

Interoperable IoT environments

Smart Solutions based on Internet of Things

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Lecture outline

- Introduction
- Smart metering
- Interoperability challenges
- symbloTe interoperability middleware
- symbloTe & smart metering
- Key takeaways

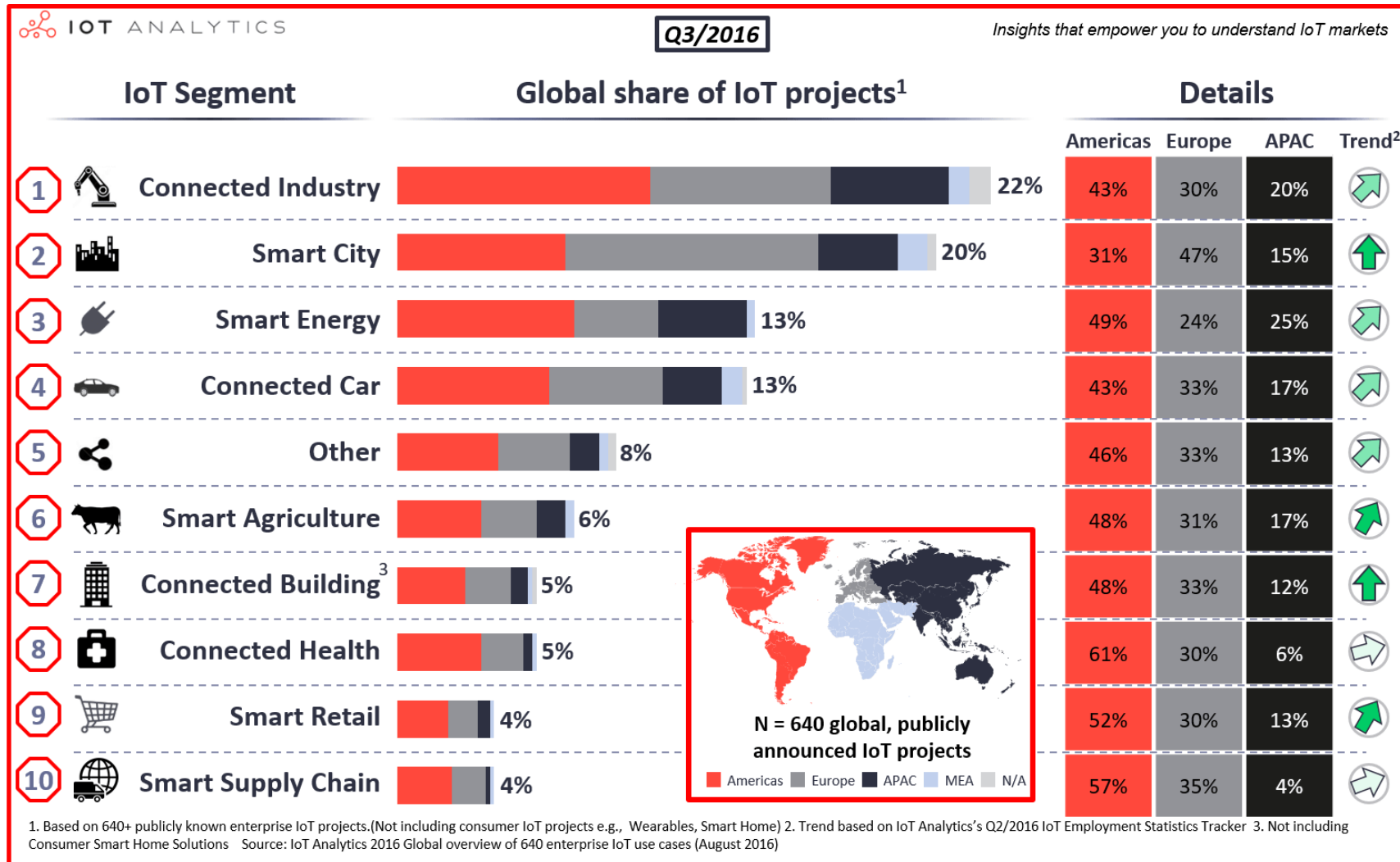
Introduction

Internet of Things

- Advancements in hardware and networking technologies
- 26.7 billion connected devices in 2019, expected to grow to 75 billion until 2025*
- Industrial domain, smart cities, health&well-being

*** Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions),**
<https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>

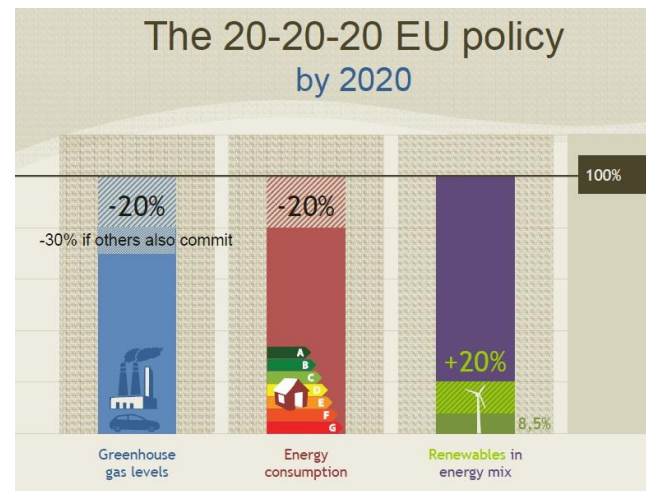
IoT – application areas



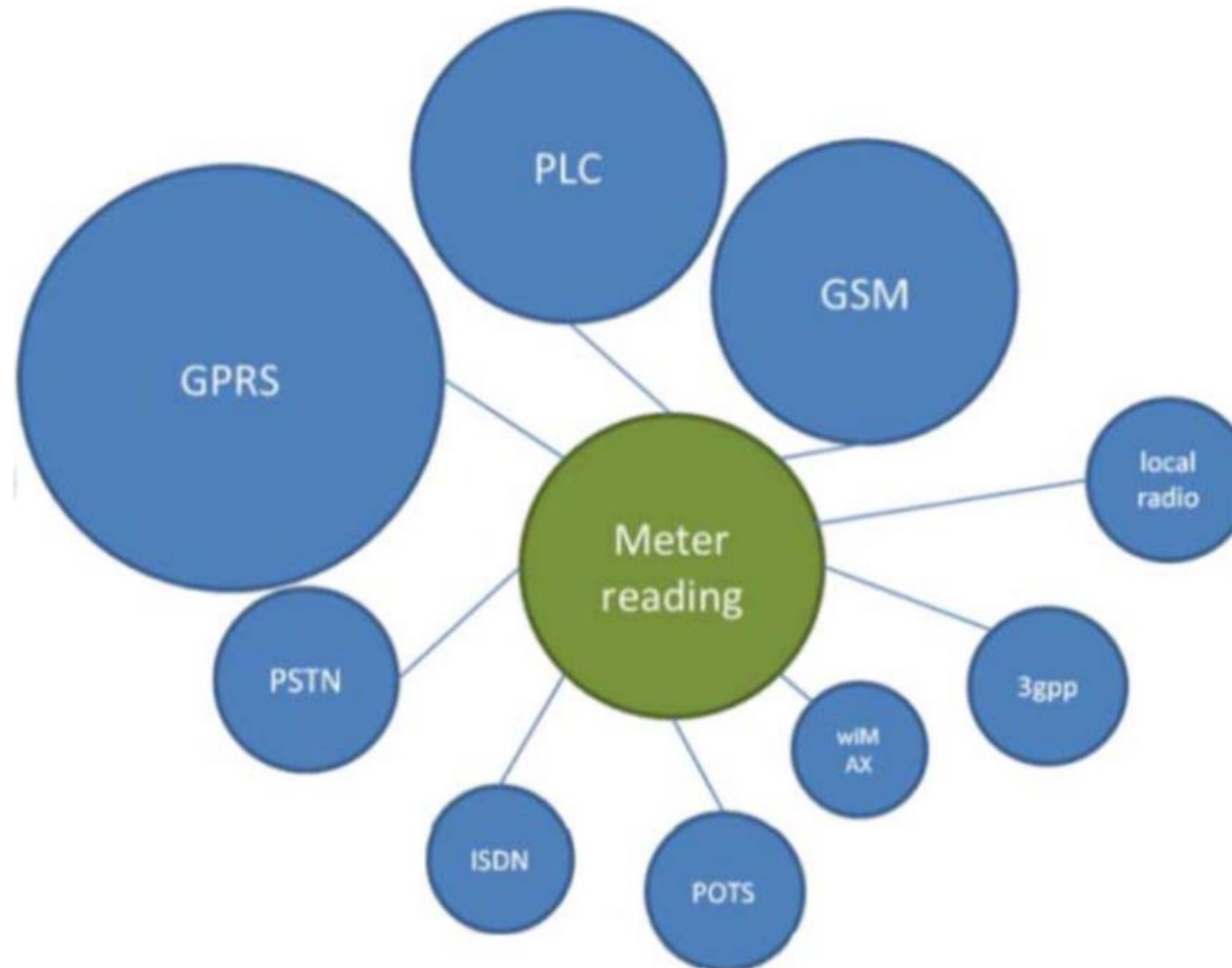
Smart metering

Smart metering

- Monitoring and reporting of electricity consumption in real-time
- Required by EU directive 2009/72/CE
- possibility for the more active involvement of the end-consumers in electricity market (part of EU's 20/20/20 targets)



Smart grid communication technologies (1)



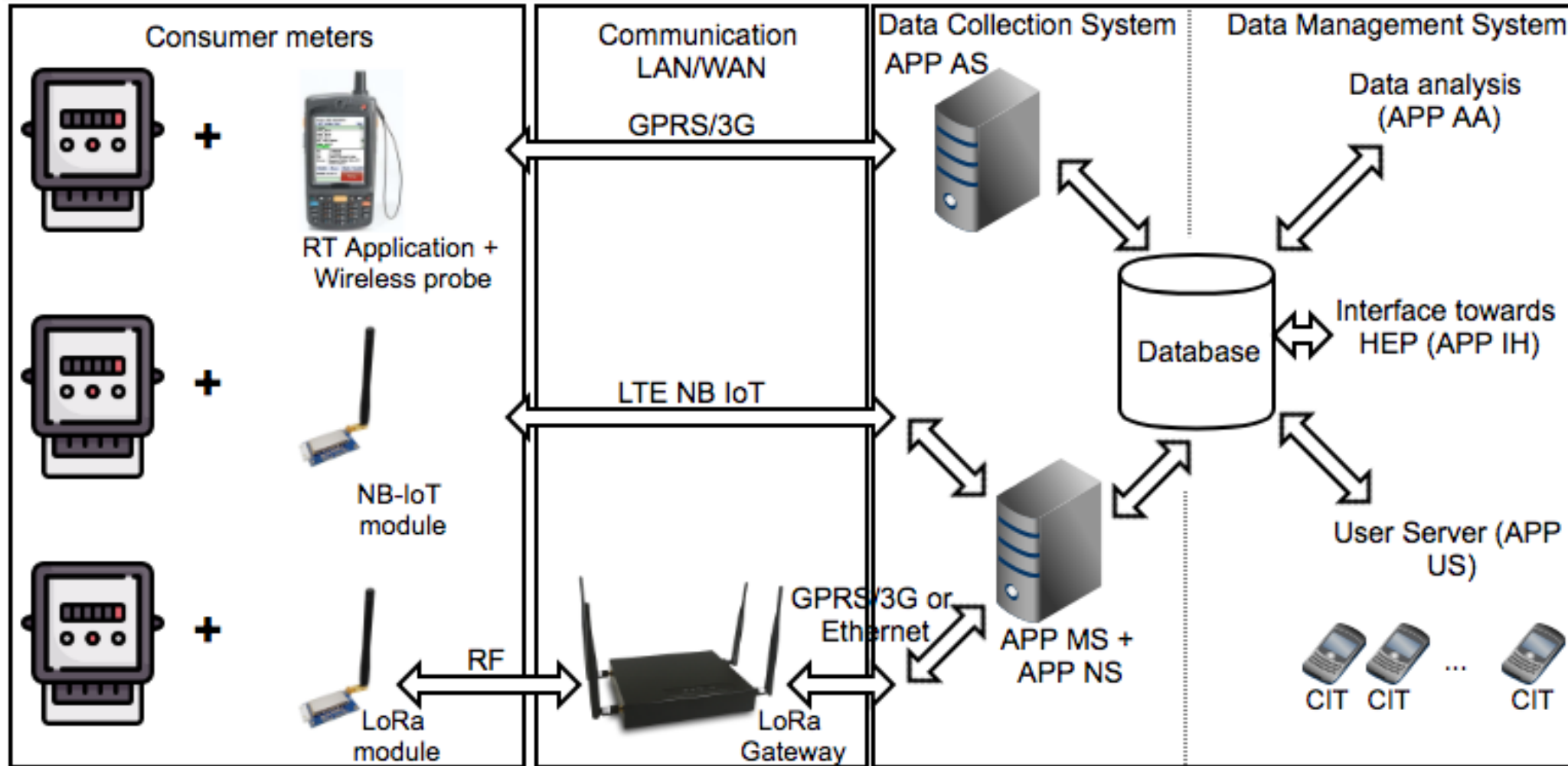
Smart grid communication technologies (2)

- PLC (power line communication) technology preferred
 - Already used in electricity distribution network
- Guaranteed time of delivery: 24-48 hours
 - Sufficient for energy consumption monitoring
 - Inefficient for consumption management

Smart grid project at IoTLab@UniZG-FER

- Design, implementation and testing of a complete smart grid solution in a real-world environment
- Research goal
 - Utilizing advanced communication protocols
 - Designing a scalable software solution for reception, storage and processing of metering data

System architecture



System software

Data Collection System

Auxiliary System Server (APP AS) + MT Application

- Application for receiving locally collected data by manual terminals with wireless probe

Main Server LoRa and NB-IoT (APP MS)

- Receiving electricity meter data

Network Server LoRaWan and NB-IoT (APP NS)

- Access control for devices with LoRa module (based on LoRaWAN protocol) and NB-IoT module towards Main Server

Data Management System

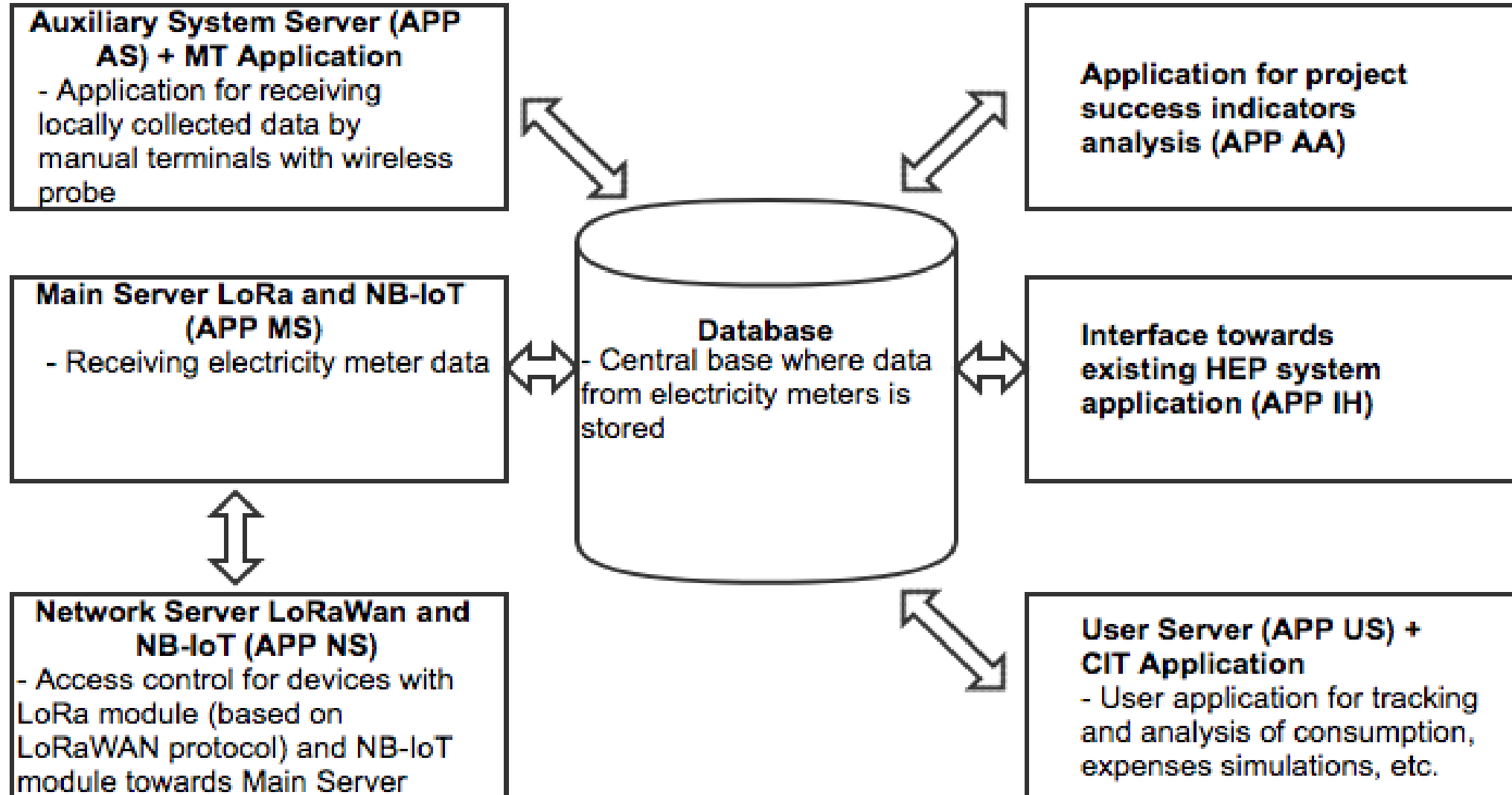
Application for project success indicators analysis (APP AA)

Interface towards existing HEP system application (APP IH)

User Server (APP US) + CIT Application

- User application for tracking and analysis of consumption, expenses simulations, etc.

Database
- Central base where data from electricity meters is stored



Smart metering

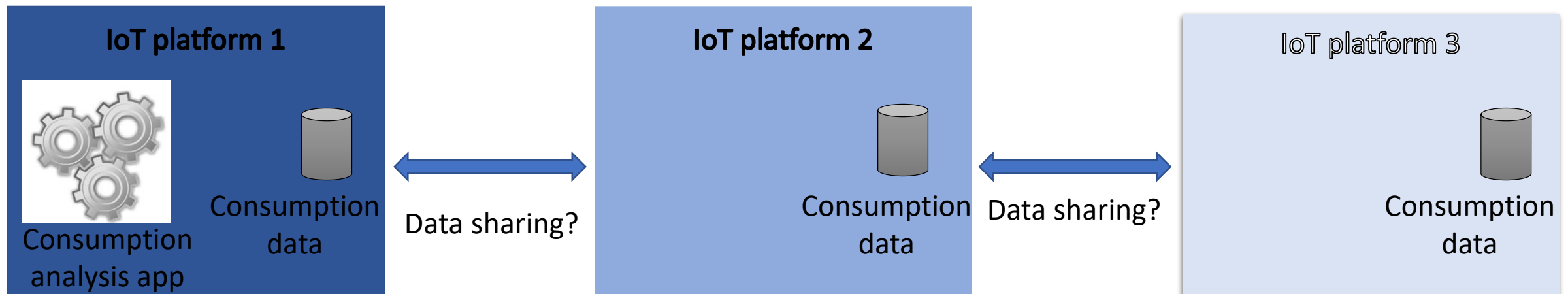
- Electric energy in focus
- Other utilities?
 - Gas
 - Water
 - Telecommunication
- Sharing smart metering data?
- Better insight into consumption for all utilities
- Unified bills for all utilities?

Smart metering – independent solutions

Electricity provider

Gas provider

Water provider

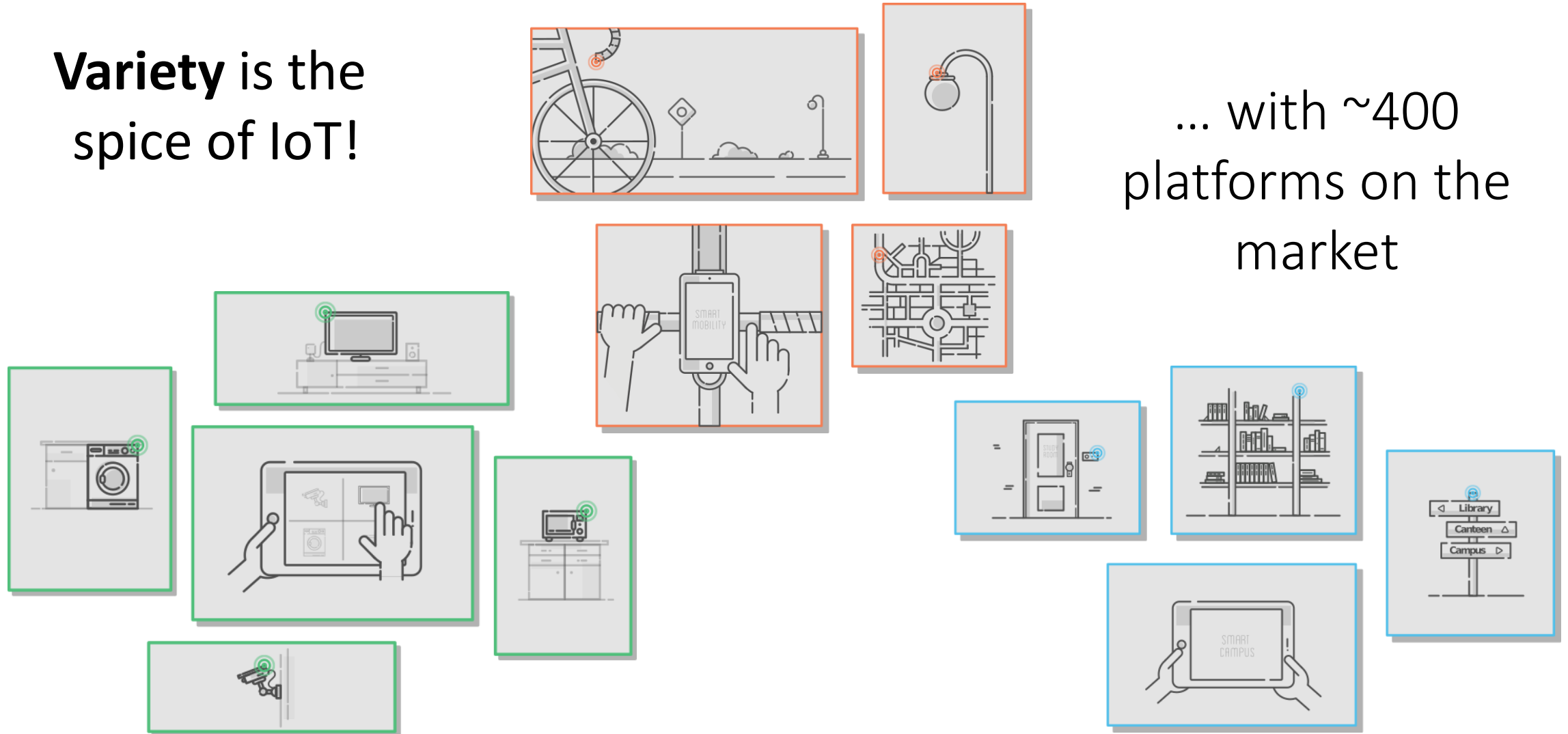


Interoperability challenges

IoT today

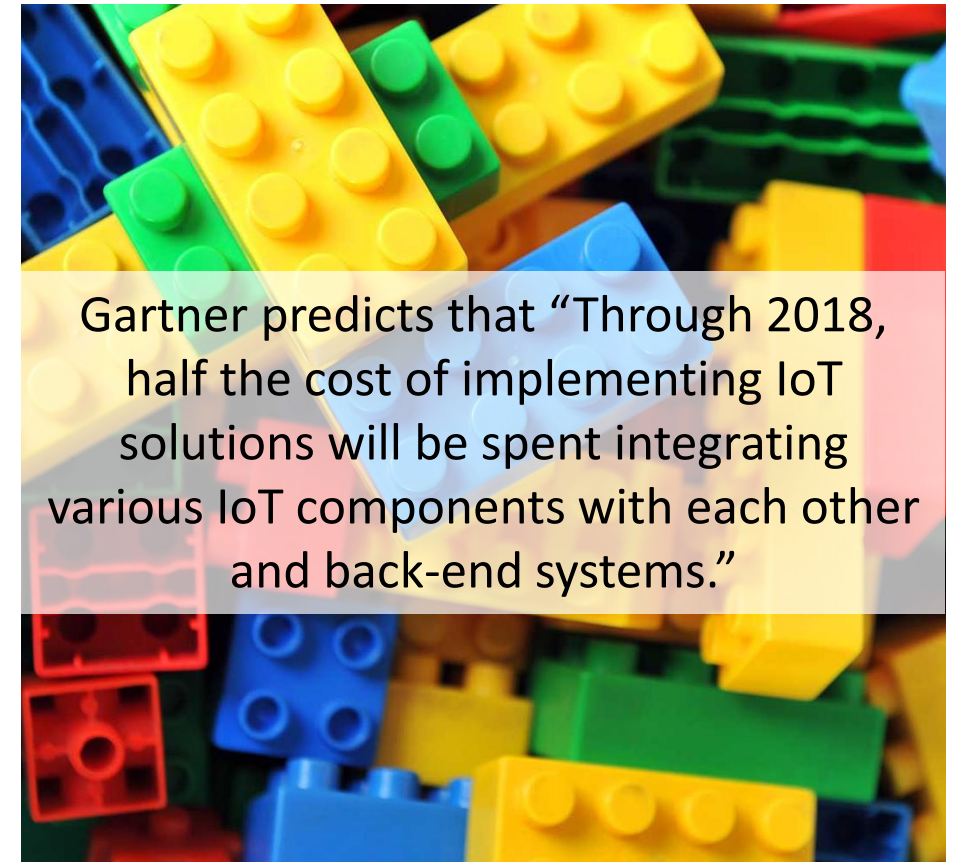
Variety is the
spice of IoT!

... with ~400
platforms on the
market



Interoperability challenge

- Absence of cross-platform and cross-domain apps
- Will a single standard/technology/protocol prevail?
- With more than 400 platforms on the market, will only a handful of them survive?*
- Interoperability at the data level (*semantic interoperability*)
- Decentralized interoperability solutions for collaborative stakeholders (*organizational interoperability*)

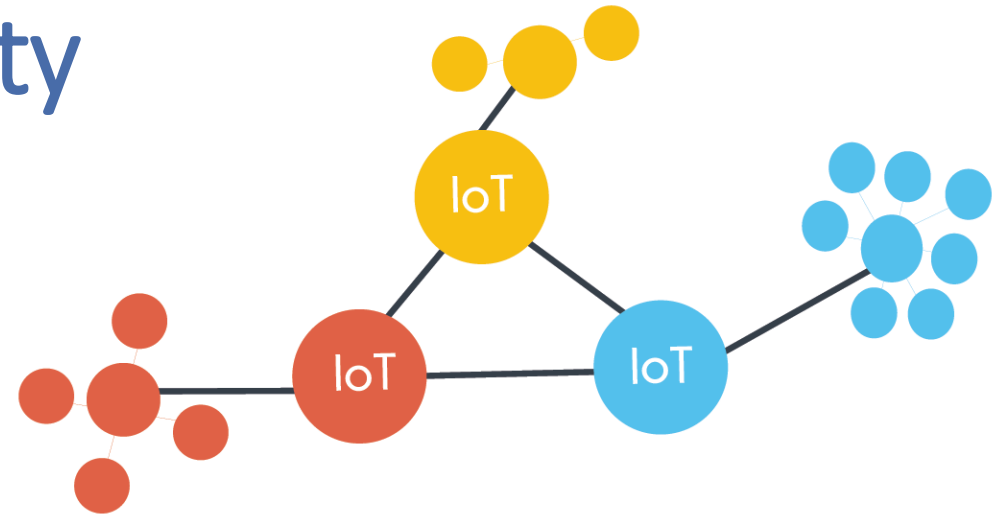


Gartner predicts that “Through 2018, half the cost of implementing IoT solutions will be spent integrating various IoT components with each other and back-end systems.”

* Akash Bhatia, Zia Yusuf, David Ritter, and Nicolas Hunke. **Who Will Win the IoT Platform Wars?** BCG Blogpost, 29.10.2017

Organizational interoperability

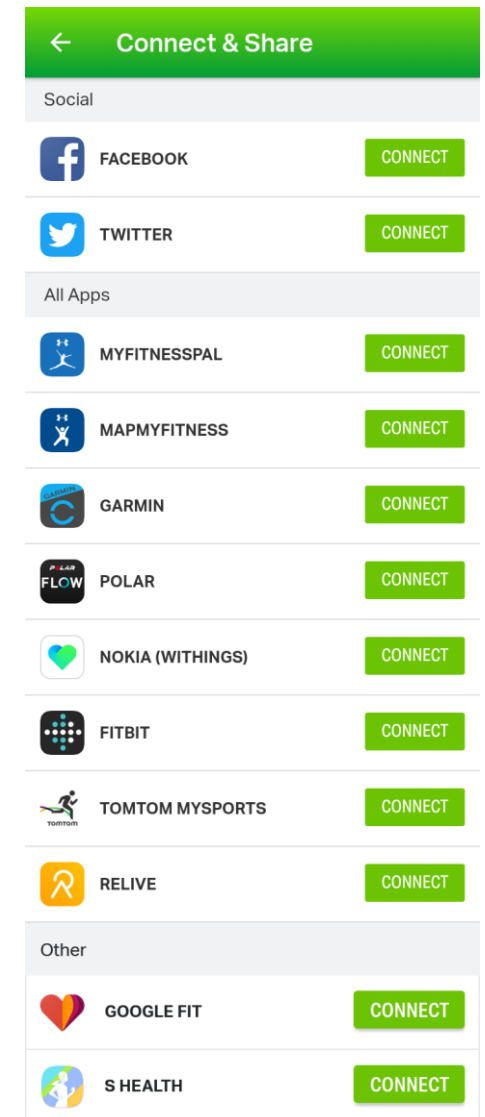
- ETSI Whitepaper 2008: “the ability of organizations to effectively communicate and transfer (meaningful) data (information) even though they may be using a variety of different information systems over widely different infrastructures.”
- IoT platform federations: **associations** between two or more platforms which are willing to **share access** to their IoT resources
- Benefit for IoT applications: an **increased set of resources** is available in platform federations



New partnerships

- A platform is a prosumer of IoT resources with a goal to extend resource offerings to its applications: collaborative platforms complement each other's infrastructure
 - similar IoT platforms operating in different locations increase their reachability
 - collocated platforms can offer cross-domain solutions

Example: Samsung Health



symbloTe interoperability middleware

symbloTe federations

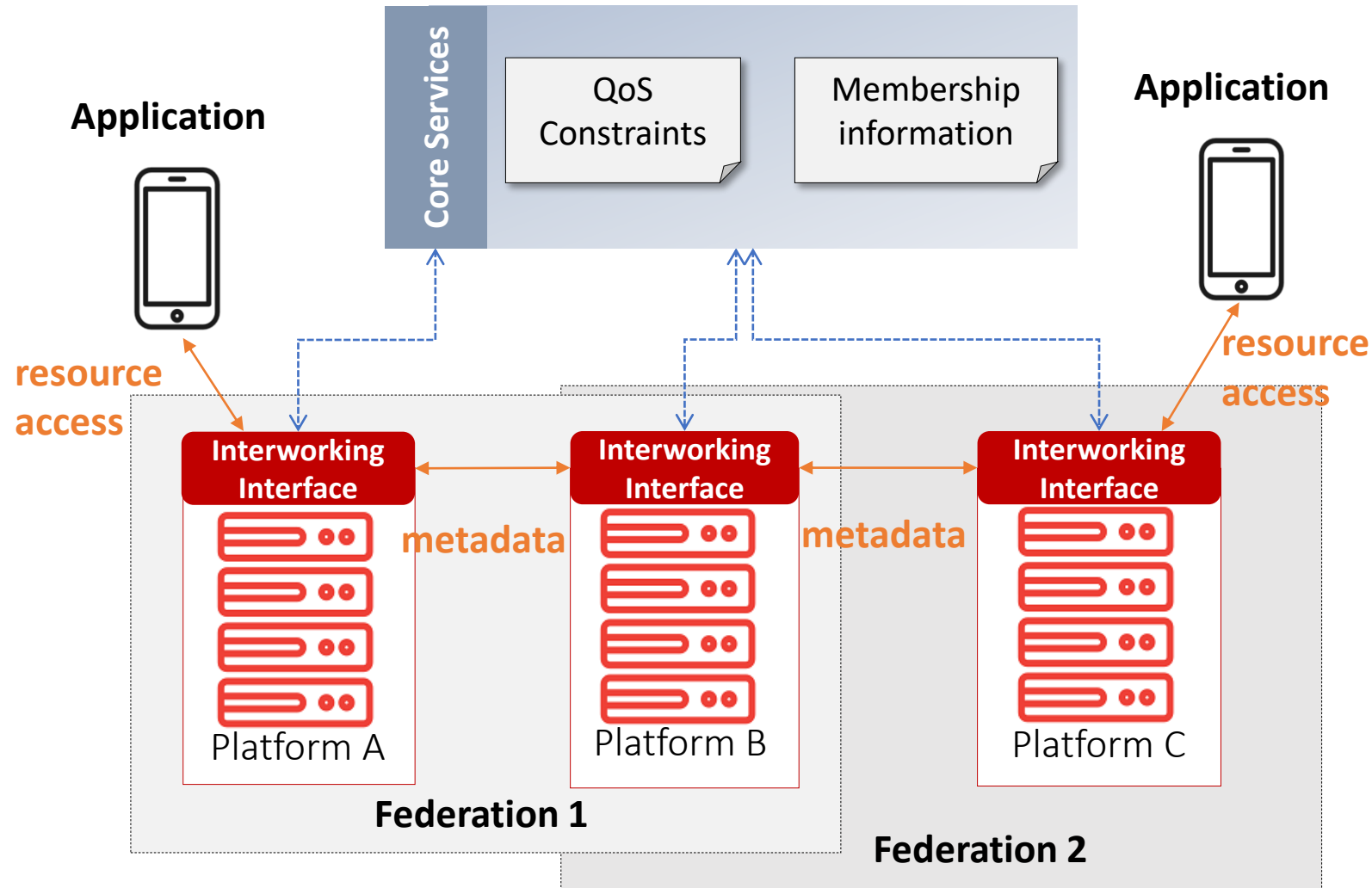
- A partnership of IoT platforms
- Resource sharing
 - Direct resource exchange for other resources
 - without monetary implications
- Decentralized solution
 - No third-party has access to shared resources

symbloTe in a nutshell



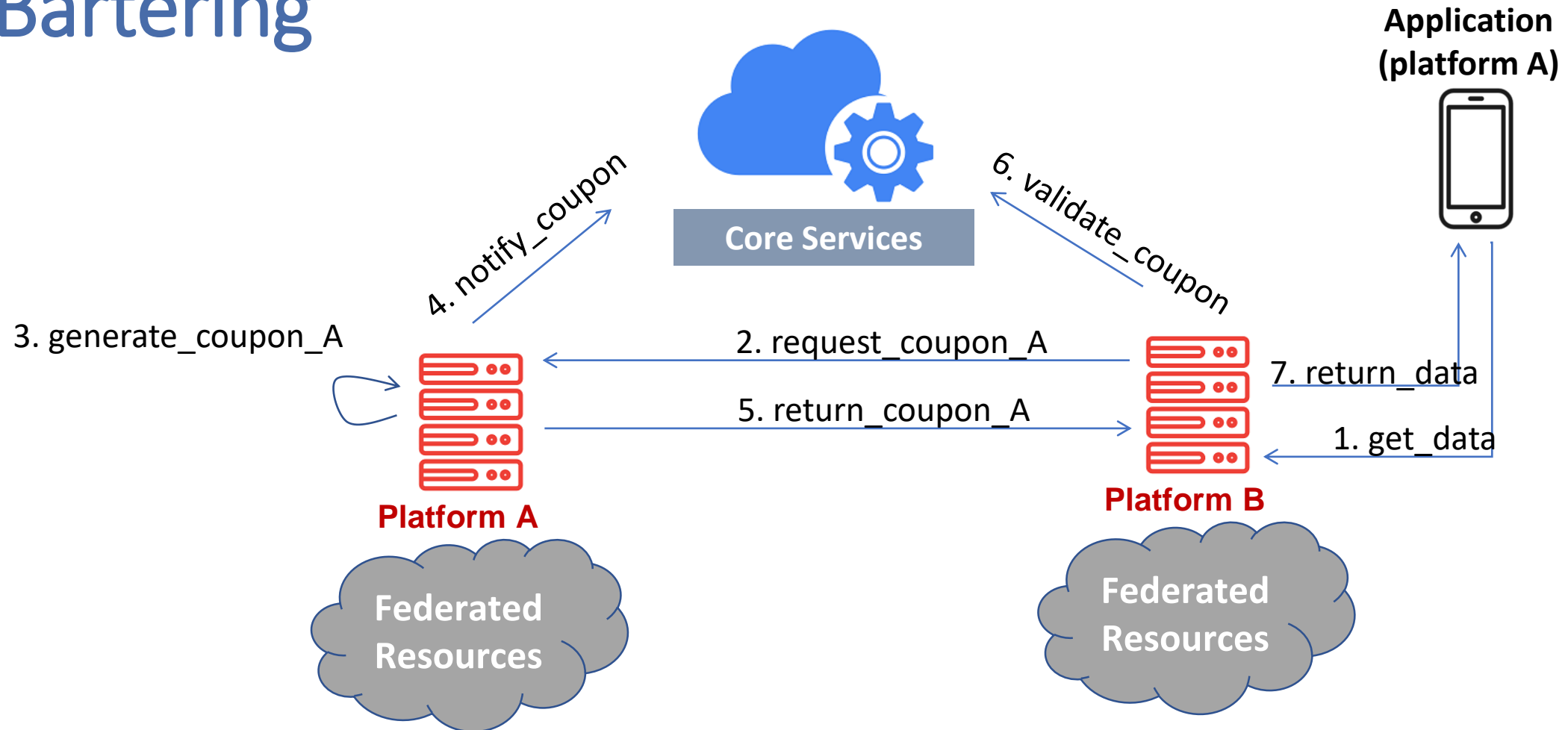
Open Source IoT interoperability middleware and not “yet another IoT platform”

symbloTe platform federations



- Support closer collaboration between federated platforms
- Decentralized metadata management (info on shared resources remains within a federation)
- Mechanisms for monitoring, SLA and trust management

Bartering



symbloTe federations – summary

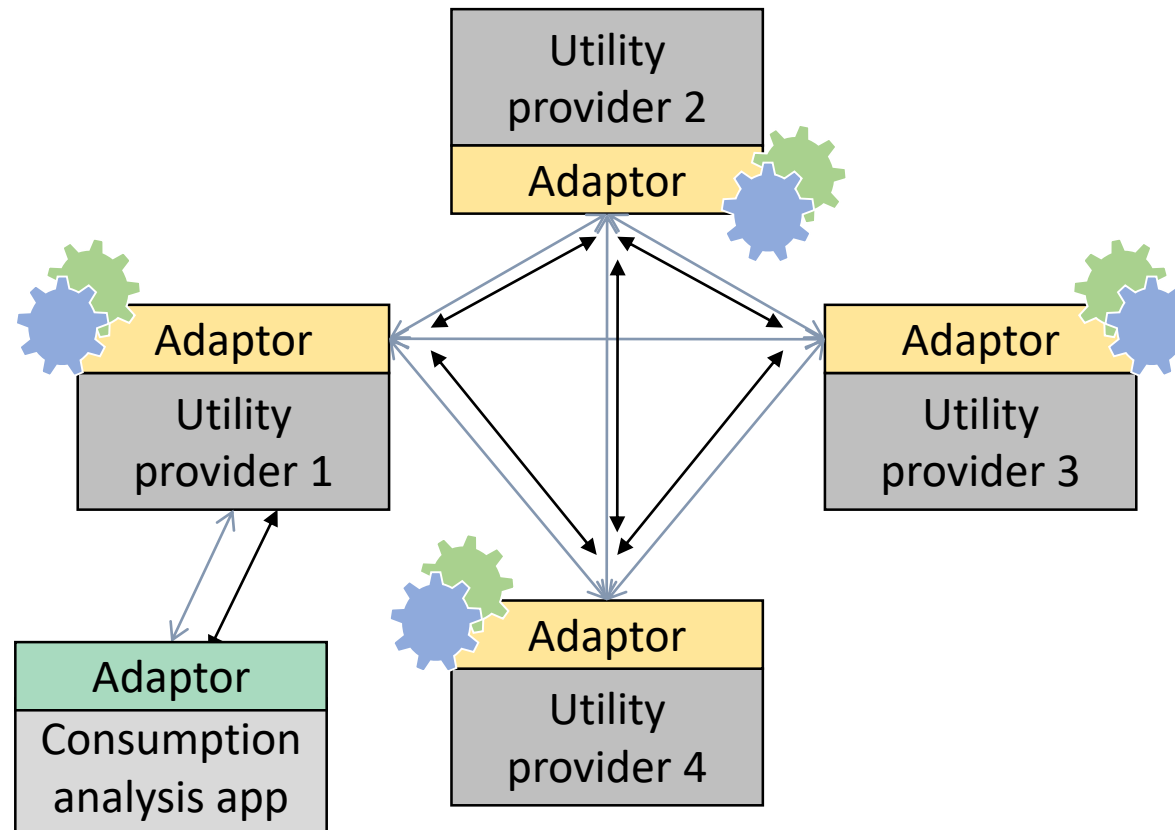
- Novel concept of IoT platform federations with a decentralized management solution
 - Enables direct and secure collaboration between federated platforms to increase offerings to their apps and users
- Novel collaboration mechanisms: SLA management, bartering mechanism and trust calculation
- Growing demand for strategic partnerships to be supported by interoperability solutions where data and information is exchanged directly in a controlled, meaningful and trustful manner

syμβloTe & smart metering

Smart metering federations

- Federations of utility companies
 - Electricity
 - Gas
 - Water
- Benefits
 - Possibility to analyze overall consumption in a household
 - Suggestions to minimize consumption
 - Unified bills?

Proposed solution



symbloTe middleware (adaptors)

- Unified interfaces for resource access
- Unified interfaces for resource metadata exchange
- Authorization & authentication solution

- Information models can be chosen according to use-case needs

Key takeaways

Key takeaways – Technical aspect

- Utilizing advanced communication protocols (LoRaWAN, Sigfox, NB-IoT)
- Designing a scalable software solution for reception, storage and processing of metering data
- Interoperability between utility providers
 - **symbloTe middleware**

Key takeaways – Business aspect

- Consumption analysis applications
 - Detailed insight into utility consumption
 - Which appliances are largest consumers?
 - Recommendations to reduce consumption
- Dynamic electricity pricing
- Sharing utility consumption information
 - Possibility for more advanced consumption analysis applications

Key takeaways – Societal aspect

- Advanced smart metering solutions
 - Precise consumed energy reports
 - Optimization and reduction of household energy consumption
- Data sharing
 - Consent from the users



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