# CENTRIC

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

EuCNC - The 6G series workshop by Hexa-X and Hexa-X-II

June 6th, 2023

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

# Key Project Facts

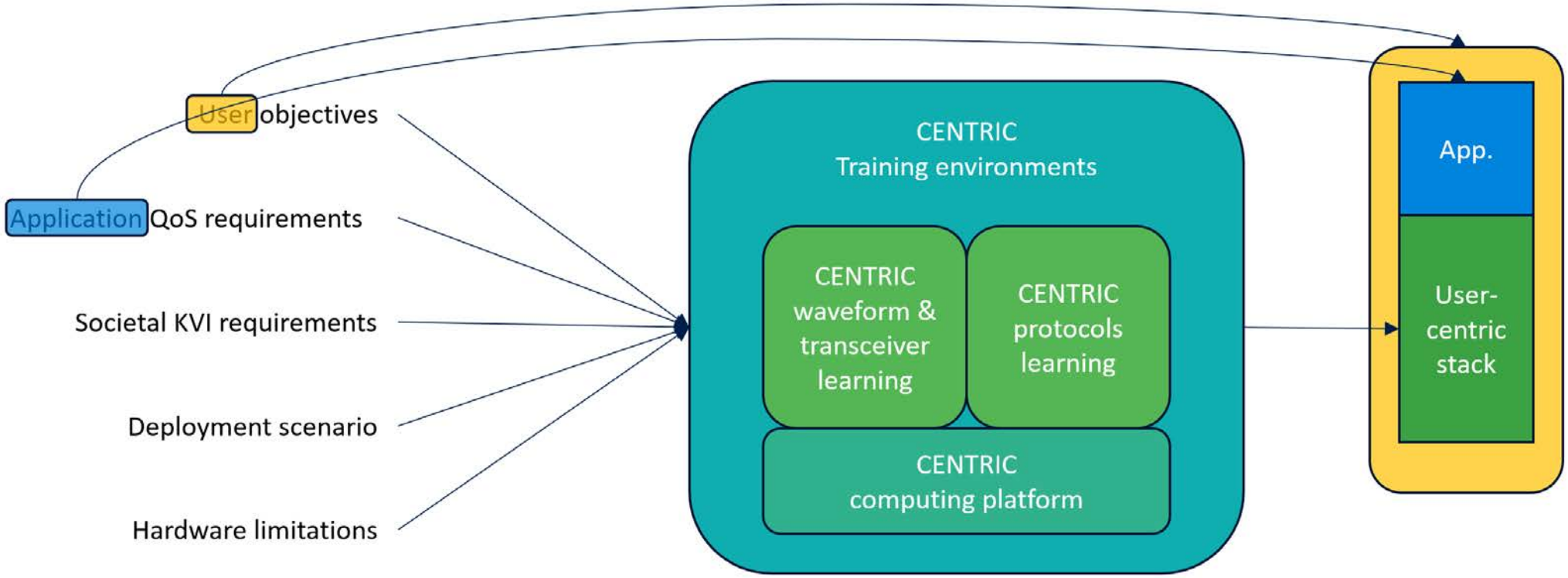
**CENTRIC is an SNS-JU Phase 1 Project, granted in STREAM-B-01-02 – "Wireless Communication Technologies and Signal Processing"**

- **Project Period:** January 2023 – June 2025
- **Budget:** € 6,840,005.94 of budget (EU Contribution of €4,215,999.00)

- **Consortium Partners:**
  - **Coordinator:** Eurescom (DE).
  - **Academic:** Aalborg University (DK) (Technical Coordinator), 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)."***



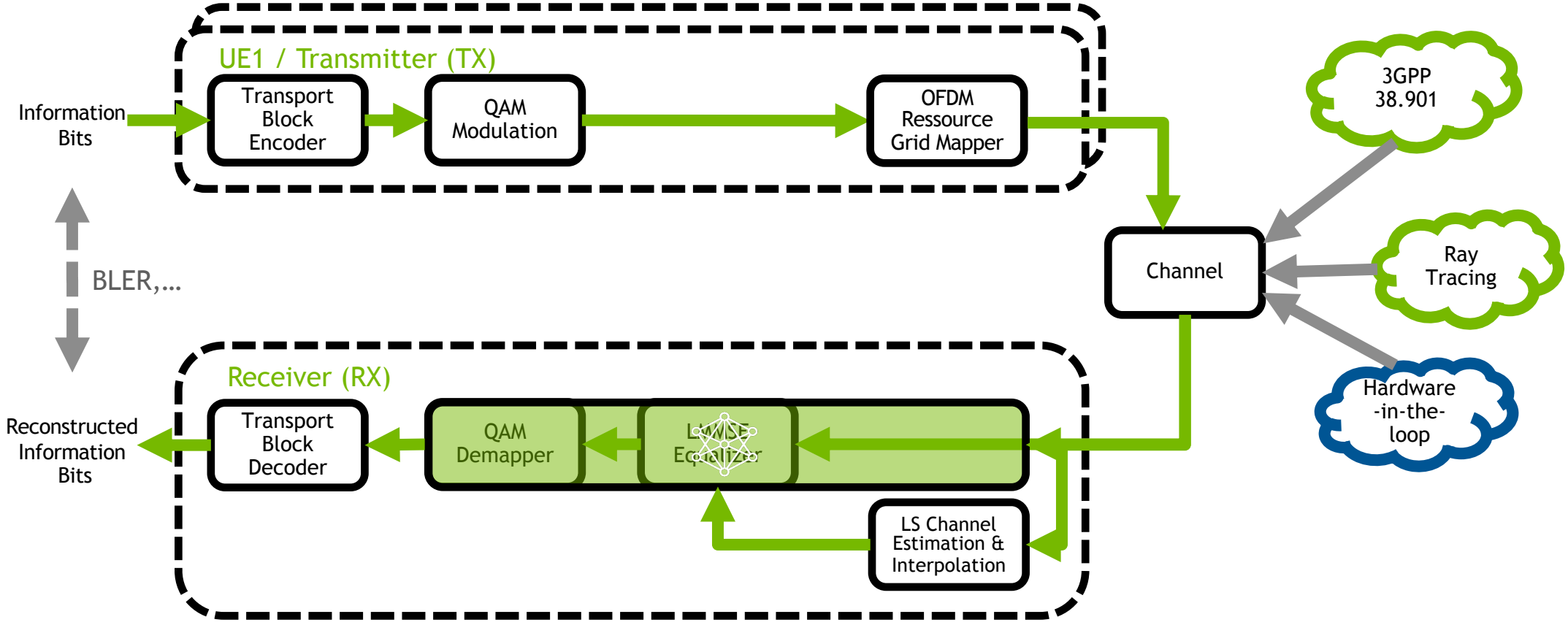
# Project Objectives

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

# Examples of AI-AI concepts

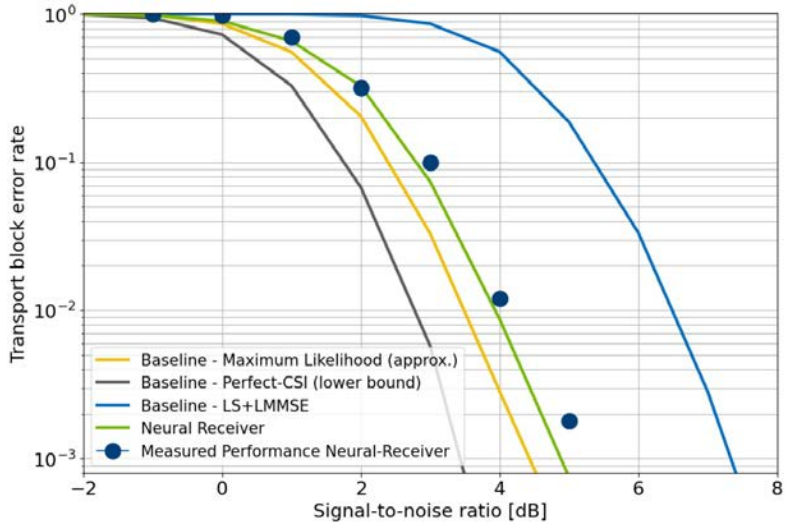
## Physical Layer: A Neural Receiver

# What is a Neural Receiver?




Simple example in Jupyter Notebook (Google Colab)

# Multiuser MIMO Neural Receiver – MWC 2023 Demo


**Hardware-in-the-loop experiment**

- Multi-user MIMO configuration with 2 users
- 2 antennas per user & 4 receive antennas
- 217 PRBs / 80 MHz bandwidth
- 16-QAM, rate=0.54, 67584 info bit per transport block
- Post-FFT signal processing by a neural network trained with data generated by **Sionna**

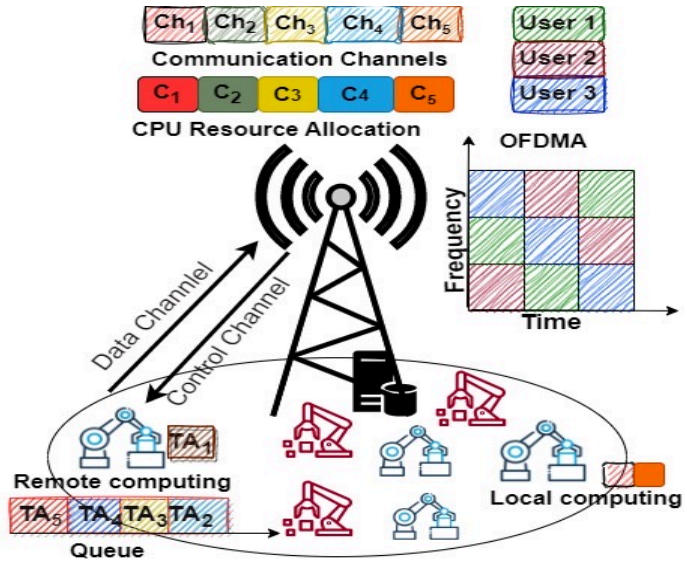
**Verified by Rohde & Schwarz test equipment**

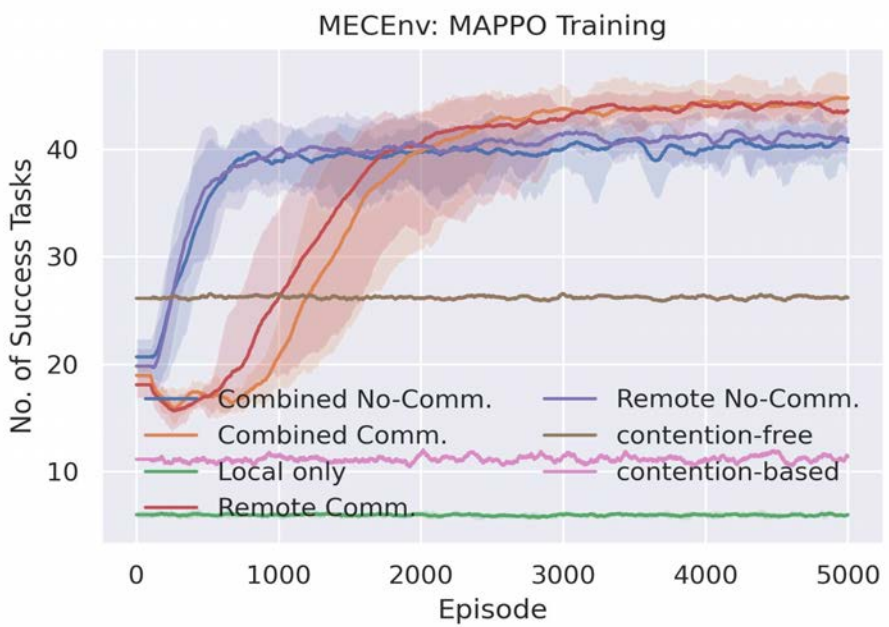
- Fully 5G NR compliant PUSCH signals
- Fading profiles following the 3GPP conformance tests
  - TDL-B 100ns/400Hz
  - TDL-C 300ns/100Hz

# Examples of AI-AI concepts

## Learned L2 Protocols

# Communication Protocol Learning for Task Offloading in Industrial Internet of Things



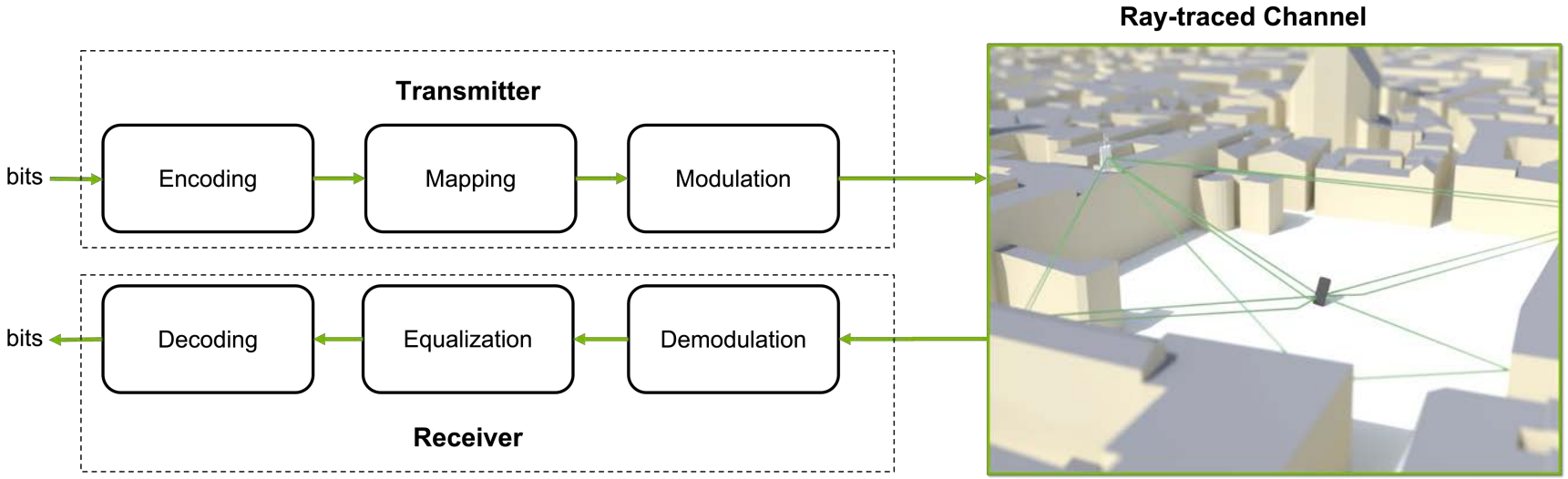




- **Problem:** joint task offloading decision and scheduling of computation tasks.
- **Objective:** maximizing the number of tasks that can be executed within the deadline constraint.
- Problem has two parts:
  1) Task Offloading Decision: Should the task be Locally or Remotely computed ?
  2) Multichannel Access: If Remotely which channel ?
- Proposed approach: Multi-Agent Proximal Policy Optimization (MAPPO) for Centralized Training with Decentralized Execution (CTDE)

# Examples of AI-AI concepts

## Digital-Twin Training Environments

# Digital Twin Platform - Sionna RT: Differentiable Ray Tracing




- Ray-traced channels in-lieu of stochastic channel models
- Differentiability enables entirely new research directions:
  - Learning of material properties
  - Calibration to measurement results for digital twins
  - Gradient-based optimization of system parameters (antenna patterns, array geometries, RIS, etc.)
  - Straight-forward integration of neural networks (e.g., learned scattering functions)

Jakob Hoydis, et al., "Sionna RT: Differentiable Ray Tracing for Radio Propagation Modeling", arXiv preprint, Mar. 2023

Base station and smartphone models CC-BY JoelGodin and Imagigoo

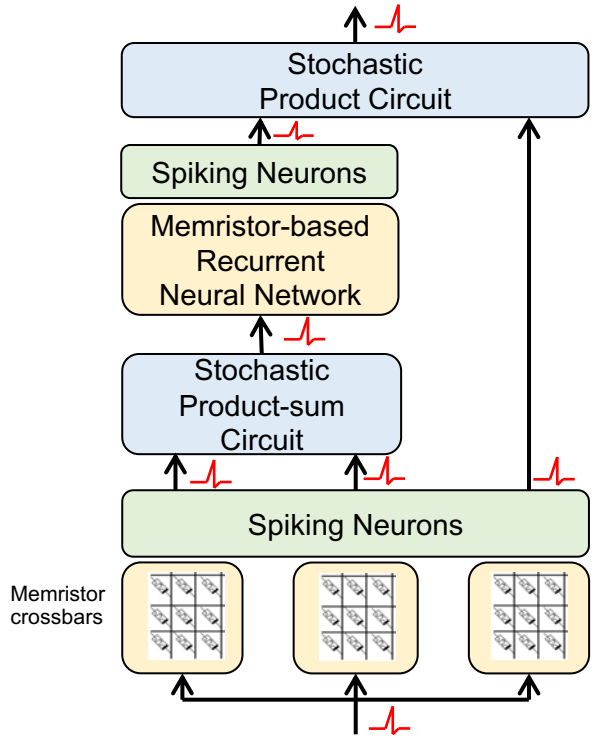
# Examples of AI-AI concepts

## Neuromorphic Computing Platforms

# Efficient Neuromorphic Hardware Design

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

Faster and more energy efficient computational paradigms are required to enable the AI-AI




**Neuromorphic Self-Attention Networks: Accelerating AI**

- Efficient mixed analogue-digital data flow design for self-attention mechanism
- Spiking self-attention solution empowered by stochastic computing

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# Outlook

- **Just a glimpse at few of the AI concepts for 6G that CENTRIC will research.**
- **Other than shown in this presentation, CENTRIC will also develop:**
  - Methods for learning of THz communication waveforms and modulations
  - AI-controlled methods for integrated sensing and communciations
  - Application- and scenario-specific RRM methods with controlled EMF exposure to users
  - Testing frameworks for AI-based PHY algorithms
  - Experimental demonstration of AI-AI concepts
  - … and many more!
- **CENTRIC is still in its first half-year, stay tuned for upcoming exciting results!**

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# Many thanks for your attention!


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