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6G-LEADER Overview

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SNS-JU Webinar – Introducing the Call 3 Projects

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LEARNING-DRIVEN AND EVOLVED RADIO FOR 6G COMMUNICATION SYSTEMS

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6G-LEADER at a glance

Project number: 101192080

CALL TOPIC

HORIZON-JU-SNS-2024-STREAM-B-01-02

DURATION

36 MONTHS
1 JAN 2025 - 31 DEC 2027

CONSORTIUM

18 PARTNERS

TOTAL ELIGIBLE COSTS:
EUR *8 483 236.25/*

MAXIMUM GRANT AMOUNT:
EUR*7 998 705.00*

Mission

To develop AI/ML-driven, sustainable, and energy-efficient 6G wireless communication systems that empower next-generation connectivity while addressing climate challenges through innovative technology solutions.

Vision

To be a leader in 6G innovation, setting new standards in wireless communications with innovative AI, advanced antennas, and spectrum-efficient technologies, fostering a connected and sustainable future.

Five Pillars

Innovation

Revolutionizing mobile networks to meet the demands of a hyper-connected world.

Collaboration

Pushing the boundaries of wireless communication through strategic partnerships and pioneering research.

Sustainability

Strengthening international cooperation for the development and deployment of 6G technology.

Global Impact

Empowering digital inclusion by ensuring 6G accessibility worldwide.

Excelence

Setting the standard for research, development, and deployment of 6G solutions.

Our goals

Innovate Future Networks

Revolutionizing mobile networks to meet the demands of a hyper-connected world.

Accelerate 6G Research

Pushing the boundaries of wireless communication through strategic partnerships and pioneering research.

Global Collaboration

Strengthening international cooperation for the development and deployment of 6G technology.

Foster Sustainable Connectivity

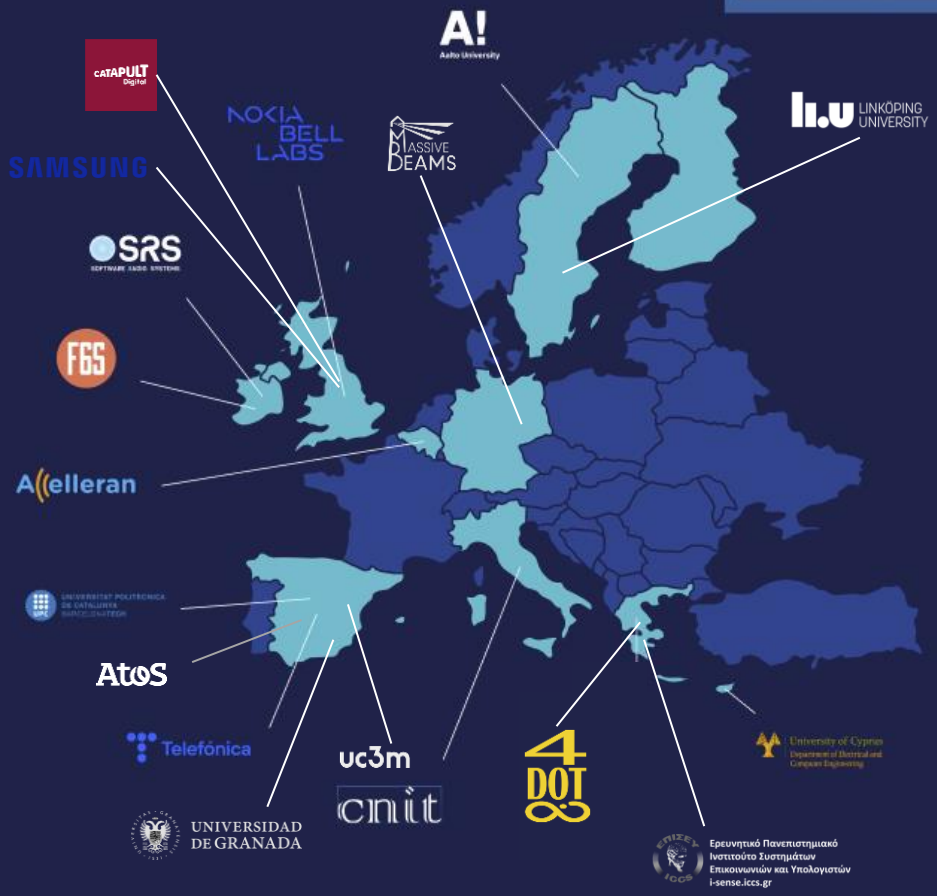
Ensuring energy-efficient, environmentally responsible solutions for future networks.

Drive Societal Impact

Developing technologies that improve quality of life and foster inclusive digital growth.

The Team

The 6G-LEADER project is powered by a diverse consortium of leading academic, research, and industry partners from across the globe.
Together, we combine expertise and resources to deliver the next frontier in connectivity.



The Team

- **18 Partners** from 10 countries including:
  - ***Academic Institutions:*** University of Cyprus, Aalto University, Universitat Politècnica de Catalunya, Linköping University, University of Granada, Universidad Carlos III de Madrid
  - ***Industry Leaders:*** Nokia, Samsung, Telefónica, Accelleran
  - ***SMEs & Research Institutes:*** F6S, Four Dot Infinity, Massive Beams, Digital Catapult, ICCS, CNIT
- **Diverse Expertise**: AI/ML, wireless communications, Open RAN, advanced antennas, sustainability

KEY OBJECTIVES

Advancing AI-Driven 6G Networks

Optimizing 6G RAN with AI/ML

Enhancing network automation, efficiency, and adaptability using AI-driven intelligence

Enhancing Spectrum and Energy Efficiency

Developing sustainable solutions to minimize energy consumption and optimize spectrum use

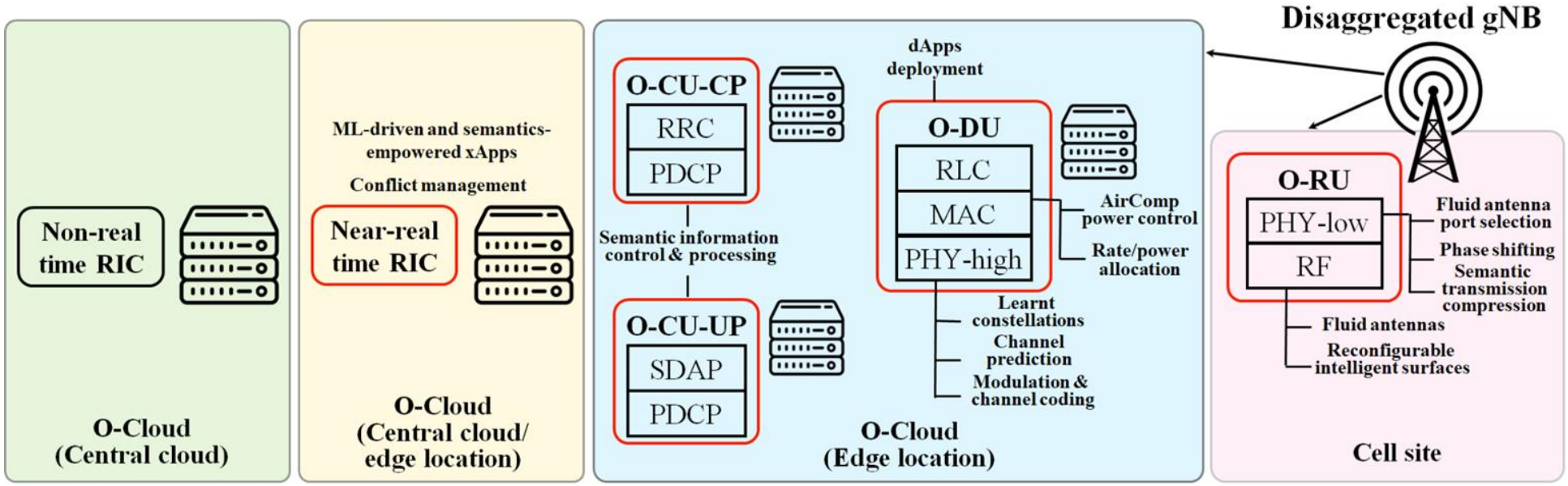
Seamless Integration of AI & Semantics

Leveraging AI-driven decision-making and semantic communication for smarter, goal-oriented networking

6G-LEADER ARCHITECTURE

6G-LEADER architecture

- 6G-LEADER adopts O-RAN's **disaggregation framework**, dividing the gNB into O-CU, O-DU, and O-RU and developing solutions for:
  - RAN control and optimisation
  - ML-driven and semantics-empowered wireless communication technologies
  - Signal processing algorithms and innovations on FAs and RISs



6G-LEADER architecture

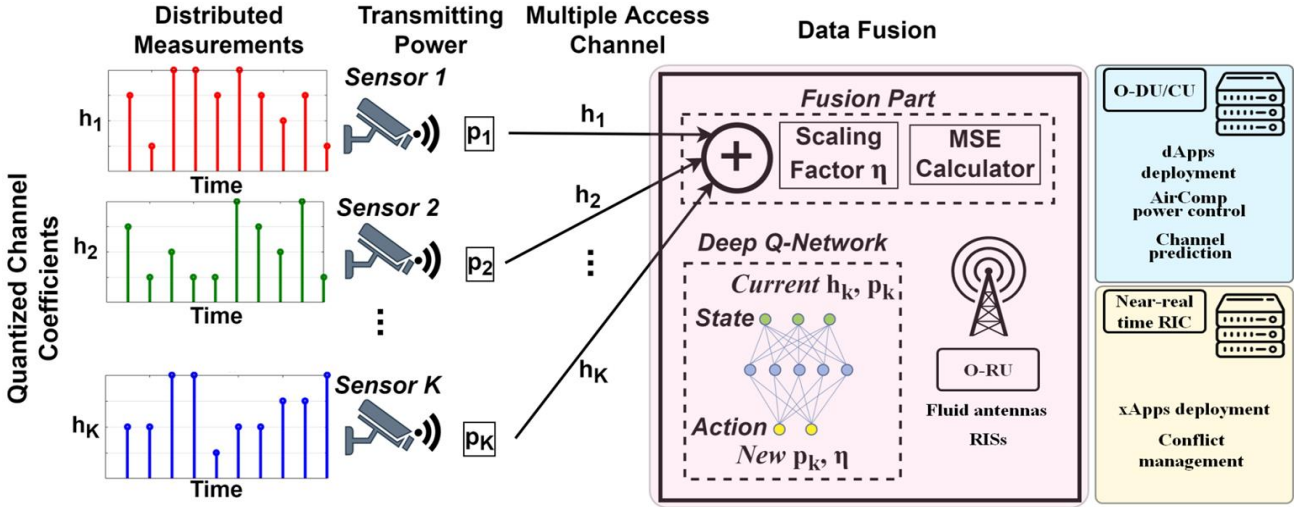
- 6G-LEADER's architecture includes closed-loop RAN control, based on Radio Intelligent Controllers (RICs)
- We will enhance the **two O-RAN closed control loops**, operating in non-real-time (**rApps**-based) and near real-time (**xApps**-based) with AI/ML techniques and semantic awareness towards:
  - Energy efficiency and EMF exposure reduction through FAs, RISs, AirComp, power control, hybrid beamforming, and optimum FR1/FR3 usage
  - Control and user plane radio-resource efficiency, using AI/ML and semantics
  - Computing resource efficiency by allocating tasks based on task descriptions and requirements, enabling Wireless for AI
- **Real-time RAN control** via distributed Apps (**dApps**), supporting a **third closed control loop** between the O-DU and O-RU in less than 10 ms
- The project will introduce a **Conflict Manager** within the near-RT RIC solving conflicts between the ML-driven and semantics-empowered xApps and dApps

6G-LEADER architecture (RF part)

- The **RF part of 6G-LEADER** comprises highly reconfigurable antenna concepts, based on fluid antennas (**FAs)** and reconfigurable intelligent surfaces **(RISs)**
  - **Benefit**: RAN adaptation with increased degrees of freedom that is not possible in current 5G deployments
  - FAs provide agility and responsiveness at the transmitter side, allowing for on-the-fly adjustments to signal transmission characteristics based on network dynamics and user requirements.
  - RISs fine-tune the wireless propagation environment, optimising signal paths, and mitigating interference and fading

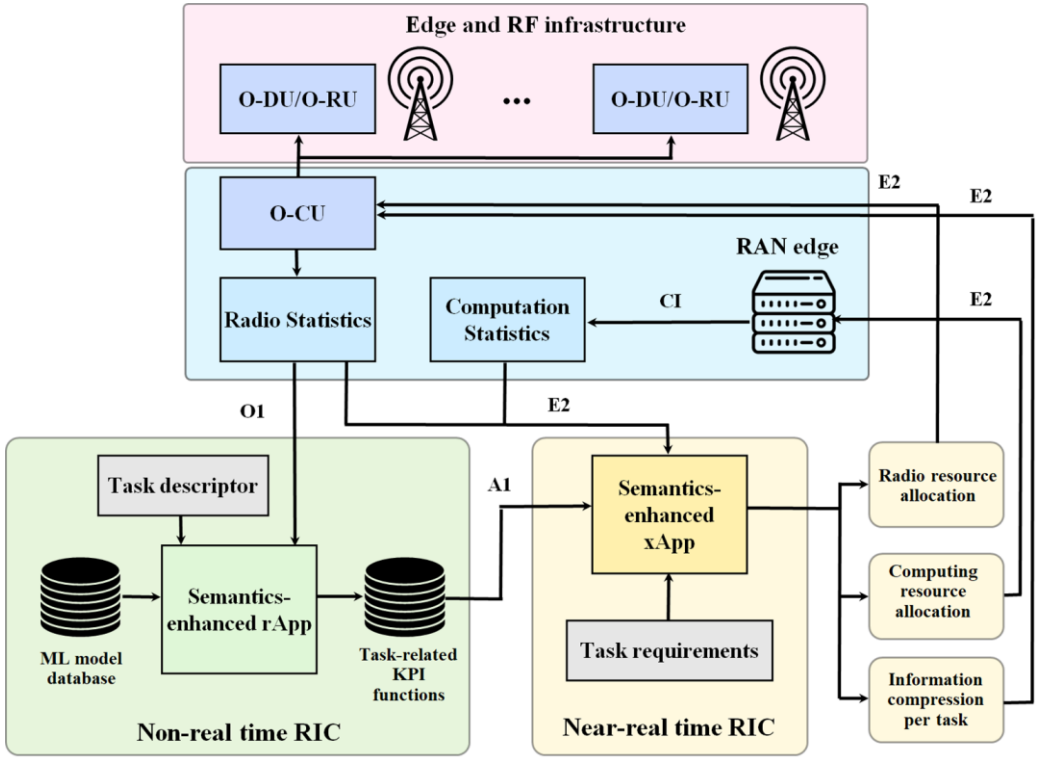
6G-LEADER architecture (Wireless for AI)

- **AirComp-based Wireless for AI** leverages the superposition property of multiple access channels, allowing simultaneous transmissions from multiple devices towards the O-RU
  - **Benefit**: Transition from "compute-after-communicate" to "compute-when-communicate"
- Two-step process:
  - The server, located at the O-RU receives distributed model updates transmitted by devices over a MAC and uses averaging functions to update the global model
  - The updated global model is broadcasted to edge devices for updating using local data



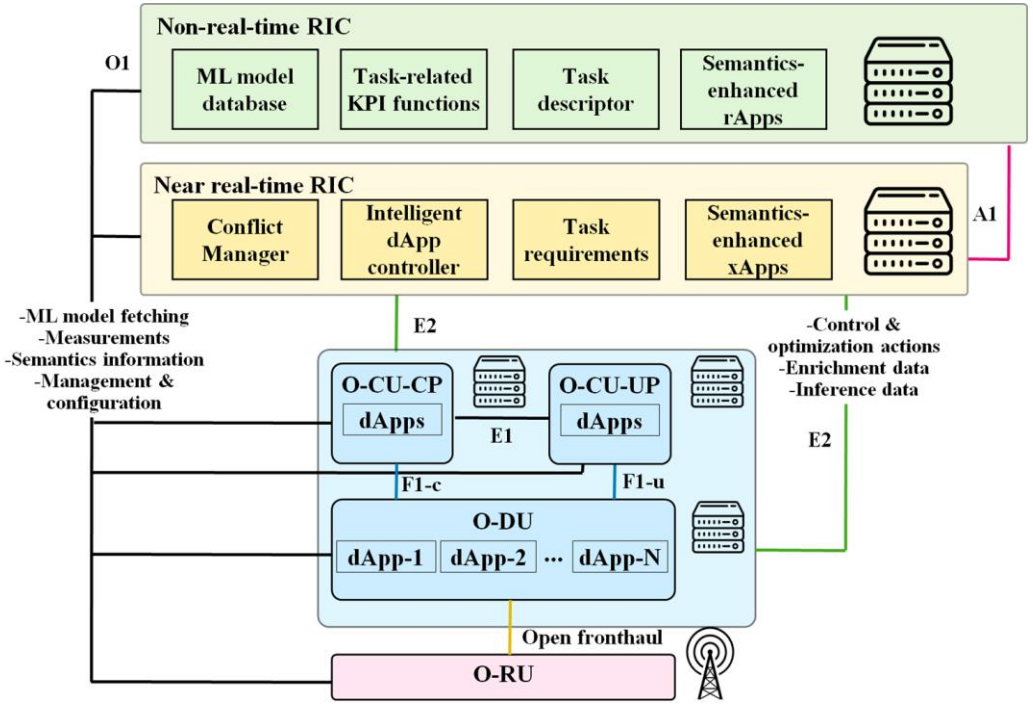
6G-LEADER architecture (Semantics)

- **Semantics integration in O-RAN** enhancing dApps, xApps, rApps
- **Benefits**:
  - Reduced communication overheads due to information filtering and compression
  - Enhanced multi-access edge computing and RAN reconfiguration
- Semantics-aware tasks consist of **Task Descriptor (TD)** and **Task Requirements (TR)** fields
  - TD defines the requested ML service, the ML model to be employed from the ML model database and the ML target classes
  - TR includes latency and accuracy requirements, affected O-RUs, number of requested UEs, and number of inference tasks per second by the UEs



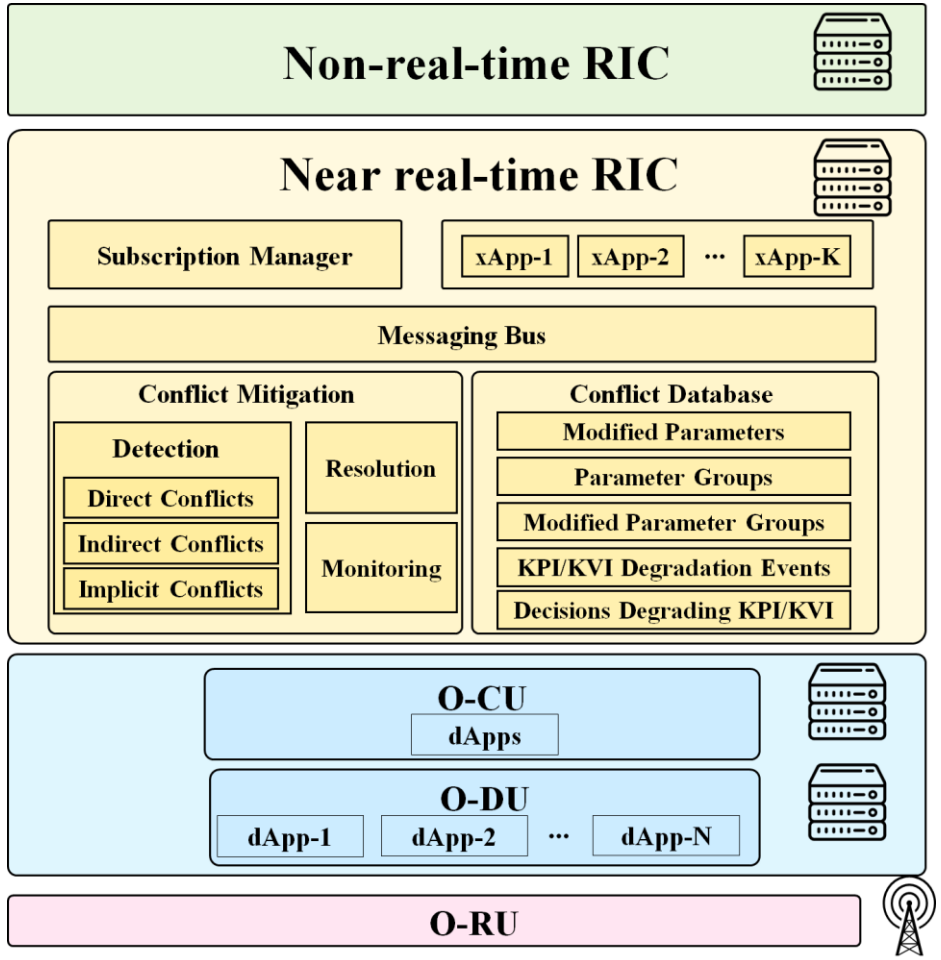
6G-LEADER architecture (dApps)

- 6G-LEADER will offer **dApps**, operating at sub-10 ms timescales
- **Benefit**: Real-time inference, supporting RAN functionalities beyond current O-RAN architectures
- Similar to xApps and rApps, dApps adopt a containerized architecture for:
  - Effectively managing the dApps life cycle (deployment, execution, and termination)
  - Simplifying the integration and use of new or updated functionalities through S/W updates
  - Establishing an abstraction level where the O-CUs, O-DUs, and O-RUs communicate reconfiguration parameters and functionalities, enabling dApps to control RAN parameters
  - Implementing H/W-independent dApps and standalone O-RAN applications



6G-LEADER architecture (Conflict Manager)

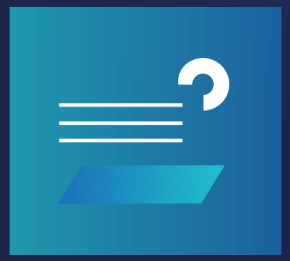
- 6G-LEADER includes a **Conflict Manager**, operating across the different control and optimisation loops
- **Benefit**: The impact of direct, indirect and implicit conflicts is mitigated
- For xApps, this component handles potential conflicts as xApps may implement conflicting configurations at different optimisation goals
- Deploying dApps requires conflict mitigation to identify conflicts among xApps, and dApps
  - Pre-action conflict resolution for directly observable conflicts between different applications, e.g. when two applications attempt to control the same parameter
  - Post-action verification for Implicit conflicts, where two or more applications control different parameters indirectly affecting the same set of KPIs/KVIs



REAL WORLD VALIDATION THROUGH PoCs

Demonstrating the feasibility and impact of 6G innovations in real-life deployments

PoC 1



XR and UAV seamless real-time interaction

PoC 2

Enhanced Mobile Broadband Experience

PoC 3

AI/ML Trainable 6G RIC Conflict Manager: Energy Efficiency & Critical Services

PoC 4

Wireless for AI based on AirComp and empowered by semantically-aware dApps/xApps

PoC 5

AI/ML-aided enhanced multiple access, integrating low-EMF FAs in the FR1/FR3 bands

OPEN FLOOR

Questions?

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Thank You

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