Overview of Ariadne Project

RapidMiner Research

21 to 22 October 2020

Presentation Layout

- Introduction to ARIADNE (an EU-H2020 5G-PPP project)
  - Partners
  - Vision Statement
  - RoadMap
  - List of Use Cases

- AI/ML Application Areas in ARIADNE
- Categories of AI/ML Application Areas
- Transferring Ariadne Experience to RapidMiner

5G PPP

ARIADNE

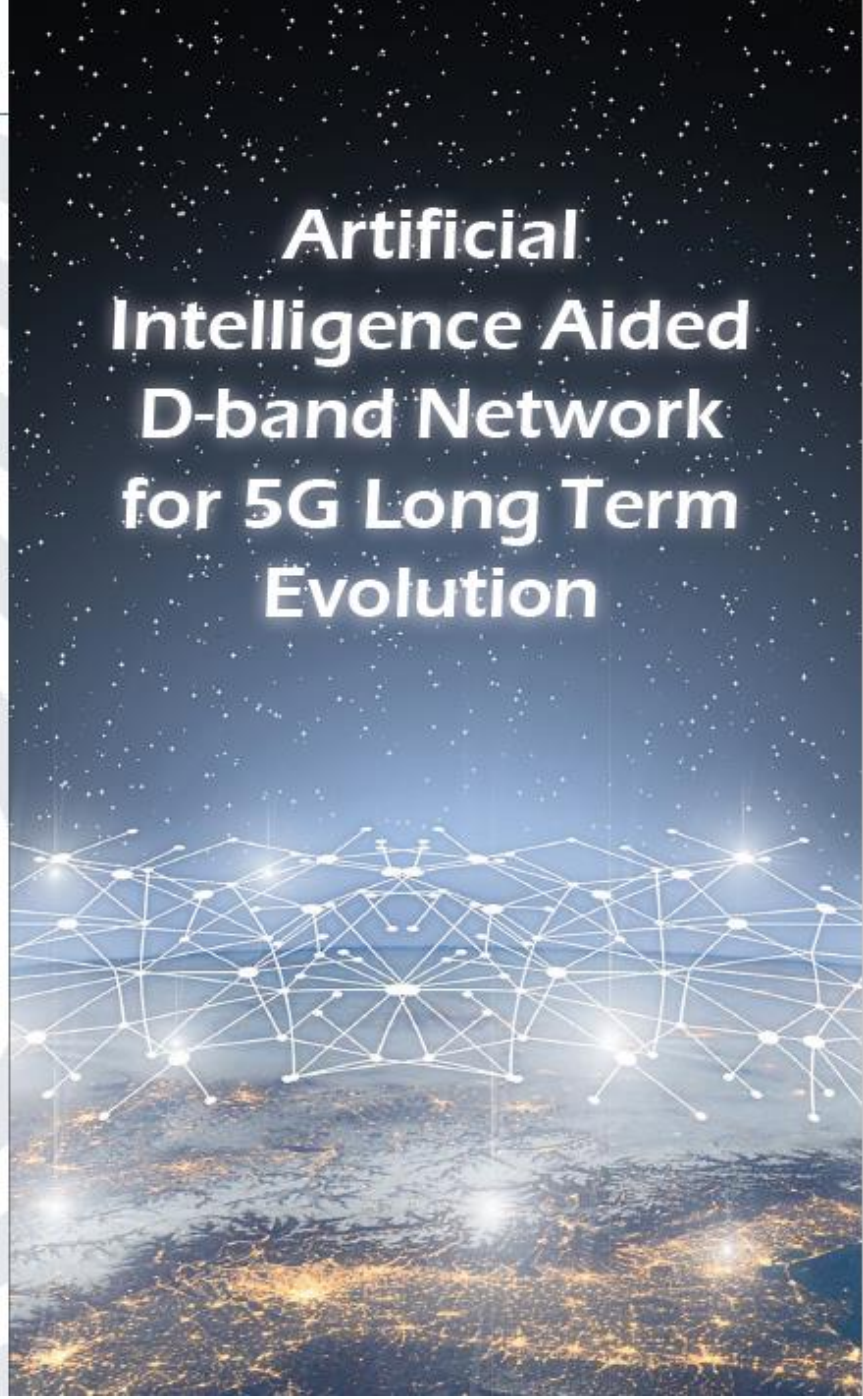
Coordinator
Dr. Halid Hrasnica
Eurescom, Heidelberg, Germany

Scientific and Technical Project Manager
Prof. Dr. Angeliki Alexiou
University of Piraeus Research Centre,
Athens, Greece

Website: https://www.ict-ariadne.eu
Twitter: @AriadneIct
Email: contact@ict-ariadne.eu

Partners

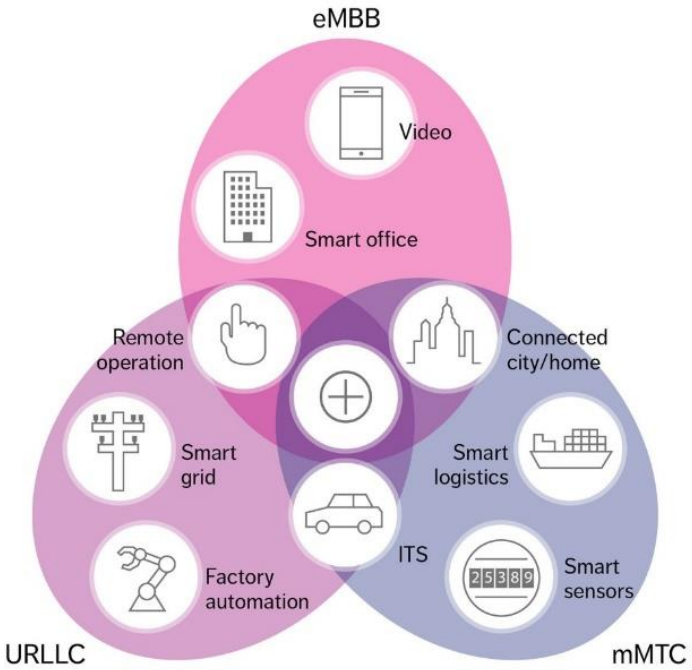
INTRACOM TELECOM
Fraunhofer IAF
cnrs
NOKIA
rapidminer
DEMOKRITOS
Telefónica
EURESCOM
Aalto University School of Electrical Engineering
UNIVERSITY OF OULU
POLITÉCNICA



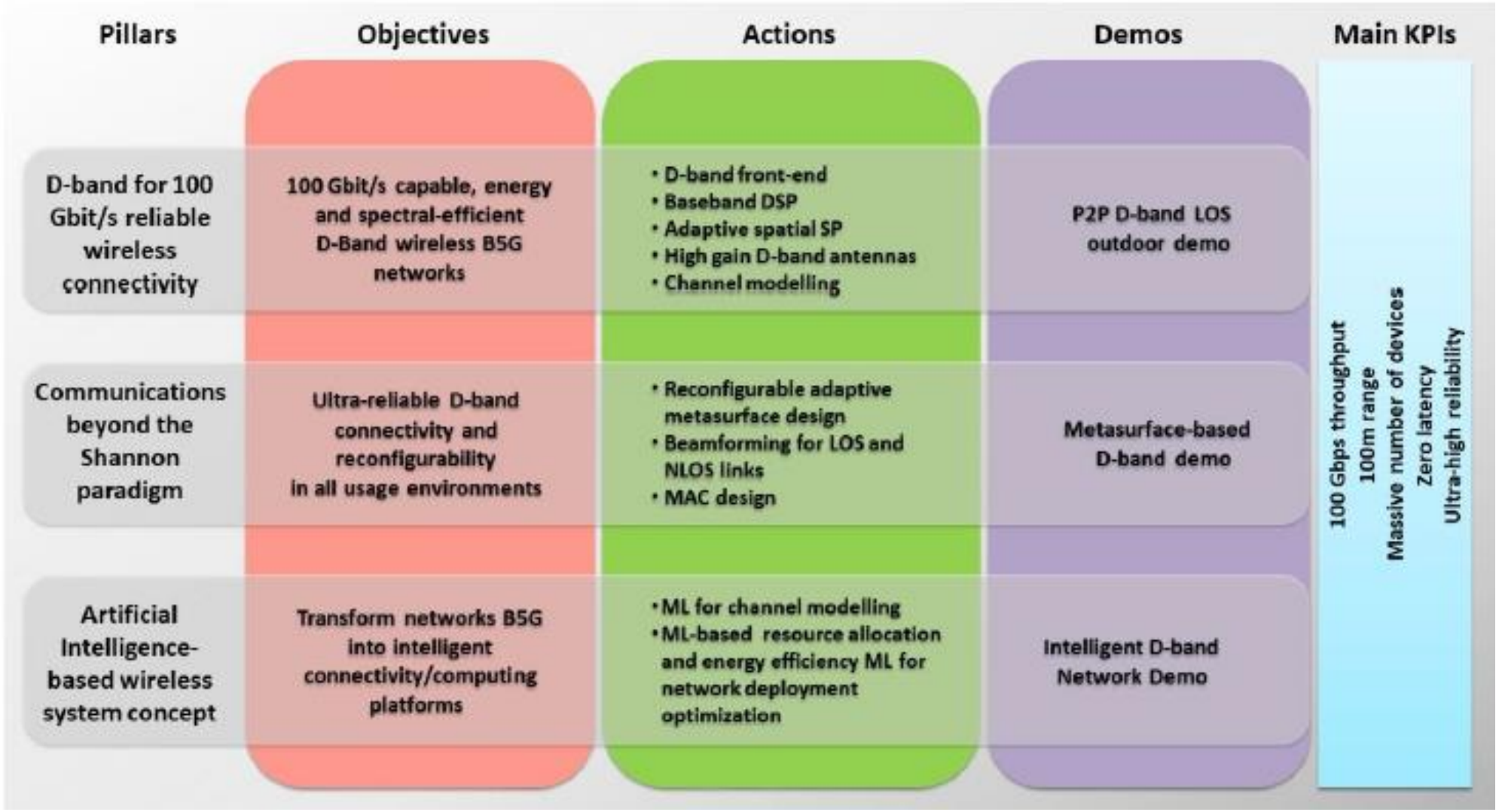
ARIADNE is a three years Research and Innovation action / project under the EU program Horizon 2020 (Grant Agreement no. 871464) started on 1 November 2019

ARIADNE – Vision Statement

***Ar**tificial **I**ntelligence **A**ided **D**-band **N**etwork for 5G Long Term **E**volution is a H2020 5G PPP project which aims to bring together **a novel high frequency radio architecture**, an advanced wireless **connectivity based on reconfigurable metasurfaces**, and an **enhanced network management supported by AI** to establish a new type of **intelligent communications system beyond 5G**.*

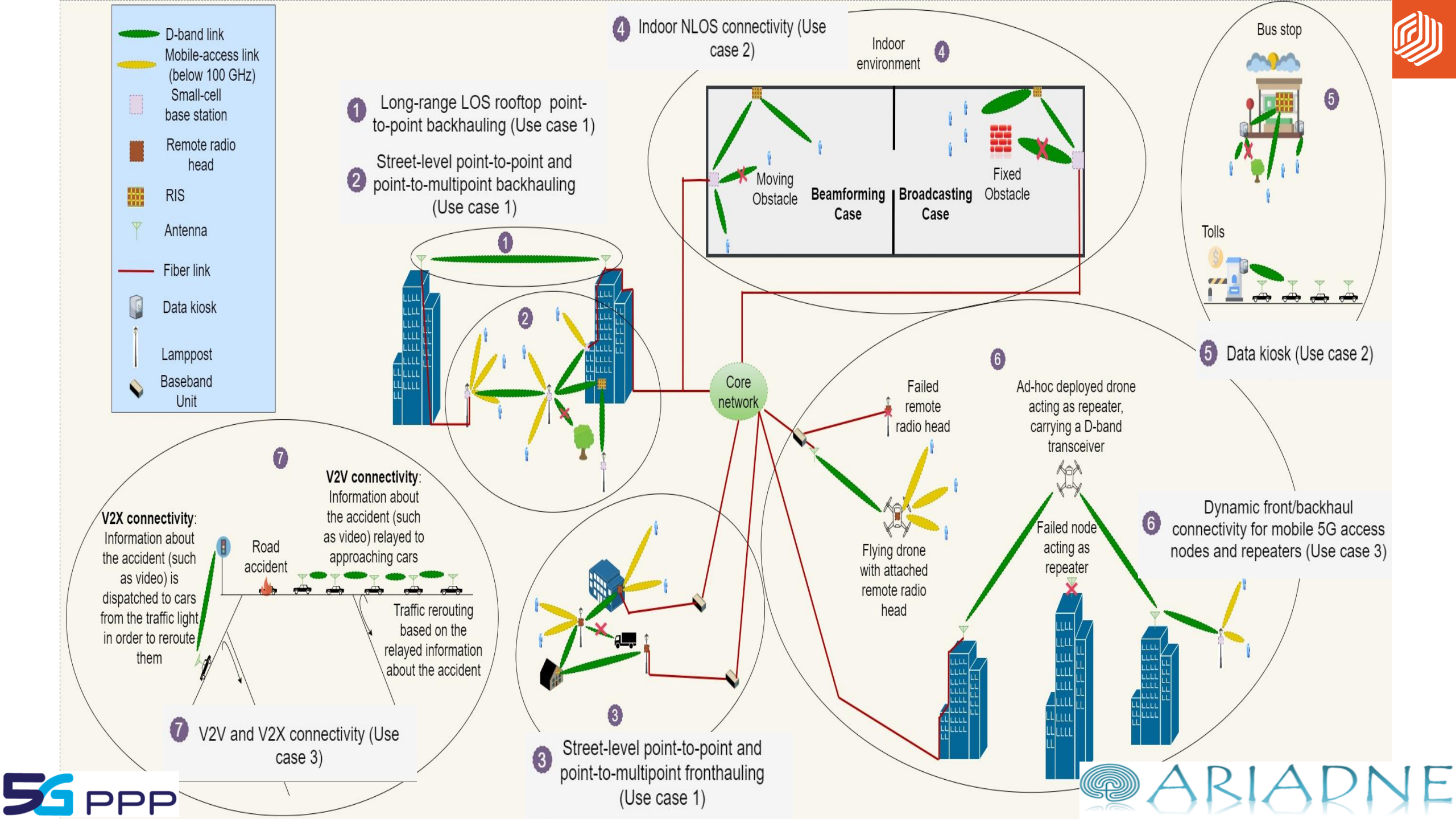


RoadMap: From Objectives to Actions



List of Use Cases

- **Use case 1**: Outdoor backhaul/fronthaul networks of fixed topology
  - Scenario 1: Long-range Line of Sight (LOS) rooftop point-to-point backhauling.
  - Scenario 2: Street-level point-to-point and point-to-multipoint backhauling/fronthauling.
- **Use case 2**: Advanced NLOS connectivity based on metasurfaces
  - Scenario 1: Indoor advanced Non-Line of Sight (NLOS) connectivity based on metasurfaces
  - Scenario 2: Data kiosk
- **Use case 3**: Adhoc connectivity in moving network topology
  - Scenario 1: Dynamic front/backhaul connectivity for mobile 5G access nodes and repeaters
  - Scenario 2: V2V and V2X connectivity


D-band link
Mobile-access link (below 100 GHz)
Small-cell base station
Remote radio head
RIS
Antenna
Fiber link
Data kiosk
Lamppost
Baseband Unit
1 Long-range LOS rooftop point-to-point backhauling (Use case 1)
2 Street-level point-to-point and point-to-multipoint backhauling (Use case 1)
4 Indoor NLOS connectivity (Use case 2)
Indoor environment
Moving Obstacle
Beamforming Case
Broadcasting Case
Fixed Obstacle
Bus stop
Tolls
5 Data kiosk (Use case 2)
Core network
Failed remote radio head
Flying drone with attached remote radio head
Ad-hoc deployed drone acting as repeater, carrying a D-band transceiver
Failed node acting as repeater
6 Dynamic front/backhaul connectivity for mobile 5G access nodes and repeaters (Use case 3)
V2V connectivity: Information about the accident (such as video) relayed to approaching cars
V2X connectivity: Information about the accident (such as video) is dispatched to cars from the traffic light in order to reroute them
Road accident
Traffic rerouting based on the relayed information about the accident
7 V2V and V2X connectivity (Use case 3)
3 Street-level point-to-point and point-to-multipoint fronthauling (Use case 1)

AI/ML Application Areas

- **Where do we apply AI/ML?**
  - **Channel modeling**
    - Estimating parameters of the channels
    - Profiling adverse effect of weather on channels
  - **Beamforming**
    - Assigning beams to users
    - Ray tracing (follow a mobile node) for pencil beams
    - Model behavior of RIS (Reconfigurable Intelligent Surface that uses Metasurface) for indoor and outdoor settings
    - Dynamically creating beams in Non-Line of Sight (NLOS) scenarios
  - **Network optimization**
    - Resource allocation and Scheduling in Line of Sight (LOS) scenarios to maximize aggregate data-rate & save energy)
    - Route finding in NLOS scenarios to maximize reliability of multiple links
    - Placement of radio network components to maximize coverage and signal strength using minimal base stations
    - Performing offline and online optimizations (for dynamic cases)
    - Optimize network load by diverting traffic to NLOS connections using RIS models.

Categories of AI/ML Methods

- **Predictive Analytics**
  - **Forecasting**
    - Demand for connections or data transmission rates at different time periods
    - Demand for energy consumption in the network
  - **Predicting**
    - Bottlenecks at different nodes and congestion in the network
    - Properties of a link: blockages, reliability, failure rate, service degradation (e.g., in terms of packet loss, effective radius, etc.)
    - Estimated parameters of a multi-path channel.
    - Attenuation level in signal quality due to weather affects.
    - Machine failures before they happen, to proactively prevent failure and save repair costs.
    - Movement (e.g. direction, angle) of user or mobile node
  - **Detecting**
    - Anomalous traffic flows

Categories of AI/ML Methods

- **Prescriptive Analytics**
  - What-If Analysis to derive insights
    - *Interact* with a predictive model to *understand* behavior of complex systems (such as a RIS or Metasurface)
    - *Exploit* predictive model by optimizing predictions for desired outcomes by injecting business constraints
    - Get optimal inputs (generate recipe)

- **Predictive Optimizations**
  - Resource allocation / Route scheduling
    - Include predictions from ML models within fitness function to get superior solutions
    - Include RIS as part of network
  - Dynamic environments: Real-time planning and optimization
    - Stochastic and non-stochastic variants.

Transferring Ariadne Experience to RapidMiner

- **Generating and Preparing Simulation Data**
  - For various use case scenarios

- **Future Work / Work in Progress**
  - Library
    - Of customizable Optimization Problems and Solutions
  - RapidMiner Extension
    - Constraint solving optimization - being developed in Ariadne for Telco (5G, Beyond5G, 6G) domains
    - Predictive and Prescriptive analytics functions
  - Web Demonstrator
    - To showcase offline and online optimization scenarios and solutions

THANK YOU VERY MUCH
PLEASE ALSO WATCH USE-CASE PRESENTATIONS

Dr. Edwin Yaqub

Senior Data Scientist

eyaqub@rapidminer.com

@byond2day

Ralf Klinkenberg

Founder & Head of Data Science Research

rklinkenberg@rapidminer.com

@RalfKlinkenberg

rapidminer

#1 Agile Predictive Analytics Platform for Today's Modern Analysts