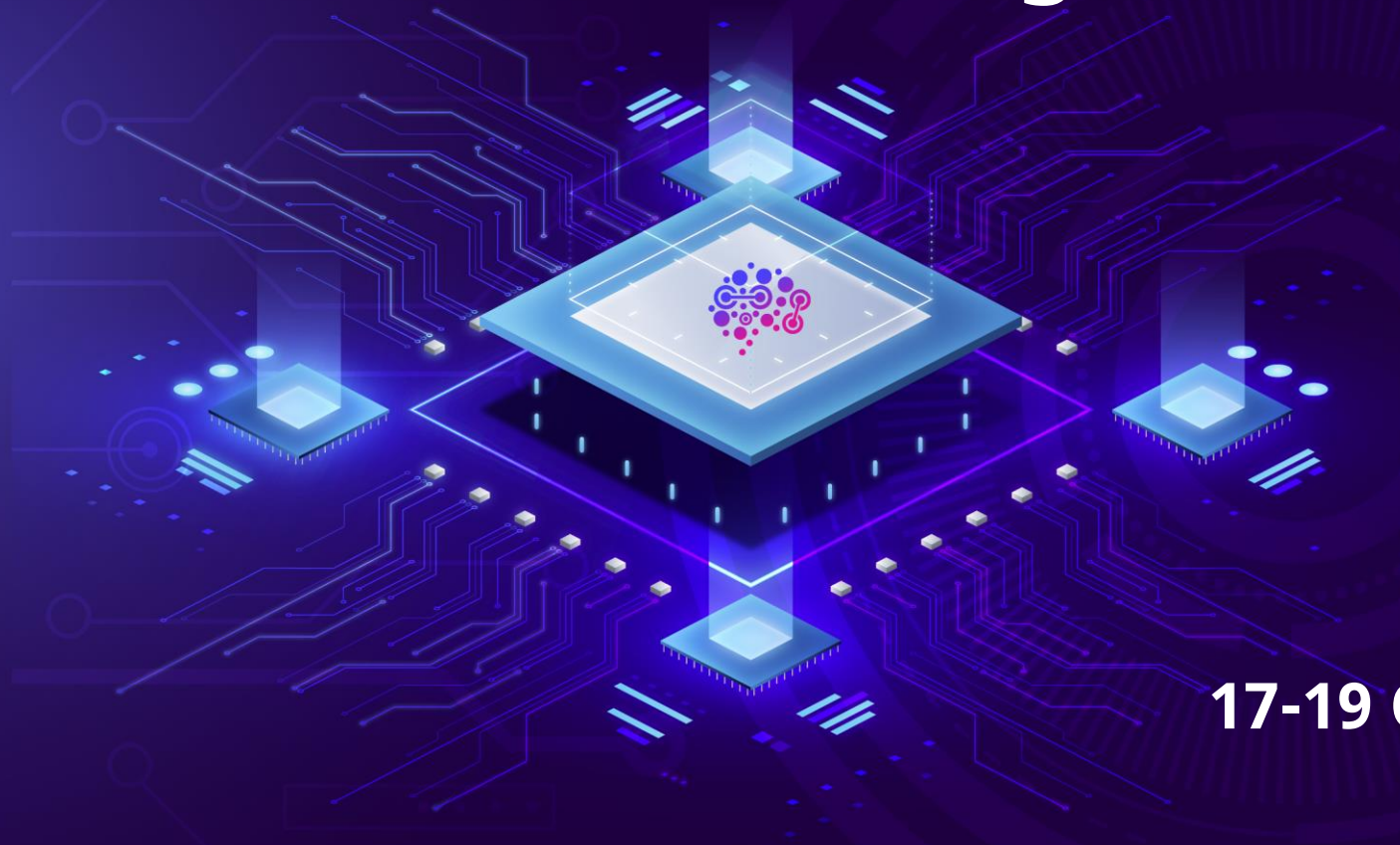
European Conference on EDGE AI Technologies and Applications - EEAI



Advancing emerging edge AI technologies and driving next generation intelligent applications.

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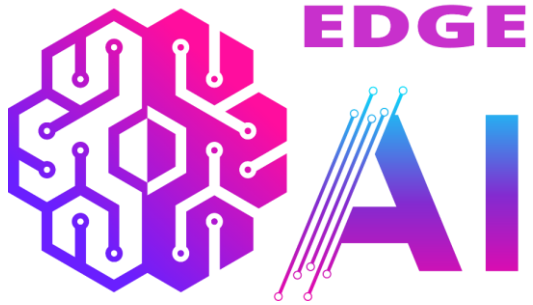

Edge AI LoRa Mesh Technologies

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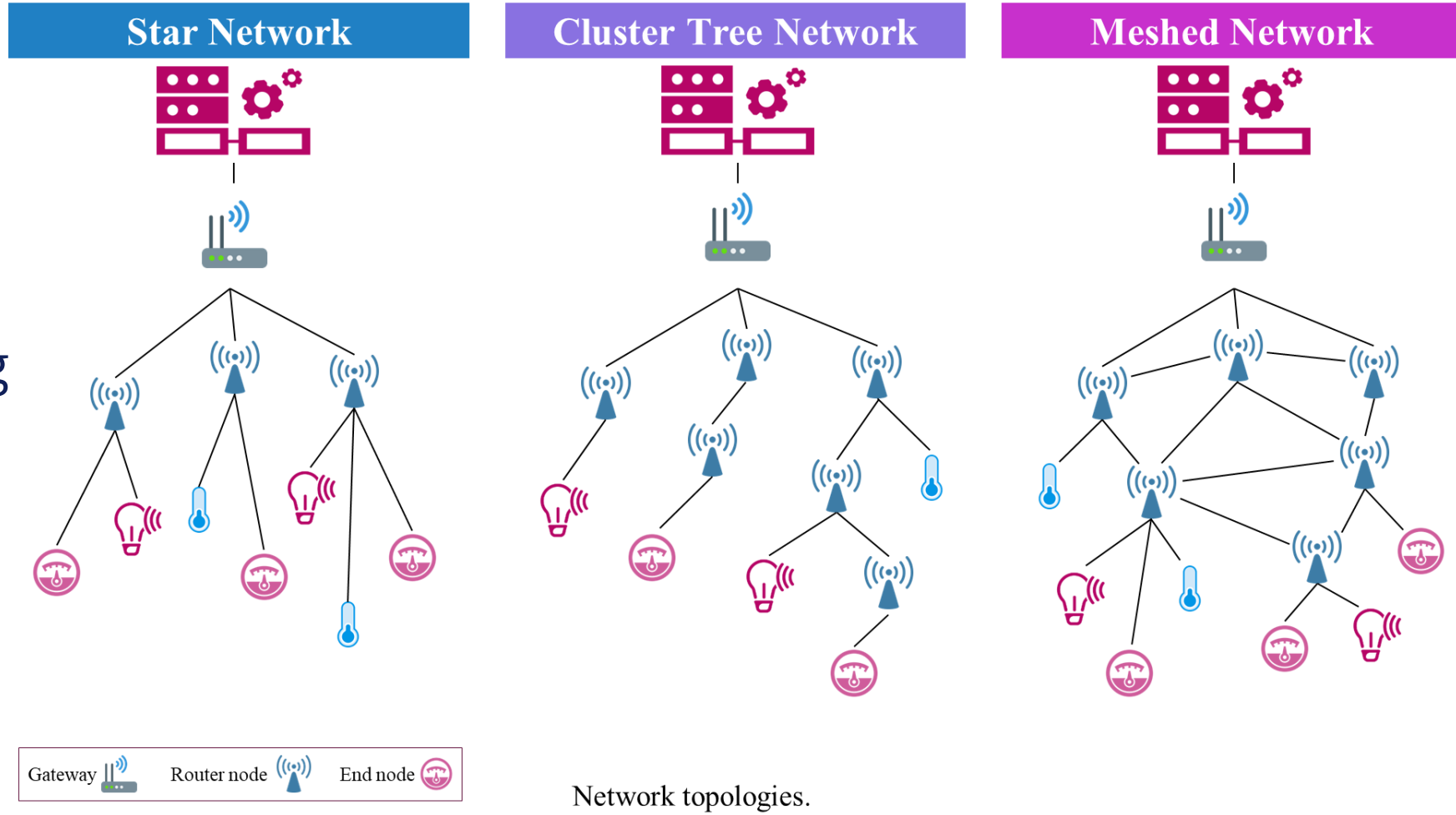
Introduction

- Addressing the Intelligent connectivity at the edge

- Needs:
  - Low latency
  - Low energy consumption
  - On-board computing
  - Distributed analytics and architecture
- Wireless mesh technology:
  - Robust
  - Flexible



Network topologies.

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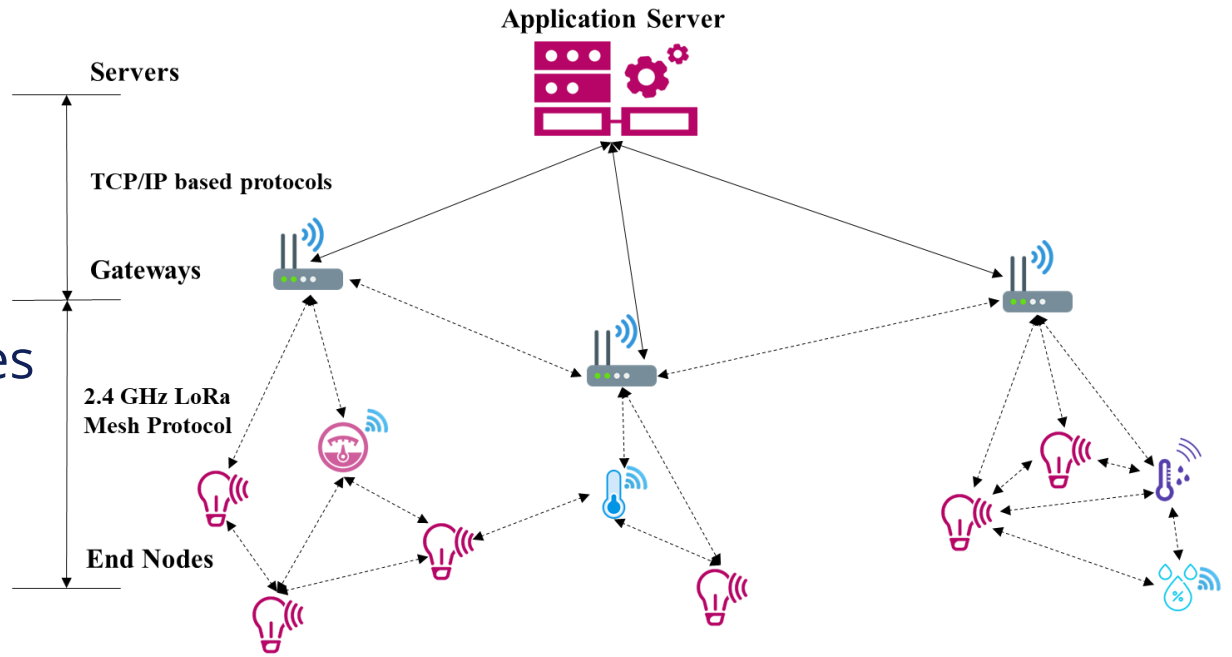
2.4 gHz LoRa

- Benefits
  - Licensed worldwide
  - Increased range
  - Lower power consumption
  - Suitable for higher device density
  - Robust against noise and interference
- New application areas with mesh:
  - Comprehensive area coverage
    - Communicate over several kilometres
  - Energy efficiency
    - Battery-operated IoT sensors and devices
  - Low cost and scalability
    - Cost-effective and scalable IoT solutions



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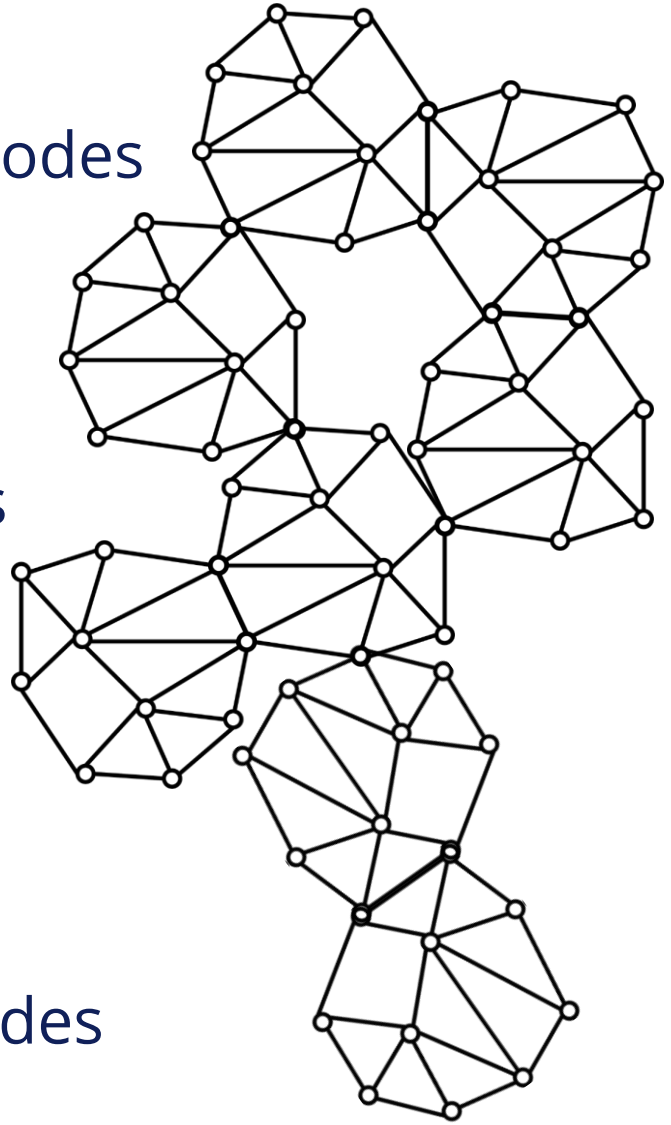
Mesh network characteristics

- **Decentralisation**
  - No single central point of control
  - Nodes can communicate directly with neighbouring nodes
- **Self-configuration**
  - Dynamically reconfigure to accommodate changes
- **Redundancy and reliability**
  - More resilient to node failures or network disruptions
- **Extended coverage**
  - Can cover a larger area by using multiple relays
- **Ad-Hoc networking**
  - Possibility to spontaneously create a network
- **Geographical scalability**
  - Quickly expand the coverage area by adding more nodes



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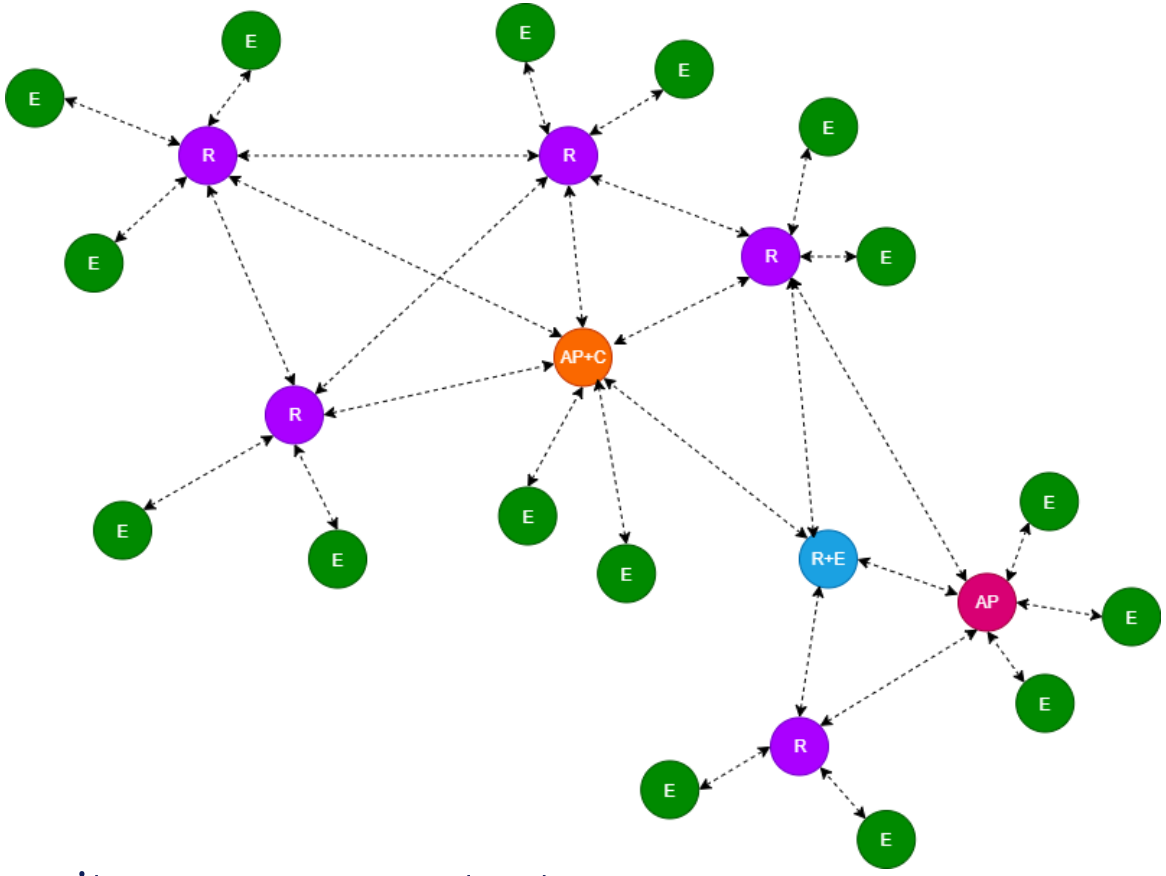
Mesh components and roles

- Mesh routers
  - Backbone of a wireless mesh network
- Mesh nodes
  - Individual devices
    - Computers, smartphones, sensors, etc.
  - Typically, senders or receivers
- Mesh coordinator
  - Managing and organising the network
  - Assigning roles
  - Controlling various aspects
    - Channel allocation, network formation, security management, etc.
  - Potential single point of failure: decentralised coordination
    - Decision-making and control is distributed
    - Each node may possess a degree of autonomy



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LoRa mesh applications

- Industrial Automation
  - Machine-to-machine (M2M) communication, asset tracking, and control systems
  - Monitoring and control of equipment and processes with low latency
- Building Management Systems
  - Optimise energy consumption in commercial buildings
- Smart Metering
  - Monitor and manage utility consumption in residential and industrial settings
- Wireless Sensor Networks (WSNs)
  - Many battery-powered sensors communicate with a gateway for data collection
- Smart Agriculture
  - Monitor soil conditions, automate irrigation systems, and track livestock
- Lighting Control
  - Enabling users to create adaptive and energy-efficient lighting environments
- Environmental Monitoring
  - Environmental parameter monitoring in smart cities
  - Possible aid in predicting critical situations such as fires, floods, or earthquakes

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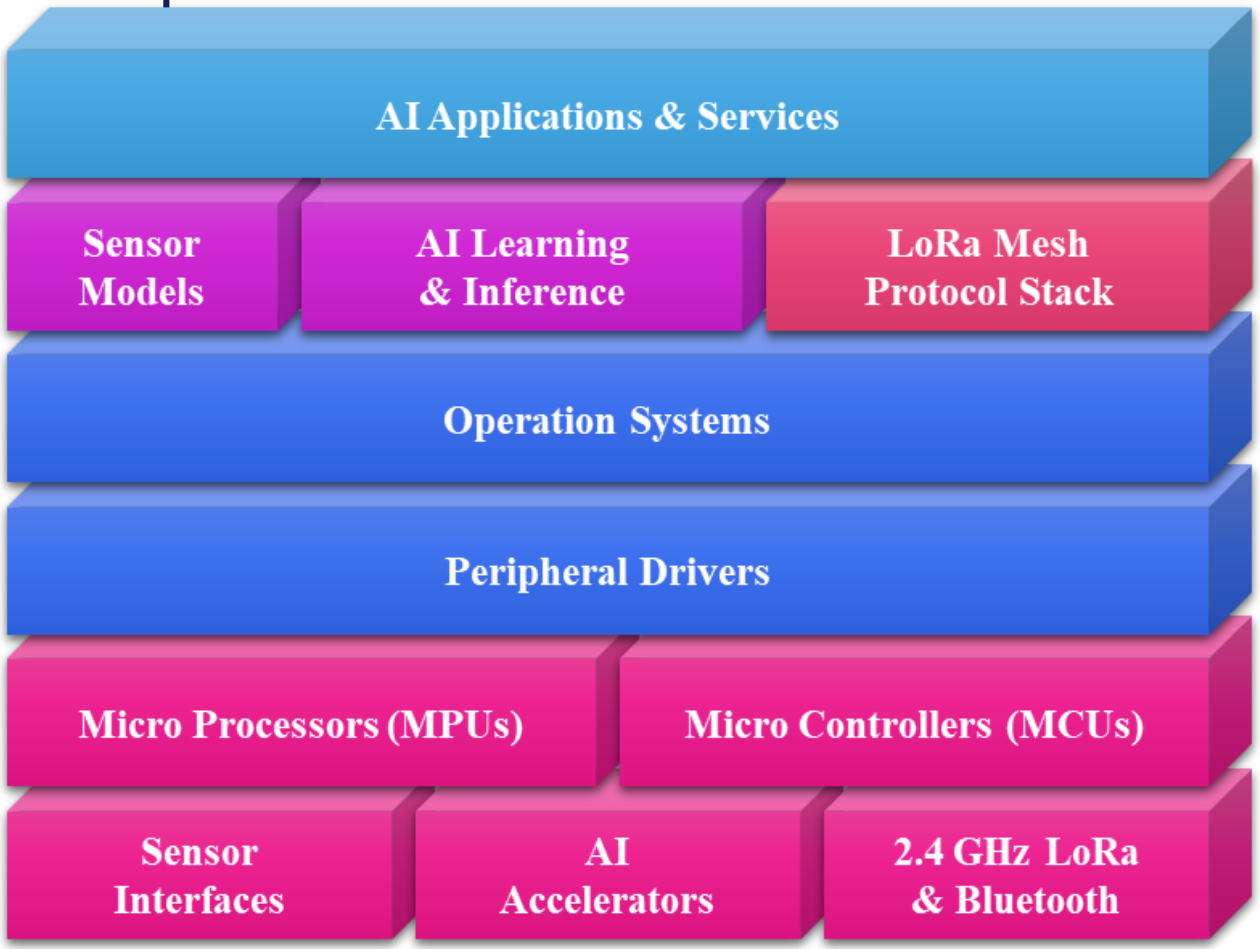
Conceptual Edge AI and LoRa Mesh Device Architecture

- A foundational framework for designing and implementing edge-devices with respect to the hardware and embedded software aspects



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Future Research

- Wireless communication efficiency
  - Reduce the size and number of messages transmitted
- Platform and sub-system heterogeneity
  - Node fault tolerance properties are essential in the case of dropout
  - Balance the redundancy and efficiency
- Data heterogeneity
  - Training process disruptions due to differences in populations, samples, and results
  - Meta-learning and multi-task learning to be improved in terms of scalability, robustness, and automation
- Protection of privacy
  - Sharing model updates can still expose sensitive information
  - Balance the privacy and accuracy

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Conclusion

- LoRa mesh network advantages
  - Easily expandable network coverage
  - Low power consumption
  - Licensed worldwide
  - Robust and flexible
- Effective monitoring through infrequent data updates, enabled by
  - Mesh network designs
  - Edge AI capabilities

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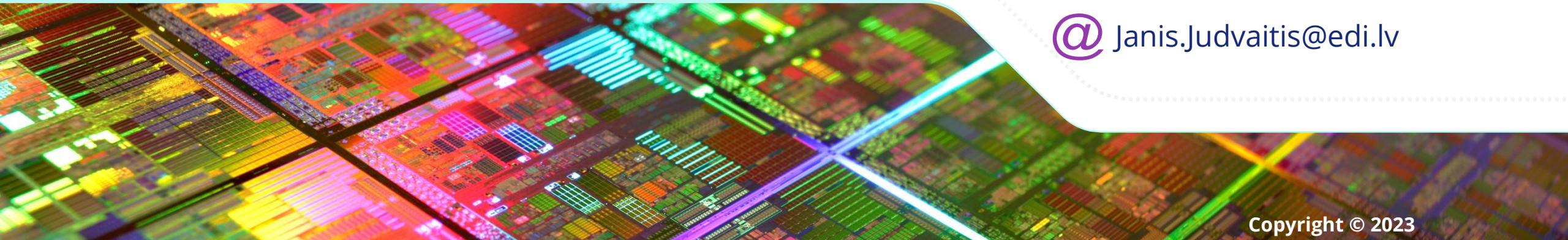
EDGE AI

Thank You

For your attention



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