RISE-6G

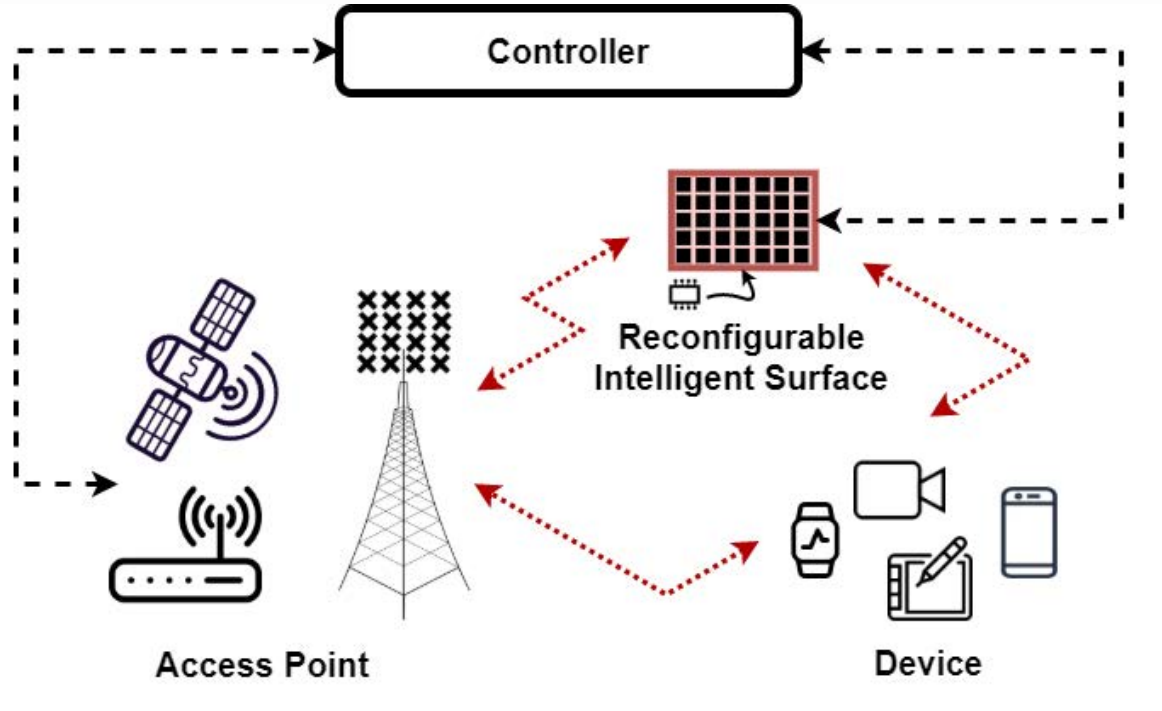
Reconfigurable Intelligent Sustainable Environments for 6G Wireless Networks

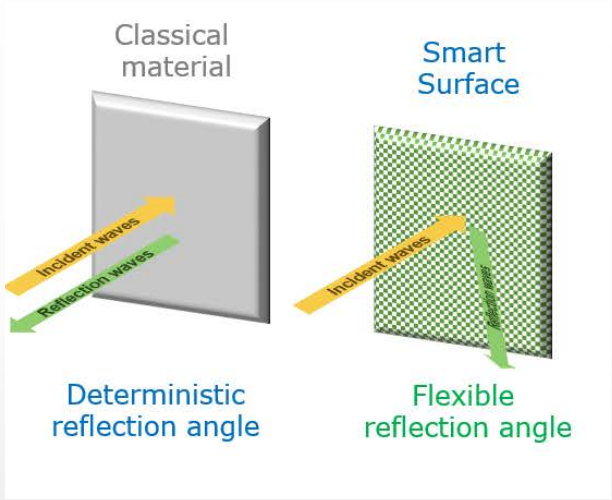
EuCNC 2023 @ Gothemburg

June 6, 2023

Reconfigurable Intelligent Surfaces for Smart Radio Environments

- *Definition:* Reconfigurable Intelligent Surfaces (RISs) are man-made nearly passive surfaces of electromagnetic material that are electronically controlled





"RIS is a new type of system node with reconfigurable surface technology, where its response can be adapted to the status of the propagation environment through implicit or explicit control signalling"

How to design and control a reconfigurable intelligent surface while enhancing network communication and localization capabilities?

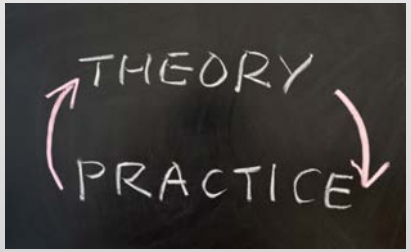
Project Overview

- **Vision:** Reconfigurable Intelligent Surfaces (RIS) technology to achieve *intelligent*, *sustainable* and *dynamically programmable* wireless environments.

- **Expectation:** RISE-6G project **actively participates** in the main standardization bodies and bring its technically advanced vision into the planned industrial exploitation

This will secure the **European technology leadership**, supporting the creation of new European-conceived service and business opportunities in the B5G/6G global race

- **Technical Approach**: bring "**Reconfigurable Intelligent Surfaces**" into conventional wireless networks by managing expected and novel technical challenges to meet operators' and verticals' needs



  - Theoretical approaches to show the validness of the technology
  - Two different field-trials to demonstrate the feasibility of considered methodology

Consortium

Education, Research Institutes (7)

Coordinator

cea

cnit

cnrs

AALBORG UNIVERSITY

CHALMERS UNIVERSITY OF TECHNOLOGY

HELLENIC REPUBLIC
National and Kapodistrian University of Athens
EST. 1837

University of Nottingham
UK | CHINA | MALAYSIA

Manufacturers, Telecom Operators and Technology Providers (4)

NEC

Technical Manager

orange

TIM

GREENERWAVE

Verticals (2)

STELLANTIS

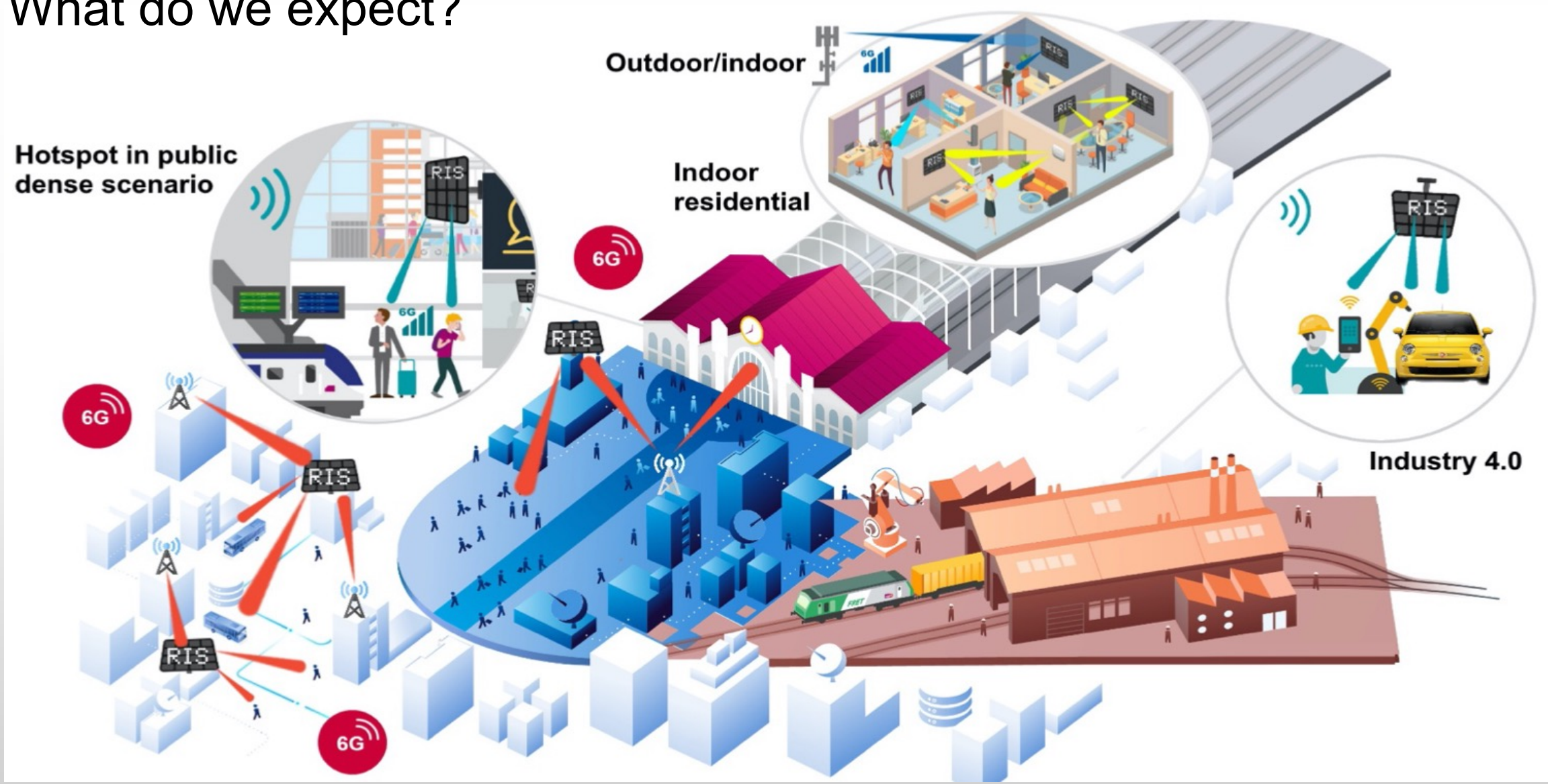
CRF

Innovation Manager

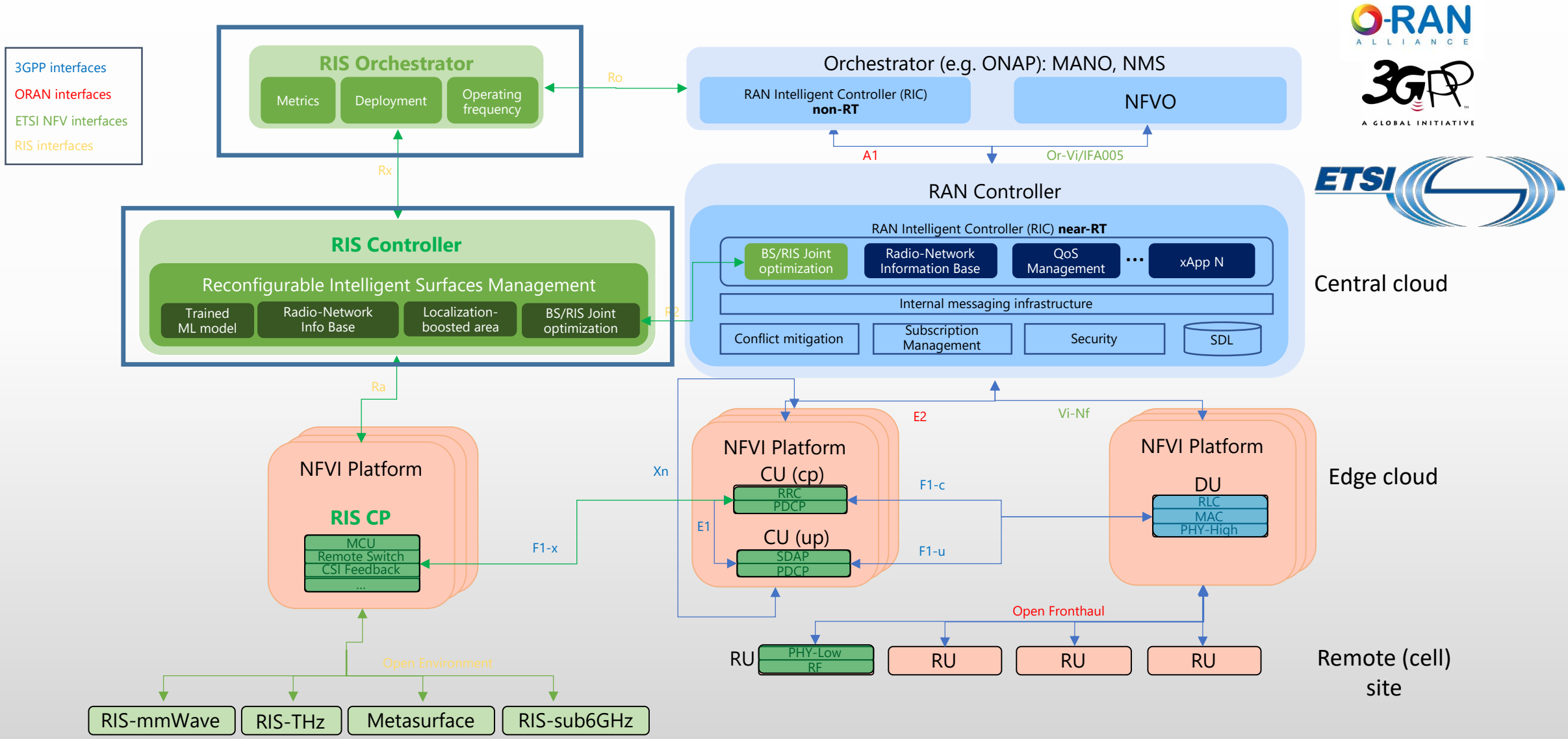
SNCF

Getting into the future

What do we expect?



Project Achievements: Architecture Impact

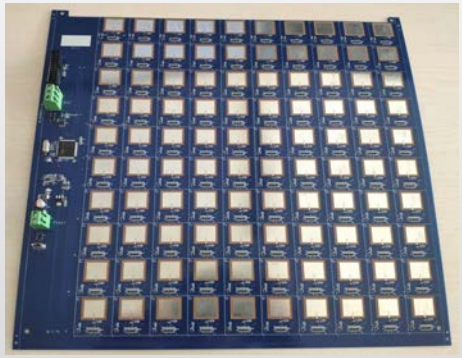


Project Achievements: Available RIS equipment

- Design, Building and Validation of RIS
- Different frequency bands (S-band, Ka-band, V-band, D-band)

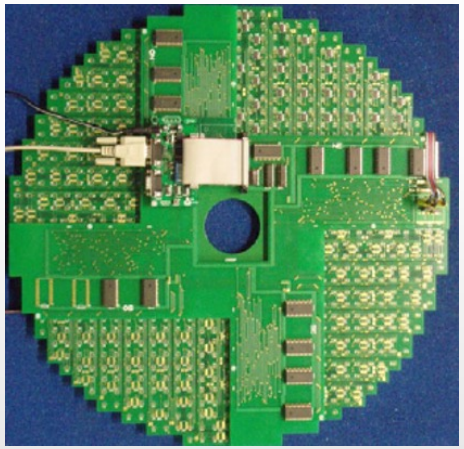
Pin diode
Frequency: 27.31GHz

CEA-LETI



NEC

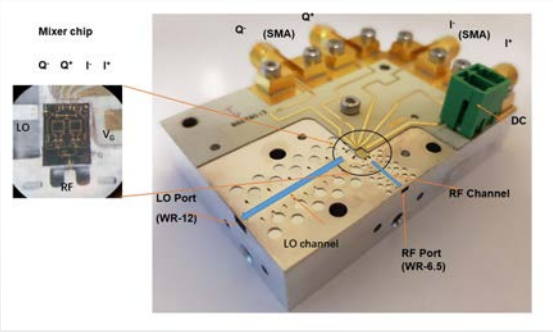
RF-Switch
Frequency: 5.3GHz



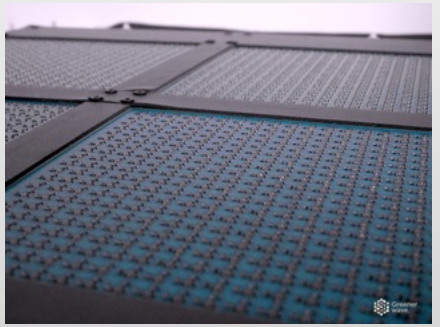
Varactor
Frequency: 5.2GHz

ORANGE

BiCMOS
Frequency: 145GHz



CHALMERS



Pin diode
Frequency: 27.31GHz

GREENERWAVE

Project Achievements: Communication and Dissemination

2021 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit): 6G Enabling Technologies (6ET)

Wireless Environment as a Service Enabled by Reconfigurable Intelligent Surfaces: The RISE-6G Perspective

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***Abstract*—The design of 6th Generation (6G) wireless networks points towards flexible connect-and-compute technologies capable to support innovative services and use cases. Targeting the 2030 horizon, 6G networks are poised to pave the way for sustainable human-centered smart societies and vertical industries, such that wireless networks will be transformed into a distributed smart connectivity infrastructure, where new terminal types are embedded in the daily environment. In this context, the RISE-6G project aims at investigating innovative solutions that capitalize on the latest advances in the emerging technology of Reconfigurable Intelligent Surfaces (RISs), which offers dynamic and goal-oriented radio wave propagation control, enabling the concept of the *wireless environment as a service*. The project will focus on: *i*) the realistic modeling of RIS-assisted signal propagation, *ii*) the investigation of the fundamental limits of RIS-empowered wireless communications and sensing, and *iii*) the design of efficient algorithms for orchestrating networking RISs, in order to implement intelligent, sustainable, and dynamically programmable wireless environments enabling diverse services that go well beyond the 5G capabilities. RISE-6G will offer two unprecedented proof-of-concepts for realizing controlled wireless environments in near-future use cases.**

I. Introduction

The 5th Generation (5G) of wireless networks is at an early deployment stage, providing a single platform for a variety of services and vertical applications [1]. However, novel concepts as well as new services and related use cases, incorporating new enabling technologies to satisfy future needs [2], are already being identified for addressing the current predictions for the performance requirements of the next 6th Generation (6G) of connect-and-compute networks around 2030. Among those predictions belong the up-to-10 Gbps/m^3 capacity, 100μs latency, 1 Tb/J energy efficiency, and 1 cm localization accuracy in 3 Dimensions (3D) [3], which will need to be offered individually or in various combinations.

As a common view, wireless networks are designed considering the signal propagation environment as a black box that cannot be artificially controlled. This would exacerbate the simultaneous fulfilment of fundamentally conflicting targets, such as boosting quality of experience for different types of services at different places of *intended users* (e.g., ultra-high data rate in hotspots, extreme reliability in factories, and massive connectivity in ultra dense areas), limiting the signal to *non-intended users* (e.g., users' ElectroMagnetic Field Exposure (EMFE) and eavesdroppers), and limiting the network and device energy consumption. Recently, there has been a surge of interest in Reconfigurable Intelligent Surfaces (RISs) [4] as hardware-efficient and highly scalable means to realize desired dynamic transformations on the signal propagation environment in wireless communications [5], [6]. RISs are man-made surfaces with thousands of reconfigurable elements, which can support various functionalities (e.g., control multi-path geometry for localization, limit EMF exposure, mitigate obstructions, and extend radio coverage in dead zones). The RIS technology is envisioned to coat objects in the wireless environment [7] (e.g., building facades and room walls), and can operate either as a reconfigurable beyond-optics reflector [8], or as a transceiver when equipped with active transmit [9] and receive [10] radio-frequency elements.

The modeling of signal propagation in such novel RIS-empowere conditions appears very challenging [11], [12] involving a number of algorithmic solutions. In [13], a free-space model based on an impedance matrix formalism for RISs with discrete elements has been presented, while the corresponding optimization of the RIS settings for communication purposes is largely disussed in [4], [12]. Additional research directions focus on the challenging task of channel estimation in RIS-empowered communication systems, where multiple users and multiple RISs with large numbers of elements and non-linear hardware characteristics are considered [14]. The relevant literature includes pilot-assisted cascade channel estimation approaches [15] as well as deep learning frameworks [16] that overcome the need for explicit channel estimation.

RISs will also have applications beyond communication,

Communication

RISE-6G Leaflets
Demos
Newsletters
5GPPP Arch WG

Dissemination

100+ Publications
1000+ Citations
30+ Collaborations among partners

Standardization

24 contributions:
22 to ETSI RIS
2 to 3GPP

Exploitation

2 Patent Applications
5 RIS Prototypes

Impact Metrics

Web: 5500+ visits
LinkedIn: 400+ members
Twitter?

Europäisches Patentamt
European Patent Office
Office européen des brevets

O-RAN ALLIANCE

ETSI

3GPP™ A GLOBAL INITIATIVE

Instagram

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