ORCA-PROJECT.EU

USING DEEP LEARNING AND RADIO VIRTUALISATION FOR EFFICIENT SPECTRUM SHARING AMONG COEXISTING NETWORKS

Presenter

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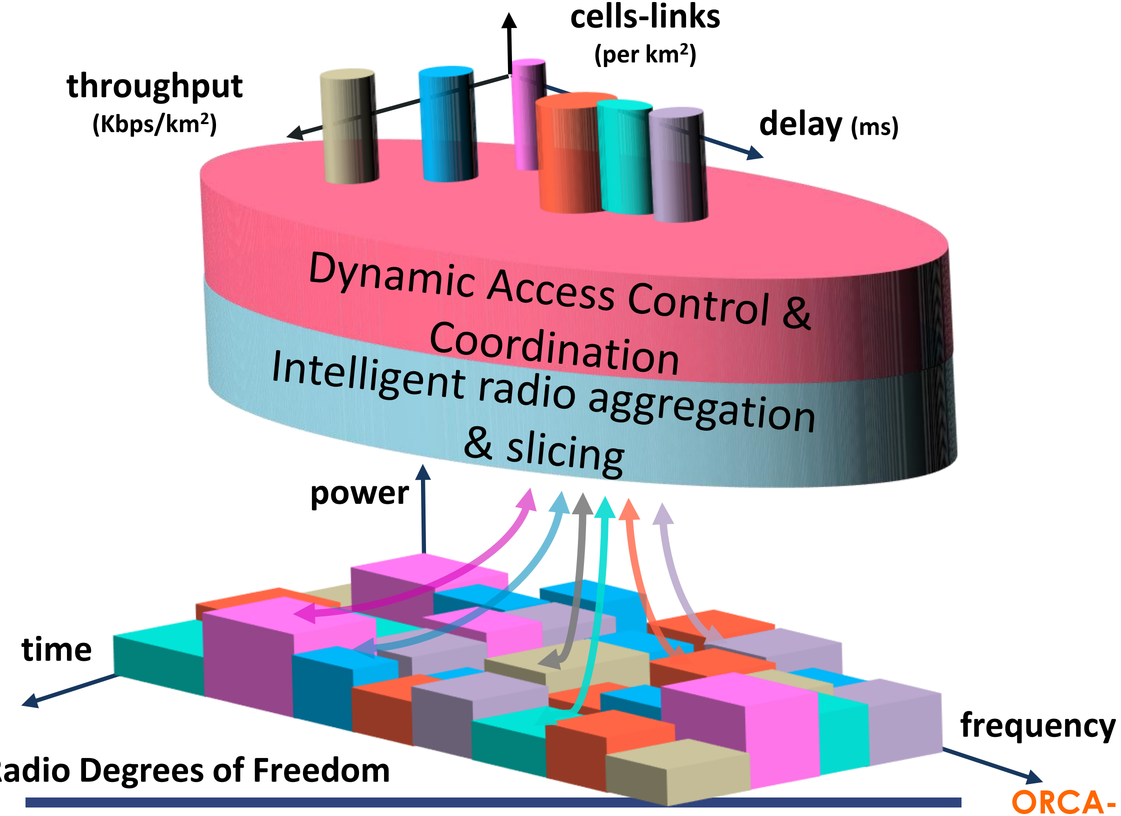
ORCHESTRATION AND RECONFIGURATION CONTROL ARCHITECTURE

Outline

- Motivation
  - Machine learning and spectrum monitoring
  - Radio virtualization
- Proposed solution
- Proof of concept – showcase experiment

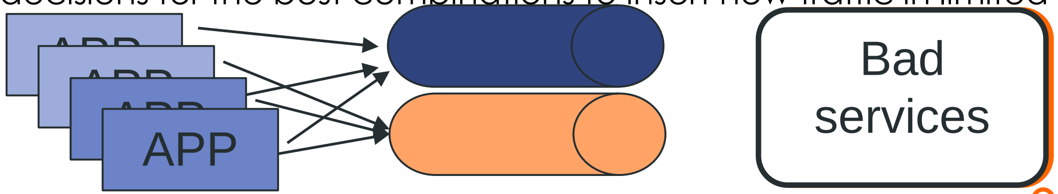
Motivation



cells-links
(per km²)
throughput
(Kbps/km²)
delay (ms)
Dynamic Access Control & Coordination
Intelligent radio aggregation & slicing
power
time
frequency
Radio Degrees of Freedom

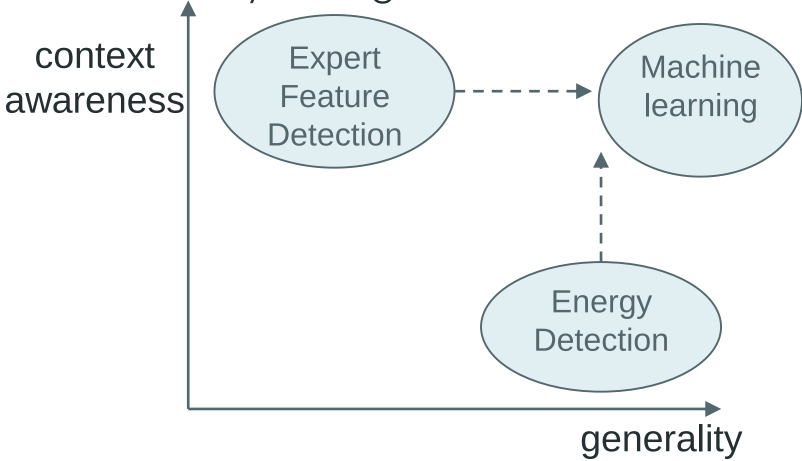
Motivation for spectrum sharing driven by context awareness

- Current approaches
  - Vertical sharing -> licensed bands, opportunistic access of spectrum
  - Horizontal sharing -> unlicensed bands, technologies each has its own strategy to share the medium, some MAC are compatible (eg, different CSMA technologies could in theory coexist)
  - Disadvantages
    - Only local vision of spectrum availability,
    - can't assess QoS performance from a global level: eg some services can't tolerate much delay, can't coexist with traffic with long burst -> low latency control loop in industrial application + youtube video stream application
- Advantages with machine learning aided spectrum sharing
  - Learn context information from ongoing traffic over air-(ie. Waveform, MAC, the amount of transmission opportunity, how frequently opportunities arrive)
  - Make decisions for the best combinations to insert new traffic in limited physical resource



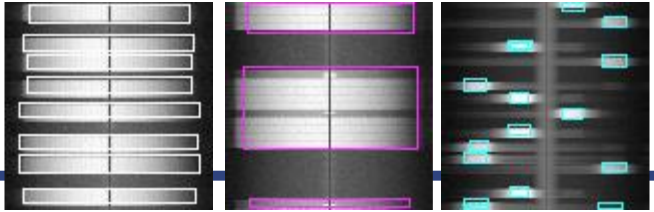
Signal classification - Challenges

- Trend of future: RATs need to coexist, instead of having exclusive spectrum bands -> need spectrum sensing
- **Feature Detection vs Energy Detection**
  - Pure energy detection has limited applicability besides CCA
  - Feature detection is impractical in very diverse environments
    - Needs substantial redesign and redeployment for every change in the environment
    - Expert-based costly design despite its low generality (companies tend to shy away from complicated approaches)
  - Sensitive to impairments (e.g. multipath, offsets, non-linearities, collisions)



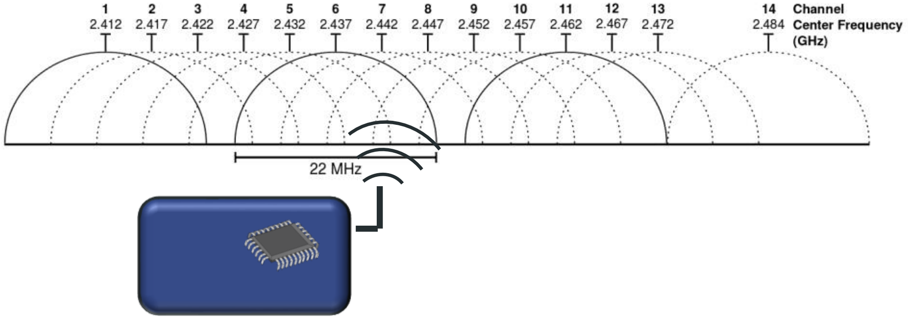
Signal Classification - Motivation

- Advantage of machine learning:
  - Generic, less sensitive to changes and impairments, and can be aware of more complex environment
- Concrete examples:
  - recognize persistent vs bursty channel activity (e.g. Wi-Fi vs LTE DL or DVBT)
  - predict neighbours' spatial deployment topologies (e.g. mesh vs centralized)
  - predict neighbours' duty cycles / inter frame durations
  - use gathered information for interference cancellation/avoidance



Motivation for radio virtualization

- Definition
  - A virtualized radio is a logical radio instance created from a physical device, we may create multiple logical instances operating in homogeneous or heterogeneous modes
  - Similar to CPU virtualization, a core can do multi-tasking
- Use cases
  - Use a single Wi-Fi access point as APs on multiple Wi-Fi channels (frequency slicing), or serve multiple space (antenna slicing), simultaneously
  - Multi-standard IoT gateway, use one device to support multiple IoT standards eg, SigFox, LoRa



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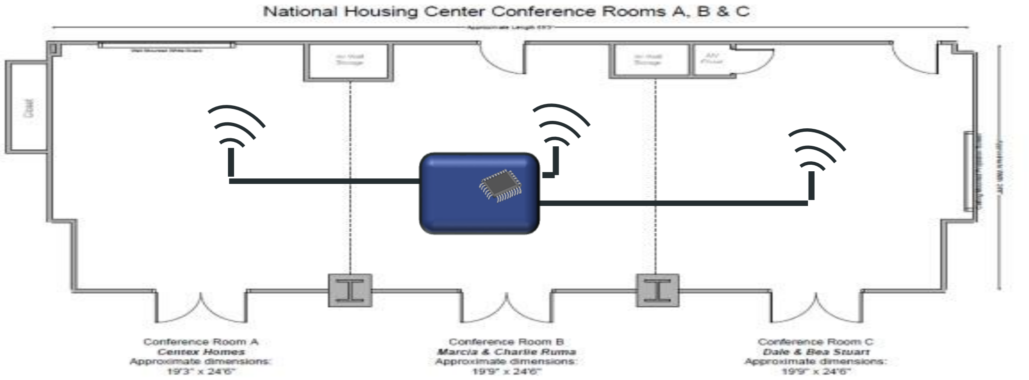

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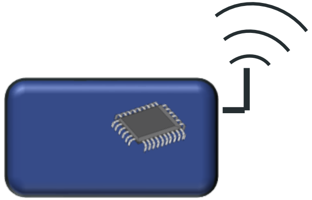
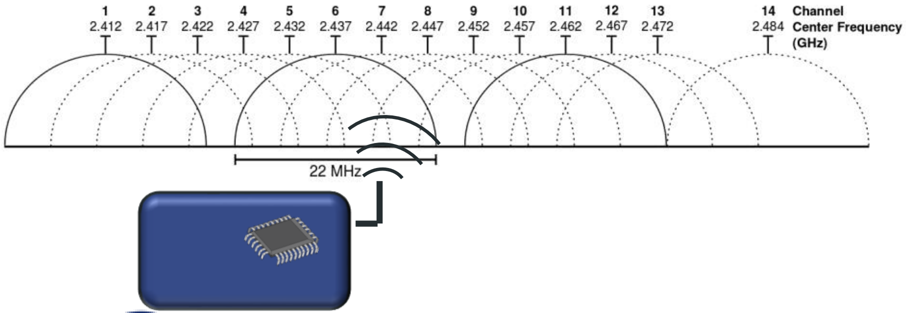


Motivation for radio virtualization

- Current SoA
  - Share the chip in a time division manner, one function at a time, eg, Wi-Fi access point broadcast a message for channel switching
  - Duplicate chips, one for each standard -> increase form factor + complexity, potential waste of resources (not all functionalities required at all time)
- Advantage with virtualized radio
  - No need to duplicate chips, virtual radios are created on demand
  - Always available for multiple concurrent services from application point of view



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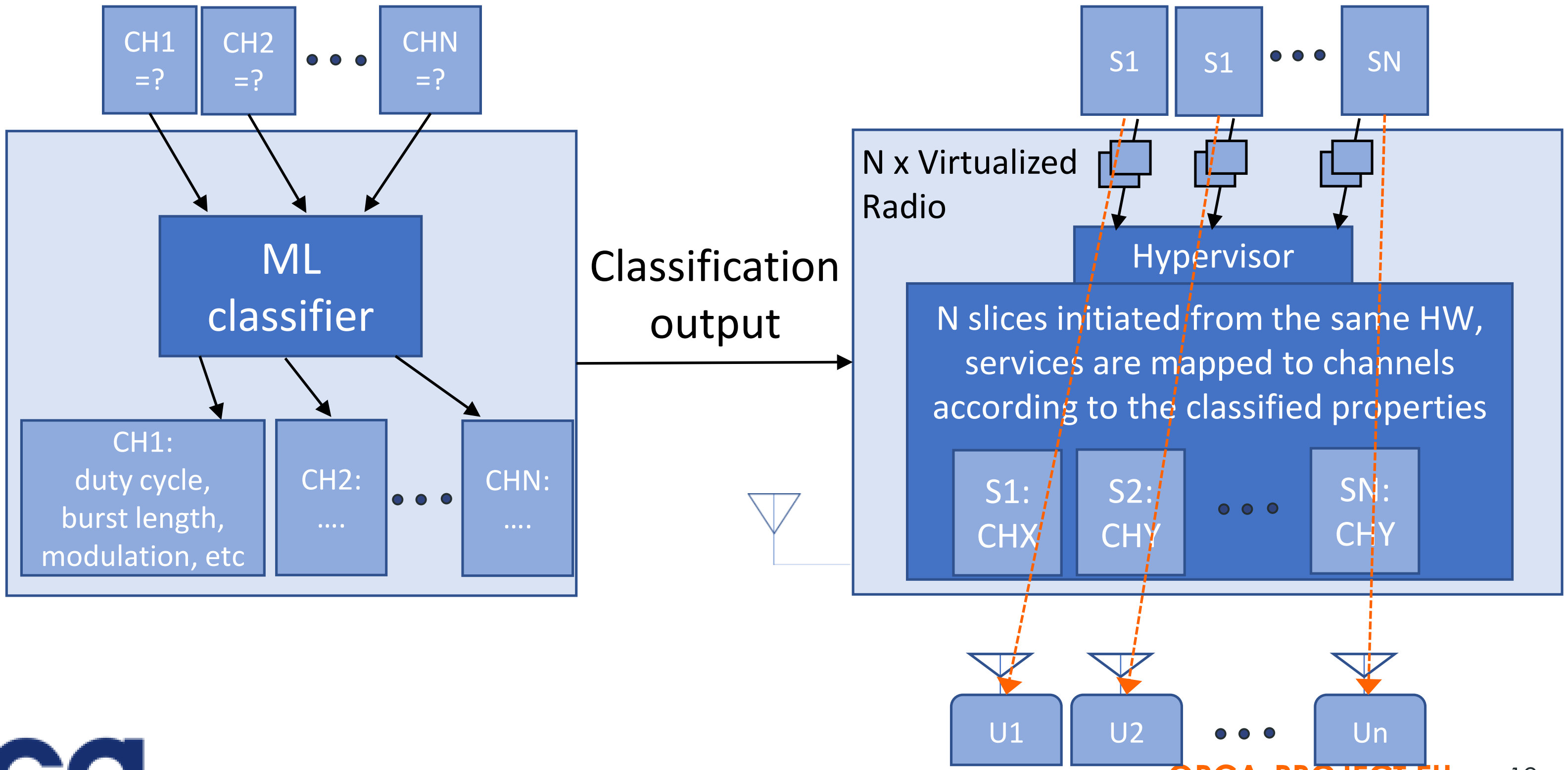
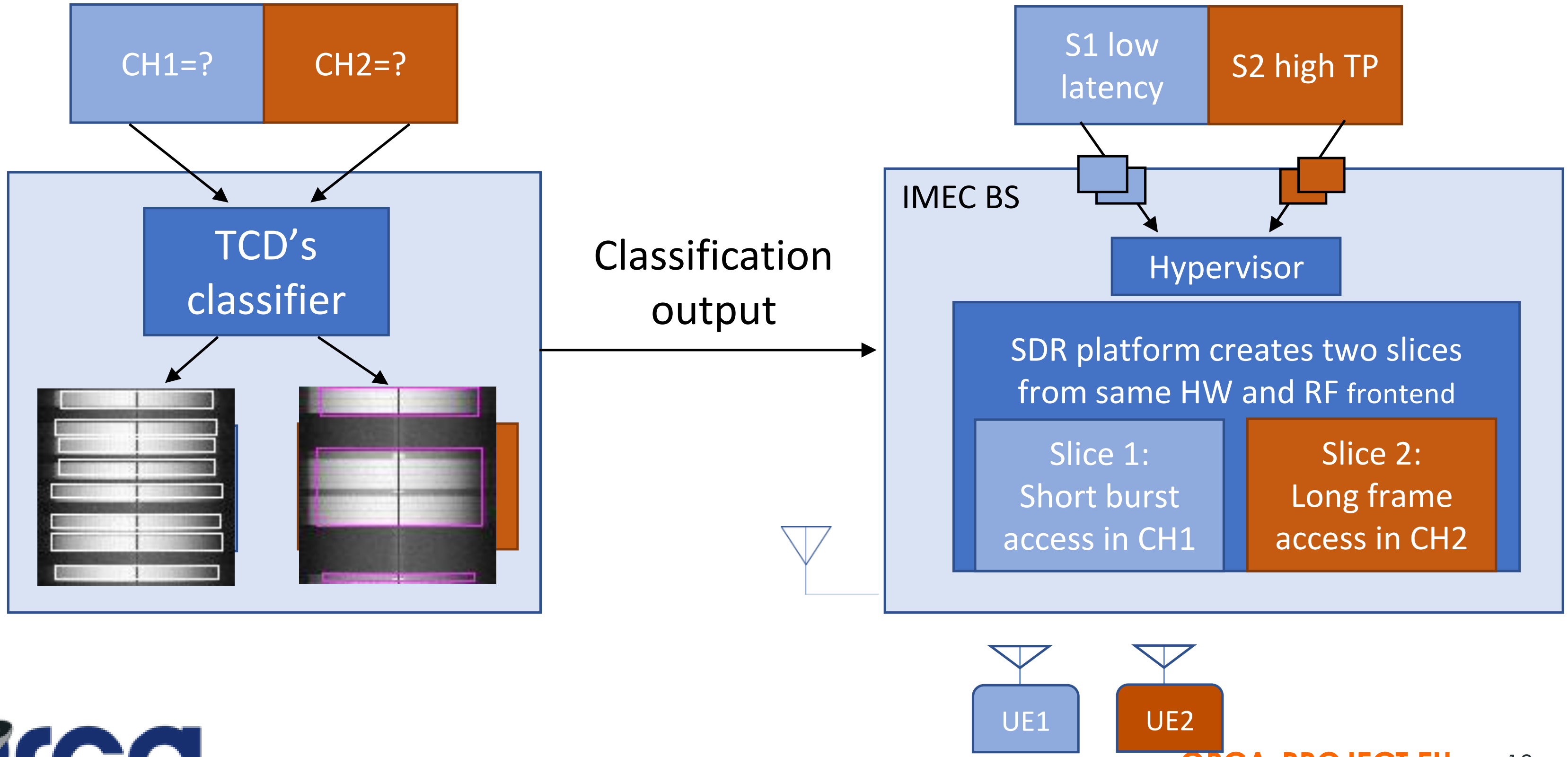
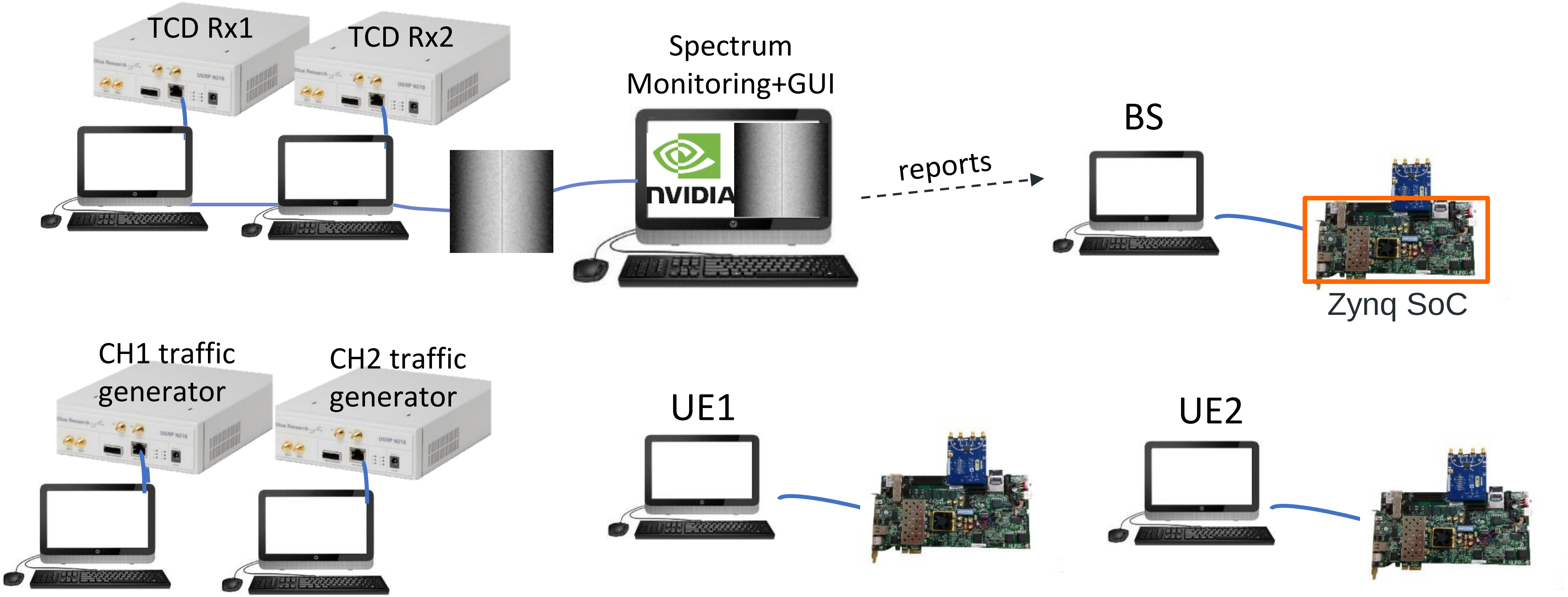
Proposed solution



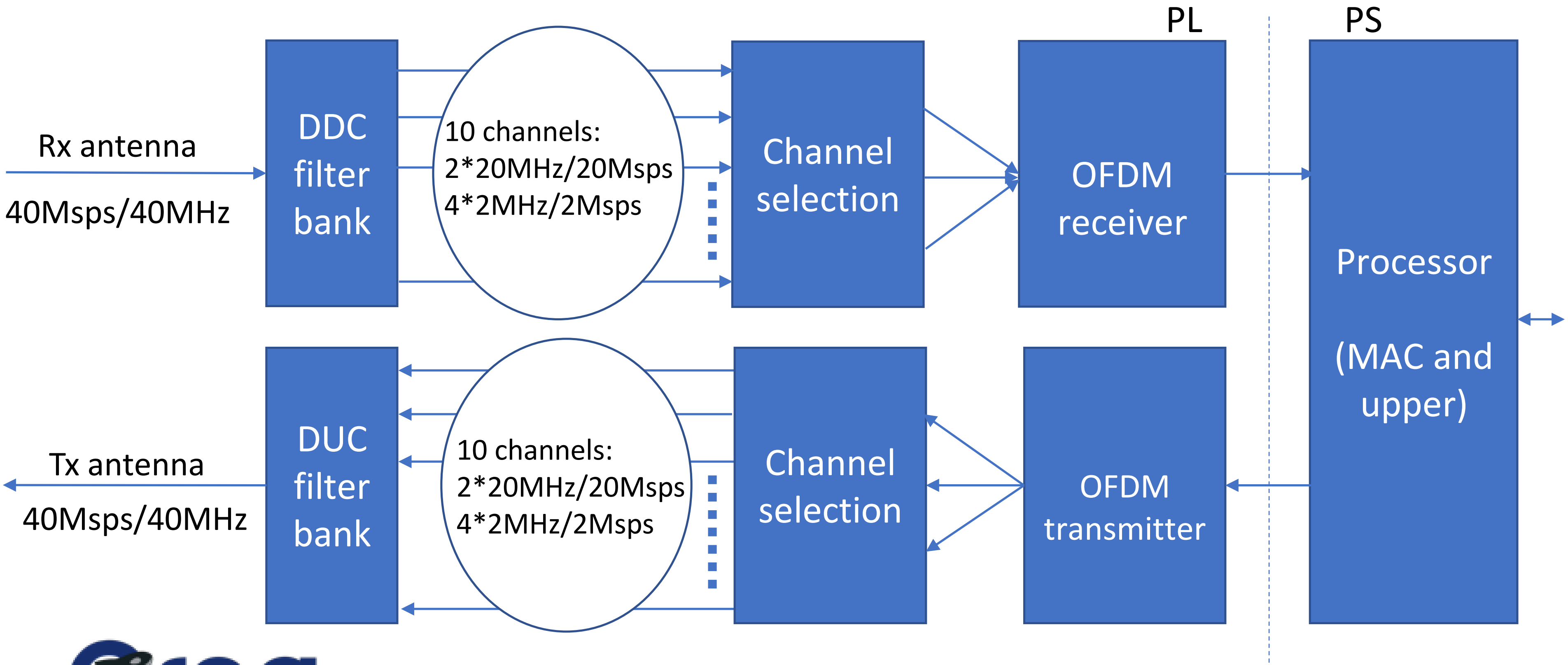
Proof of concept



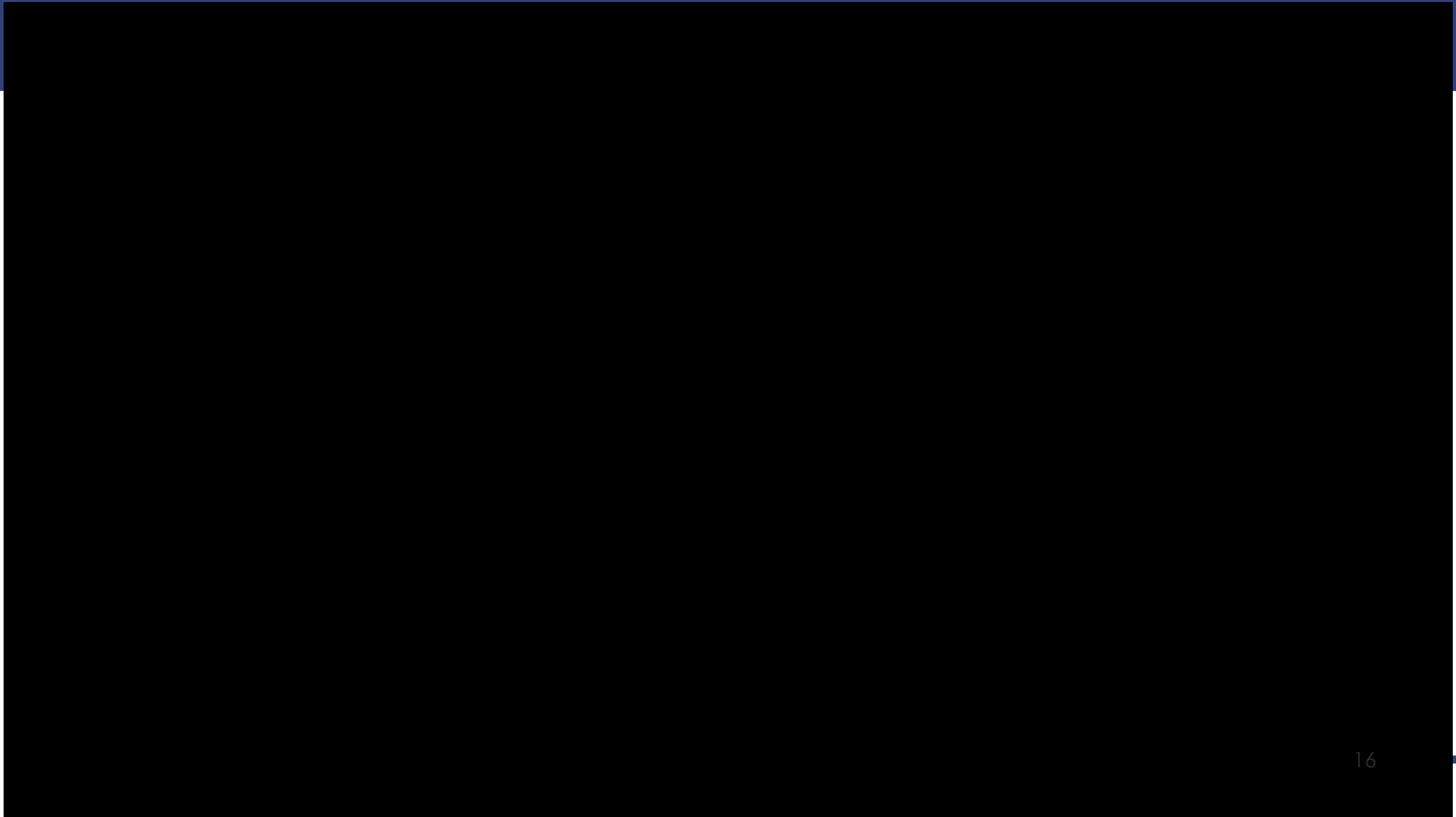
Experiment set-up



How is radio virtualization achieved?



Show time!



Take away message