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GROPIUS
An agnostic and Multi-Service IoT Platform
Use Case and Needs in Real Smart Applications

Welcome

IoT

Internet of Things (IoT), and the most recent paradigm of Internet of Everything (IoE), are the ICT sectors with the highest rate of growth.

The number of connected devices is expected to grow up to 50 billions within 2020 with the goal to provide information to consumers, manufacturers and service providers.

In the IoT world a moltitude of devices will be interconnected by means of Internet or peer to peer connections or ad hoc networks as for Smart Grid infrastructure.

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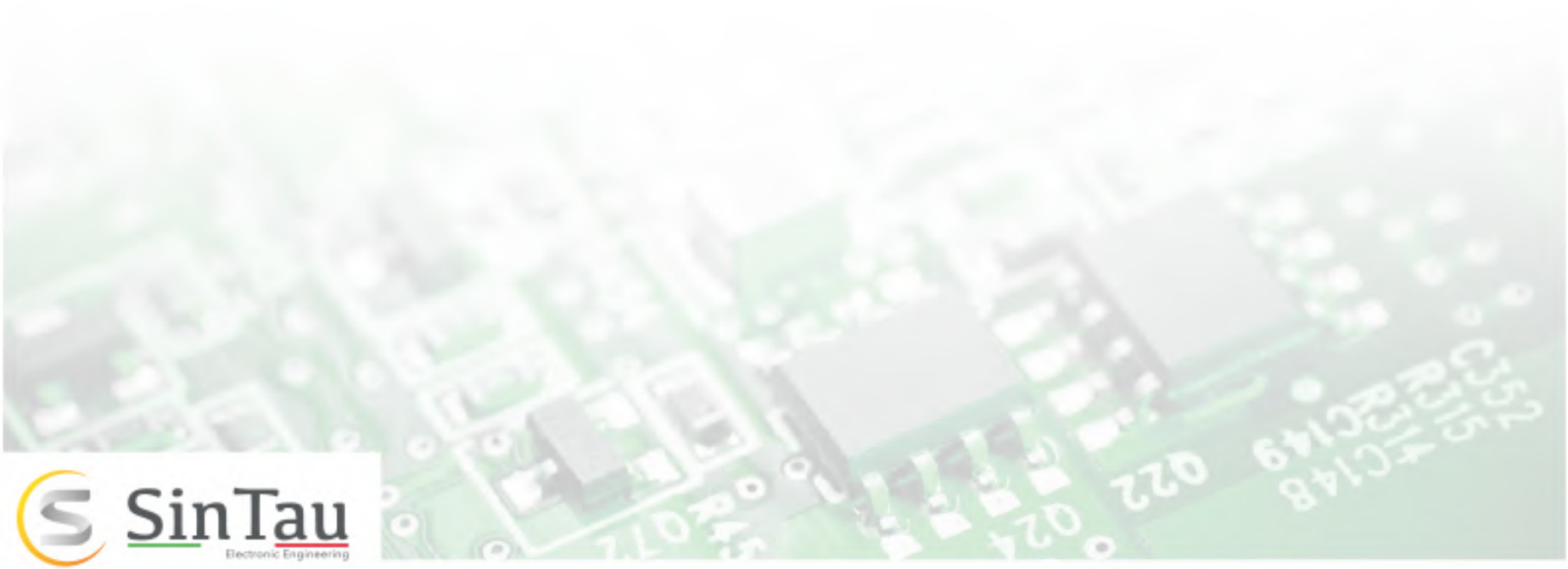
IoT

Internet of Things is made of sensors and actuators connected to objects and communication devices.

It has the goal to provide data that can be analyzed and used to start automatic actions.

The collected data can be also vital information to planning, managing, policy and decision processes.



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IoT: applications

From building automation to wearable devices, IoT can touch every single phase of our lives:

- Wearables
- Smart Manufacturing
- Building & Home automation
- Health care
- Smart cities
- Automotive
- Automatic Meter Reading & Management

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IoT: concepts and technologies

The concepts and technologies that brougth to the idea of IoT are effective since long time. I.e, the M2M communication is one of the more important aspect of IoT.

Indeed, IoT is a more complete phenomenon because it includes also:

- Machine-to-Human communication (M2H)
- Radio Frequency Identification (RFID)
- Location-Based Services (LBS)
- Augmented Reality (AR)
- Robotics
- Car telematics

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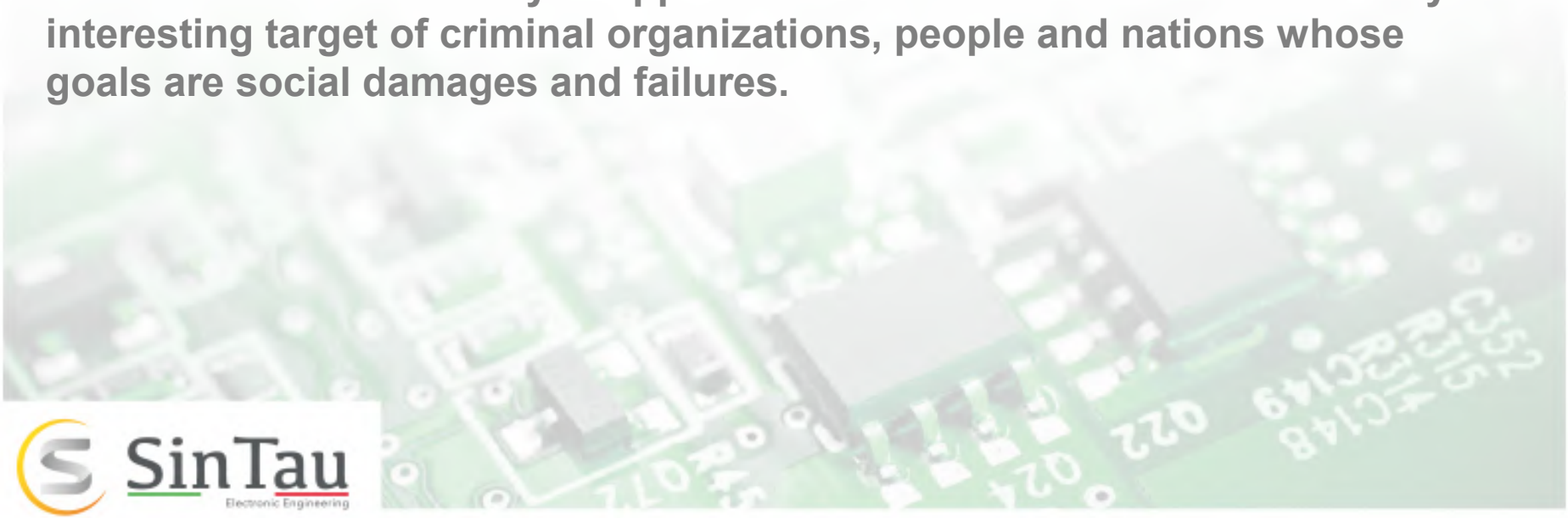
IoT – social aspects and security implications

The IoT applications have influence on many aspects of our daily life, form industrial control, to transportation, to Smartgrids o Heathcare, and for this reason it is absolutely necessary to ensure that IoT systems are reliably and secure.

Because the used networks are based in IP protocol, the IoT applications have been object of cybernetic attacks that will grow in quantity and complexity.

The use cases and variety of application of IoT determine that it is a very interesting target of criminal organizations, people and nations whose goals are social damages and failures.



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Building Energy Management Systems (BEMS)

Building Energy Management Systems (or BEMS) are computer-based systems that help to manage, control and monitor building technical services (HVAC, lighting etc.) and the energy consumption of devices used by the building. They provide the information and the tools that building managers need both:

- to understand the energy usage of their buildings;
- to control and improve energy performances.

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Building Energy Management Systems (BEMS) - benefits

There are a number of important benefits associated with use of a Building Energy Management system.

- It provides energy analysis, management and control information.
- It enables equipment, air conditioning, lighting etc to be switched on and off automatically.
- It optimises space heating within the building.
- It allows monitoring of equipment status and environmental conditions.

With the advent of the Smart Grid, the BEMS can help businesses better manage their electricity demand. With a varying price of electricity, the BEMS can program the system can turn on and turn off loads without sacrificing occupant safety, comfort, and productivity.

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Smart Metering

The Smart Metering structure is a management network that, exploiting the advantages offered by the wireless technologies to collect data from the users' devices, is able to interface the Network Management System (NMS) bye means of wired or wireless communication network in order to:

- Help the service utilities to optimize their processes in order to allow a better control, management and rationalization of activities
- Help the end user to create new communication channels that allow to improve the service offering a real time reading of his consumptions in order to have energy savings, security and control services.

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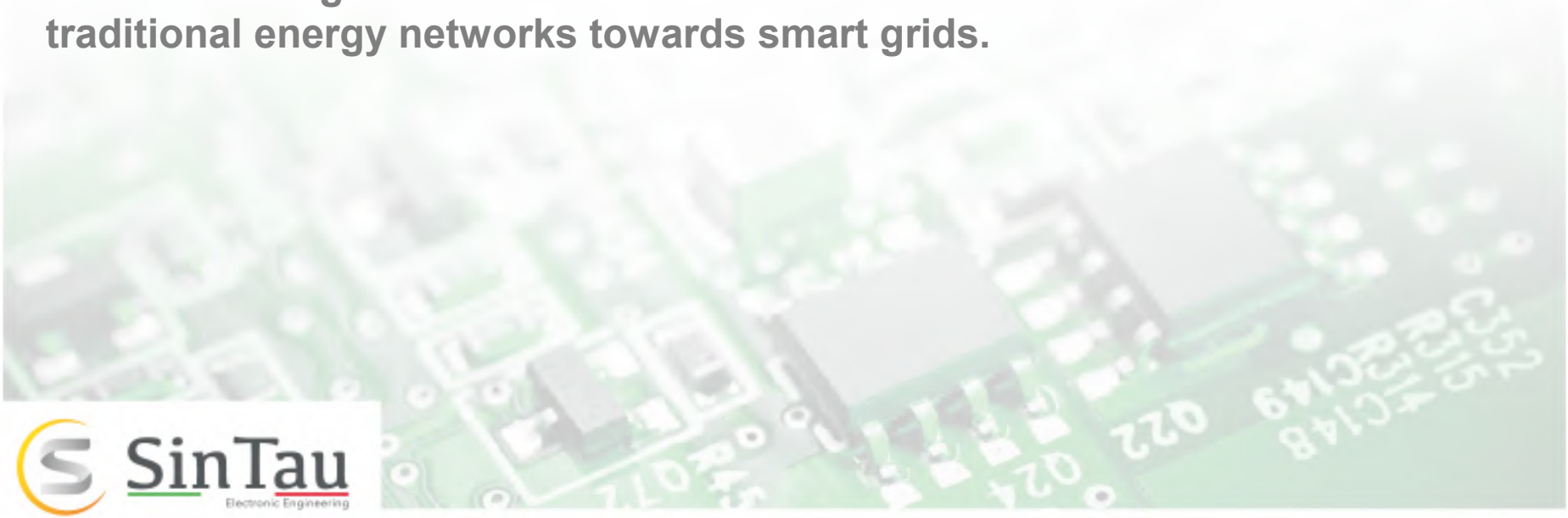
Smart Metering

The technologies used in this case, in particular the sensors, are well consolidated and well spreaded on the market and are very cheap.

The use of Smart Metering is desirable at every level of the distribution network or energy load, from central station, to intelligent network and to every single home unit, because with small costs it will allow the measurement of the energy consumptions and the scheduling and management of the efficiency actions.

Smart metering is also an essential instrument for the evolution of the traditional energy networks towards smart grids.



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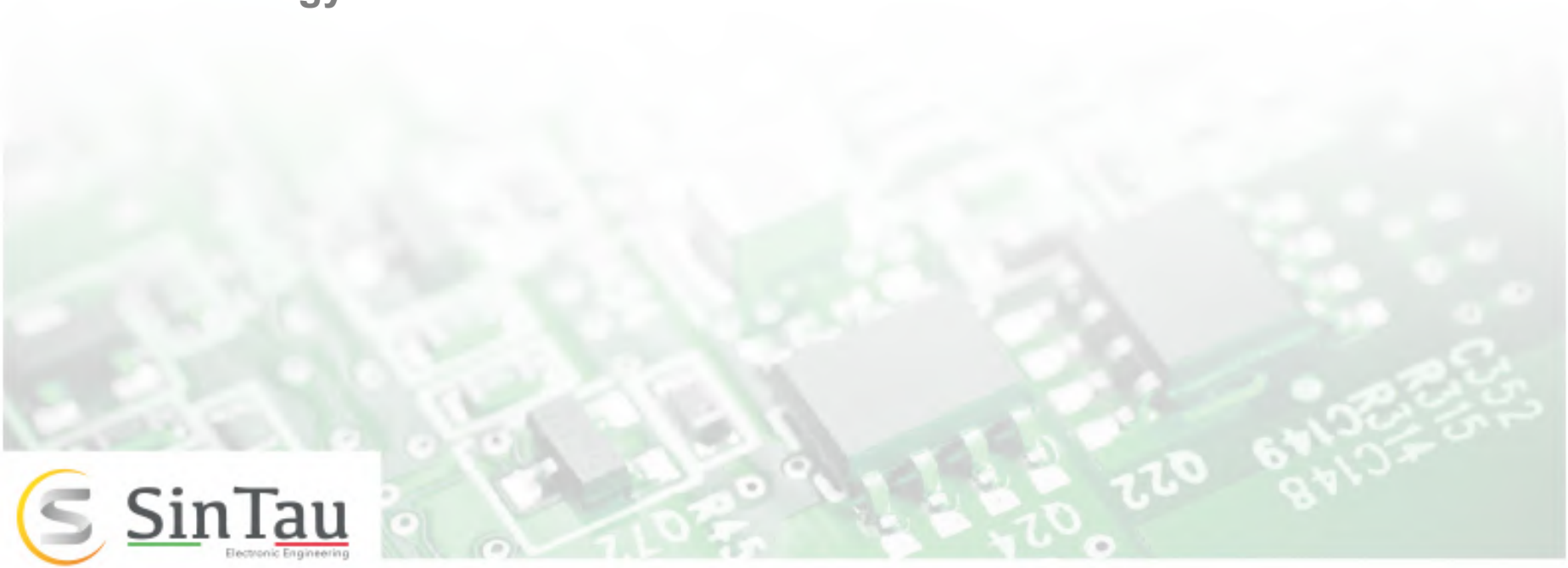
Smart Metering

Smart metering represents a very useful technology in the field of energy efficiency because it is the instrument used for the quantization of the achievable savings after the planned actions.

Infact its application allows to follow through every efficiency action form the design phase, with the energy measurements and leakage evaluation of a building before the requalification actions, pasisng through the monitoring during the implementation phase and ending with the energy measurement and control after the action.



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Automatic Metering Infrastructure & Management

The functionalities of Automatic Meter Reading (AMR) are moving towards the Advanced Metering Infrastructure (AMI), passing through the Automatic Meter Management (AMM).

This evolution has been possible only by means of the progressive development of communication systems that allow that this infrastructure is not used only for simple reading goals but also:

- To manage smart policies of demand management
- To automatically manage and control the distribution network.

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Automatic Metering Infrastructure: components

Smart Meter

The smart meter is the main component of the Ami network because it is the interface between client and AMM management system. Beyond the accuracy, reliability and resilience the other main characteristics that is required id a stable and reliable communication system towards the data concentrator and the client.

Concentrator

The data concentrator id an intermediate element between the control and management system and the smart meters and it is characterized by a stable and reliable communication system towards both terminal devices and central system.

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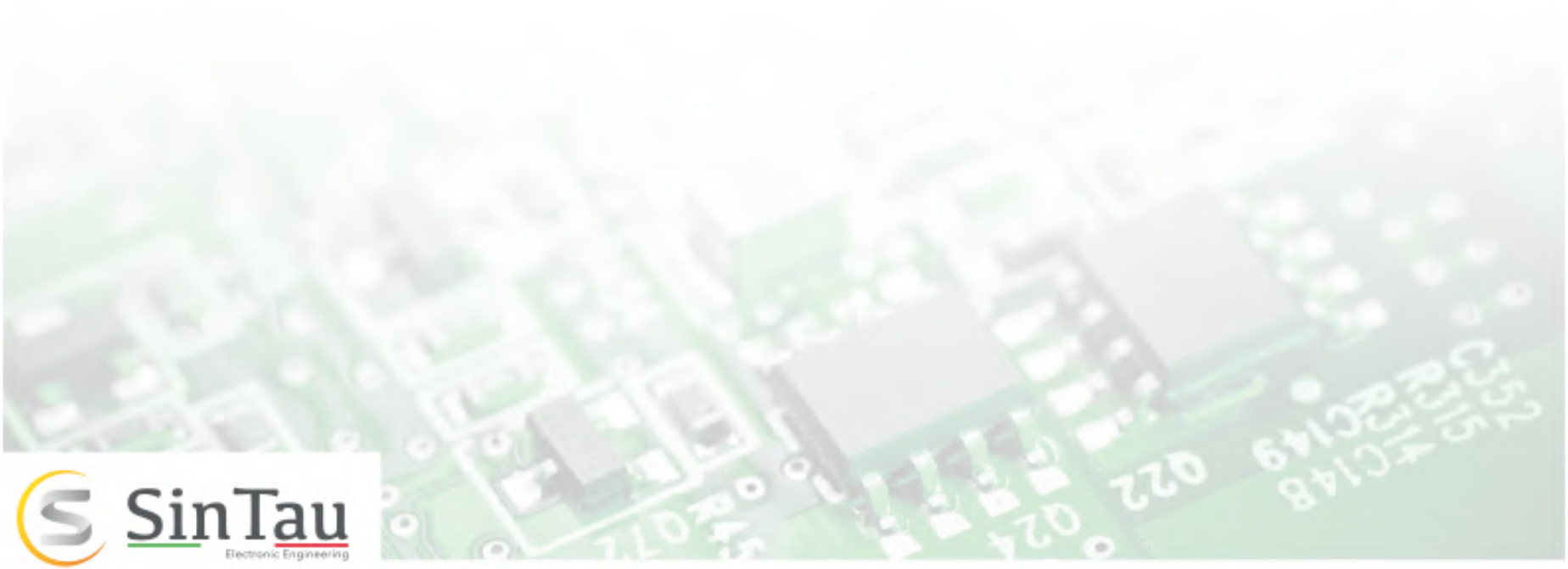
MuliUtility Environments

AMM systems must be ready to support the measurements coming from other utilities like gas, water and heat meters.

The access to these data can be done through many communication technologies and this characteristic requires an open communication architecture.

The evolution in the AMM field it will be to have Multi Utility systems with a modular approach.



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Smart Grid

Smart Grid is a electric power network that is able to integrate all the actions of all connected users (consumers and producers, prosumers) in order to distribute energy in an efficient, substainable, economically convenient and secure way.

The Smart Grid uses innovative products and services together with smart technologies of monitoring, control, communication, self healing with the goal to:

- simplify the connection and operation of heterogenous electric generators of any size and technology;
- provide eavaluation instruments to the consumers to optimize the global system behaviour;
- Give more information and choice capability to the consumers in order to reduce the environmental impact of the whole electric system;
- Increase the reliability and security level of the electric system.

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Smart Grid

With Smart Grid approach the classic vision of the electric network has been overtaken.

The electric power network is no more a passive network transporting energy in one direction, from few big generating stations to many small consumer points localized among the end users.

It has no more a centralized control center with lines, circuit breakers, transformers, but also bidirectional power flows and active networks made also of ICT components.

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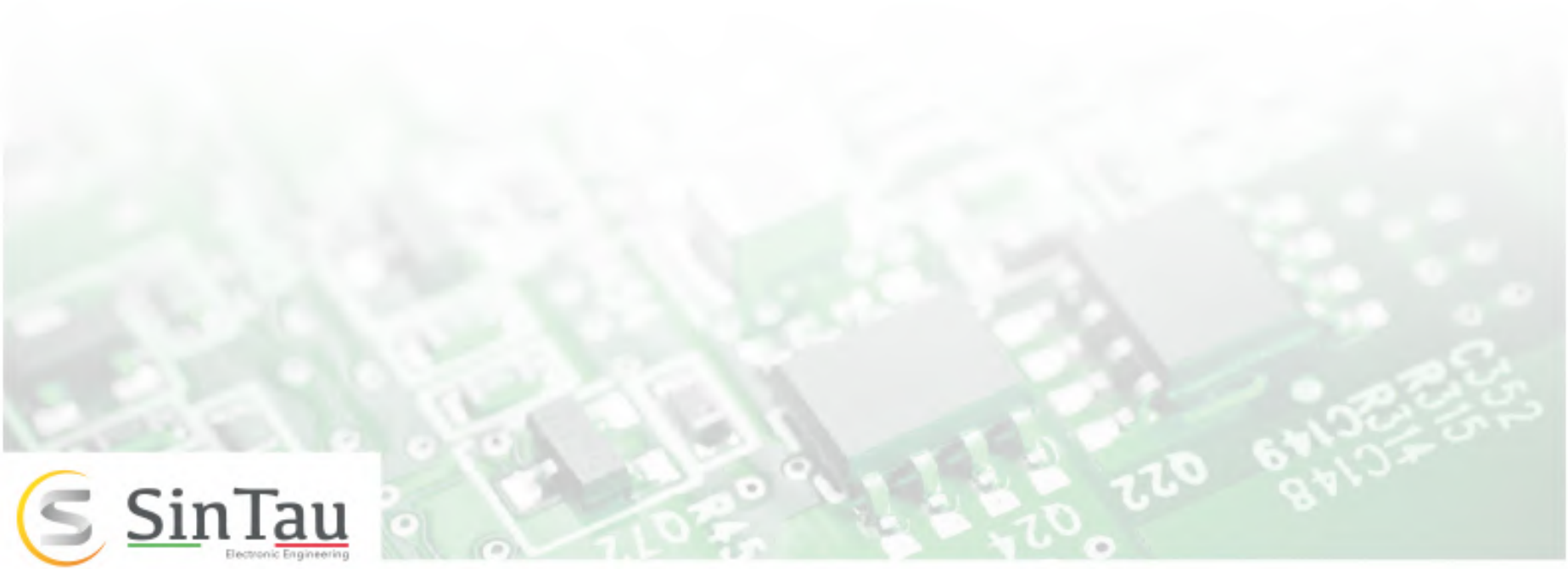
Smart Grid

With such transformation of the distribution network it is necessary also to manage:

- energy flows produced by big generatong stations;
- energy flows from generating points of medium and small size, from renewable sources (photovoltaic, wind, thermal) overtaking also the difficulties related to the flow inversion at HV/MV stations and on MV lines.



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Smart Grid

From a control point of view the electric power network must lok like an "Internet of Energy" where every micro generation system could be grid connected and also be able to communicate, transmit and receive data.

Every single house, users could become a prosumer, energy producer and consumer at the same time in a market open both to big distribution companies and small users.

The need to make available in real time the profiles of consumption and micro generation of the users and network managers request the introduction of smart meters connected with a broadband communication network able to mange bidirectional monitoring and control data streams in real time.

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Smart Grid

The use of ICT technologies is the fly wheel for the evolution of the energy networks in smart networks because they allow the communication between utilities and end users.

At the same time the information technologies and frameworks and the distributed control algorithms allow to optimize the efficiency of all involved systems.

Furthermore the ICT technologies can guarantee a new application layer of services on energy such as:

- smart metering;
- new proce list schemes;
- home portals for the management of the energy production and consumption;
- automatic systems for the purchase, storage and trade of electric energy;
- balancing systems for the management of energy offer and demand.

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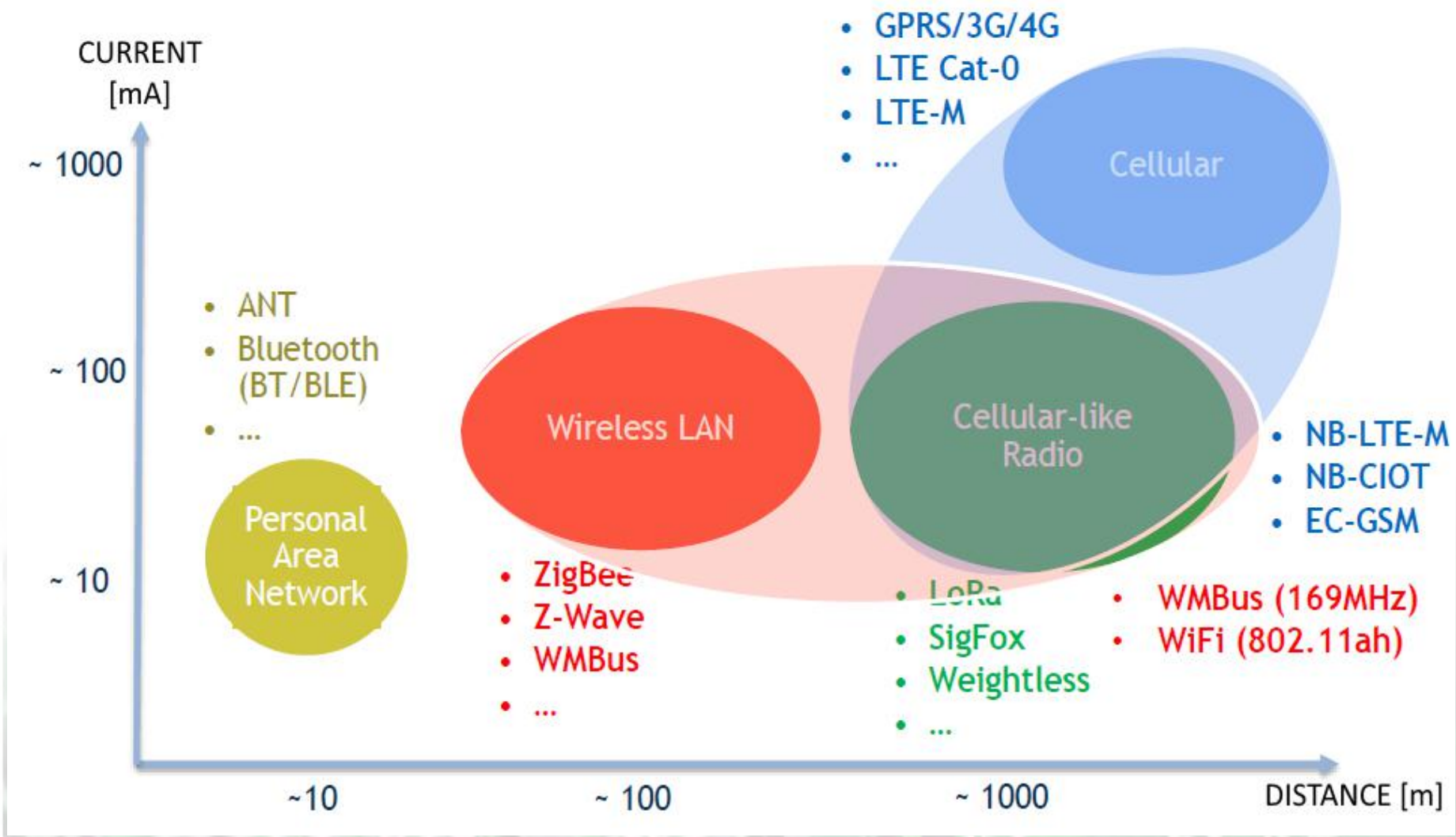
Protocols


CURRENT
[mA]
~ 1000
~ 100
~ 10
• GPRS/3G/4G
• LTE Cat-0
• LTE-M
• ...
Cellular
• ANT
• Bluetooth (BT/BLE)
• ...
Personal Area Network
Wireless LAN
Cellular-like Radio
• NB-LTE-M
• NB-CIOT
• EC-GSM
• ZigBee
• Z-Wave
• WMBus
• ...
• LoRa
• SigFox
• Weightless
• ...
• WMBus (169MHz)
• WiFi (802.11ah)
~10
~ 100
~ 1000
DISTANCE [m]

Cellular-like Protocols (LPWAN)

The main characteristics are:

Energy Efficiency

- Battery life > 5 years
- It depends by may factors likepower, # messages, size of messages, bandwidth, battery capacity

Unlicensed spectrum

- ISM band free usage
- Limits to the use and duty cycle
- Different frequencies in different countries

Narrow bandwidth

- Long distances
- Very low consumption
- Very low throughput
- High scalability in terms of managed nodes

SIGFOX

WEIGHTLESS™

LoRa™

INGENU

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Cellular-like Protocols (LPWAN)

The main features are:

SIGFOX

Distance	→	10 – 50 Km
Bandwidth	→	100 Hz
Throughput	→	UL 0.1 Kbps DL: limited
Standard	→	Proprietary

LoRa™

Distance	→	8 – 45 Km
Bandwidth	→	125 KHz
Throughput	→	UL 0.3-40 Kbps DL: Yes
Standard	→	Industrial

WEIGHTLESS™

Distance	→	2 – 5 Km
Bandwidth	→	200 Hz/12.5 Khz
Throughput	→	UL 0.2-100 Kbps DL: Yes
Standard	→	Open Industrial

ingenu

Distance	→	4 Km
Bandwidth	→	1 Mhz
Throughput	→	UL 8 Kbps DL: Yes
Standard	→	Proprietary

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Ingenu works in the 2.4 Ghz band, all others work < 1Ghz

Cellular-like Protocols – LPWAN vs cellular world

Infrastructure

- LPWAN networks have high concentration factors and transmission coverages very huge
- I.e in a medium city you need <10 LORA or SigFox base station vs 100 cellular base station

Operating costs

- The LPWAN reduced complexity result into reduced operating costs
- No license needed to access the spectrum

Service Level

- The use of license free ISM band determines the impossibility to provide any kind of warranty or SLA for mission critical services.
- Without any control, the proliferation of the use of these protocols will lead to saturation of the bandwidth available in the future

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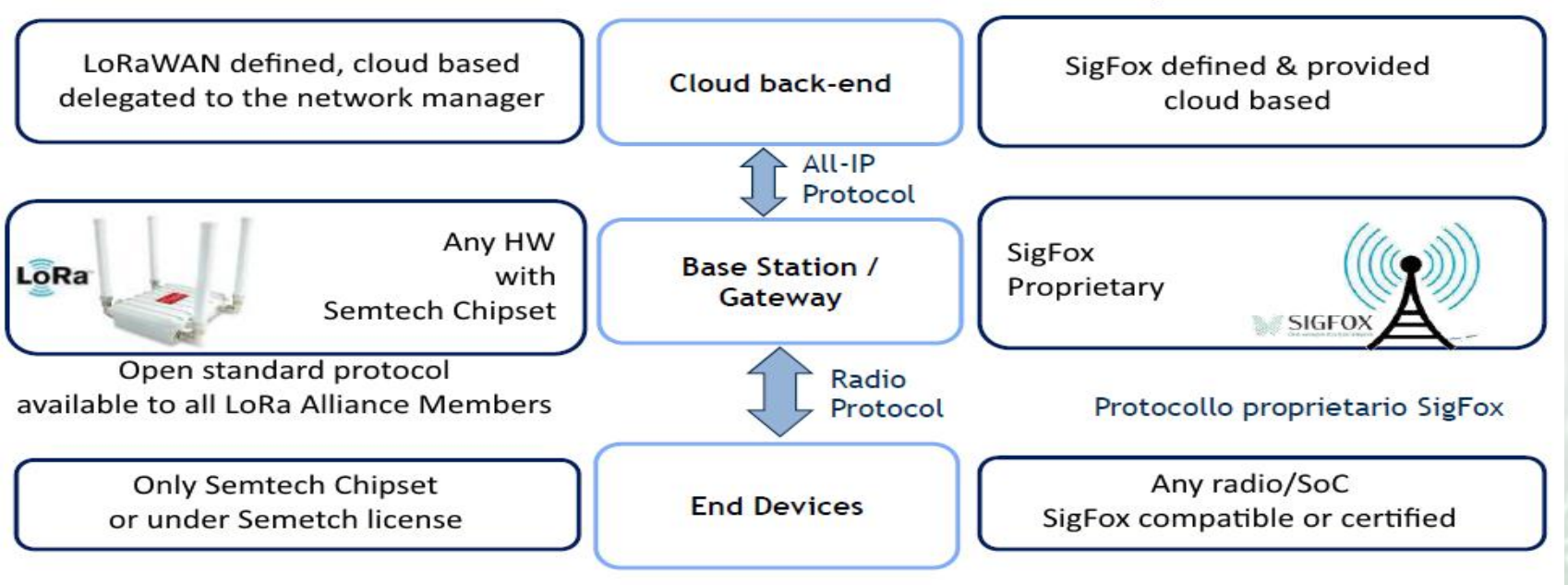
Cellular-like Protocols – LORA vs SigFox

Revenue:
chipset royalties (Semtech) + connectivity (network manager)

Public or private deployment, usually at more restricted level, no choreography

Revenue:
product certification (SigFox) + connectivity (network manager/ SigFox)

Public deployment, one national network manager, choreography by SigFox



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Cellular-like Protocols – threat or opportunity

How do telco see the cellular like IoT networks?

Threat

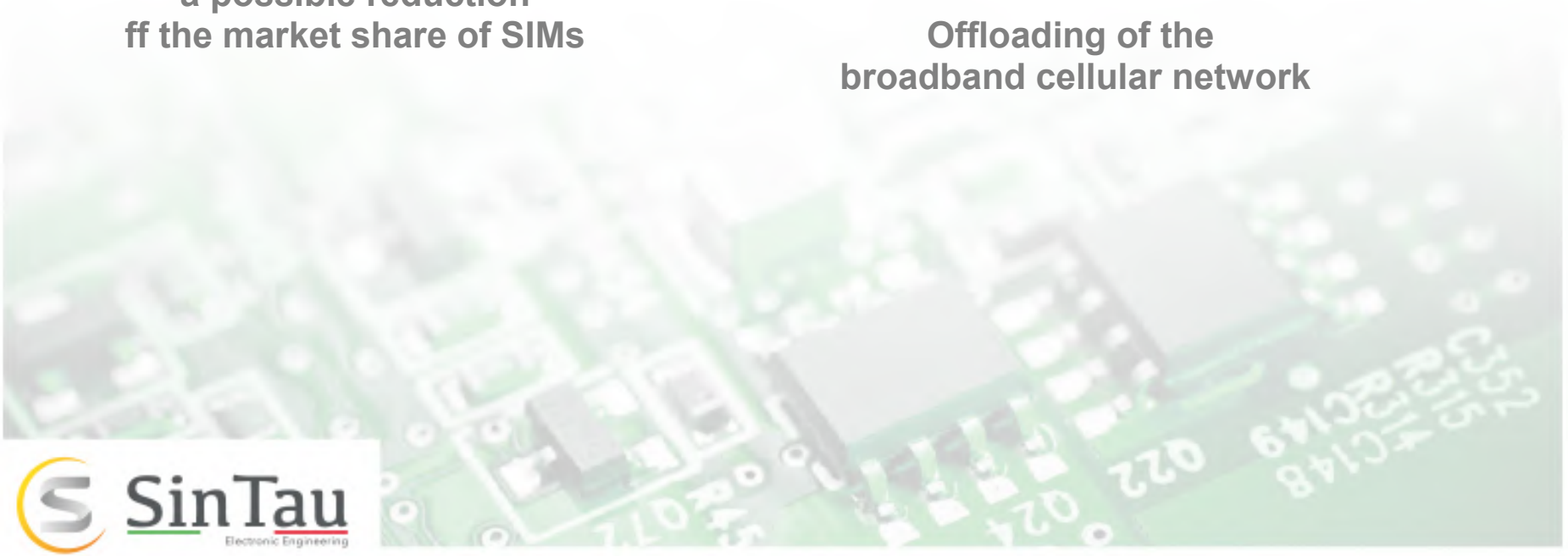
An alternative approach,
many times more competitive,
To the cellulari M2M connectivity

The first impact is
a possible reduction
ff the market share of SIMs

Opportunity

Acquire new market share
(in use cases incompatible with
cellular networks)
by means of the deployment
of cellular like networks

Offloading of the
broadband cellular network



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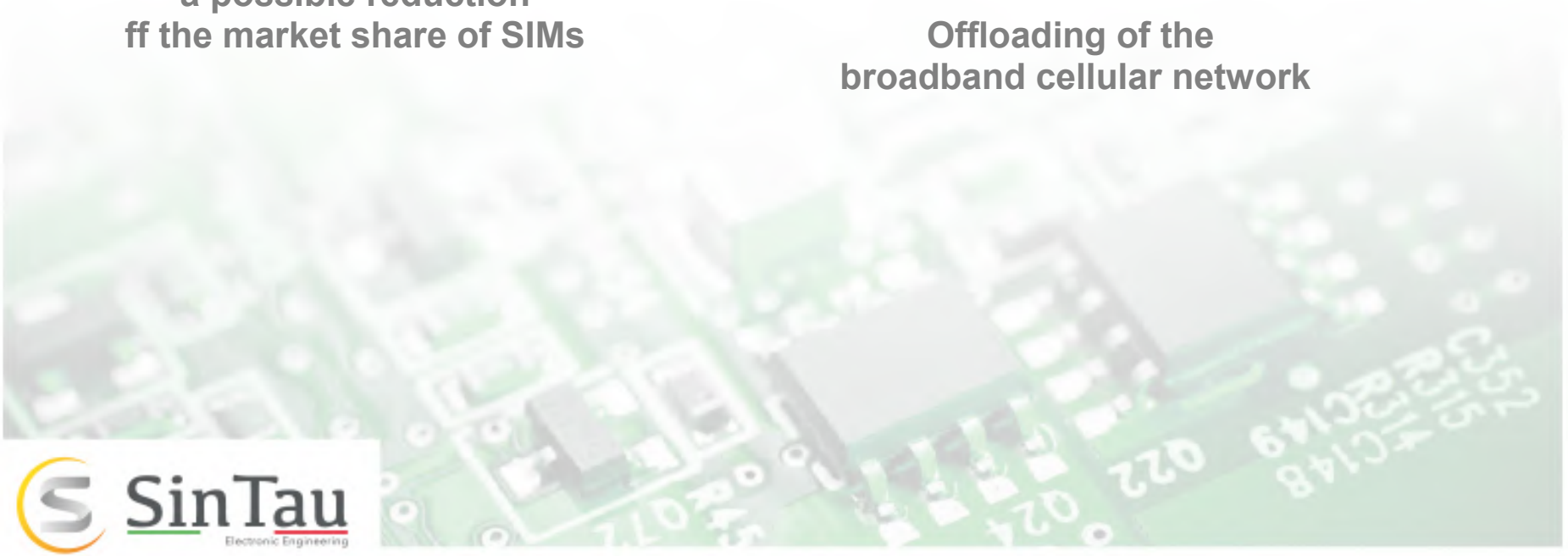

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Cellular-like Protocols – telco position

Cellular protocols are in rapid evolution

Two different approaches:

- Evolution of the existing cellular network : LTE Cat M and NB-LTE
- Clean state :NB-CIoT

In any case there are at least 3 years of delay respect to the cellular like networks

LTE cat M
All manufacturers

Nokia Networks

ERICSSON

intel

NB-LTE

HUAWEI

NB-CIoT

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Cellular-like Protocols – some considerations & questions

Cellular-like technologies have a time advantage

- New operators and business models based on existing assets (i.e. Towers) are emerging
- General purpose infrastructure enabling new applications

Cellular technologies are in standardization phase

- When available, the network deployment by traditional operators will be very quick

Ecosystems & platforms

- What is the position of the different actors (new and old operators) against of emerging ecosystems related to SW platforms and communities of developers?

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Short Range Protocols

There exists a huge choice of connectivity options for engineers and application developers working on products and systems for the Internet of Things (IoT).

Depending on the application, factors such as range, data requirements, security and power demands and battery life will indicate the choice of one or some form of combination of technologies.

Many communication technologies are well known such as WiFi, Bluetooth, ZigBee and 2G/3G/4G cellular, but there are also several new emerging networking options such as Thread as an alternative for home automation applications and for wider area IoT-based use cases.

Below it will be presented an extensive list of IoT protocols in no particular order.

But in any case we can not worry about the protocol needed by a particular application until we know precisely what are the application needs.

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Short Range Protocols

Bluetooth is a global 2.4 GHz personal area network for short-range wireless communication. Device-to-device file transfers, wireless speakers, and wireless headsets are often enabled with Bluetooth.

BLE is a version of Bluetooth designed for lower-powered devices that use less data. To conserve power, BLE remains in sleep mode except when a connection is initiated. This makes it ideal for wearable fitness trackers and health monitors.

ZigBee is a 2.4 GHz mesh local area network (LAN) protocol. It was originally designed for building automation and control—so things like wireless thermostats and lighting systems often use ZigBee.

Z-Wave is a sub-GHz mesh network protocol, and it is a proprietary stack. It is often used for security systems, home automation, and lighting controls.

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Short Range Protocols

6LoWPAN uses a lightweight IP-based communication to travel over lower data rate networks. It is an open protocol like ZigBee, and it is primarily used for home and building automation.

Thread is an open standard, built on IPv6 and 6LoWPAN protocols. You can actually use some of the same chips for Thread and ZigBee, because they're both based on 802.15.4.

SmartMesh wireless sensor networks (WSN) deliver unmatched data reliability over ultra-low power, secure wireless communications, enabling sensors to be placed anywhere in tough Industrial Internet of Things (IoT) environments.

Designed specifically for low data rate, long-range sensors and controllers, 802.11ah is far more IoT-centric than many other WiFi counterparts.

Near field communication is precisely as it sounds—a protocol used for very close communication. When you wave your phone over a card reader to pay for groceries, you're likely using NFC.

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Short Range Protocols

MiWi is Microchip's proprietary network protocol. It was created for short-range networks and designed to help customers reduce their products' time to market.

EnOcean is a protocol designed specifically for energy harvesting applications that are extremely low power. Thus, its applications are centered around building automation, smart homes, and wireless lighting control.

WirelessHART is built on the HART Communication Protocol, and is what the company considers "the industry's first international open wireless communication standard."

More details on

http://www.link-labs.com/complete-list-iot-network-protocols/

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Wired Protocols

HOMEPLUG POWERLINE ALLIANCE

The HomePlug Green PHY specification was developed to drive emerging smart home, home automation & control and electric vehicle communication applications. HomePlug Green PHY technology brings a completely new dimension to networking via the powerlines; products based on HomePlug Green PHY typically have greater distance coverage and and lower power consumption than HomePlug AV products.

Nétricity

The Netricity program promotes the adoption of products built on the new IEEE 1901.2 Low-Frequency Narrow-Band powerline communications standard, which provides for urban and long distance communications and propagation through transformers of the distribution network using frequencies below 500 kHz. The technology also addresses requirements that assure communication privacy and secure networks.

G3-PLC Alliance

G3-PLC was developed to meet the industry's need for an ubiquitous powerline communications standard that will enable the smart grid vision. G3-PLC facilitates high-speed, highly-reliable, long-range communication over the existing powerline grid. It has the ability to cross transformers and supports IPv6.

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Wired Protocols

Modbus®

Modbus is a serial communications protocol for use with programmable logic controllers (PLCs). Simple and robust, it has since become a de facto standard communication protocol, and it is now a commonly available means of connecting industrial electronic devices

KNX

KNX is a standardized (EN 50090, ISO/IEC 14543), OSI-based network communications protocol for building automation. KNX is the successor to, and convergence of, three previous standards: the European Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB or Instabus

EtherCAT®

EtherCAT - Ethernet for Control Automation Technology - is an Ethernet-based fieldbus system, invented by Beckhoff Automation. The protocol is standardized in IEC 61158 and is suitable for both hard and soft real-time requirements in automation technology. The goal is to apply Ethernet for automation applications requiring short data update times (≤ 100 µs) with low communication jitter (≤ 1 µs) and reduced hardware costs.

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Protocols – some considerations & questions

There is a huge amount of connectivity technologies, wireless and wired,

Key aspects when considering network connectivity:

- Range - are you deploying to a single office floor or a wider area?
- Data Rate - how much bandwidth do you require?
- How often does your data change?
- Power - is your sensor running on mains or battery?
- Frequency - have you considered channel blocking and signal interference?
- Security - will your sensors be supporting mission critical applications?

In other words, there is not a single solution to a particular problem, there is not a killer technology satisfying all needs.

In IoT use cases and application scenarios many short and long range protocols and also wired protocols will be used simultaneously in order to fulfill many operating requirements.

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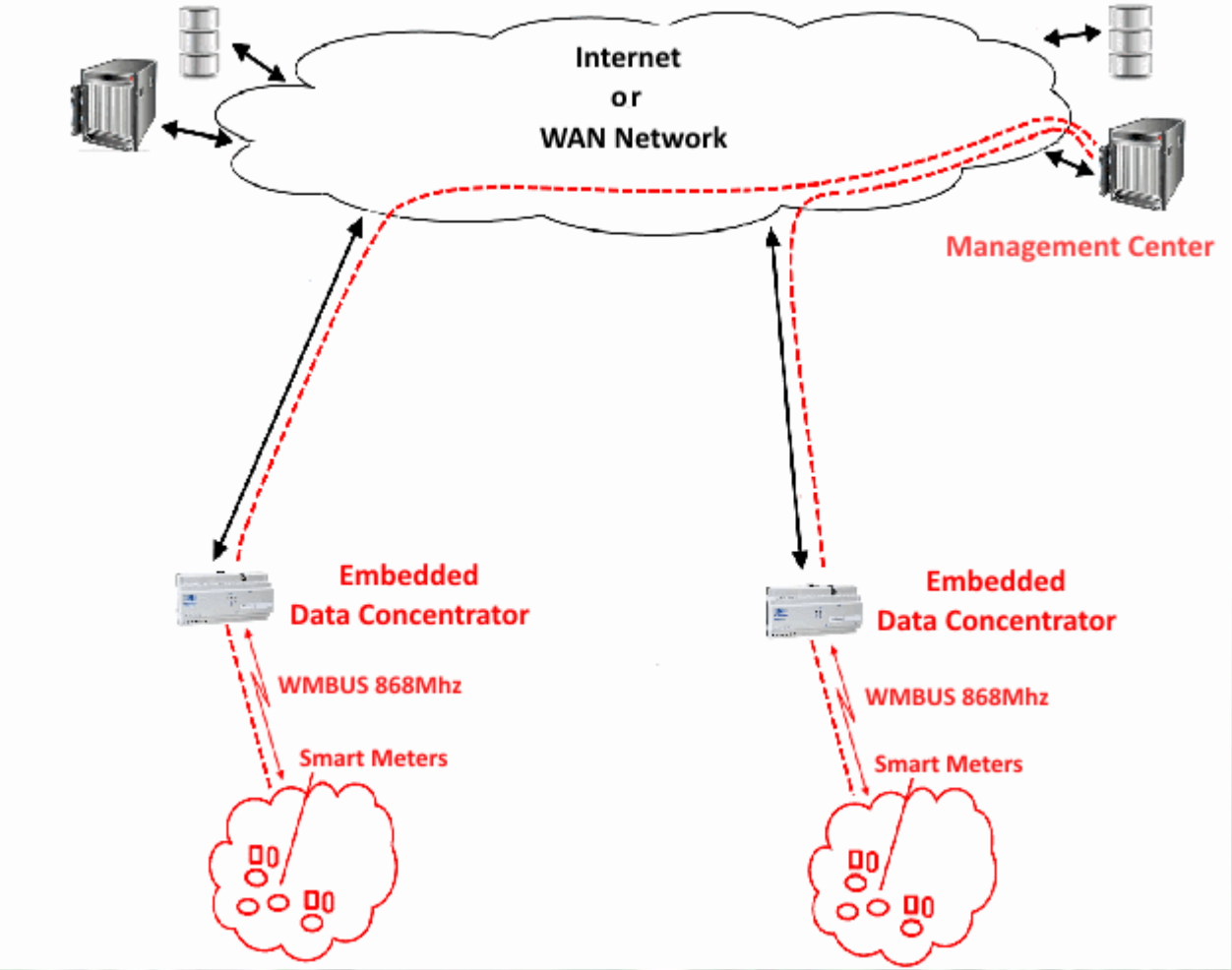
Use Case #1 – Water Meter Scenario

In this scenario the architecture of a metering and monitoring system for the water meters is depicted.

The implemented infrastructure is embedded and closed.

The system is designed to interface that particular kind of water meters with that particular transmission technology. In the example the WMBUS 868Mhz is used.



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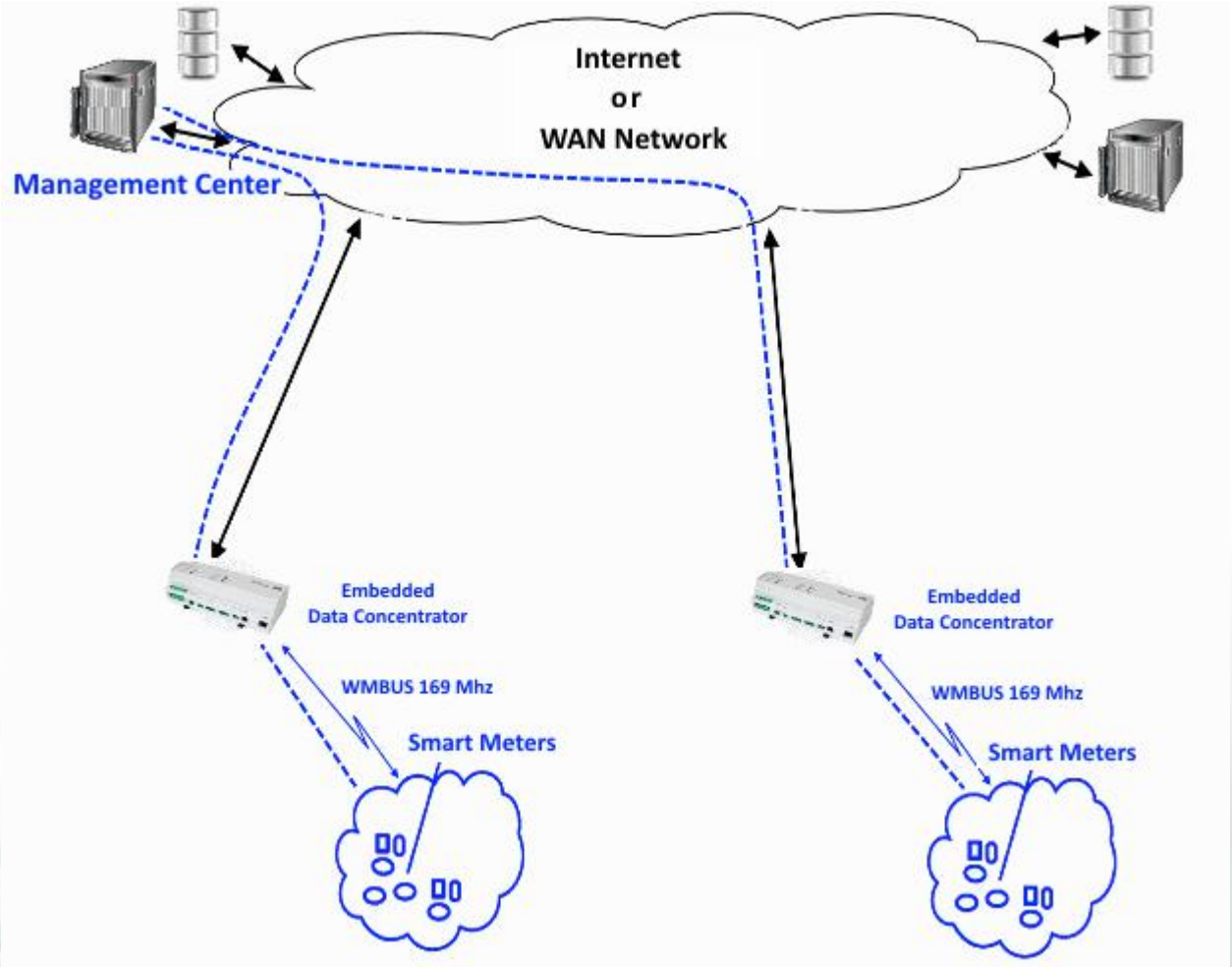
Use Case #2 – Gas Meter Scenario

In this scenario the architecture of a metering and monitoring system for the gas meters is depicted.

The implemented infrastructure is embedded and closed.

The system is designed to interface that particular kind of gas meters with that particular transmission technology. In the example the WMBUS 169Mhz is used.



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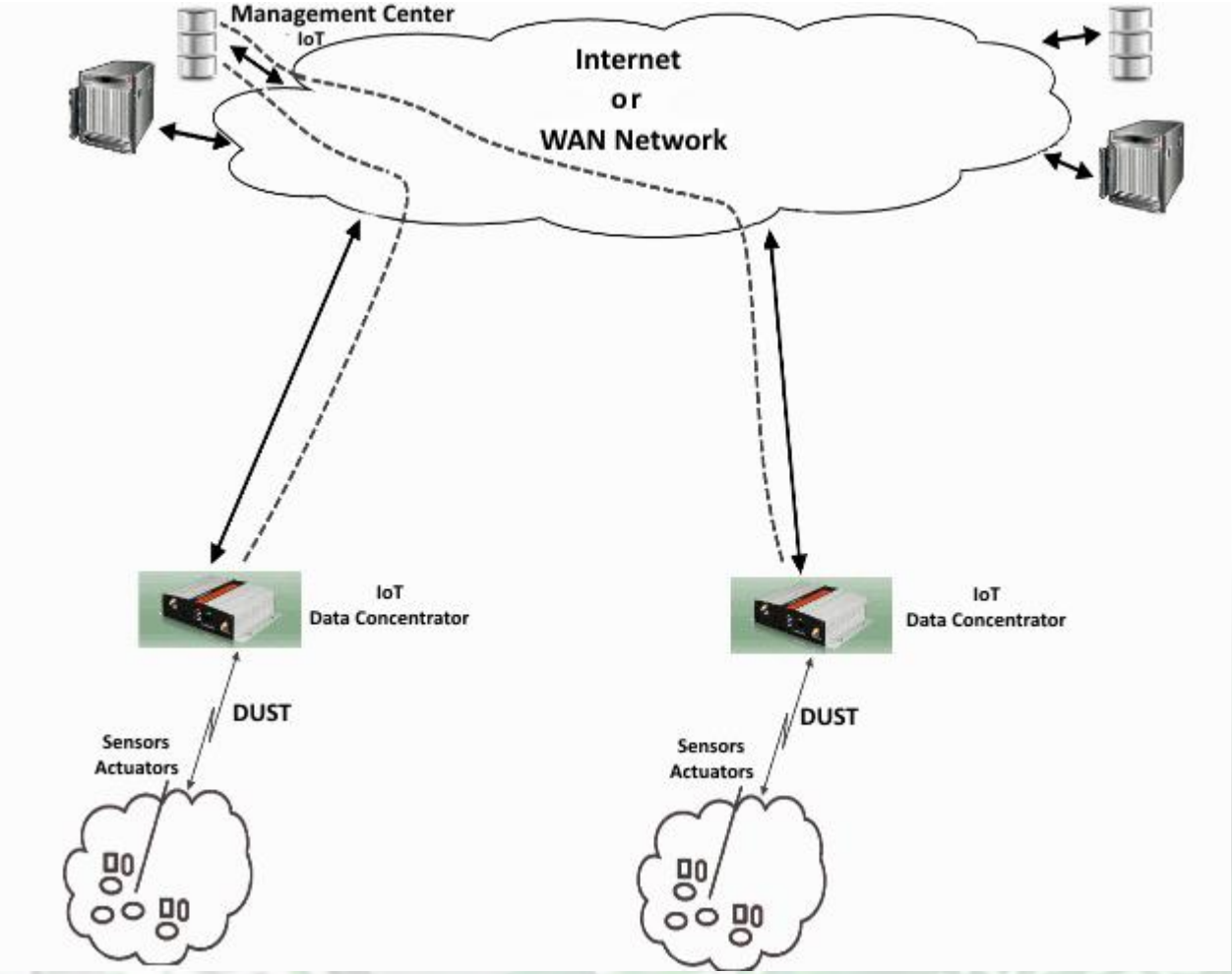
Use Case #3 – IoT Scenario

In this scenario the architecture of a metering and monitoring system for an IoT sensors and actuators network is depicted.

The implemented infrastructure is embedded and closed.

In this example the wireless technology used is DUST by Linear Technology.



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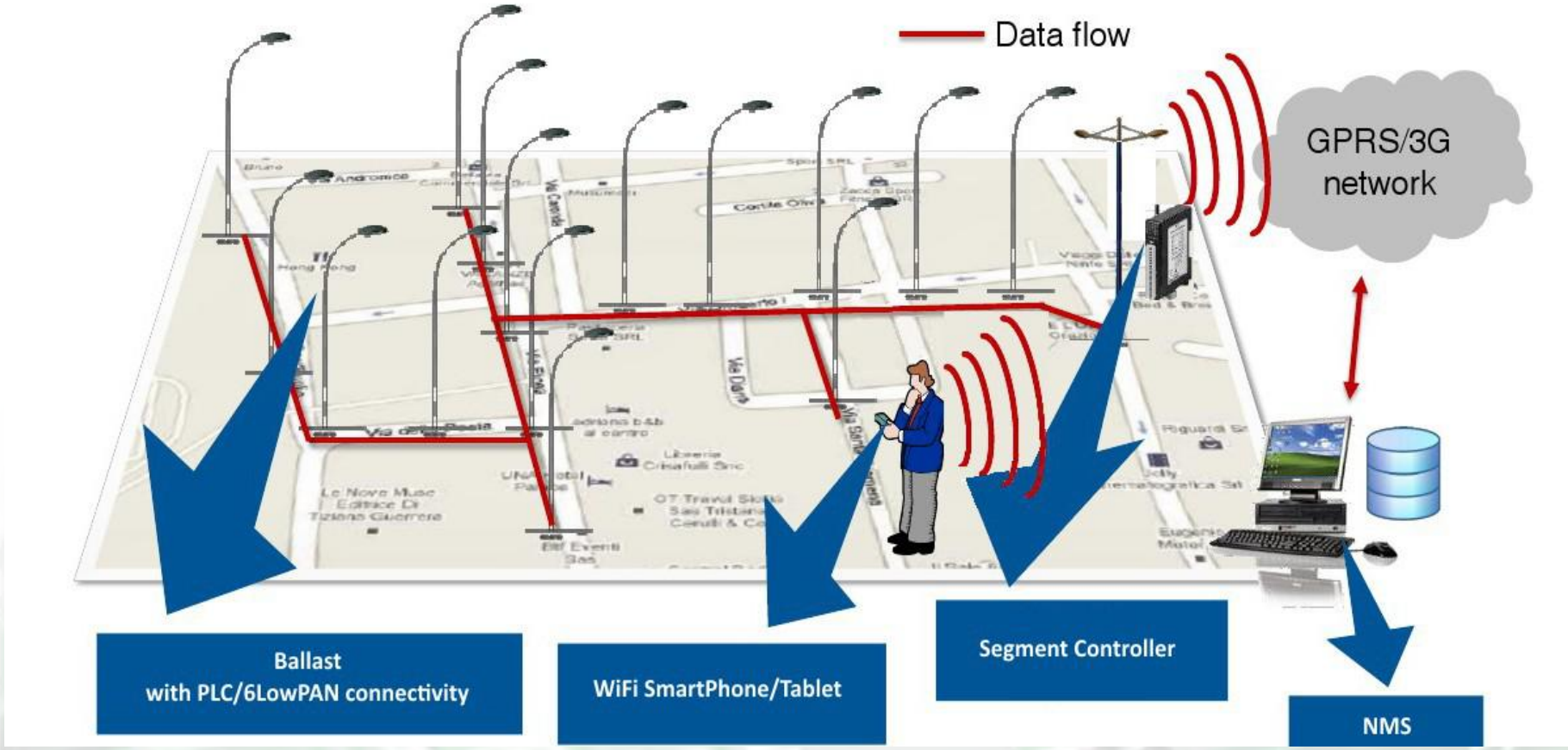
Use Case #4 – Smart Ligthing



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Network architecture – some considerations

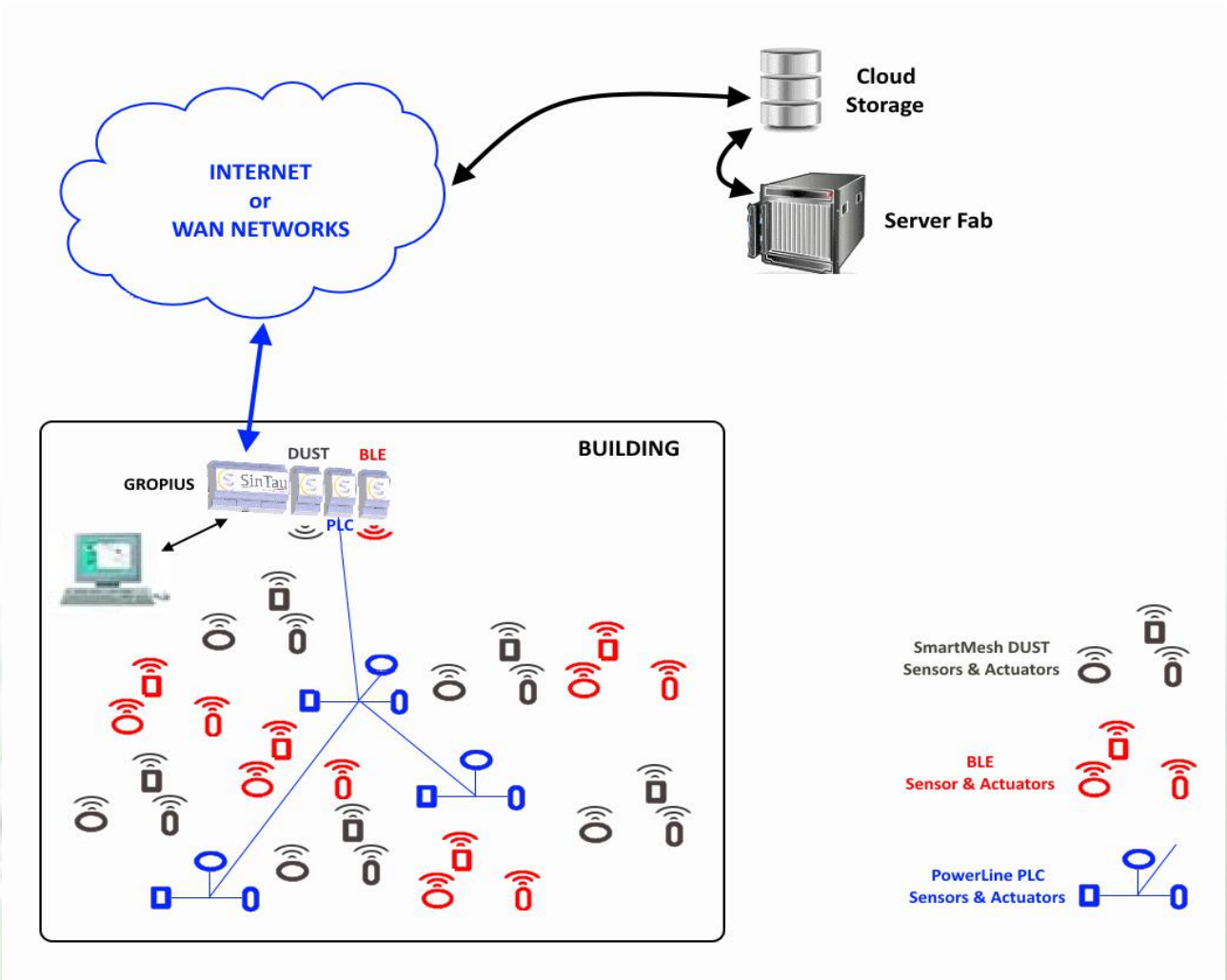
- In a Smart City/Metering or IoT environment every network seems to have its own structure and communication technology.
- Every network has its own control and management infrastructure.
- It is impossible or difficult to manage more than one communication technology on the same network.
- Closed architectures do not allow to share resources.
- In a control environment called Smart the number of networks and infrastructures could become very huge.
- The installation and maintanace costs could increase considerably.

Gropius - the Cloud gateway

GROPIUS could be the data concentrator for many IoT networks and the gateway to the Cloud infrastructure.

Because of its open architecture, it is able to collect data from multiple sensor/actuator networks.

In the example wireless BLE and SmartMesh networks and a wired powerline PLC network.



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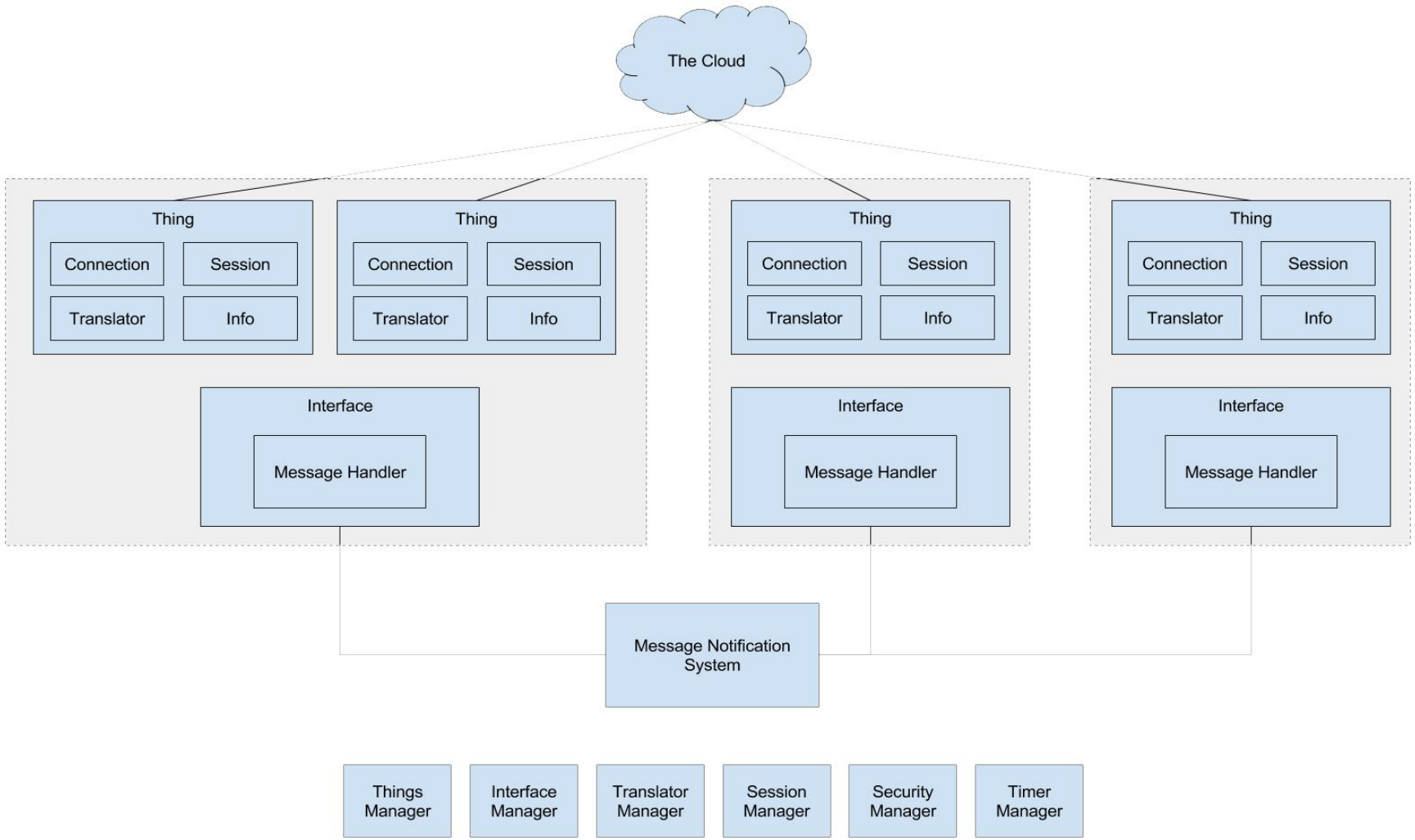
Gropius - the SW architecture



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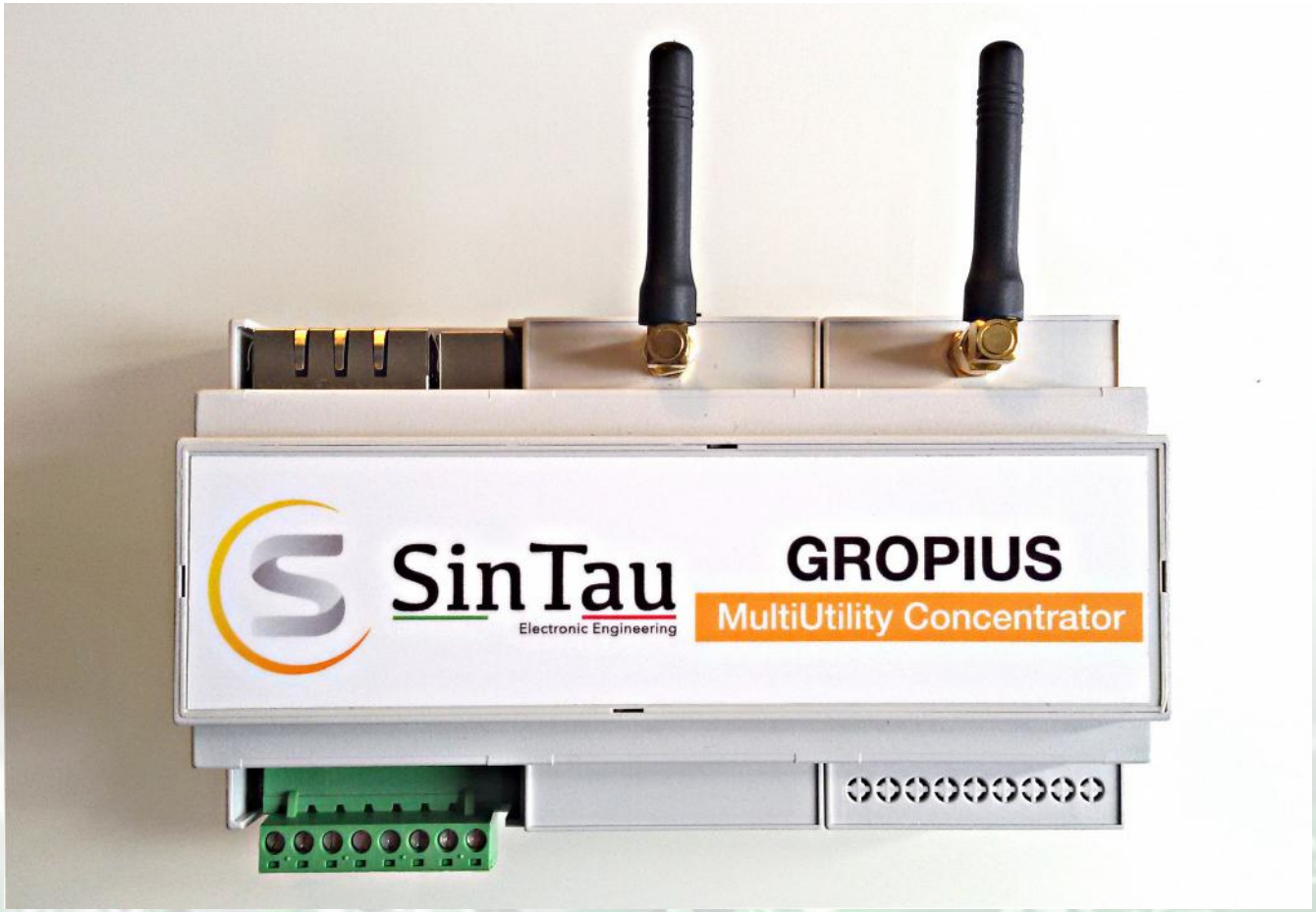
GROPIUS – an open architecture system

GROPIUS is a Linux based system with standard communication interfaces characterized with open HW and SW architectures.



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GROPIUS – a modular approach

The main controller is based on an ARM processor running Linux Debian Embedded or OpenWRT. The system is provided with 2 Gigabit Ethernet, RS485, CAN bus, USB.

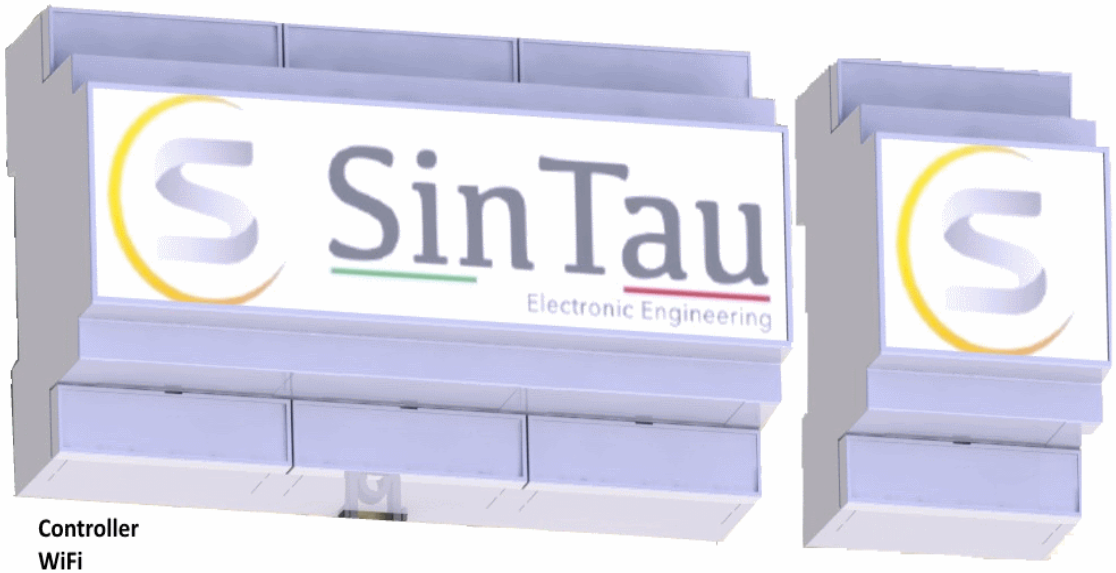
Also two expansion modules with WiFi and GPRS/3G/LTE connectivity are available.

Controller
WiFi
GPRS/3G/4G
GbE
Usb
CAN
RS485

GROPIUS – a modular approach

A number of communication modules are available in order to increase the interface capability and communication technology.

In the following example a WMBUS at 169 or 868 Mhz is depicted.

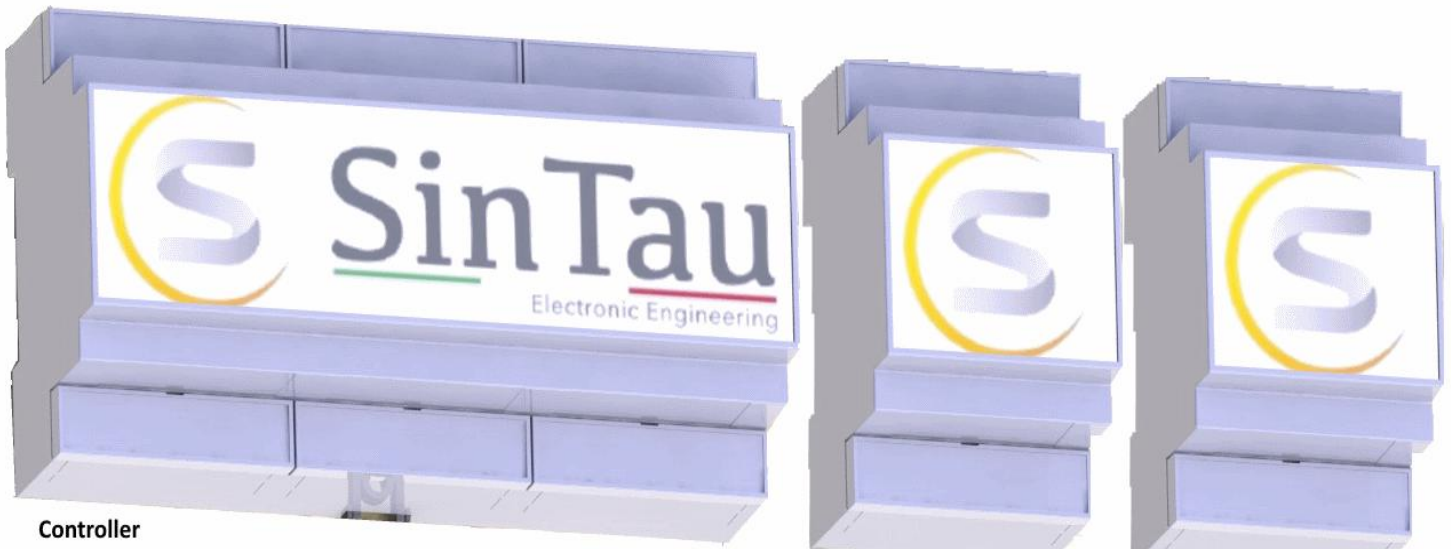


Controller
WiFi
GPRS/3G/4G
GbE
Usb
CAN
RS485

WMBUS 169/868 Mhz

GROPIUS – a modular approach

.. and then the DUST module for IoT application



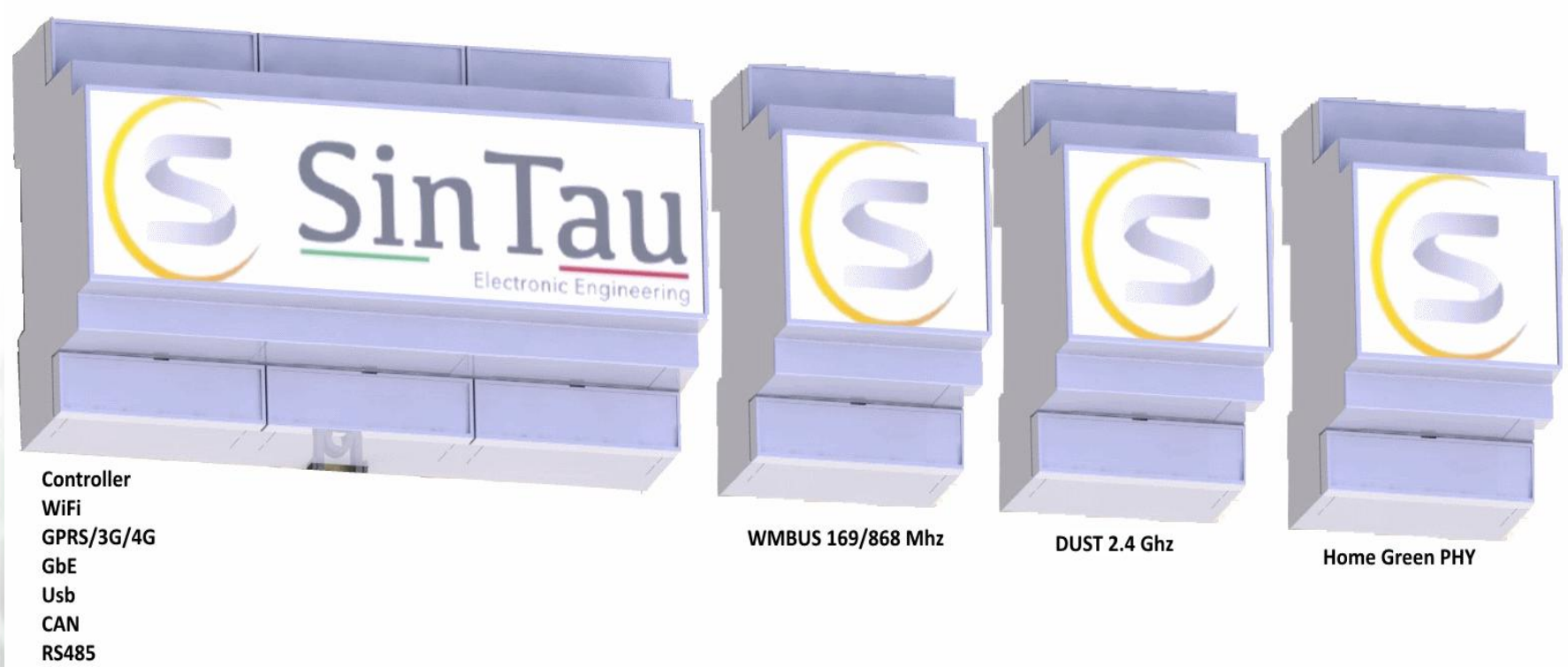
Controller
WiFi
GPRS/3G/4G
GbE
Usb
CAN
RS485

WMBUS 169/868 Mhz

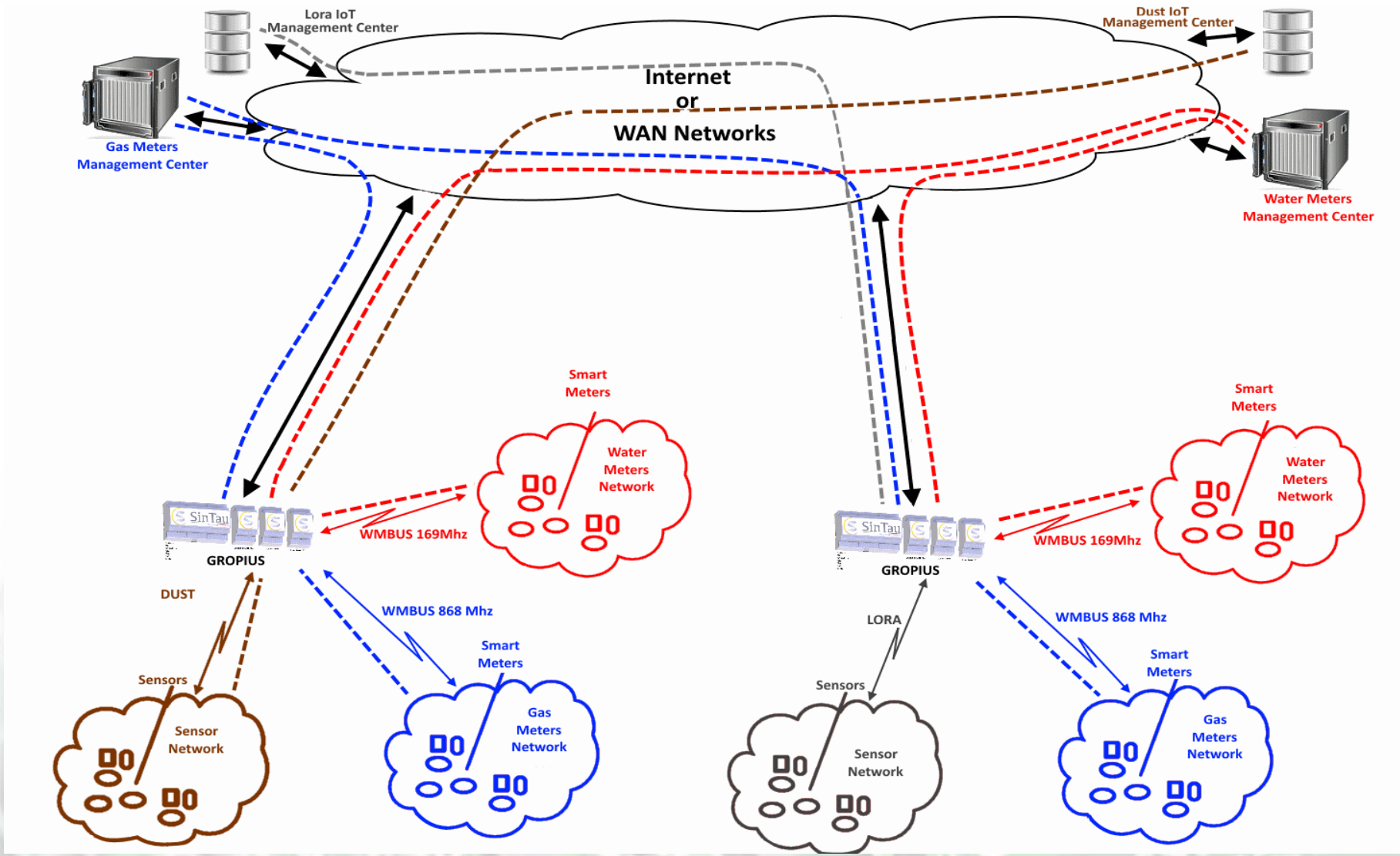
DUST 2.4 Ghz

GROPIUS – a modular approach

and then the Home Green PHY module for the powerline communication.



GROPIUS – a more complete scenario



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GROPIUS – the management system

Gropius has been implemented with open HW and SW architectures.

The same concept has been extended to the network management systems and at this purpose Gropius supports SW clients for all most important IoT frameworks.

Google Cloud Platform

amazon web services

Gropius has a Linux based core supporting

OpenWrt Wireless Freedom

emdebian

It has been developed also an open management system base on Zabbix in order to support ad hoc customization whre requested

ZABBIX

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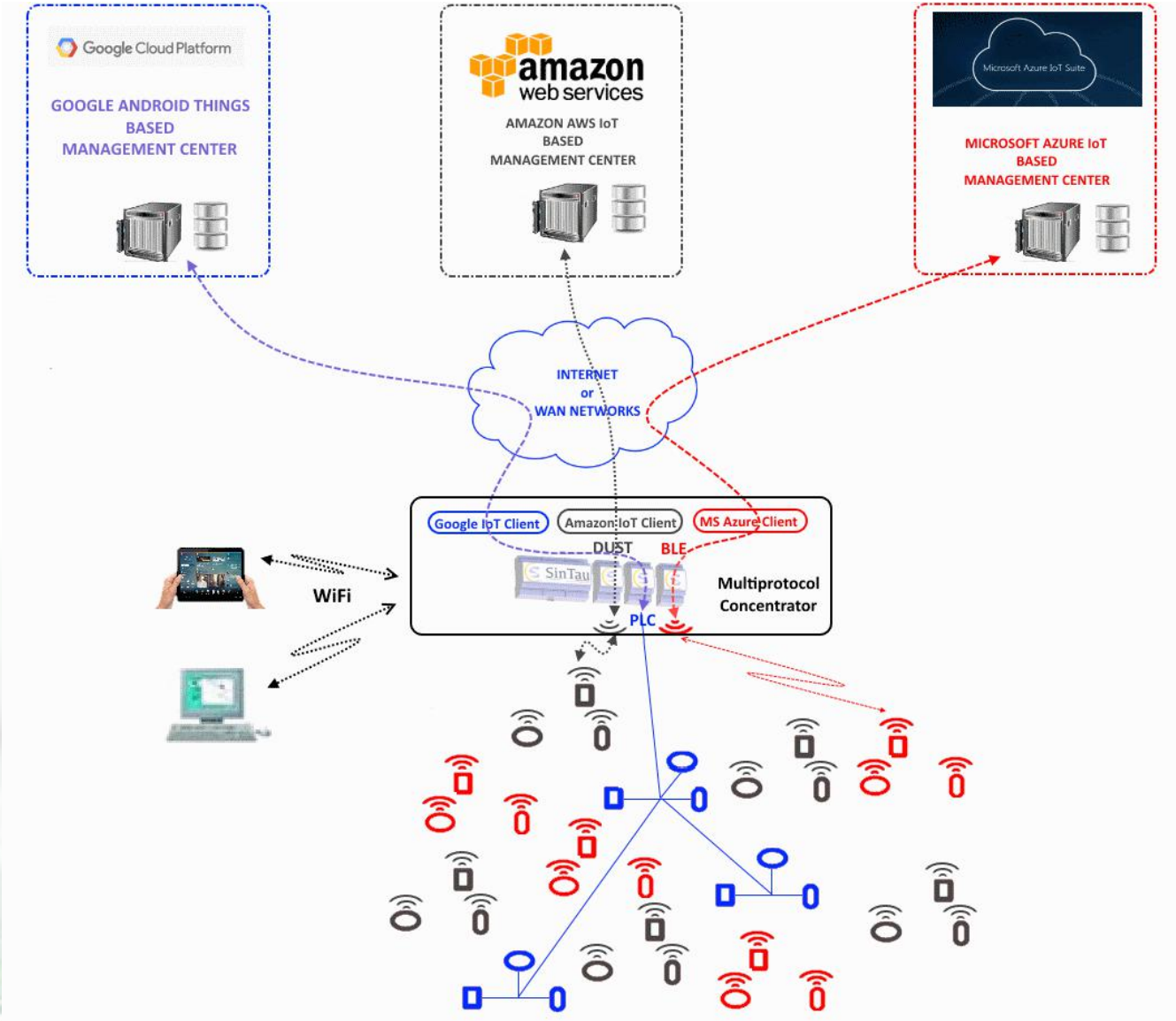
GROPIUS – supporting multiple IoT platforms

In the example the presence of three different management platform support is shown.

It will be like to have three vitual concentrators running on the same HW device and structure.



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GROPIUS – Zabbix management system

ZABBIX

The Zabbix support allows to easily and quickly implement ad hoc and open management centers. Thea main characteristics of this ad hoc management system are:

- Perfomance Monitoring support.
- SW agents for all OS.
- Agent-Less Monitoring.
- Support for the reporting on resources availability.
- Support for all kind of post processing like graphic or maps or istograms.

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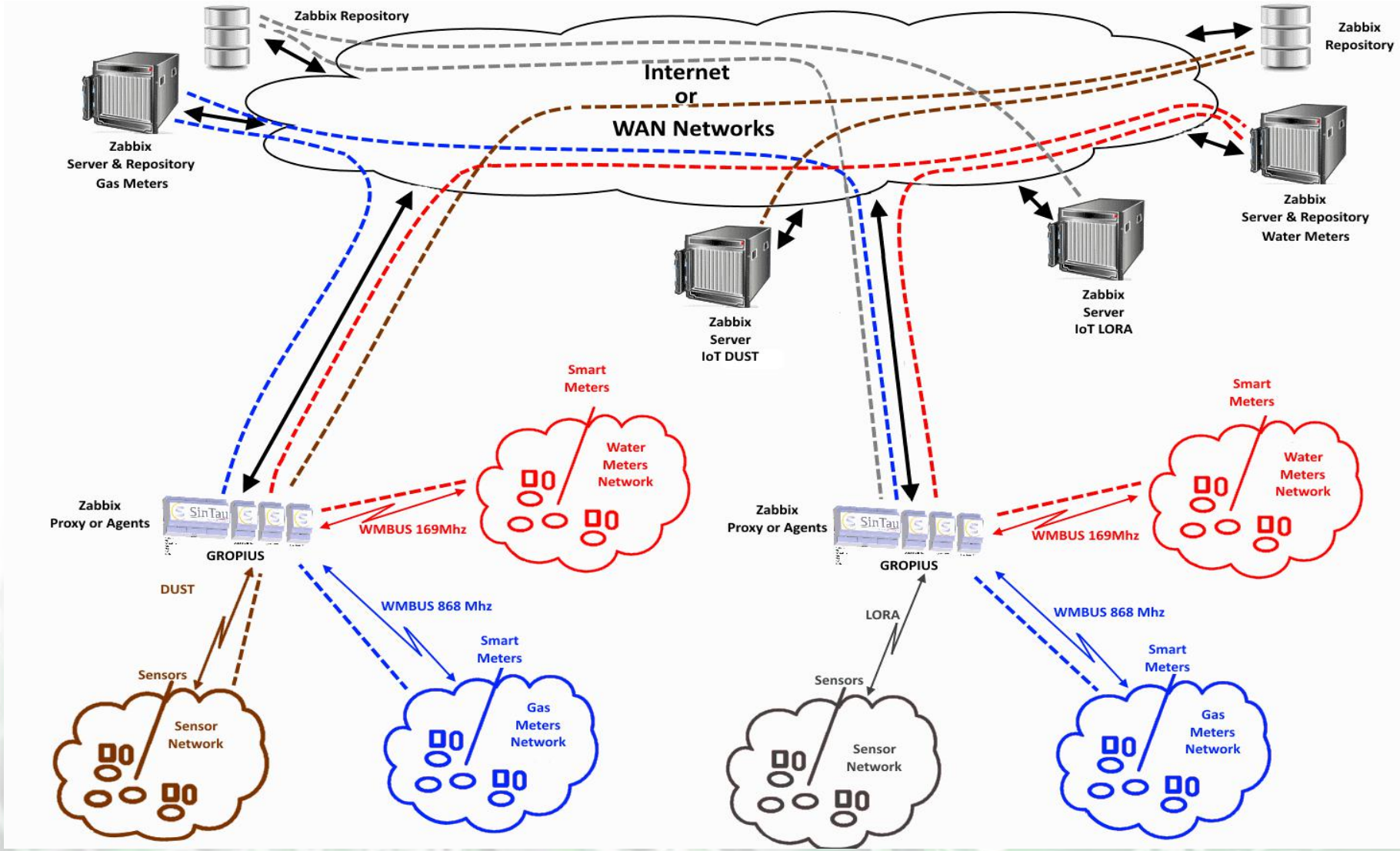
Zabbix management architecture



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Welcome