Iquadrat Informatica

5G Prototyping via Open Source tools and platforms

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IQUADRAT Overview

Iquadrat, based in Barcelona, provides **ICT services** since 1997.

- ✓ **Multidisciplinary team**: Telecom engineers, programmers, designers, marketing and communication consultants
- ✓ **R&D Department since 2008**: 5 Senior researchers (PhD holders), 13 research engineers, 2 R&D admins

*Iquadrat offers **innovative and customizable platforms** that integrate **cutting-edge telecommunications and networking technologies** for a wide portfolio of emerging applications (Smart homes/cities, energy management, industrial applications, etc.)*

R&D Targets and Potential Applications

R&D Technological Targets

✓ **IoT platform**

- multi-sensor support and energy management

✓ **Industrial IoT (IIoT) platform**

- supporting virtualization and security

✓ **5G communications platform**

- for novel vertical application testing

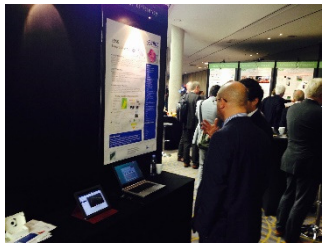
Potential Use Cases

- ✓ Smart City
- ✓ Smart Buildings
- ✓ Smart Grid
- ✓ Smart Water Management
- ✓ Smart Environment
- ✓ Industry 4.0
- ✓ Broadband/entertainment services

International Collaborations

- ✓ 12 concluded EC Funded projects
- ✓ 11 Ongoing EC Funded projects
- ✓ International collaboration with more than 60 European partners
- ✓ 1 Innovation Award
- ✓ 1 Demo Award
- ✓ 1 Best Paper Award
- ✓ Multinational R&D Team
- ✓ Visitors from 10 different countries
- ✓ 5GPPP Association SME member
- ✓ ARTEMIS Association Member
- ✓ Organization of Industrial Seminars

Participation in International Exhibitions



- ✓ MWC 2019
- ✓ European Nanoelectronics Forum 2014
- ✓ EUCNC 2015
- ✓ IoT Solutions World Congress 2017
- ✓ SmartCity Expo World Congress 2017
- ✓ EUCNC 2018
- ✓ IoT Solutions World Congress 2018
- ✓ SmartCity Expo World Congress 2018

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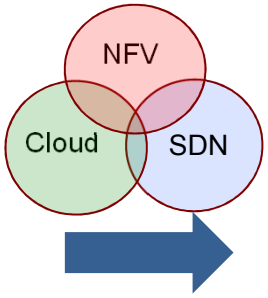
Software-defined 5G Networking

- ✓ **Commoditization** is changing the economics of mobile networks.
  - TIP OpenCellular project implements fully-compliant 4G eNodeB and EPC with commodity, general purpose hardware and SDR
- ✓ **Virtualization (NFV) and Cloudification**: execution of network functions on top of virtualized (and shared) computing, storage, and networking resources controlled
- ✓ **SDN** allows centralized control plane and network programmability. Modern COs are rearchitected as Data Centers!

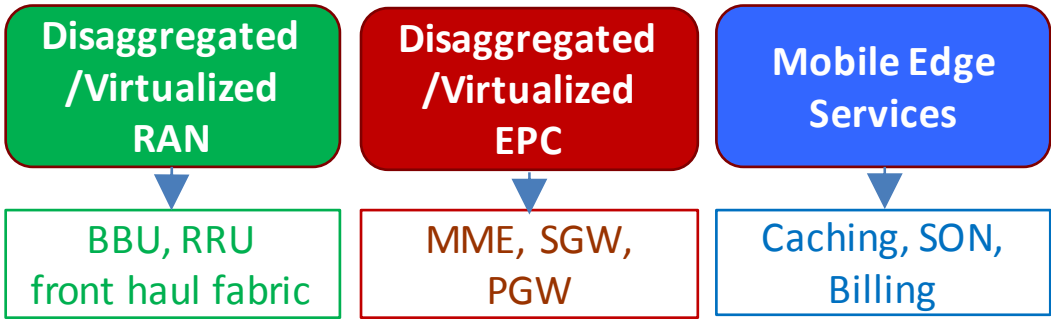
300+ Types of equipment
Huge source of CAPEX/OPEX



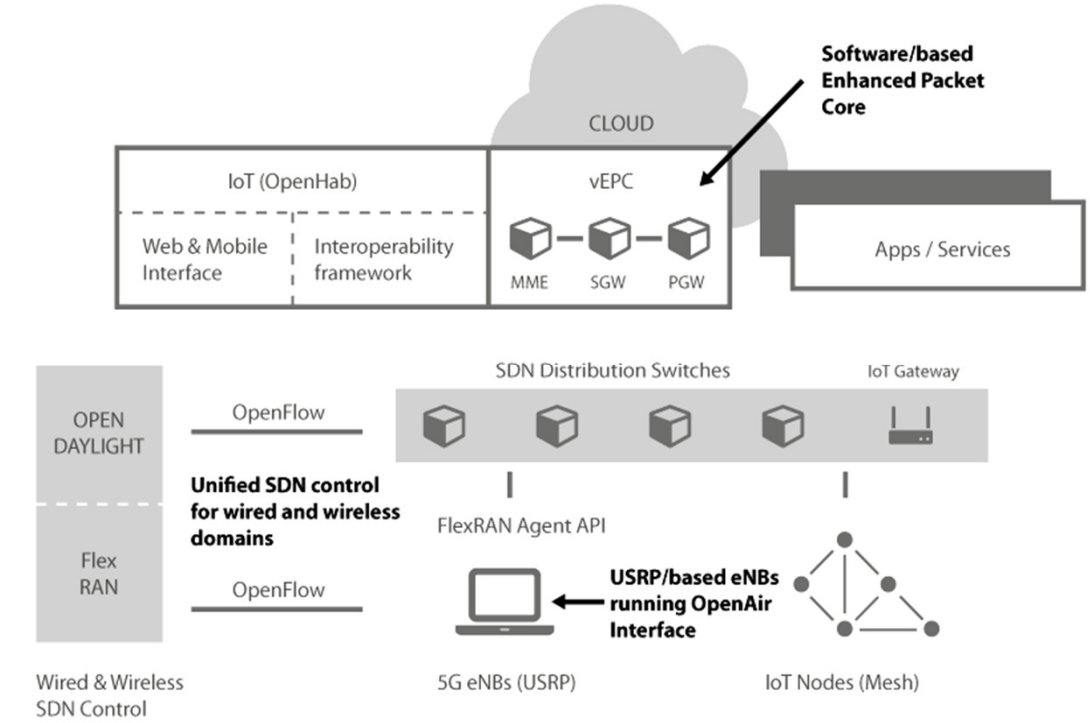
General Purpose (White Box) equipment in Data Centers

Software-defined 5G Networking (2)

- ✓ Virtual RAN is a new approach where radio functions become a general-purpose application that operates on top of a virtualized environment. The resulted virtualized software radio application can be delivered as a service, and disaggregated in DUs / CUs (CRAN concept).
  - Strong open source 5G community allows small players to have a big impact, lowering the cost of implementing testbeds
  - Academic and Open Source community representation in 3GPP, collaboratively prototyping of 5G concepts
- ✓ OpenAirInterface Software Alliance (OSA) is a non-profit consortium that oversees the development of a full 5G Cellular Stack on Commercial Off-The-Shelf (COTS) components
- ✓ Open5GCore is an open source implementation of the 3GPP Release 15 5G Core Network



Iquadrat 5G prototype platform



Vertical industries applications

Key innovative features

- ✓ 5G access and Core modules based on OpenAirInterface
- ✓ Network & infrastructure virtualization allows RANaaS
- ✓ Flexible orchestration for network slicing and on-demand resource allocation
- ✓ Services can be created through cloudification of underlying infrastructure

Target Customers

- ✓ Vertical industries for testing and service enhancement

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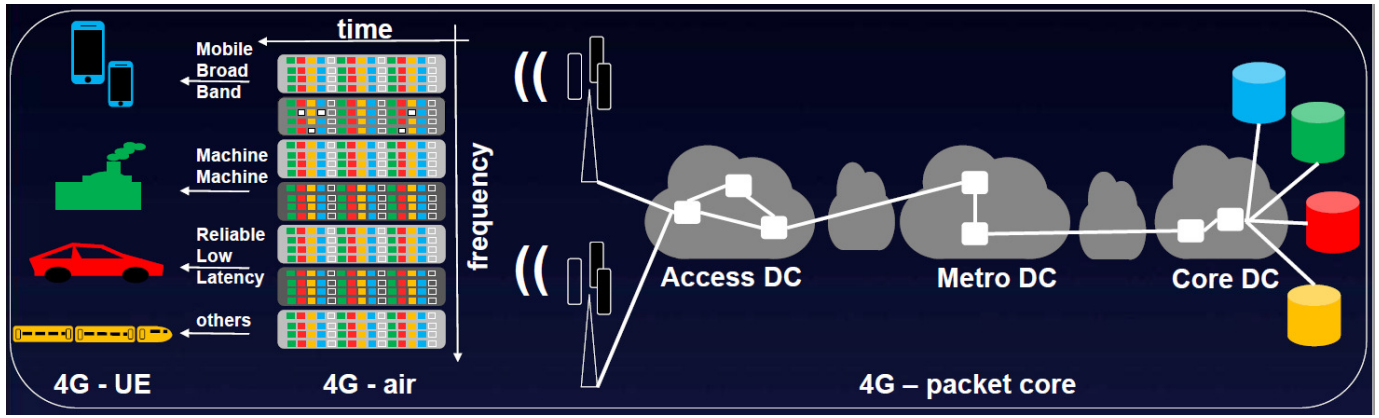
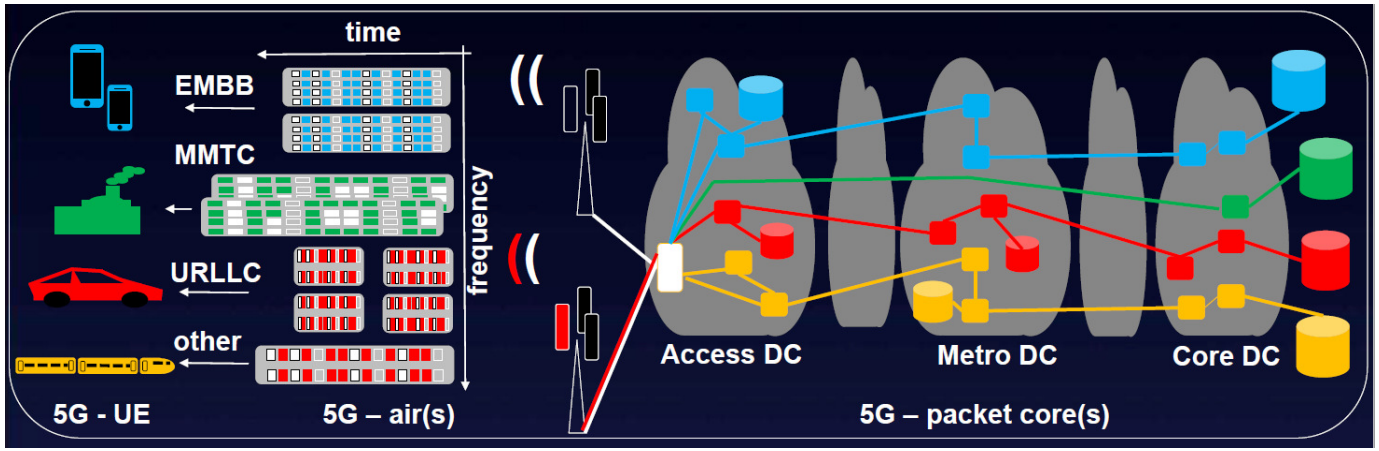
Slicing

Slicing in 4G

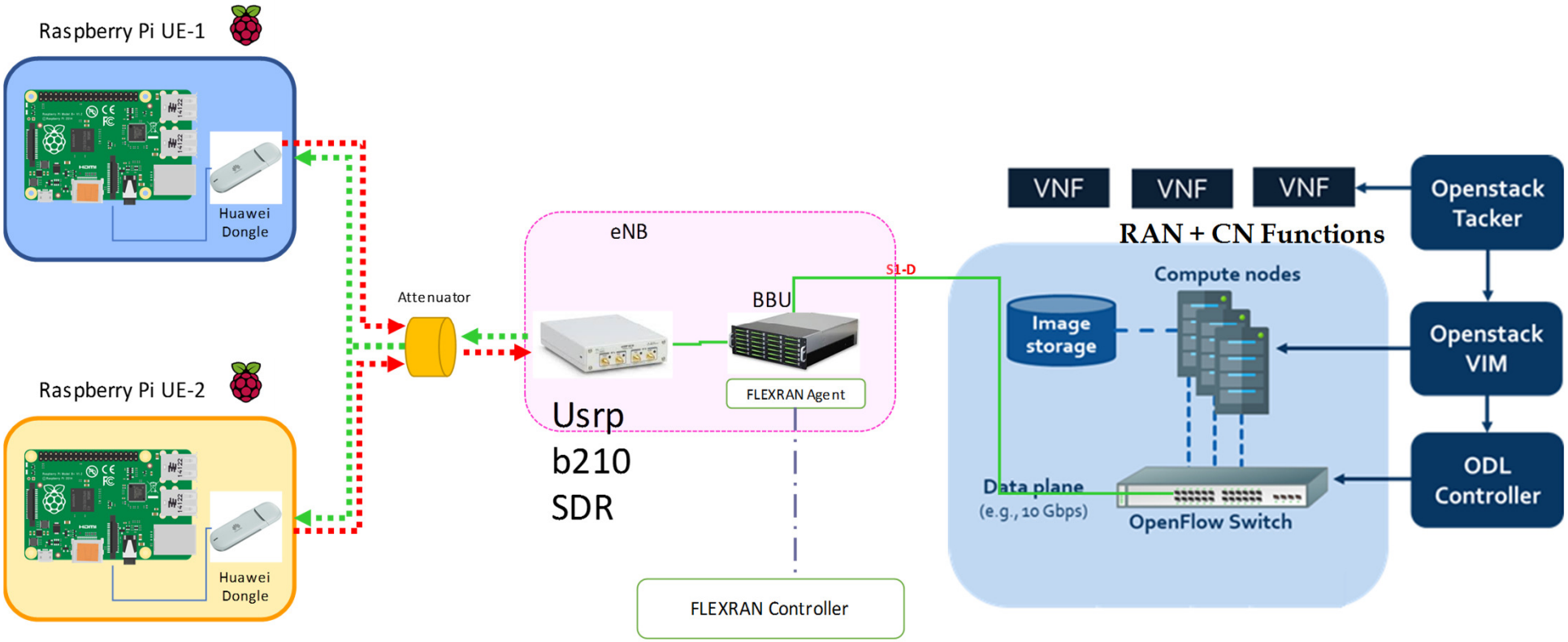


Slicing in 5G



Iquadrat 5G Testbed

- ✓ Core Tier consists of a virtualized data center based on OpenStack.
- ✓ Software-based vEPC (5Gc to be released soon) and vBBU from OpenAirInterface
- ✓ RF unit implemented with a USRP B210 SDR.



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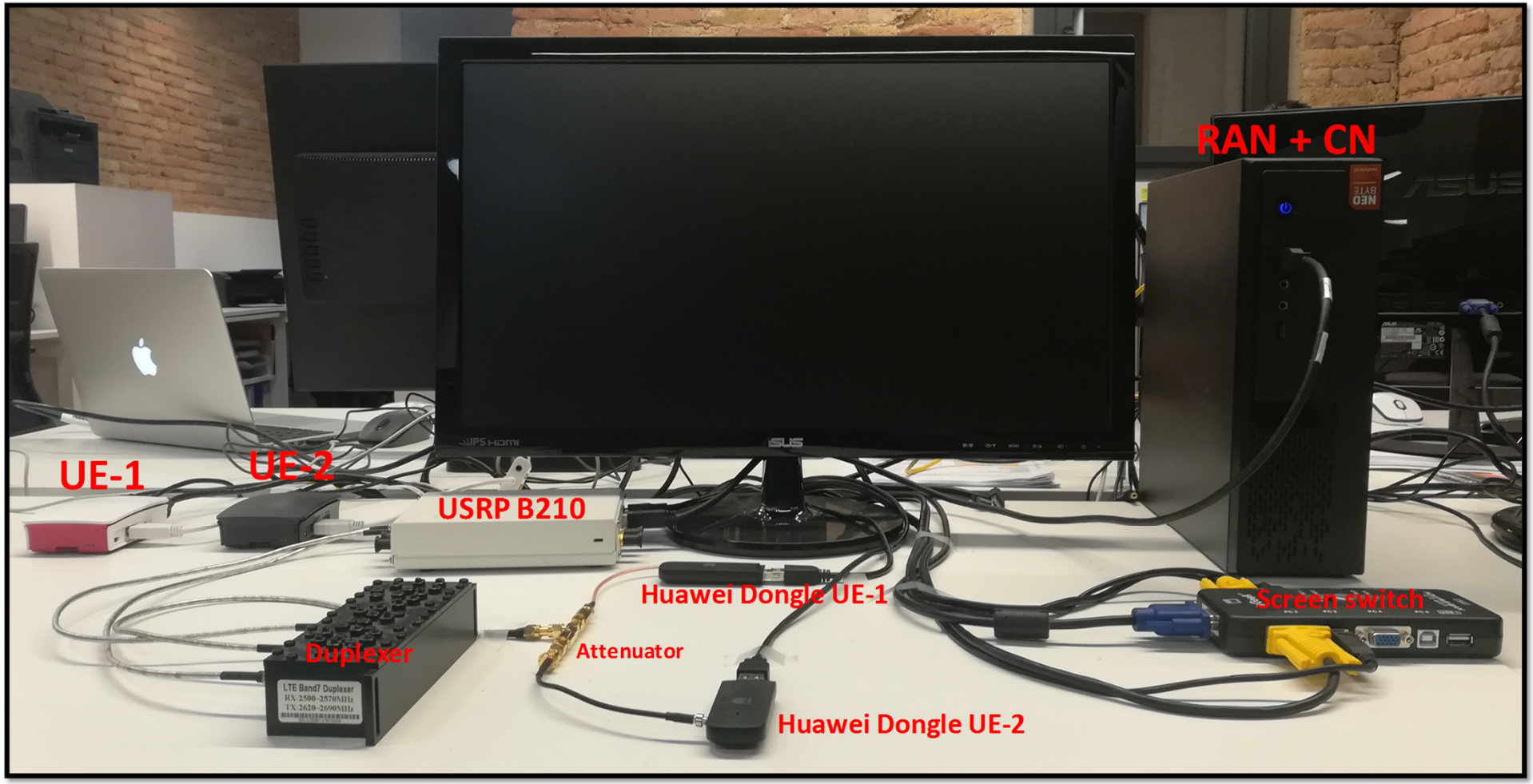
Iquadrat 5G Testbed (2)



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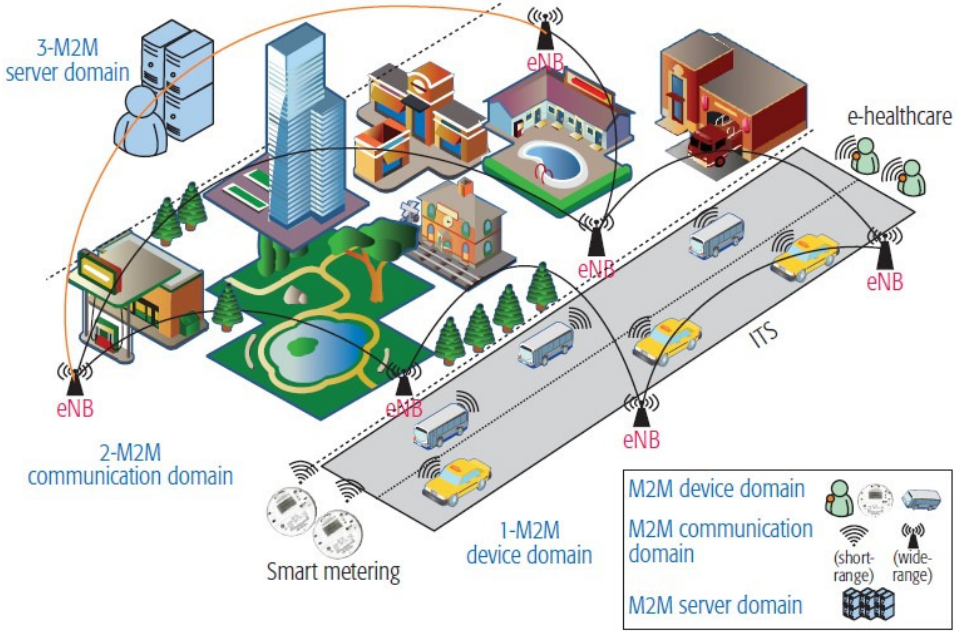
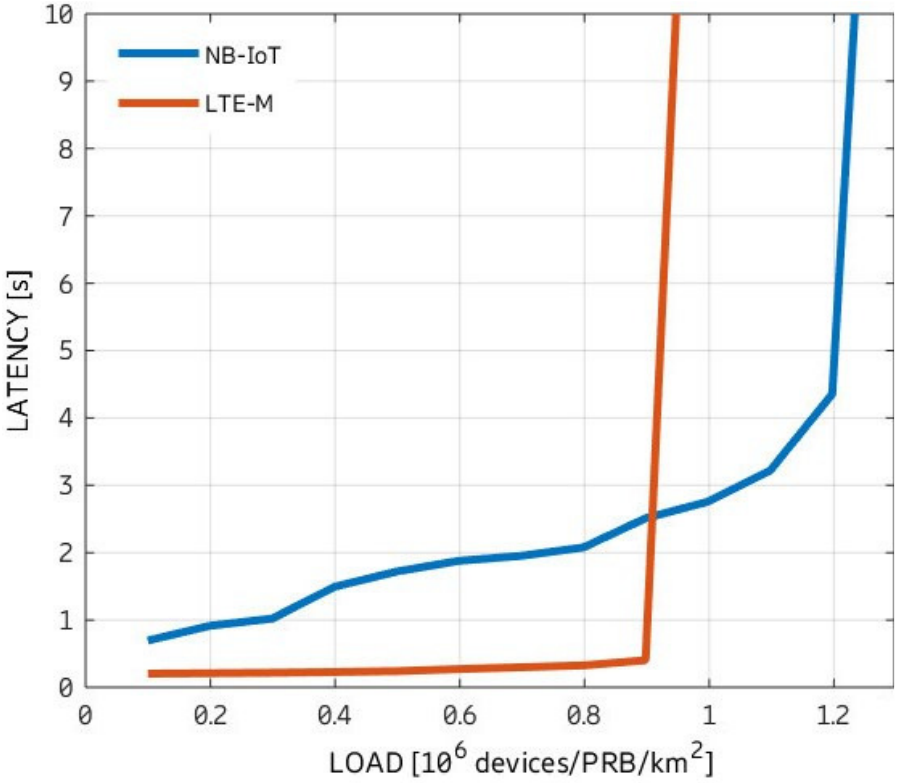
Machine Type Communication (IoT) in 5G

- ✓ IoT is one of the 5G application domains, with massive density requirements for Machine Type Communications (MTC)
- ✓ Low power is also a major requirement for battery operation
- ✓ LTE-M and NB-IoT meet 5G mMTC requirements and can operate within an NR sub-carrier
- ✓ LPWAN options available in unlicensed spectrum (Sigfox, LoRa)





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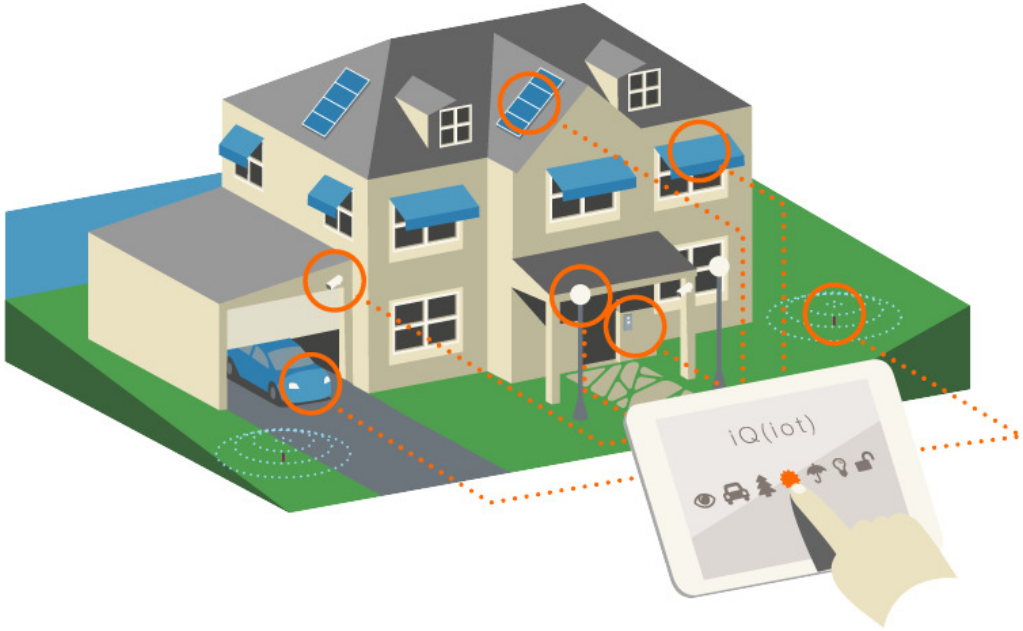
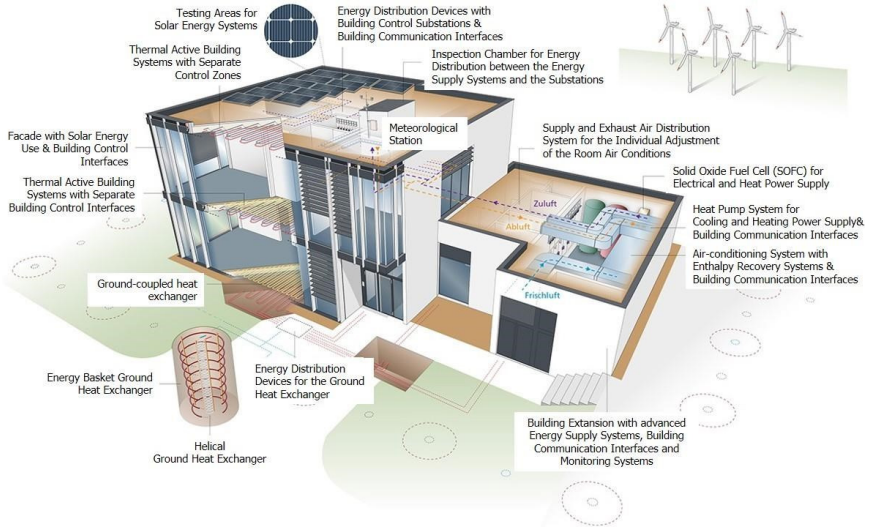
Iquadrat IoT platform



Key features

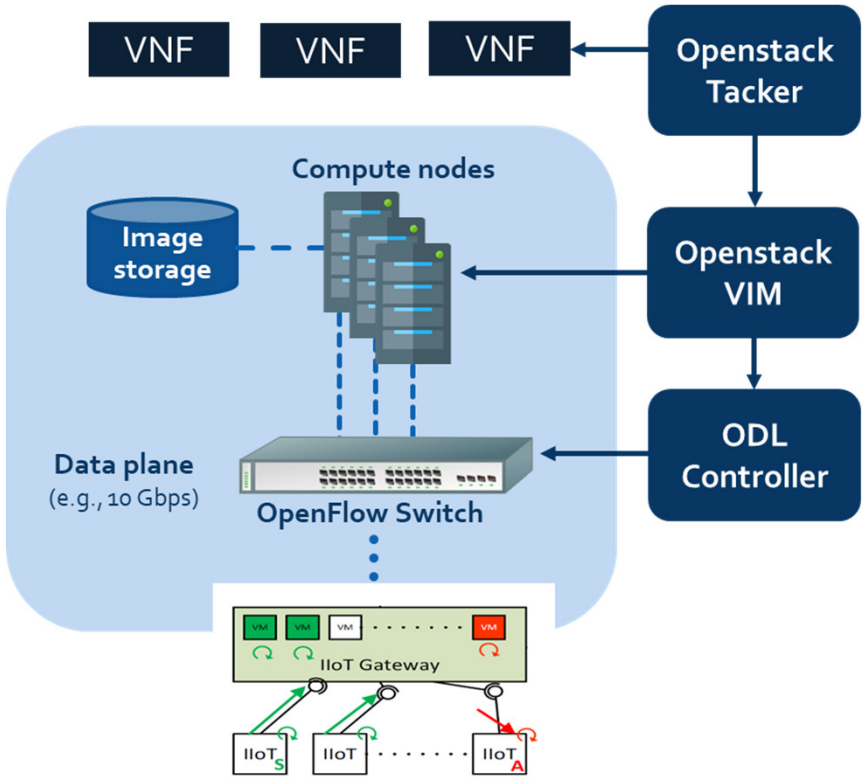
- ✓ Interactive Mobile and Web applications
- ✓ Open Source Backend (OpenHab.org)
- ✓ Support for industrial applications
- ✓ Interoperability
- ✓ Bindings for commercial IoT devices
- ✓ Automation & Energy management
- ✓ Local data storage



Deployment Examples

- ✓ The IoT platform has being deployed for CO2 testing in the living lab ENERGETIKUM, within the IoSense project (http://www.iosense.eu/)\
- ✓ The IoT deployment in Iquadrat's headquarters is accessible in http://iot.iquadrat.com/

Iquadrat IoT platform - Innovation



Key innovative features

- ✓ Openstack-based private cloud solution for IIoT deployments
- ✓ Use of 5G technologies (SDN and NFV) for network & infrastructure virtualization
- ✓ Centralized orchestration of network slices, services and end-user applications.
- ✓ Virtualized IIoT gateway able to host delay-sensitive services
- ✓ Machine learning algorithms for anomaly detection

Deployment Examples

- The IIoT platform has been a water management use case within the **Water4Cities project** (www.water4cities.eu/)
- The Openstack-based private cloud solution of the IIoT platform has been contributed to the **SEMIoTICs project** (https://www.semiotics-project.eu)

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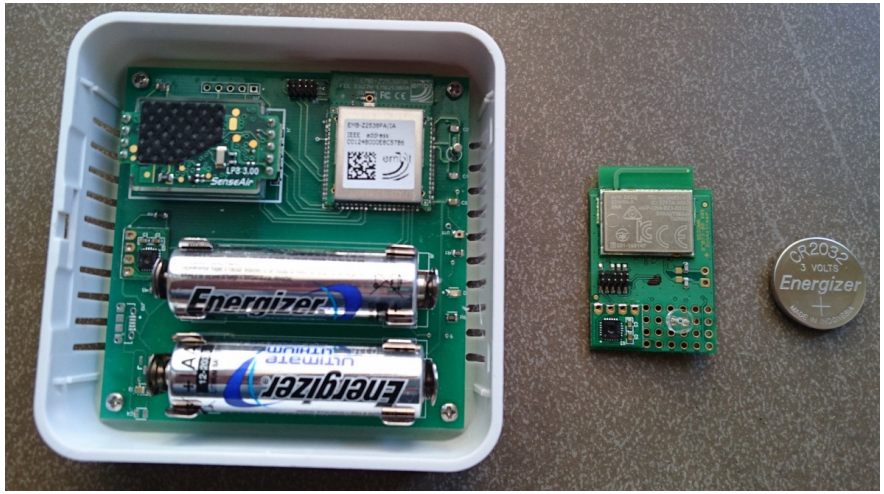
IoT Platform - GUI

IoT Platform - Customizable Sensor Nodes



IoT Nodes

- ✓ Wall mounted (IEEE 802.15.4) or portable (Bluetooth Low Energy)
- ✓ Battery or Grid Powered
- ✓ On board sensors and connectors for external modules
- ✓ Ability to monitor energy consumption & generation

Supported software/protocols

- ✓ IPv6 , RPL, MQTT, COAP, HTTP/REST
- ✓ Multiple Radio Duty Cycling and MAC protocols
- ✓ Resilient Mesh operation
- ✓ Time slotted operation (6TiSCH) for industrial applications

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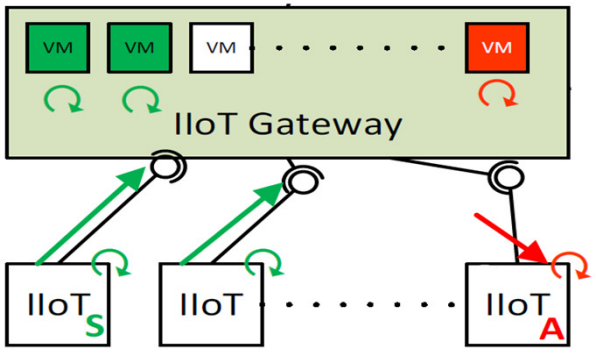
IoT Platform – gateway

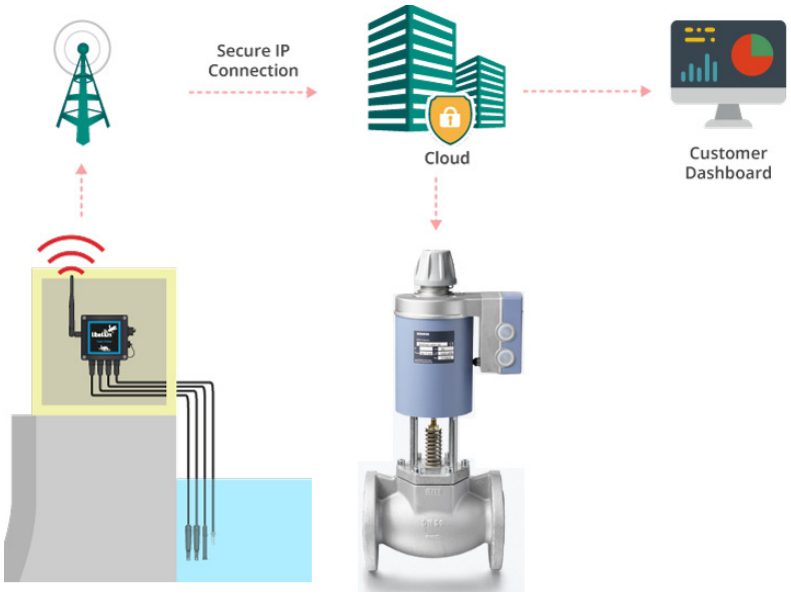


✓The IoT gateway is implemented with a Linux-Based Odroid Single Board Computer

✓Virtualization via KVM and Containers (Mobile Edge Computing)

✓A custom radio module interconnects Field devices via 802.15.4, and more interfaces can be added via USB adapters.

IoT platform - Smart Water Management



- ✓ IIoT platform builds on (and expands) our IoT platform for Smart Buildings
- ✓ Low Power radios (NB-IoT, LoRA) for optimal coverage and low power consumption
- ✓ Local Cloud storage for sensor values and controls actuators
- ✓ Use of SDN and NFV for network and infrastructure virtualization and control
- ✓ Applications in Smart Water management, to optimize pressure in Water Distribution

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IoT Platform - Demo

Iquadrat Business Perspective

The IoT and IIoT Iquadrat solutions are **mature and ready for deployment**

- ✓ Home/Building automation (e.g., comfort sensing, HVAC control)
- ✓ Smart energy domain (e.g., energy demand matching, photovoltaic monitoring, energy exchange)

Additional features can be added **on demand**, to meet customer's needs and support new use cases

- ✓ Integration and control of new sensors, actuators, etc.
- ✓ Support for new telecommunication modules

Ongoing **development of 5G platform** for testing new applications

- ✓ New vertical markets (AR/VR and broadband services, industry 4.0, mHealth, V2X, etc.)
- ✓ Integration of cutting-edge features for 5G support in existing platforms

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Thank you!