ARIADNE

5G PPP

Newsletter

Issue 2020/1

FIRST ARIADNE PRESS RELEASE

ARIADNE reference system concept established

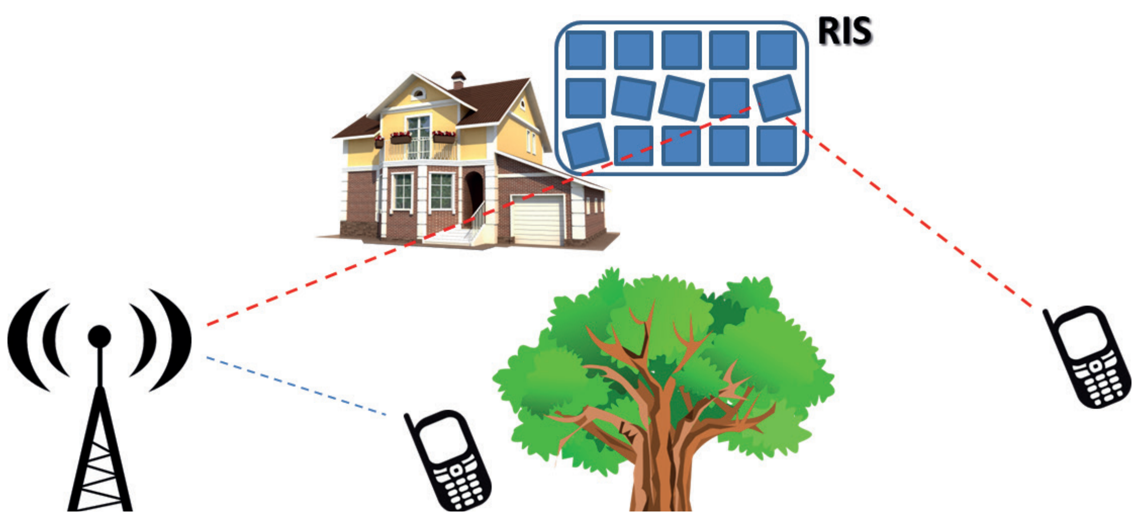
ARIADNE - Artificial Intelligence Aided D-band Network for 5G Long Term Evolution – is a three years Horizon 2020 project started in November 2019, aiming to enable spectral efficient, high-bandwidth, and intelligent wireless communications. After six months on its life time, the ARIADNE project consortium defined a reference system model as base for future investigations which will be carried out within the project scope. The ARIADNE system concept includes three general use cases and corresponding scenarios, allowing detailed system modeling and designed as well as further planned research activities.

Brief Scope

Currently used 6 GHz bands, in the mobile communications, are reaching their limits to respond to always more demanding services and applications as well as number of served end users and devices. Therefore, the new communications networks are being designed to utilize higher frequency bands and with it increase the overall network capacity and data rates, such as the D band (130 – 174.8 GHz) mainly used for wireless backhaul and fronthaul which are also considered for short range communications in radio access networks and are considered in ARIADNE.

The D bands enable LOS (Line of Sight) communications in outdoor environments, where NLOS (Non LOS) communications are possible in indoor environments, due to in some cases convenient signal reflections. On the other side, the outdoor NLOS communications is difficult to achieve, due to changing propagation characteristics caused by weather conditions (rain, fog), or unpredictable signal reflections. A kind of conventional NLOS communications can be ensured by deploying so-called relay nodes, which are actively repeating received signal, so that certain areas can be covered. However, the relays as active network elements need power supply leading to increased power consumption of the overall communications system.

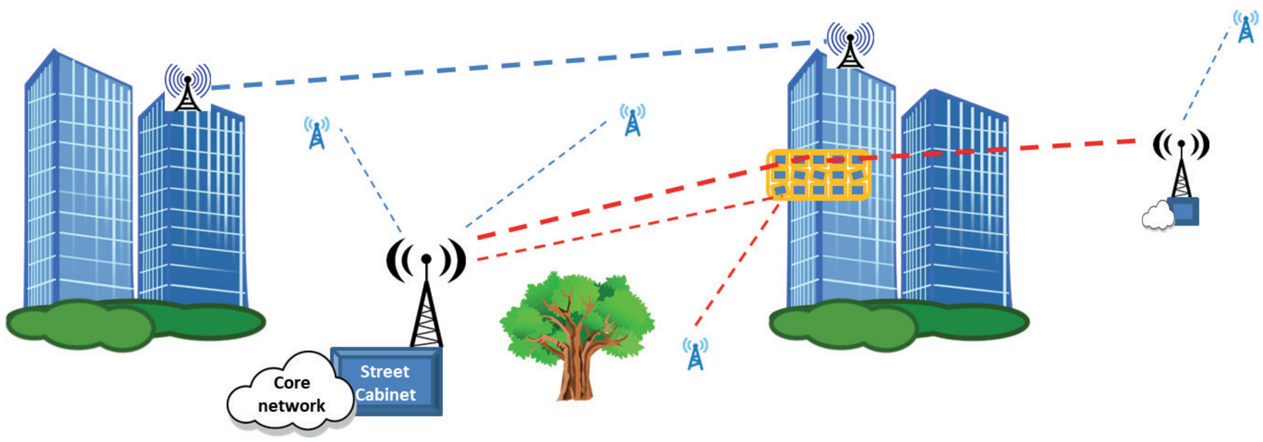
This is one of the reasons to look for passive elements serving as specular reflectors, e.g. dielectric mirrors. However, such passive reflectors are non reconfigurable, which means that directions they are reflecting the radio signals are not dynamically adaptable, so that



RIS attached to a house enabling communications avoiding obstacles dynamic beam shaping is not possible. For this, it is needed to be able to change angels of the reflectors, so that the beams can be directed as needed. This requirement can be fulfilled by application of so-called Reconfigurable Intelligent Surfaces (RIS), which are made of materials with appropriate characteristics to arbitrarily shape electro-magnetic wave front, to reflect, refract, or absorb the waves as needed, which can be dynamically controlled to support specific communications requirements.

Use Cases

To investigate usage of the D bands in wireless access communications networks, the ARIADNE laid down the following three use cases and corresponding scenarios, starting from a scenario focused on exploring the targeted frequency range – D Band, followed by consideration of RIS application in a rather static scenario, in the second use case introducing scenarios with dynamic reconfiguration of RIS, and finally highly demanding scenarios enabling ad-hoc connectivity and networking. Note that ARIADNE is not intending to implement the presented scenarios in practice and will rather use them for channel characterization and modelling, antenna and trans-receiver design, and investigation on RIS application.



Backhaul/fronthaul network with and without RIS

Outdoor backhaul/fronthaul fixed topology network

This use case includes two scenarios:

- Long-range LOS rooftop point-point backhauling, using the high frequency spectrum (D Band) – a simple scenario without using RIS and
- Street-level point-point & point-multipoint backhauling/fronthauling – also a static scenario, but enabling NLOS communications via RIS (e.g. attached at large building), which might be frequently found as a typical mobile network set-up in urban areas

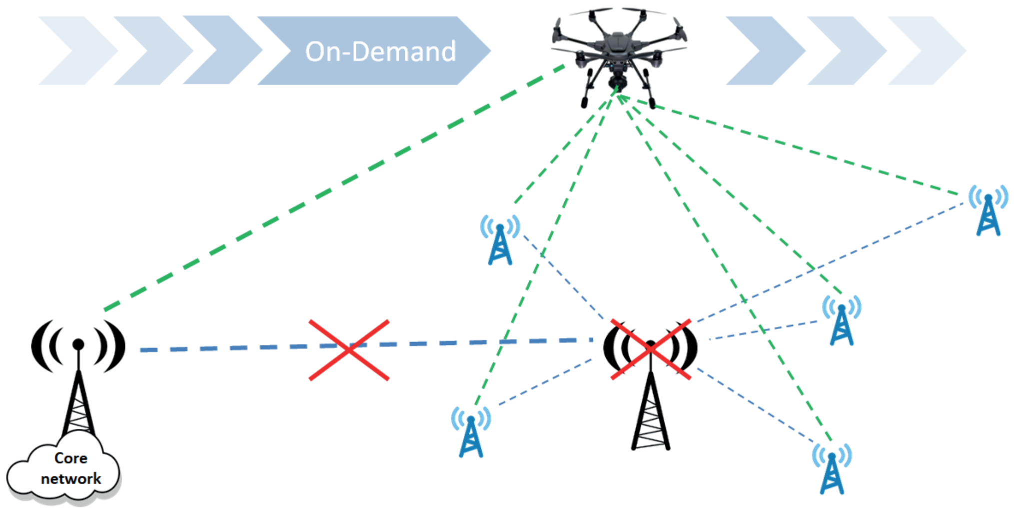
RIS based NLOS connectivity

This use case is considering application of RIS, which are dynamically reconfigured to track slowly moving users and devices, to enable communications responding to specific requirements of currently demanded applications and services.

Here, the following two specific scenarios are defined for investigation in ARIADNE:

- Advanced indoor connectivity – where RIS assisted communications is establishing alternative LOS hops via RIS, which are attached on the walls within an indoor environment (home, school classes, production halls, etc.)
- Data kiosk scenario – where a large amount of data so beamed to slowly moving users/devices during a limited time period, enabling download of required data, e.g. at particular point of interests in the cities close to touristic attractions, cars queuing in front of tool stations, users located in buses and trains during stops at stations, etc.

Ad-hoc connectivity in moving network topology



Fronthauling topology (blue) replaced by alternative links (green) by using a drone

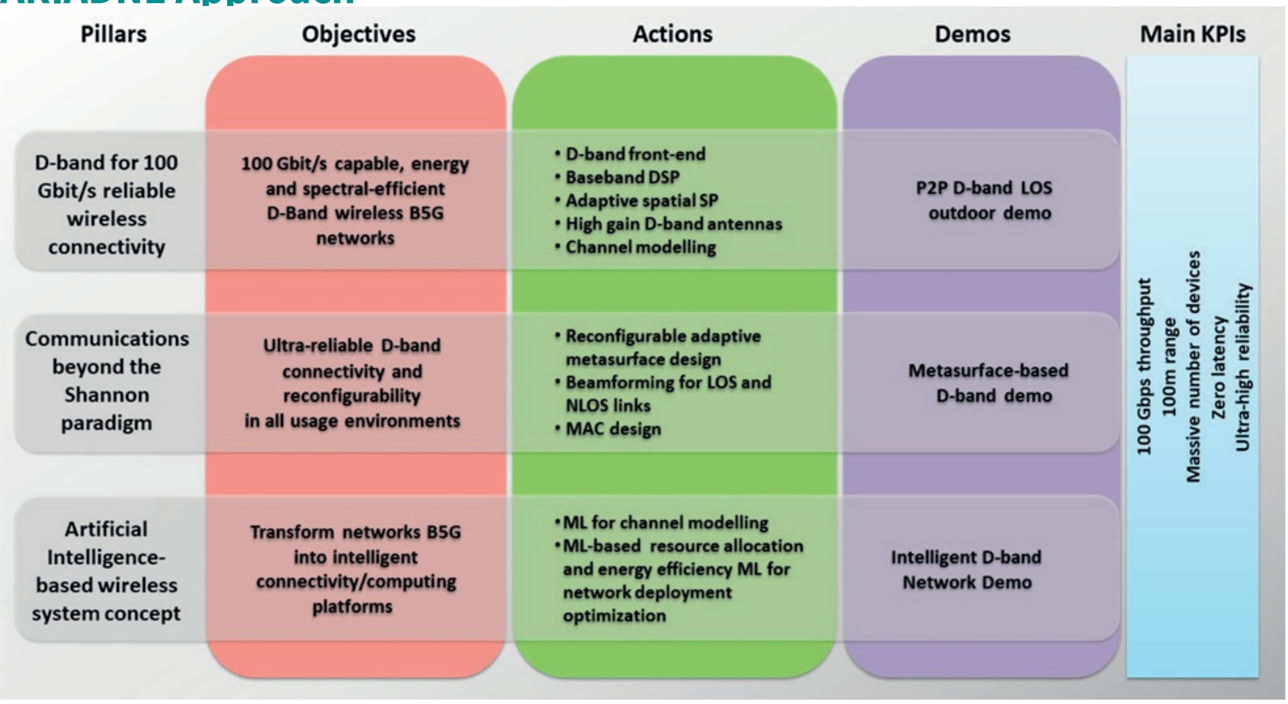
Here, the following specific scenarios are considered:

- Dynamic front/backhauling for 5G access nodes & repeaters - e.g. applicable to network topology where due to a failure of one of the antennas or base stations, a drone (equipped with antenna / base station) is used to repairing the failed connections with other antennas / small base stations. The drone can hover temporarily in the affected area or land, for example on nearby rooftops, to bridge disconnected network devices.
- V2V and V2X connectivity – Vehicle to Vehicle and Vehicle to everything connectivity, where the moving network topology emerges from current traffic conditions – e.g. number of moving cars within a certain area are communicating among themselves and with the road infrastructure.

RIS Control and Management – Challenges in front of ARIADNE

Nowadays and future communications services and applications will have very high requirements on the networks, demanding a highly dynamic control of the RIS based wireless network infrastructure. Here, a full optimization for dynamic control of the RIS based networks could be achieved by accurate mathematical models, which are however very complex and therefore not feasible to be efficiently used for the purpose.
On the other hand, Artificial Intelligence (AI) technologies, in particular Machine-Learning (ML) techniques learning from a large amount of data, without being explicitly programmed, might be able to ensure network respond to current data traffic situations, where the RIS structure is configured as needed as well as dynamically changed in accordance with the changing demand of currently used communications services and applications. Furthermore, AI/ML should also be able to predict overall situation in a network / network segment / and react by configuring dynamically the RIS stricter as needed.

ARIADNE Approach



ARIADNE objectives and activities

Project Consortium

This project has received funding from the European Horizon 2020 Programme
under grant agreement number 871464 – ARIADNE