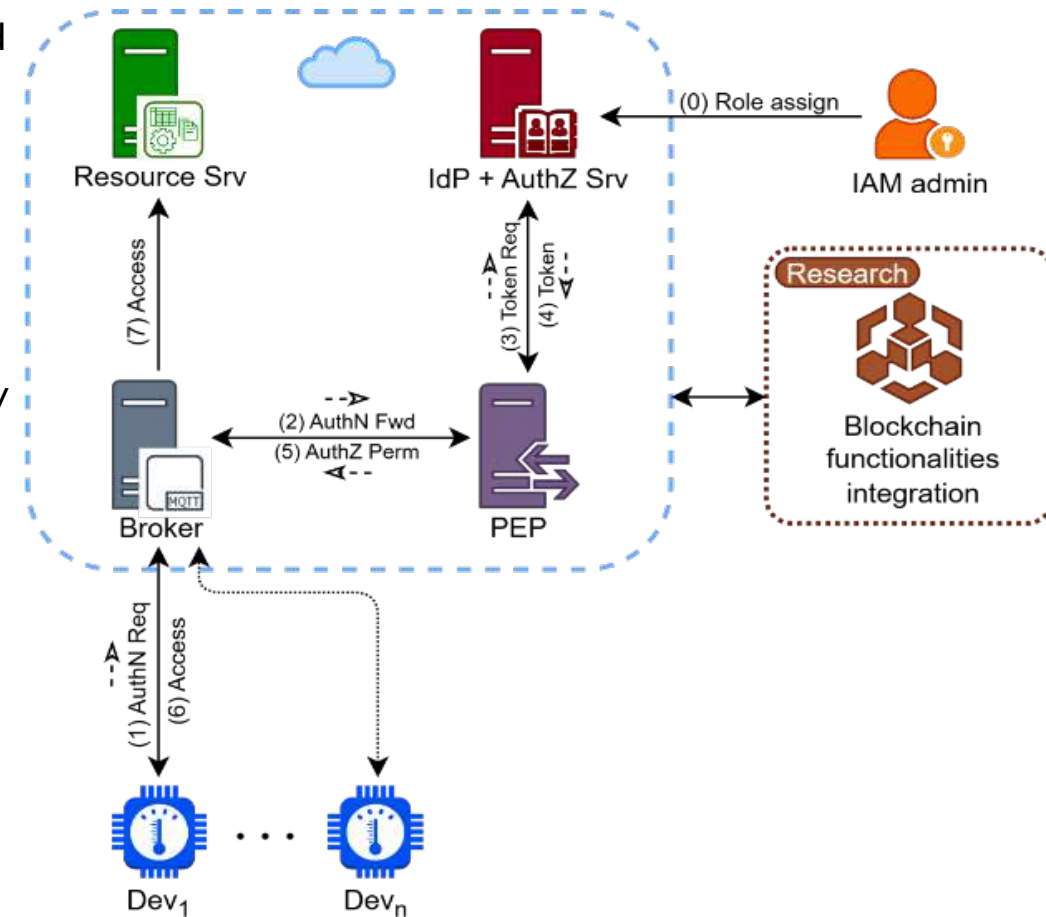
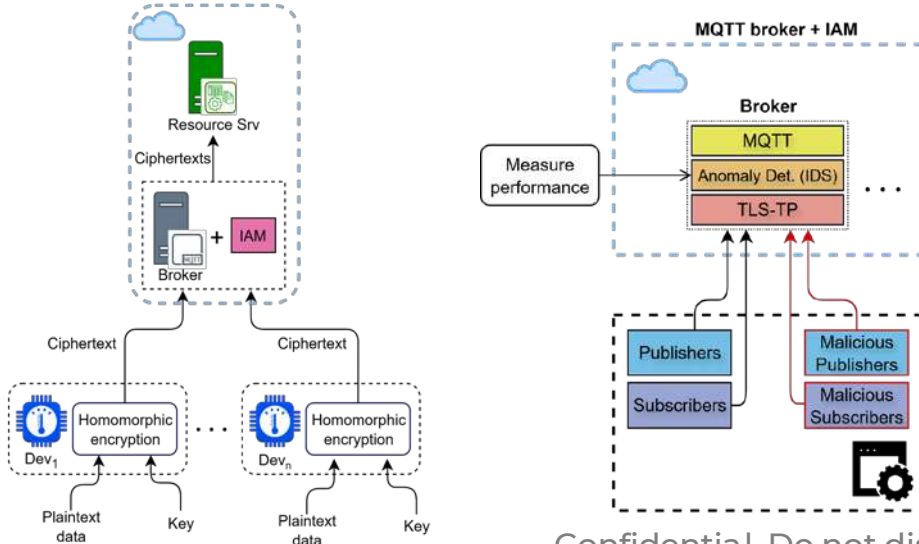
Protección integral del ciclo de vida del software

- Análisis de vulnerabilidades y control de calidad del código (SonarQube, Trivy).
- Gestión centralizada de secretos (Vault).
- Firma y verificación de artefactos con (Cosign)
- Construcción segura de imágenes (Kaniko).
- Despliegue automatizado y trazable (ArgoCD).
- Monitorización continua (Prometheus y Grafana).

Gestión de identidad y acceso en IOT

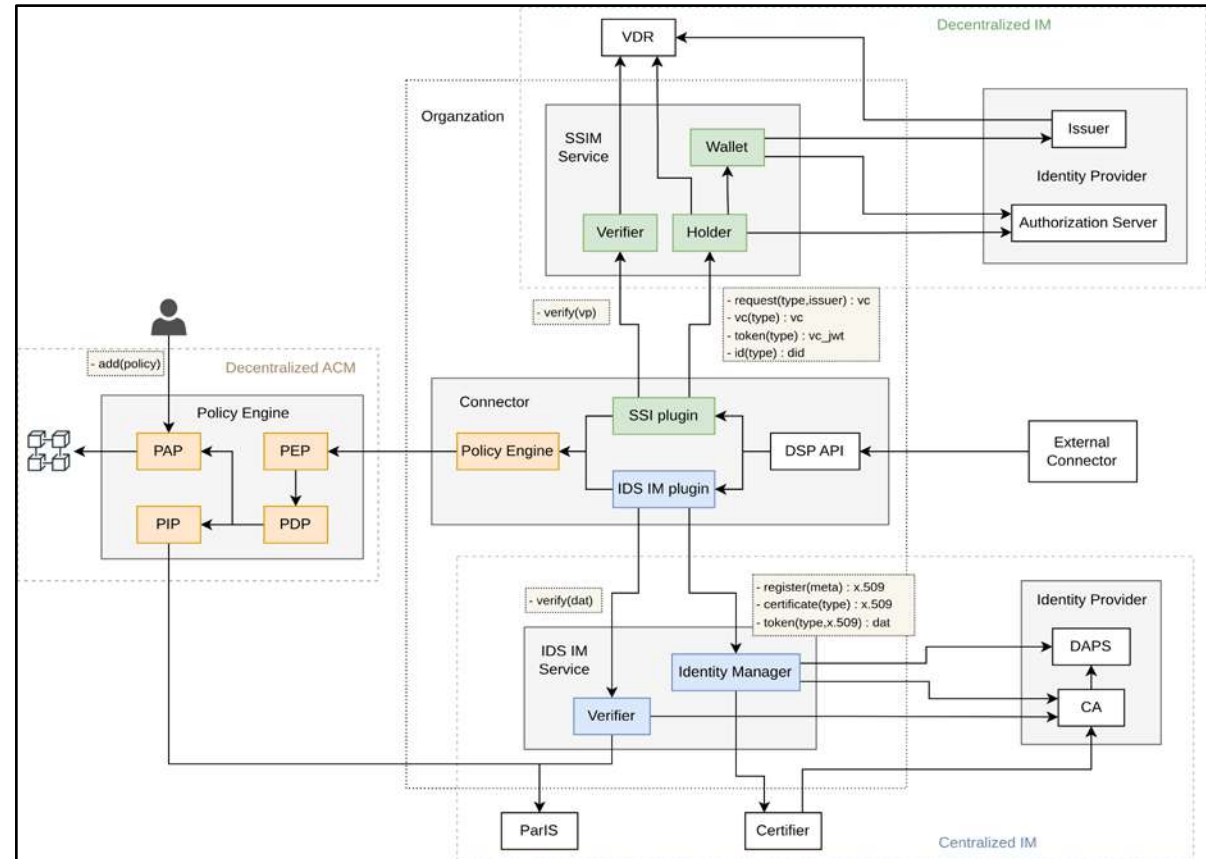
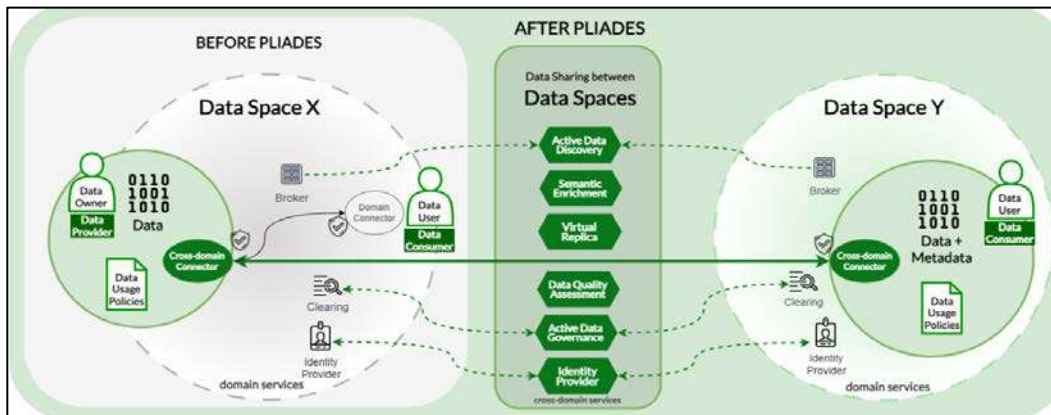
A cybersecurity strategy for IoT monitoring systems in Wind Farms

- Development of an IAM architecture for IoT monitoring systems.
- Network segmentation techniques and VPN dedicated connections for critical assets.
- Anomaly and attack detection systems for IoT communication protocols.
- Homomorphic encryption techniques for confidentiality and privacy-preserving data storage and usage.



PLIADES: AI-Enabled Data Lifecycles Optimization and Data Spaces Integration for Increased Efficiency

Interoperable and decentralized: identity management, access control, privacy-preserving data sharing, federated learning, clearing house, and mobility use cases.



ICT division

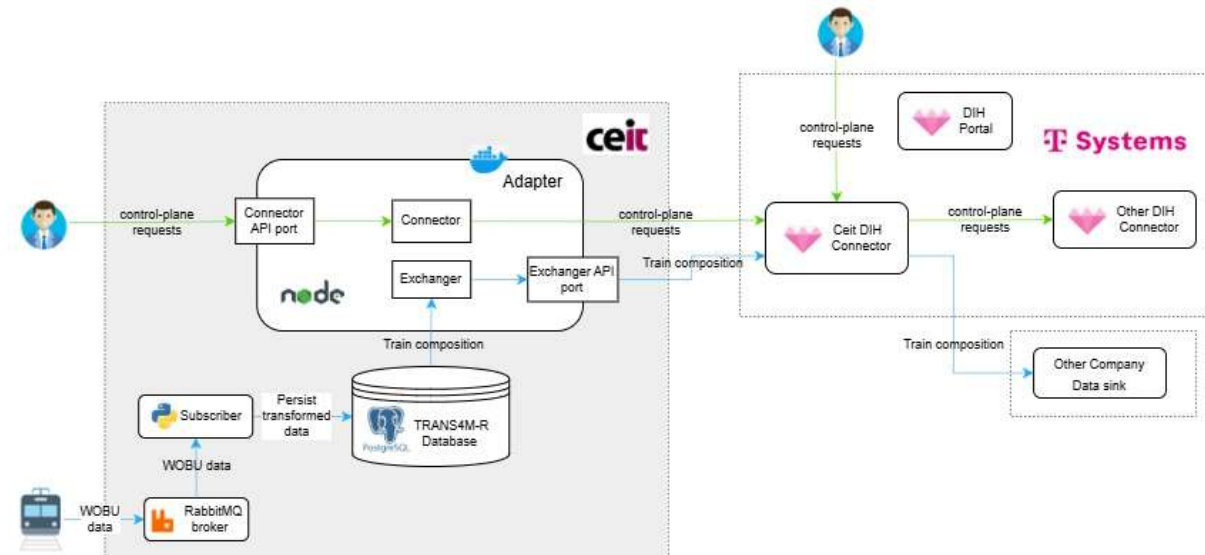
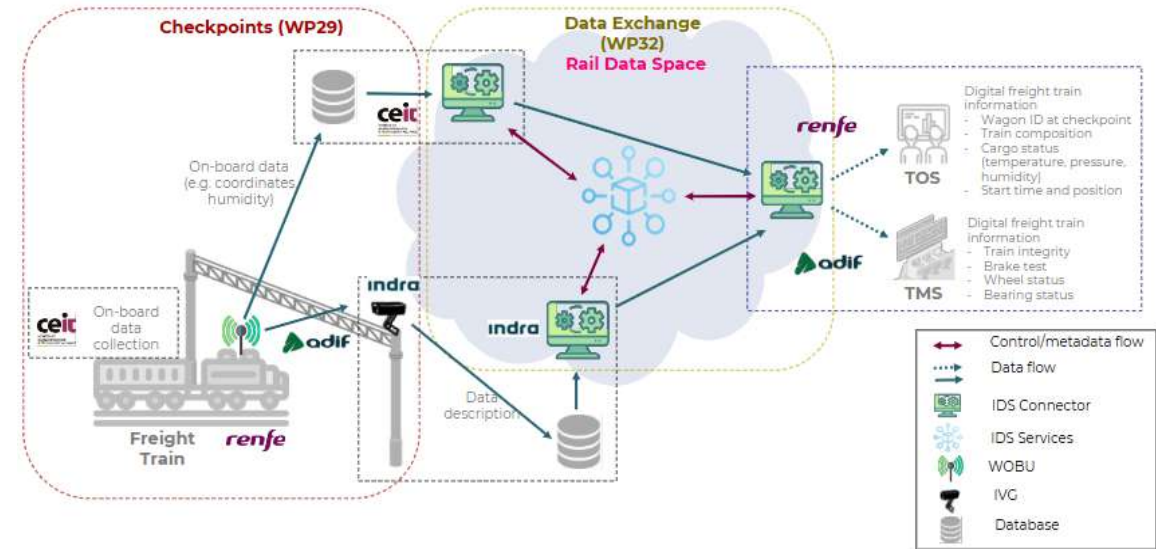
Espacios de datos

Transforming Europe's Rail Freight

- Development of the internal platform to manage information obtained through WOBU
- Application of data sharing technologies for freight trains at checkpoints
- Development of connectors for federated data spaces
- Development of connectors based on IDSA standards

TRANS4M-R

Demonstrator Description



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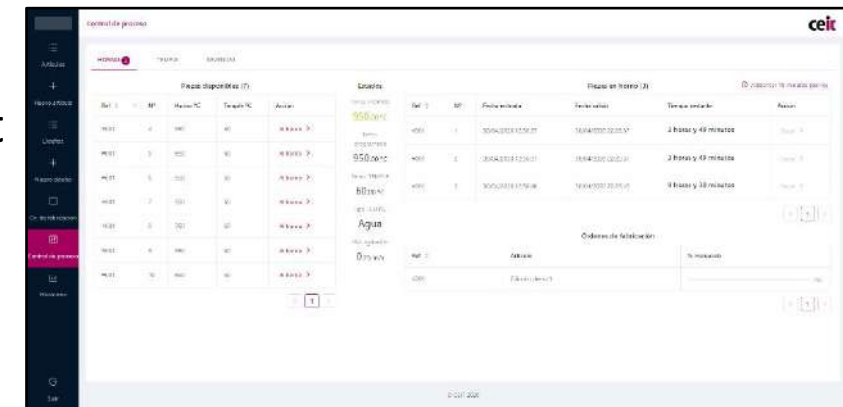
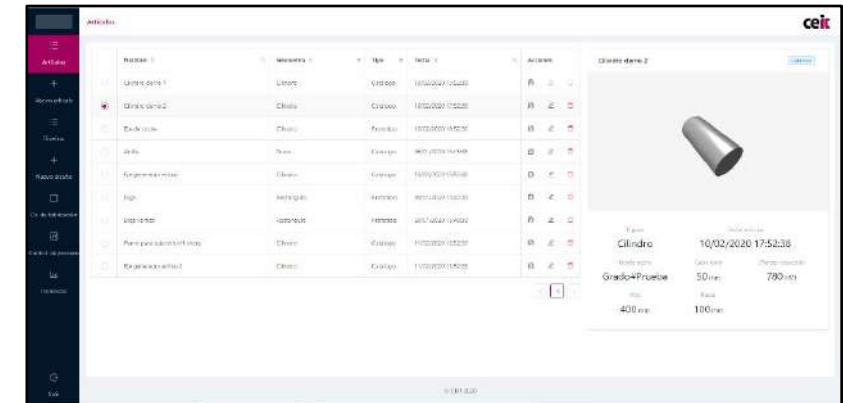
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► MIRAGED – Development of digital twins to support the operation of conventional and induction TT processes

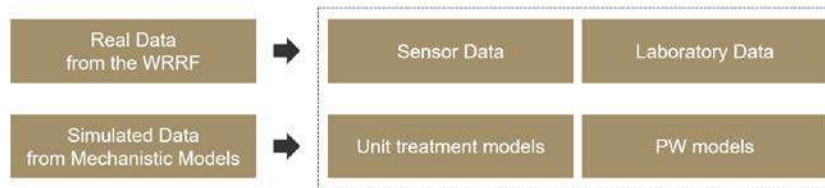
- Digitization of subprocesses and parts:
 - Reduced models for immediate recommendations in each subprocess
 - Traceability at the sub-process and part level
- Part depth and hardness prediction from NDT test data analysis
- Dashboards for process design and operation, and for product traceability
- Key technologies:
 - Machine Learning to obtain reduced models from FEM data
 - Machine Learning for part quality prediction from NDT test data



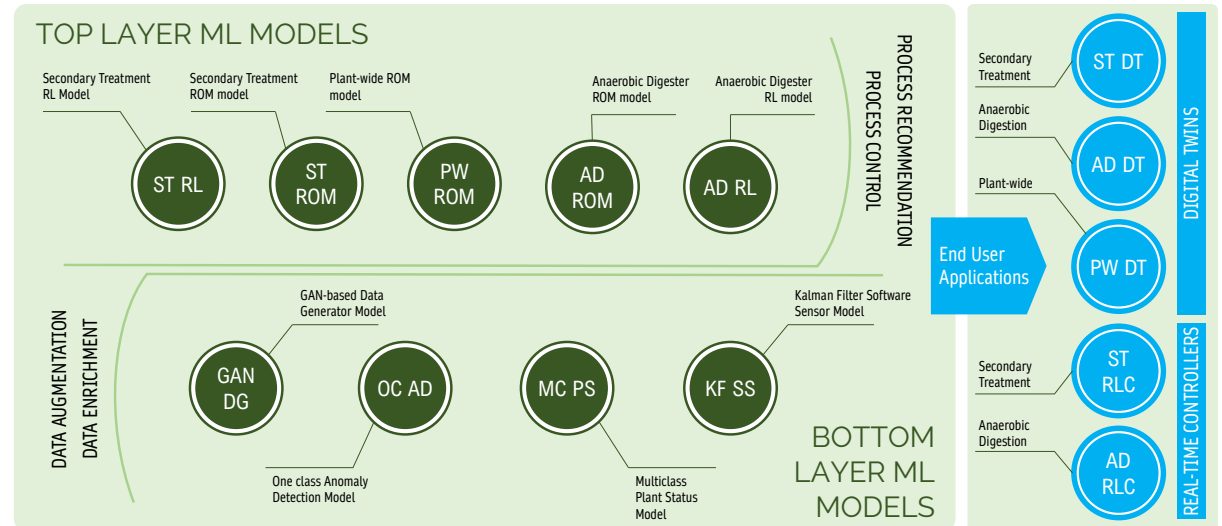
Driving the future of WRRF through Data Intelligence

Technical Approach

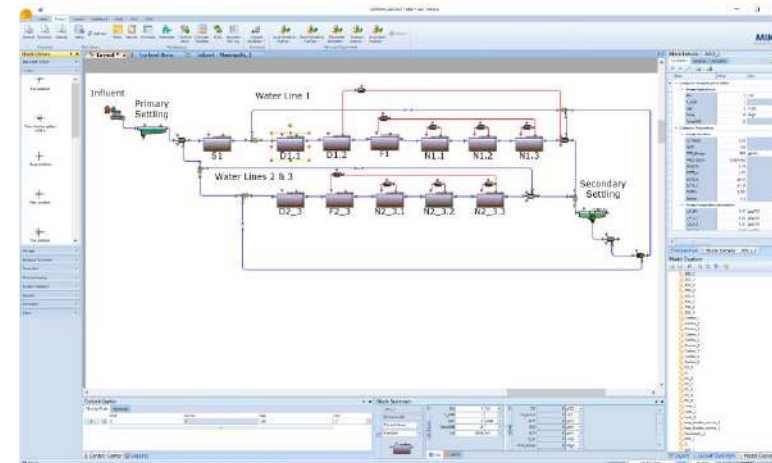
- Our data-driven AI solution will rely on ML models obtained by exploitation of two **complementary** data sources:



- ML models in DARROW will focus on three **complementary** operational requirements: (1) Data Enrichment; (2) Real-time process control; (3) Process recommendations

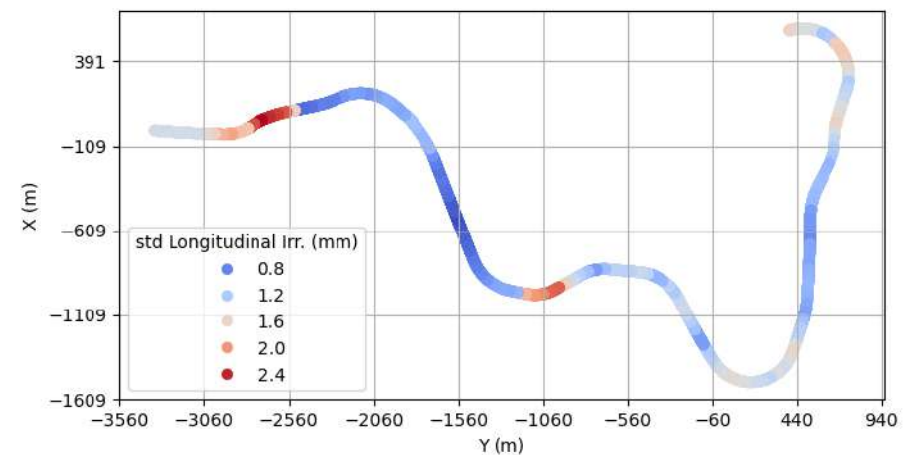
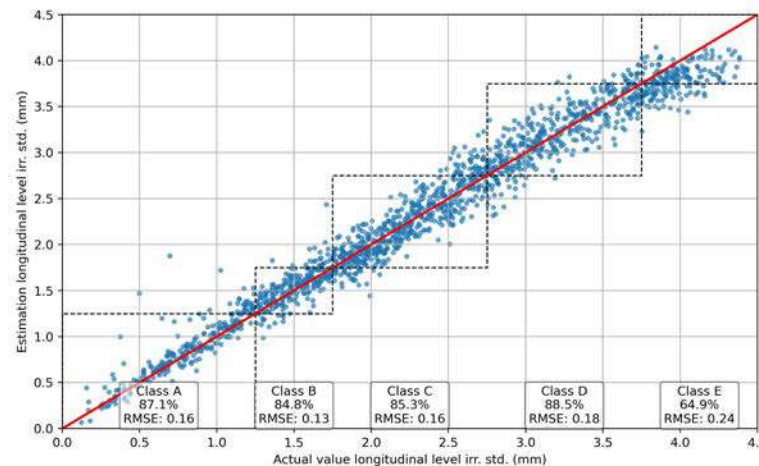
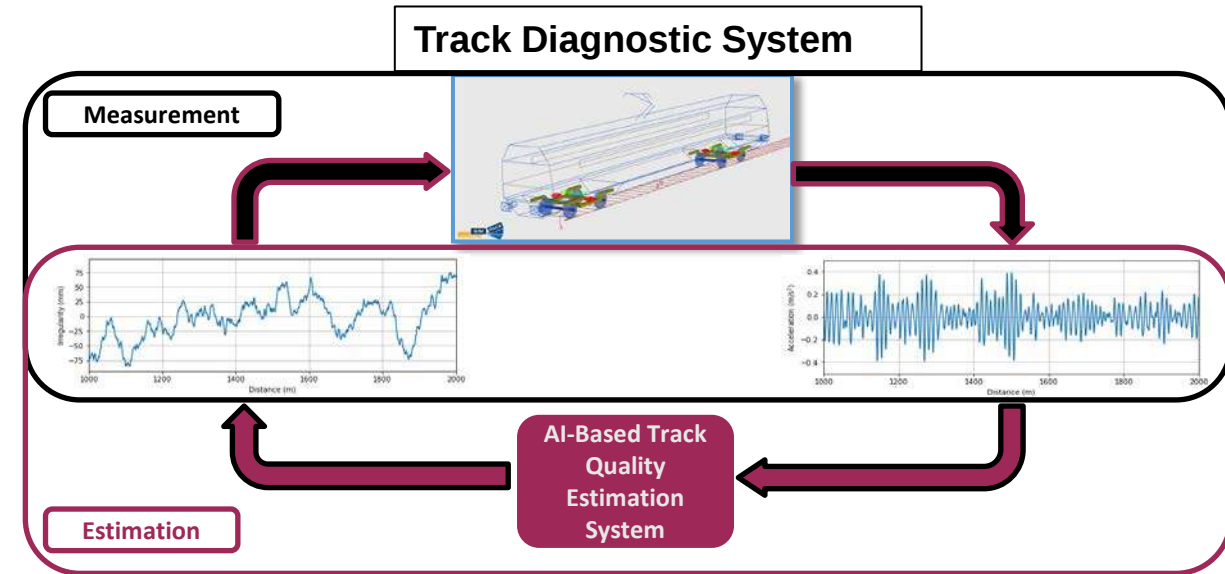


WRRF Tilburg



AI for railway infrastructure health monitoring

- Development of an AI-based track quality estimation system from on-board inertial measurements.
- Use of multibody simulations for the generation of reliable data.
- Estimation of track quality indices based on optimization algorithms and Machine Learning models.





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Thank you,
muchas gracias,
eskerrik asko

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