CENTRIC

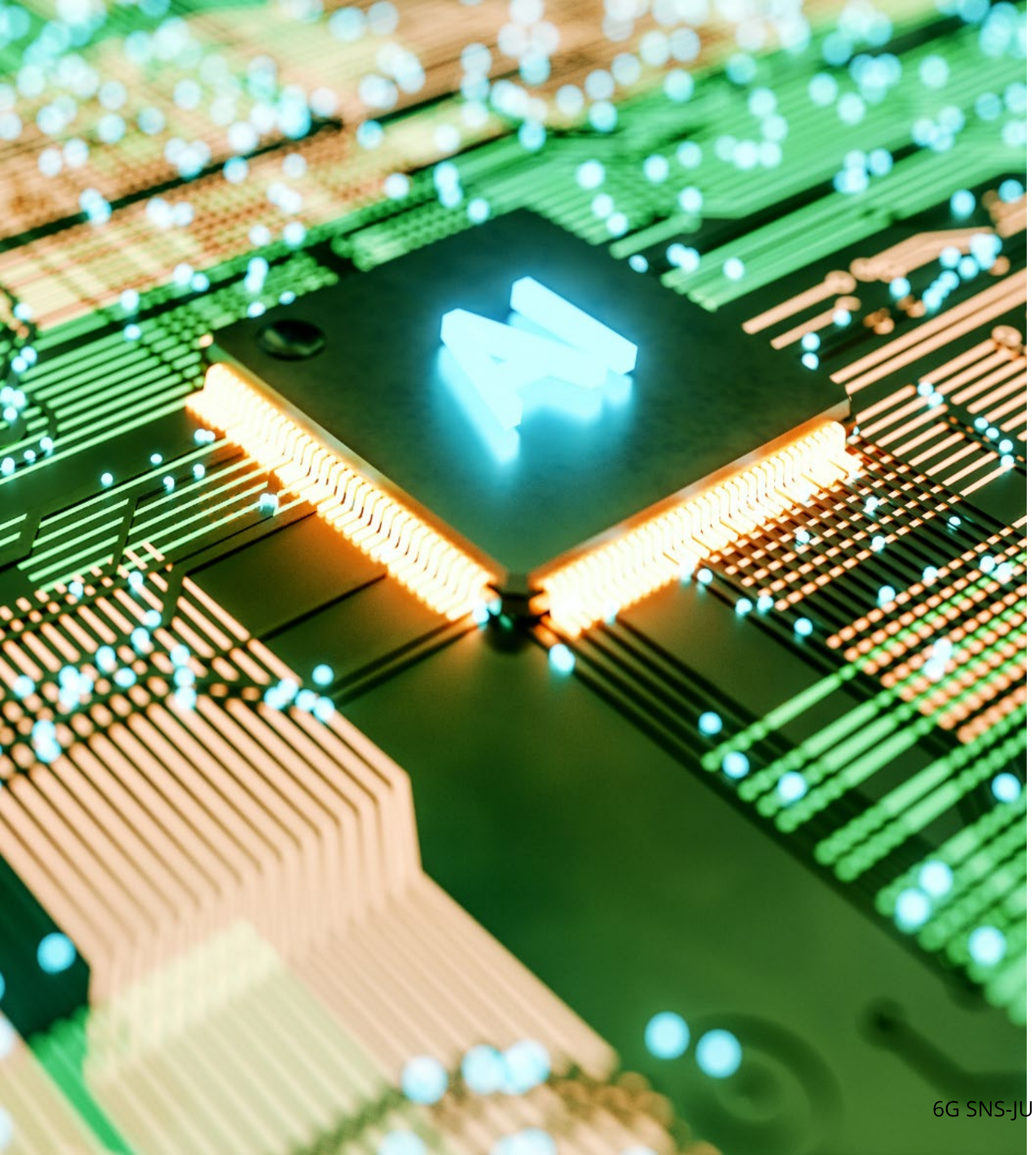
TOWARDS AN AI-NATIVE, USER-CENTRIC AIR INTERFACE FOR 6G NETWORKS

6G SNS-JU Phase 1 Project Presentation Webinar

March 6th, 2023

Carles Navarro Manchón, Aalborg University, Technical Project Manager

CENTRIC project has received funding from the European Horizon Europe Programme for research, technological development and demonstration under grant agreement 101096379.



Key numbers

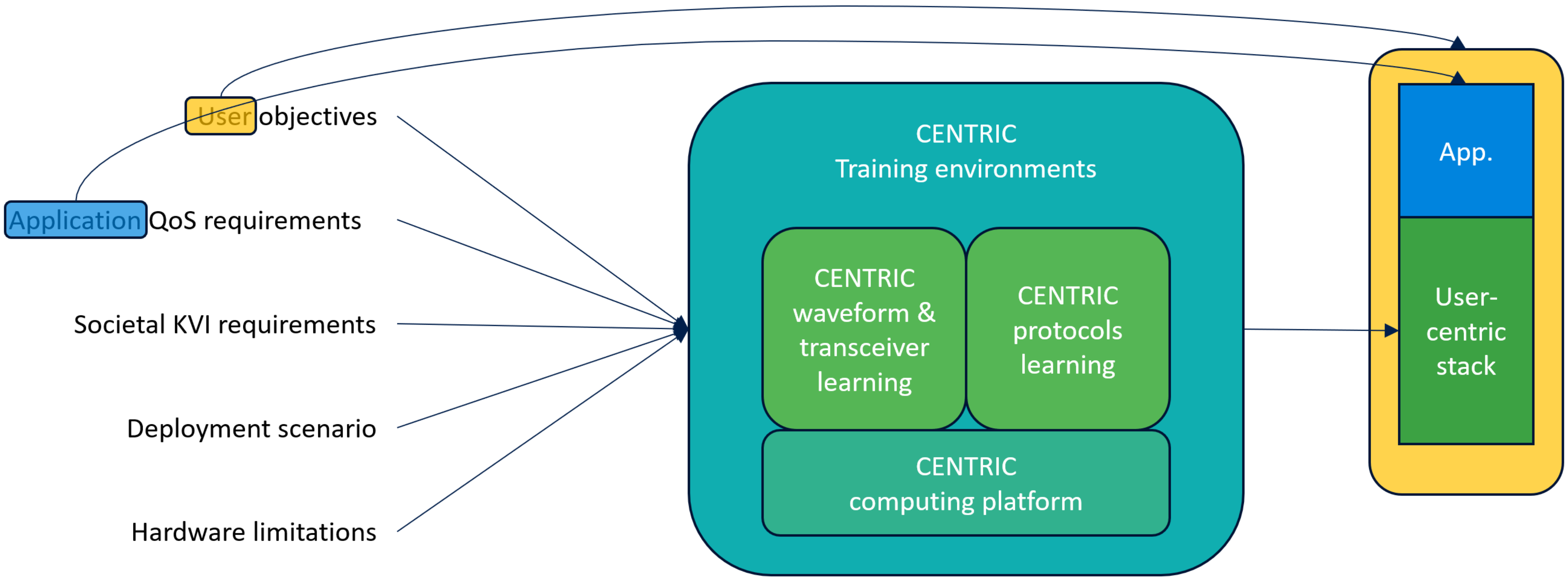
- **13 consortium partners**
- **€ 6,840,005.94 of budget (EU Contribution of € 4,215,999.00)**
- **8 European countries**
- **30 months duration from 01/01/2023 until 30/06/2025**
- **Grant Number Agreement: 101096379**

Consortium partners

- **Members:**
  - **Coordinator:** Eurescom (DE).
  - **Academic:** Aalborg University (DK), CNIT (IT), CNR (IT), King’s College London (UK), University Oulu (FI).
  - **Industry:** Nokia Networks France (FR), NVIDIA (DE), Sequans Communications (FR), Keysight Technologies (ES), Interdigital Europe (UK), Nokia Solutions and Networks (DE)
  - **SME:** Synthara AG (CH)

Vision & Goal

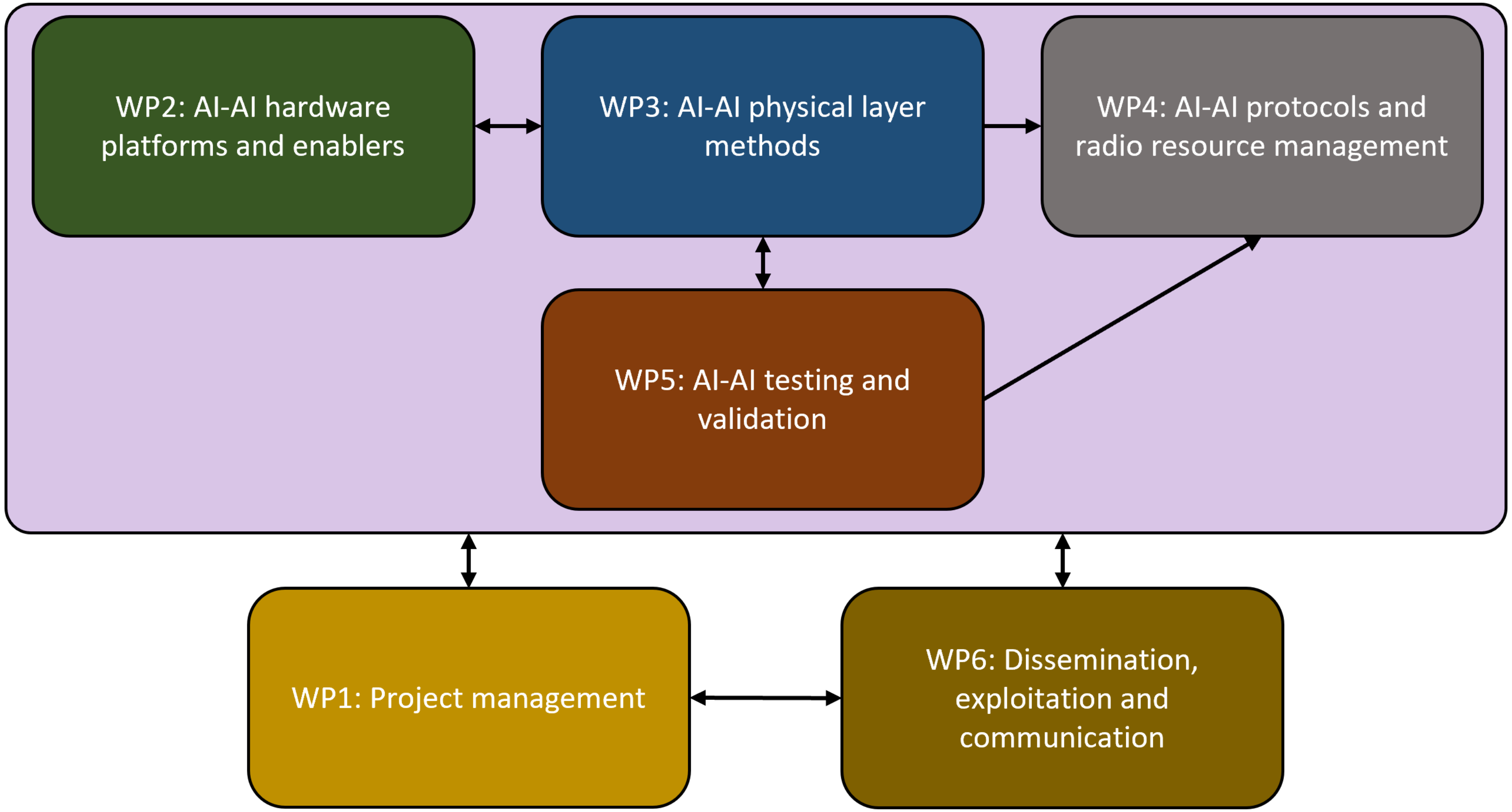
"The goal of project CENTRIC is to enable sustainable, user-centric 6G networks through an AI-native Air Interface (AI-AI)."



Project Objectives

1) To develop AI methods for the discovery of **novel and efficient waveforms**
2) To develop AI methods for the discovery of **novel and efficient transceivers**
3) To develop AI methods for the discovery of **customized lightweight communication protocols**
4) To introduce novel end-to-end **hardware co-design solutions** for energy-efficient AI-native transceivers
5) To develop **training and monitoring environments** as enablers for AI-AI deployments
6) To **validate user-centric AI-AI** solutions in a lab setting
7) To **demonstrate and disseminate** AI-AI concepts

Work package structure

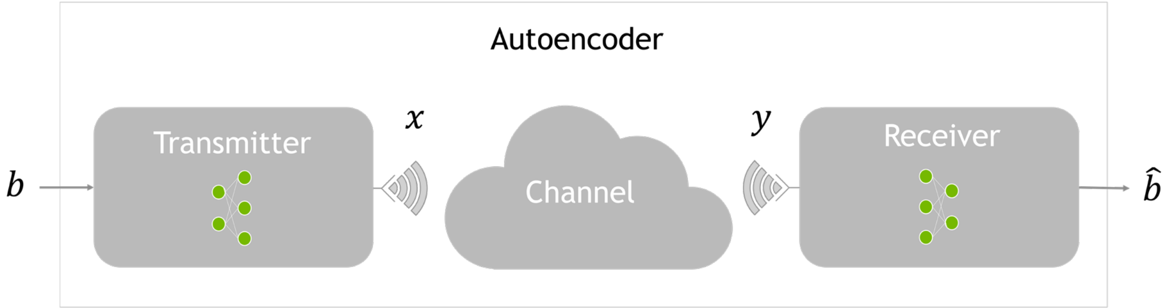


CENTRIC's Technical Innovations

Technical Innovations		Main involved CENTRIC partners	Technical Innovation Areas	
TI-1	Novel waveforms for sub-THz band and short packet transmission	NVIDIA, INTERDIGITAL	TIA-1	E2E-learned waveforms and modulations
TI-2	Methods for user-tailored modulation learning	INTERDIGITAL		
TI-3	Deep learning methods for multi-user MIMO receivers	SEQ, NVIDIA	TIA-2	AI-empowered MIMO communications
TI-4	Learning frameworks for CSI acquisition, and MIMO precoder selection	NSN, SEQ, INTERDIGITAL		
TI-5	AI methods for user-centric, sensing-aided beam operations in mmWave networks	AAU, INTERDIGITAL, NSN		
TI-6	AI methods for emerging multiple-access protocols for specialized services.	UOULU, NNF, AAU, INTERDIGITAL	TIA-3	Application- and scenario-specific learned protocols
TI-7	Methods for transmission-mode selection in dense deployments	AAU, INTERDIGITAL		
TI-8	Caching methods for distributed learning	CNIT, UOULU	TIA-4	Sustainable and human friendly RRM
TI-9	RRM techniques for cell-free massive MIMO networks targeting EMF exposure reduction	CNR, CNIT		
TI-10	Multi-objective AI methods for RRM performance-energy trade-offs	NNF, KCL		
TI-11	New digital CMOS in-memory computing architecture	SYNTHARA	TIA-5	Novel AI-computing hardware and real-time optimization
TI-12	New mixed analog-digital memristor-based in-memory computing architecture	KCL		
TI-13	Novel computing platform designs based on neuromorphic computing paradigms	KCL		
TI-14	Methods for GPU acceleration of deep learning algorithms	NVIDIA		
TI-15	Theoretical guidelines for the management of AI-AI models	KCL	TIA-6	Training and monitoring environments for AI models
TI-16	Algorithms and procedures for the management of AI-AI models	KCL, NVIDIA, AAU		
TI-17	Novel methodologies for benchmarking and testing AI in 6G	KEYSIGHT	TIA-7	AI-suitable testing frameworks and Proof of Concept
TI-18	PoC of AI-AI concepts	KEYSIGHT		

TIA-1: E2E-learned waveforms and modulations

Technical Innovations		Main involved CENTRIC partners
TI-1	Novel waveforms for sub-THz band and short packet transmission	NVIDIA, INTERDIGITAL
TI-2	Methods for user-tailored modulation learning	INTERDIGITAL



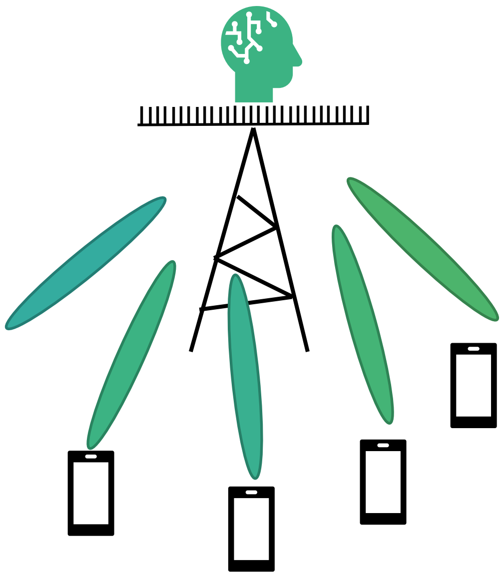
End-to-end PHY learning: PHY transceiver chain (transmitter, channel, and receiver) are interpreted as a single neural network, and **trained as an autoencoder**

Targeted Use Cases:

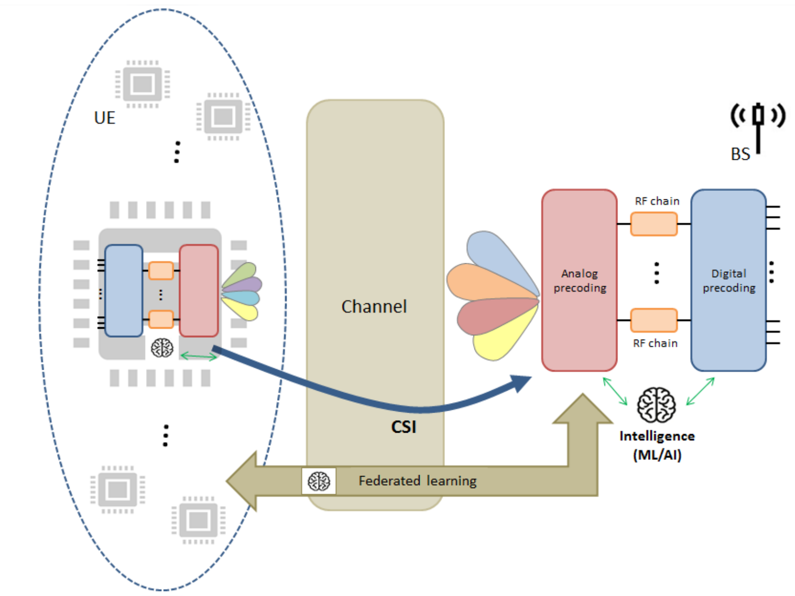
- THz Communications
- Short packet transmissions
- Novel modulations

TIA-2: AI-empowered MIMO communications

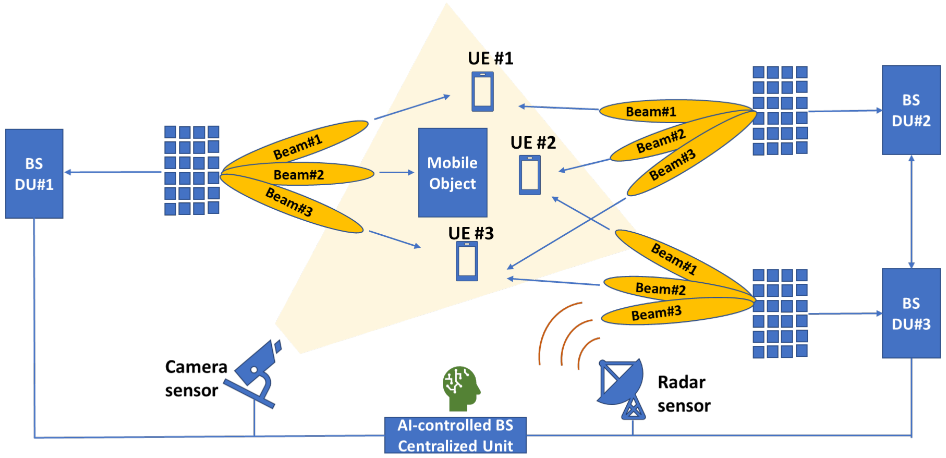
Technical Innovations		Main involved CENTRIC partners
TI-3	Deep learning methods for multi-user MIMO receivers	SEQ, NVIDIA
TI-4	Learning frameworks for CSI acquisition, and MIMO precoder selection	NSN, SEQ, INTERDIGITAL
TI-5	AI methods for user-centric, sensing-aided beam operations in mmWave networks	AAU, INTERDIGITAL, NSN



TI-3: Deep learning methods for multi-user MIMO receivers



TI-4: Learning frameworks for CSI acquisition, and MIMO precoder selection

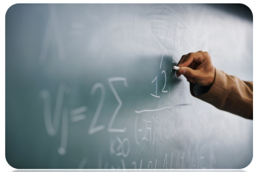


TI-5: AI methods for user-centric, sensing-aided beam operations in mmWave networks

TIA-3: Application- and scenario-specific learned protocols

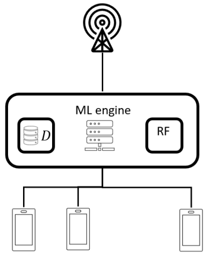
Technical Innovations		Main involved CENTRIC partners
TI-6	AI methods for emerging multiple-access protocols for specialized services.	UOULU, NNF, AAU, INTERDIGITAL
TI-7	Methods for transmission-mode selection in dense deployments	AAU, INTERDIGITAL

5G: Protocol is designed by humans

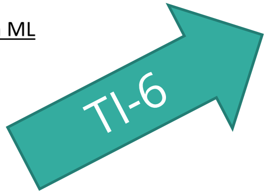


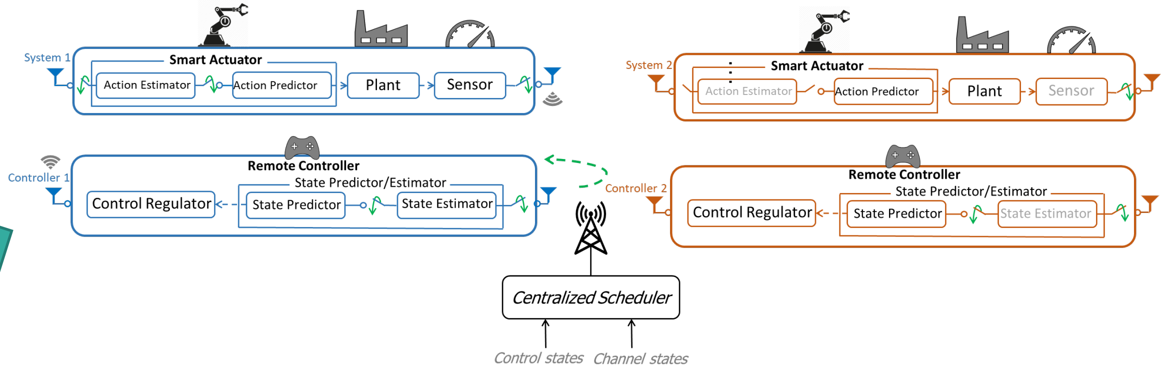
1. Basic research
2. Simulations
3. Feasibility study
4. Proof of concepts
5. Lab validation
6. Standardization
7. Implementation
8. Deployment

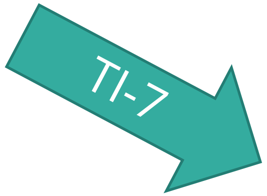
6G: Protocol is emerged automatically via ML

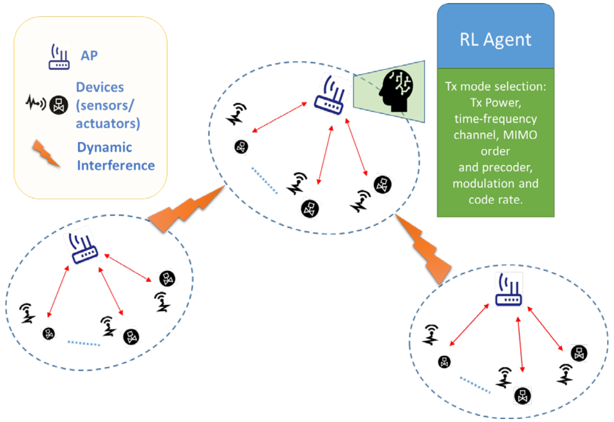


1. Describe user objectives
2. Click "Train protocol"
3. Obtain a user-centric protocol implementation



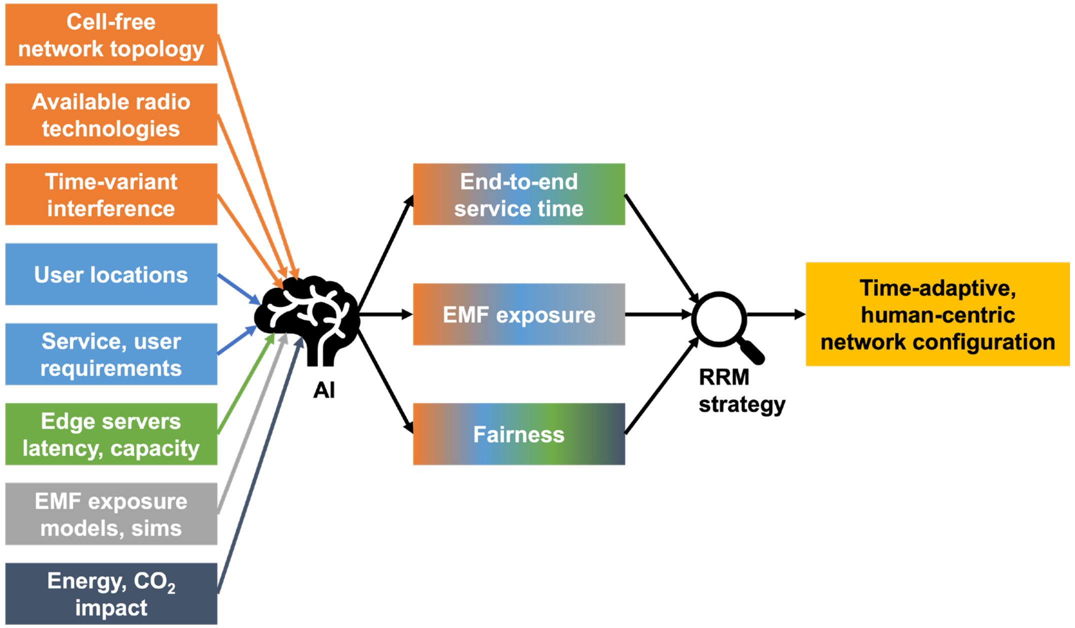






TIA-4: Sustainable and human friendly RRM

Technical Innovations		Main involved CENTRIC partners
TI-8	Caching methods for distributed learning	CNIT, UOULU
TI-9	RRM techniques for cell-free massive MIMO networks targeting EMF exposure reduction	CNR, CNIT
TI-10	Multi-objective AI methods for RRM performance-energy trade-offs	NNF, KCL

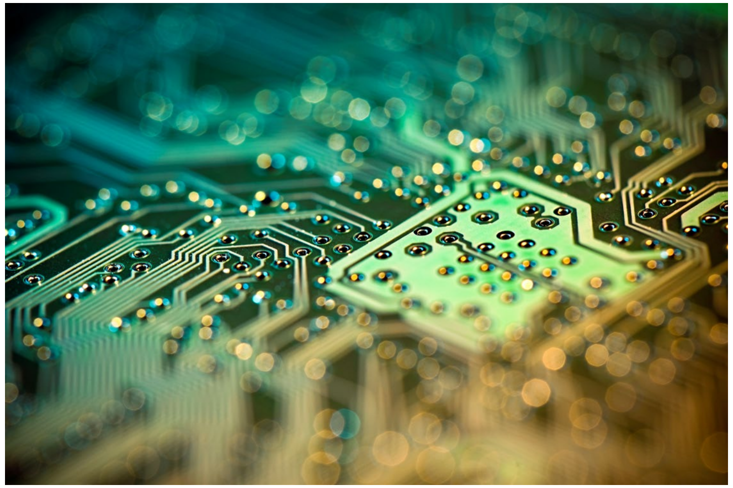


<u>Computational and energy efficiency:</u>

- Caching strategies for data and AI models
- Multiobjective RL and/or Bayesian optimization for RRM

TIA-5: Novel AI-computing hardware and real-time optimization

Technical Innovations		Main involved CENTRIC partners
TI-11	New digital CMOS in-memory computing architecture	SYNTHARA
TI-12	New mixed analog-digital memristor-based in-memory computing architecture	KCL
TI-13	Novel computing platform designs based on neuromorphic computing paradigms	KCL
TI-14	Methods for GPU acceleration of deep learning algorithms	NVIDIA

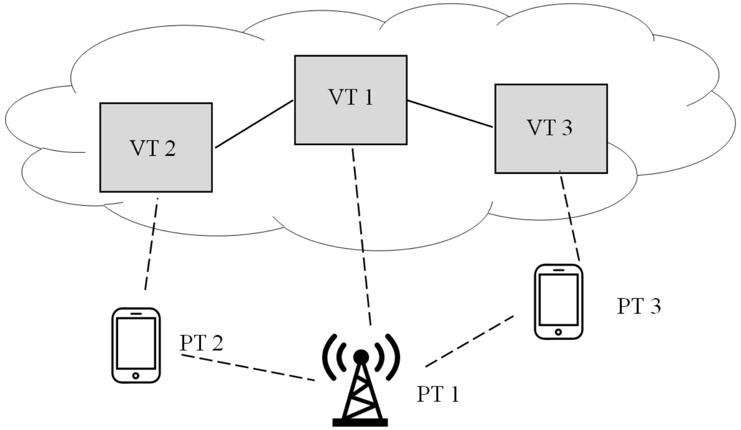


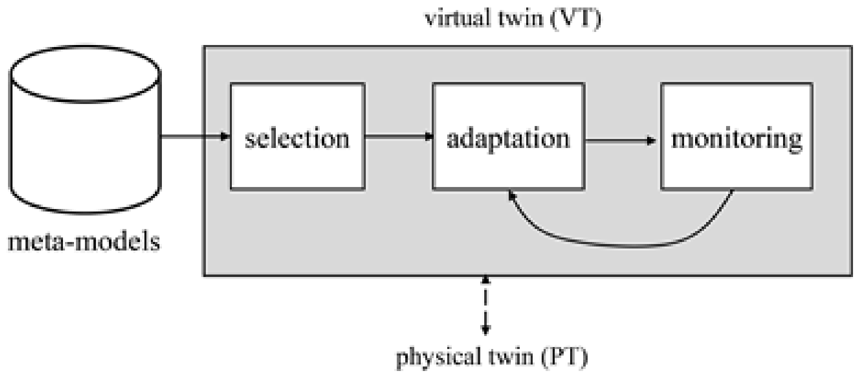
Latency and throughput requirements in communications are 1—3 orders of magnitude more stringent than in typical AI applications

TI-14: GPU Acceleration → TI-11: CMOS in-memory computing → TI-12: Mixed analog-digital computing → TI-13: Neuromorphic computing

TIA-6: Training and monitoring environments for AI models

Technical Innovations		Main involved CENTRIC partners
TI-15	Theoretical guidelines for the management of AI-AI models	KCL
TI-16	Algorithms and procedures for the management of AI-AI models	KCL, NVIDIA, AAU





DIGITAL TWIN PLATFORM:

- **user-provided models** of traffic and of service demands
- **repository of AI modules** implementing different functionalities
- **models of the propagation and interference** environments
- **interfaces** with physical entities being modelled by virtual twin counterparts

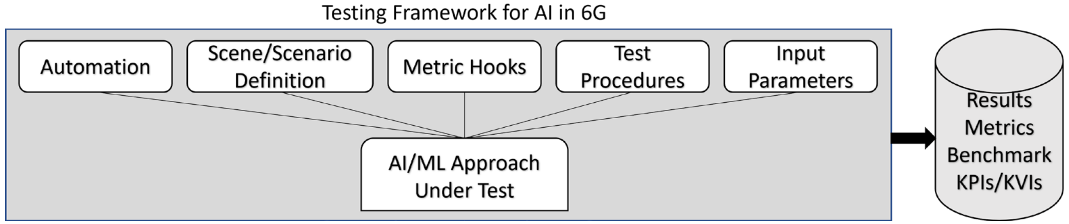
AI MODEL MANAGEMENT:

- Use of information theory and statistical learning theory to address fundamental questions: 1) How much data is required? 2) What is the effect of modularity?
- Use theoretical guidelines to develop practical solutions to the AI management problem

TIA-7: AI-suitable testing frameworks and Proof of Concept

Technical Innovations		Main involved CENTRIC partners
TI-17	Novel methodologies for benchmarking and testing AI in 6G	KEYSIGHT
TI-18	PoC of AI-AI concepts	KEYSIGHT

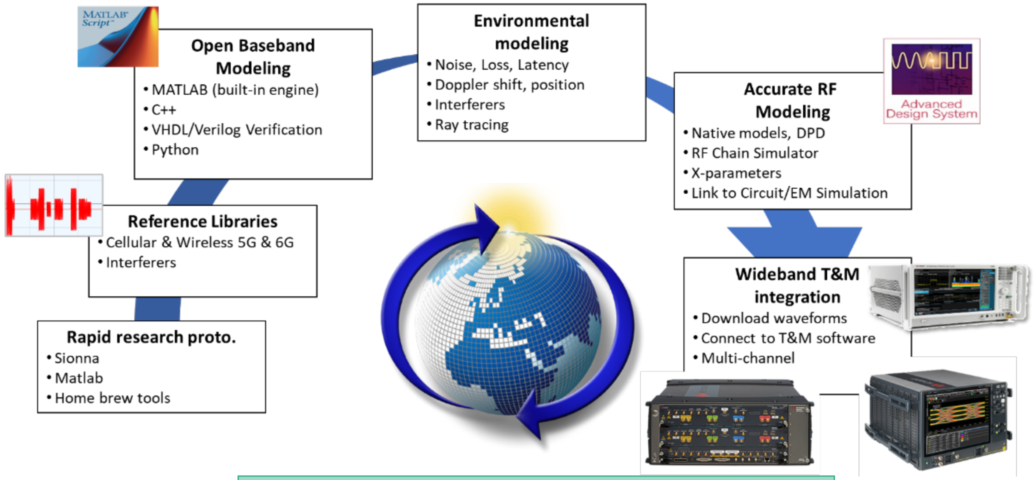
Challenge: lack of interpretability of AI models



GOALS:
- Gain transparency
- Automated framework
- Evaluate on multiple performance metrics

TI-17: Benchmark and Testing

For selected AI-AI concepts, we aim for full development cycle from idea generation to proof-of-concept demonstration.



TI-18: Experimental Proof-of-Concept

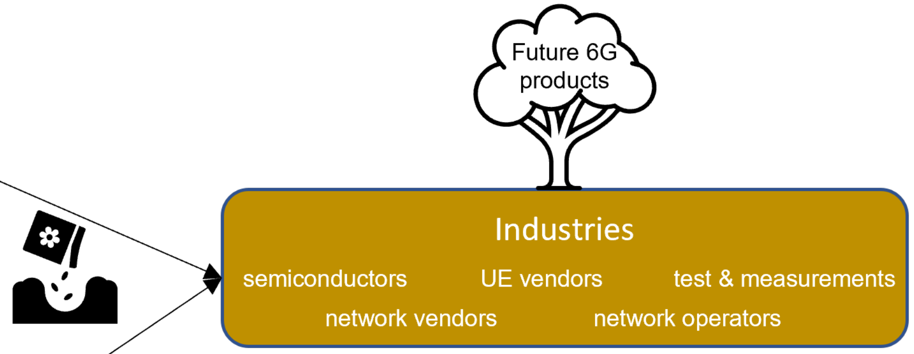
Dissemination and Exploitation Strategy

Academic partners

- Increase of scientific production
- Training of young researchers
- Attraction of talent
- Expansion of educational curriculum
- Spinoffs/startups (potential)

Industrial partners

- Intellectual property production
- Exploration of new markets enabled by CENTRIC discoveries
- Insertion of CENTRIC discoveries into 6G standards
- Productization of some CENTRIC ideas (potential)



Exploitation Strategy

Dissemination Targets

Measure	Indicators / Targets
Conference publications	At least 20
Publications in journals	At least 12
Vision / white papers on main project aspects and goals	2-3
Contributions to standards	At least 10
Contributions to open-source community	At least 10
Project workshops	At least two
Online project webinars	At least 3
Participation in industry events	3
Project booths at events	2
Liaison with other projects/initiatives in the area	2-3

Online Presence

Do not hesitate to follow us on Social Media and subscribe to our Newsletter to avoid missing any news:

https://centric-sns.eu/

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Many thanks for your attention!

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