ARtificial Intelligence Aided D-band Network for 5G long term Evolution

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ARIADENE outline

<table>
<thead>
<tr>
<th>Topic</th>
<th>ICT-20-2019</th>
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<tbody>
<tr>
<td>Duration</td>
<td>36 Months</td>
</tr>
<tr>
<td>Start Date</td>
<td>1/11/2019</td>
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<td>Consortium</td>
<td>11 Beneficiaries and 1 third Party from 5 European countries</td>
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ARIADNE objectives

• Objective-1: To design 100 Gbit/s capable, energy and spectral-efficient wireless B5G networks based on D-Band connectivity

• Objective-2: To provide ultra-reliable D-band connectivity and reconfigurability in all usage environments

• Objective-3: To transform networks beyond 5G to intelligent platforms integrating ultra-reliable connectivity and highly-efficient computing
ARIADNE approach

ARIADNE proposes a novel hybrid wireless system architecture, which combines the benefits of **D-band** and **Artificial Intelligence**, optimised by means of:

- **novel radio technologies for D-band connectivity** enabled by transceivers capable of electronic beam steering and reflected connectivity;
- **intelligent surfaces** (*metasurfaces*) used to enable tunable or switchable reflections and overcome limitations in obstructed links and NLOS scenarios;
- a **novel Communication Theory framework beyond the Shannon paradigm**, according to which the environment itself is made reconfigurable and can assist to establishing reliable communications;
- **propagation characterisation in the D-band** for indoor/outdoor, LOS/NLOS;
- **Machine Learning-based approaches** for ultra-reliable connectivity, optimal and adaptive RRM and E2E network optimisation (resource allocation, routing, etc).

"5G Experimentation Facilities and Vertical Trials: Current Status and Future Perspectives" 5G Workshop, October 14, 2020
ARIADNE Use Cases

Use Case 1 – Backhaul/Fronthaul networks of fixed topology

Use Case 2 - Advanced NLOS connectivity based on metasurfaces

Use Case 3 – Adhoc connectivity in moving network topology
Use Case 1 – Backhaul/Fronthaul networks of fixed topology

- Outdoor environment with LOS or NLOS conditions
- No mobility
- Use of metasurfaces to avoid signal blocking
- Optimal routing, adjustment of metasurface parameters
- KPIs: Throughput, Latency, Reliability, Availability
Use Case 2 - Advanced NLOS connectivity based on metasurfaces

- Indoor and outdoor environment
- Up to low-to-moderate mobility
- NLOS connectivity through reconfigurable metasurfaces
- Optimal beamforming, user tracking
- KPIs: Throughput, Latency, Availability
Use Case 3 – Adhoc connectivity in moving network topology

- Outdoor environment
- Mobile nodes assist network connectivity
- Low-to-moderate mobility
- Demanding beamforming, tracking and alignment
- KPIs: Throughput, Latency, Reliability, Availability
ARIADNE demonstrators

• Point-to-Point LOS demonstrator (HW demo)
• Metasurface NLOS demonstrator (HW demo)
• Intelligent D-band network demonstrator (SW demo)
• Demonstrations will be realized around mid-2022
COMPONENTS
• Spectral efficient Baseband Unit, polarization diversity, FDD operation
• Highly integrated transceiver RF-frontend
• High-gain antennas

TARGET
• Error free long-range LOS outdoor communication at the D-band (> 100 m)
Metasurface NLOS demonstrator (1)

D-band Metasurface mounted on a wall

RF Front-end Antenna Reflected beam Antenna RF Front-end

LOS link obstructed; NLOS rays weak to accommodate a reliable communication
COMPONENTS

• RF front-end
• Passive metasurface acting as a reflector
• Low-cost reconfigurable reflect array antenna

TARGET

• Showcase an alternative propagation route in NLOS cases through reflection on a passive metasurface structure
Intelligent D-band (SW) network demonstrator

TARGET

- Validate machine learning algorithms for the D-Band network optimization
  - Simulate a dynamic D-Band network with time-varying traffic demands and channel conditions
  - Apply ML algorithms to adjust parameters (power and spectrum allocation) as well as reconfigure metasurface structures to optimize network performance
Thank You!

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