Co-funded by the
Erasmus+ Programme
of the European Union

Project management

Part 1

Dr. sc. Ing. Anatolijs Zabasta
Anatolijs.Zabasta@rtu.lv
Prof. Dr. sc. Ing. Nadezhda Kunicina
Nadezda.Kunicina@rtu.lv

Riga Technical University

Co-funded by the Erasmus+ Programme of the European Union

“IMPROVEMENT OF MASTER-LEVEL EDUCATION IN THE FIELD OF PHYSICAL SCIENCES IN BELARUSIAN UNIVERSITIES” ERASMUS+ PROJECT “PHYSICS”

561525-EPP-1-2015-1-LV-EPPKA2-CBHE-JP – ERASMUS+ CBHE

Student’s mobility and training event

25.09.2017 - 06.10.17., RIGA, LATVIA

Improvement of master-level education in the field of physical sciences in Belarusian universities

Physics

Co-funded by the Erasmus+ programme of the European Union

Co-funded by the
Erasmus+ Programme
of the European Union

Riga city

Co-funded by the
Erasmus+ Programme
of the European Union

- ✓ Riga, the capital of Latvia http://www.riga.lv was founded in 1201
- ✓ It has a population of around 706 400 (1/3 of Latvia population) and its area is around 307 square kilometers
- ✓ Riga has always been a city at the cross roads of the large markets of Western Europe and the East
- ✓ The historic center of Riga exemplifies all architectural styles characteristic for the Northern Europe from Gothic to Modernism including unique ensemble of Art Nouveau buildings
- ✓ In 1997 the historic center of Riga due to this valued architecture was inscribed into the UNESCO World Heritage List.
- ✓ See more at tourism information portal : http://www.liveriga.com

Co-funded by the
Erasmus+ Programme
of the European Union

Price for Energy efficient building in Riga 2014

Co-funded by the
Erasmus+ Programme
of the European Union

Story about RTU

https://www.youtube.com/watch?v=i8gvSFuRHNs

Anatolijs Zabasta,
Dr.sc.ing., MBA, leading researcher
Faculty of Power and Electrical Engineering,
Institute of Industrial Electronics and Electrical Engineering,
12/1 Azenes Str., office 503, Riga, Latvia,
Contacts: +371-29232872
anatolijs.zabasta@rtu.lv

Nadezhda Kunicina,
professor, Dr.sc.ing., leading researcher
Faculty of Power and Electrical Engineering,
Institute of Industrial Electronics and Electrical Engineering,
1, Kalku Str., office 218, Riga, Latvia,
Contacts: +371-26162662
nadezda.kunicina@rtu.lv

Program

Co-funded by the
Erasmus+ Programme
of the European Union

- **1st**: Introduction to the project management
- **2nd**: Idea generation
- **3rd** : New product development
- **4th**: PM methods. Projects selection and evaluation. Launch of product

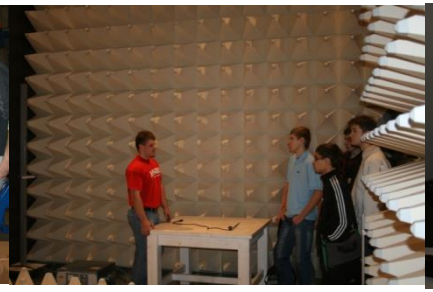
Competences and experience of Faculty of Power and Electrical Engineering

Co-funded by the
Erasmus+ Programme
of the European Union

Competences and experience

Faculty of Electronics and Telecommunications (FET) incorporates:

- ✓ Institute of Radio Electronics
- ✓ Institute of Telecommunications
- ✓ Chair of Transport Electronics and Telematics
- ✓ Electromagnetic Compatibility and Electric Security Research Centre

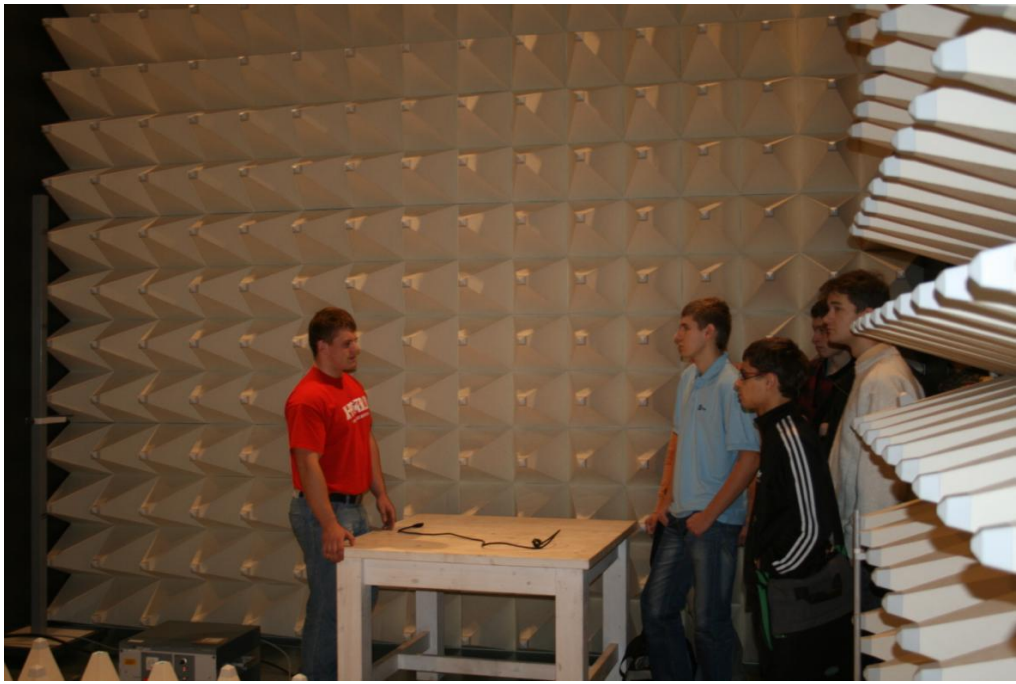



Co-funded by the
Erasmus+ Programme
of the European Union

Electromagnetic Compatibility and Electric Security Research Centre

- ✓ The centre offers the most update and comprehensive electronic and electro technical equipment testing facilities in the Baltic.
- ✓ An anechoic measurement chamber with the intensity range up to 40GHz which ensures the testing results of complex electromagnetic compatibility and electric security in accordance with EU standards

- ✓ The EMC researches focus on research and development of electromagnetically compatible matrix-type converters



Co-funded by the
Erasmus+ Programme
of the European Union

IEEI main topics of research

- ✓ Energy Saving
- ✓ Electric Drives, DC Traction Drives
- ✓ Converters, Power Electronics
- ✓ Hydrogen Power Electronic Converters
- ✓ Control and Regulation
- ✓ Signal transmitting
- ✓ Energy storages
- ✓ Electric transport
- ✓ Non-Destructive Testing using Capacitance Method
- ✓ Analysis and optimization of public transport

Experience in research

Co-funded by the Erasmus+ Programme of the European Union

The main national projects:

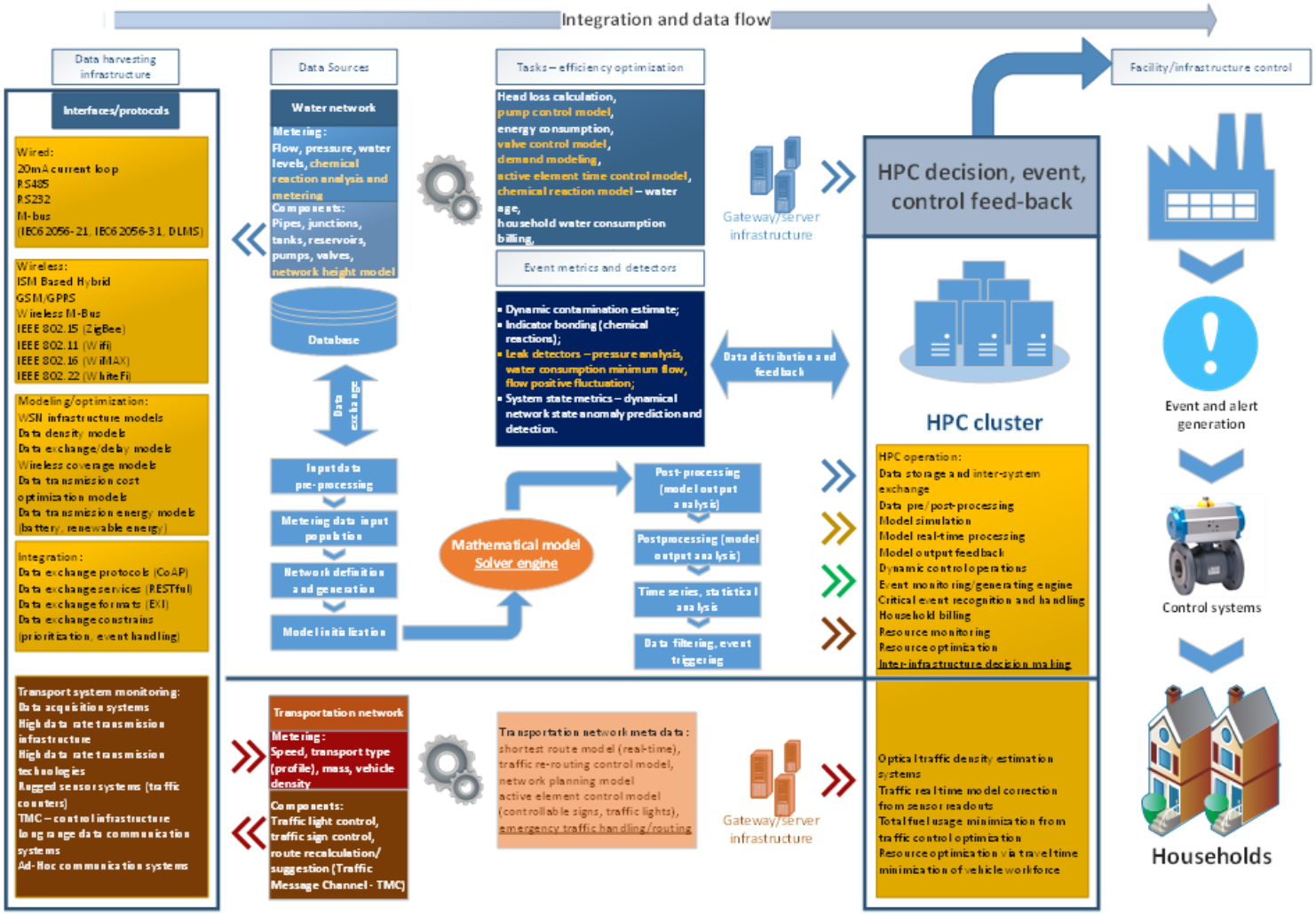
- ✓ Latvian climate change financial instrument “Designing of LED based lamp for an illumination of the streets lightening using intelligent control system”
- ✓ Latvian climate change financial instrument “Intelligent wind”
- ✓ Power electronics technologies to reduce energy consumption and to promote the use of renewable energy sources in Latvia
- ✓ Wind and hydrogen power supply an autonomous system
- ✓ Intelligent hybrid uninterruptible power systems and components design and research to improve energy efficiency
- ✓ A modular slow speed electric generator design of wind turbines




Co-funded by the
Erasmus+ Programme
of the European Union

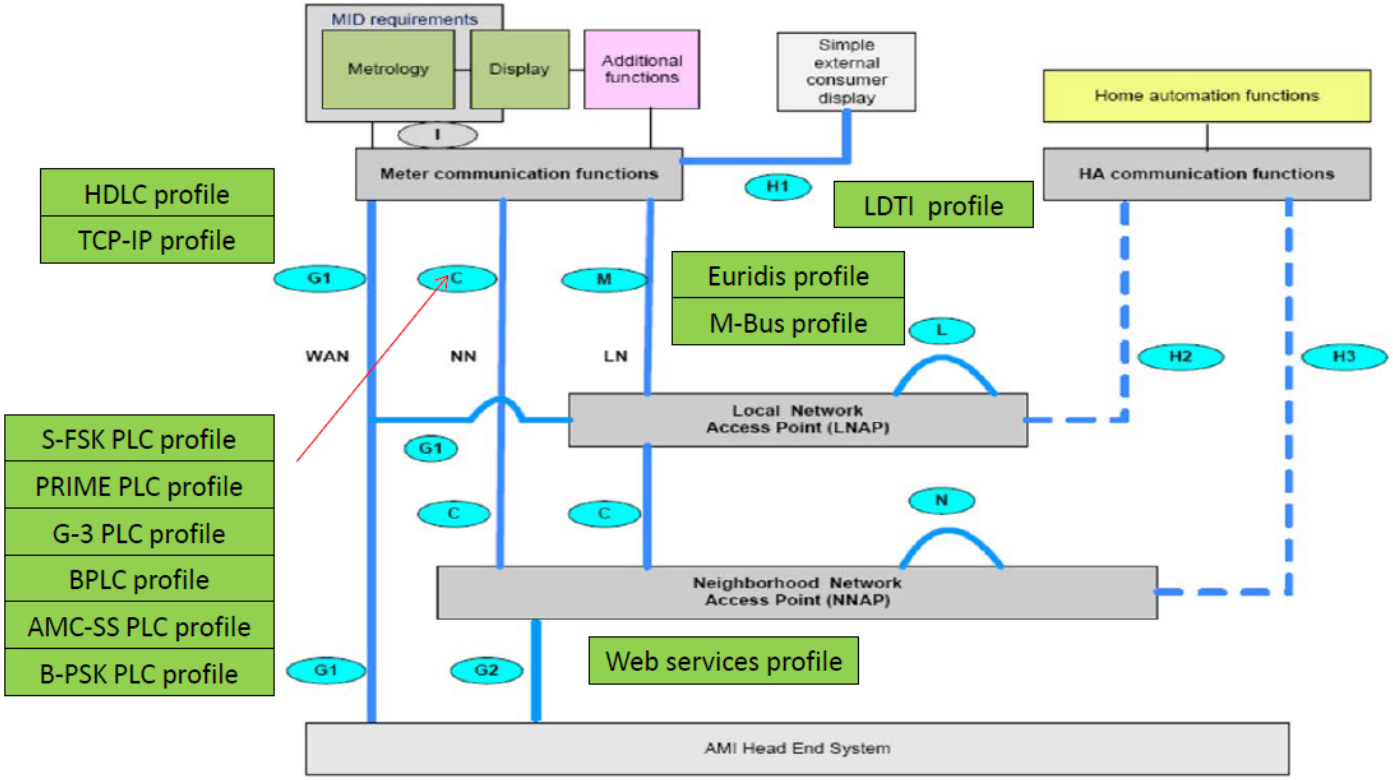
Case studies and examples

Co-funded by the Erasmus+ Programme of the European Union



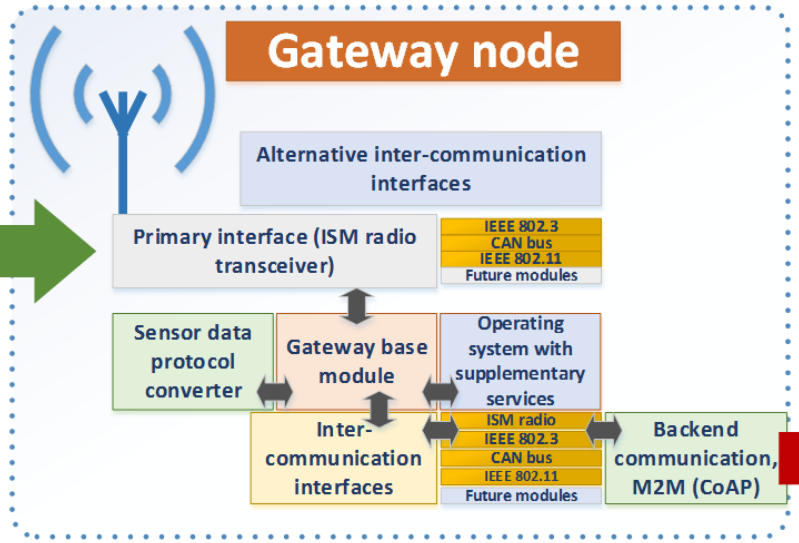
Co-funded by the
Erasmus+ Programme
of the European Union

Smart metering system reference architecture



Co-funded by the
Erasmus+ Programme
of the European Union

Hardware implementation

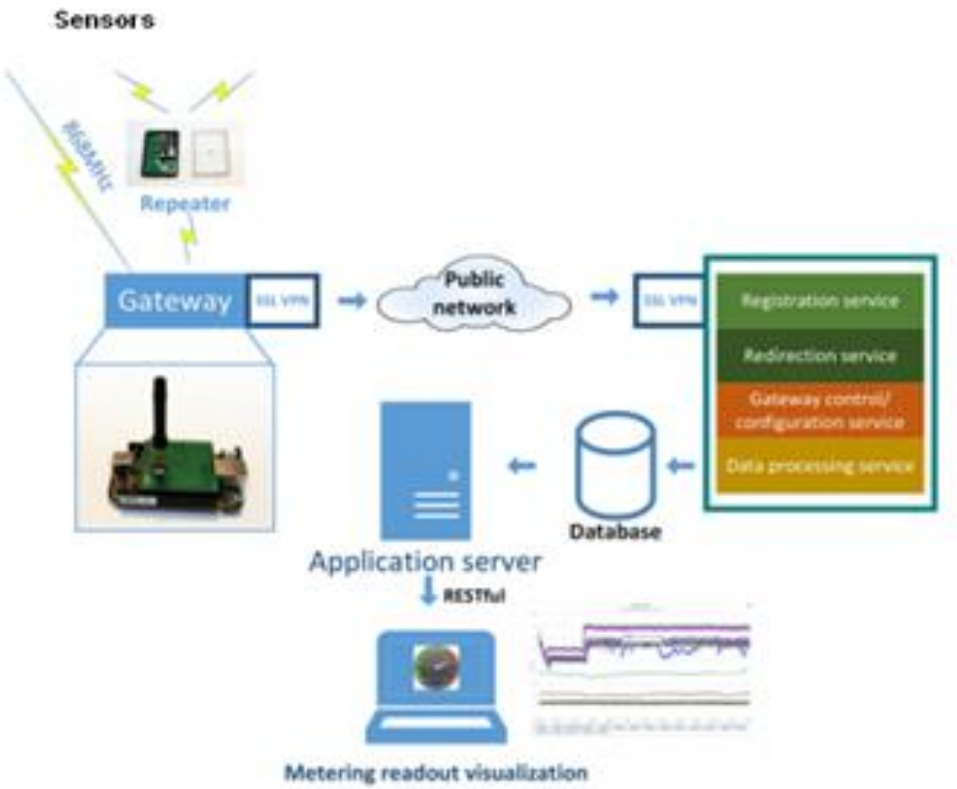


The metering units consists of a microcontroller, readout interface, power supply and ISM band radio module operating at 868MHz. Transmission ranges of up to 500m are possible. The coded telegrams are transmitted using Manchester coding and GFSK modulation. To one or multiple gateway that provide area coverage.

The gateway nodes consist or a radio module and 802.11b/g/n Wi-Fi module that integrates a microcontroller (ESP8266). The Wi-Fi module supports both station (Wi-Fi client mode) and access point modes. On start-up the gateway tries to connect to a Wi-Fi access point to access internet, if no access point is configured or not reachable, the gateway enter access point mode and starts

Co-funded by the
Erasmus+ Programme
of the European Union

Data transferring



Co-funded by the
Erasmus+ Programme
of the European Union

ARTEMIS "Arrowhead"

- ✓ The Arrowhead vision is:
  - Enable collaborative automation by networked embedded devices
- ✓ Arrowhead's grand challenges are:
  - Enabling the interoperability of services provided by almost any device
  - Enabling the integrability of services provided by almost any device
- ✓ 80 partners; Latvia: RTU and Micro Dators
- ✓ Call is closed on 6th September 2012

Arrowhead

Co-funded by the Erasmus+ Programme of the European Union

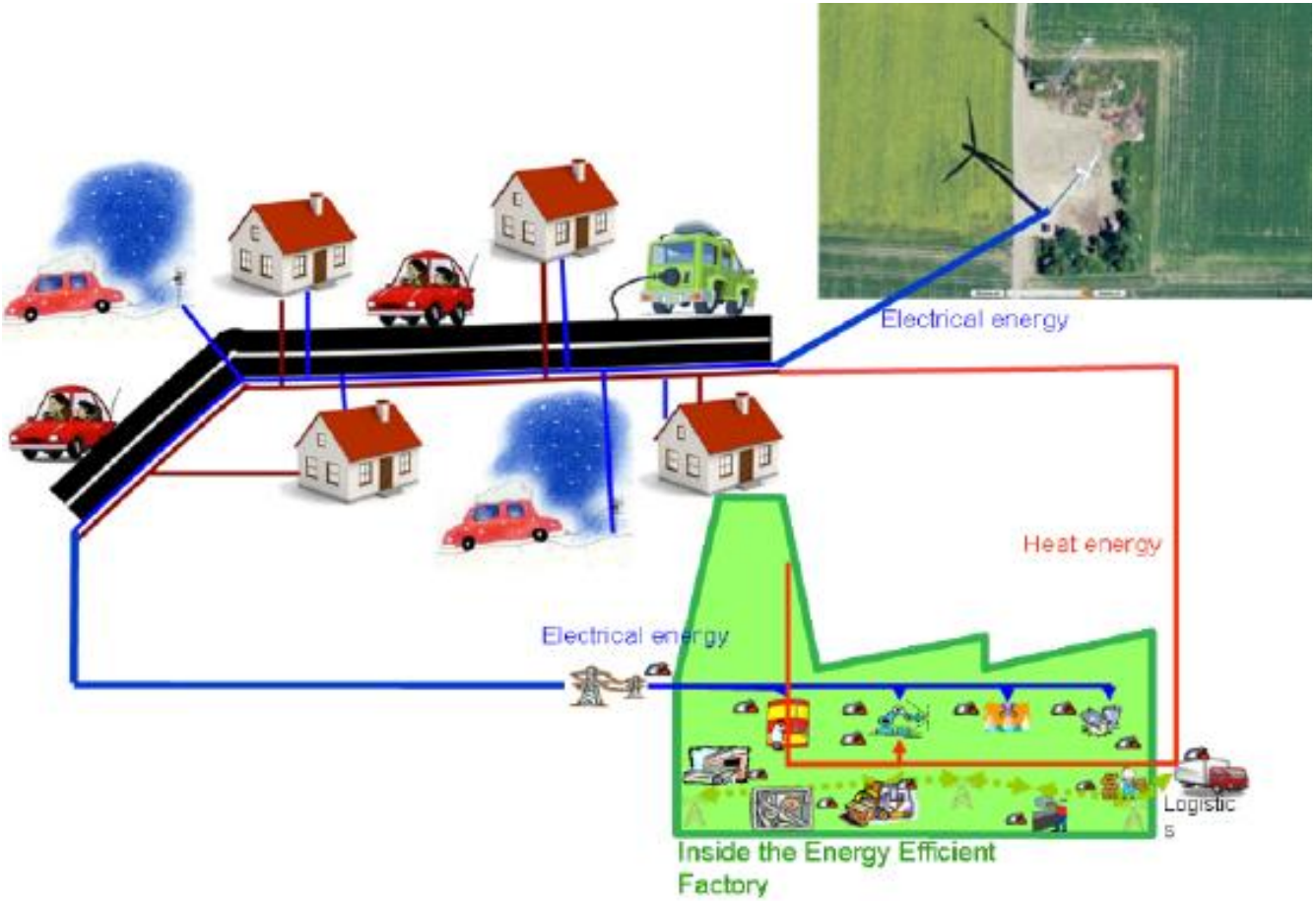
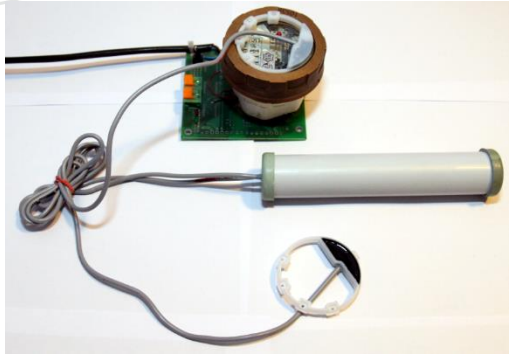


Figure 1.1: Arrowhead will improve production efficiency and energy efficiency and flexibility through collaborative automation innovations.

Sensor (metering) node development

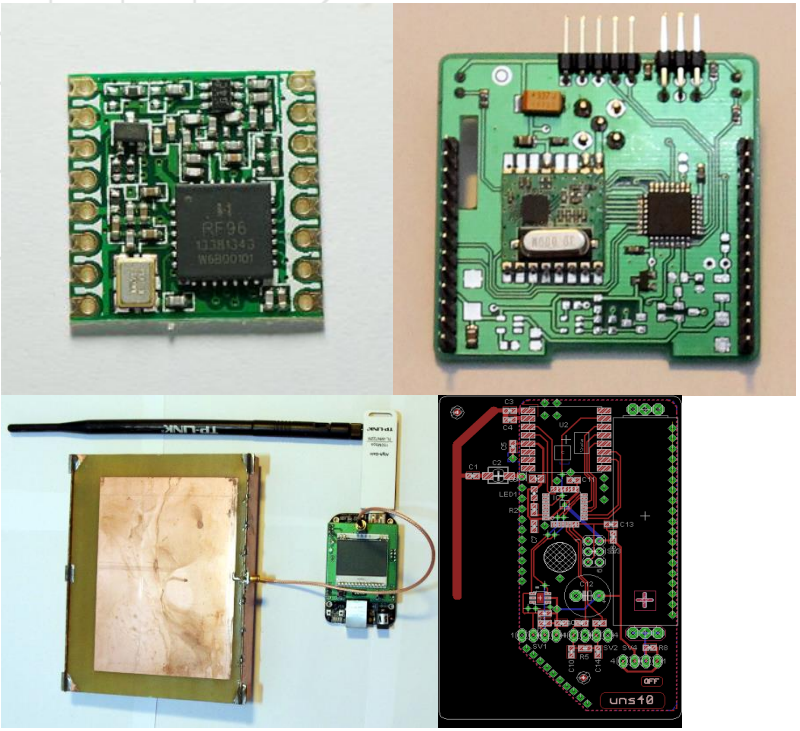


- Temperature: actual, cumulative
- Pressure
- Humidity
- Electricity meter readout (impulse)
- Electricity meter readout using IEC62025 (work in progress)
- Water flow readout (impulse)
- CO2 metering (almost finished)
- Lithium Thionyl Chloride battery – estimated life times of at least 5 years
- Various combination of metering interfaces

Heating energy – 1 impulse, 2 digital temperature

ARROWHEAD

RF module and antenna designs



- ISM band 868Mhz HopeRF transmitters
  - Modulation: GFSK, manchester
  - Optional encryption (RFM69)
  - LoRa option (RFM92W, RFM95W) being tested (long range ~5km
  - Support for high performance (G)FSK modes for systems including WMBus, IEEE802.15.4g
- Antennas
  - Manual resonance frequency correction
  - Automatic resonance frequency correction (wip)

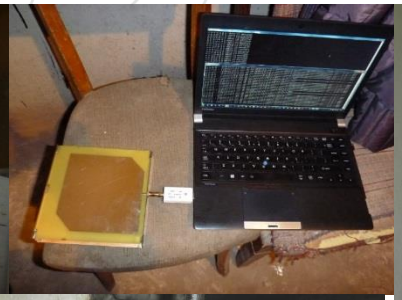
ARROWHEAD

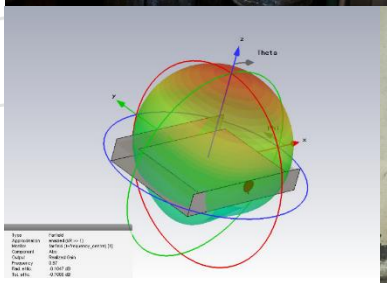
Applications – test deployments 1

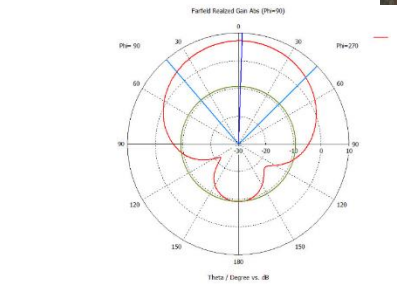
- Water supply network monitoring
  - Leak detection
  - Water consumption accounting
- Elderly people environment monitoring and event triggering for care services
- Heating system monitoring and high rise apartment building individual energy accounting, energy efficiency analysis

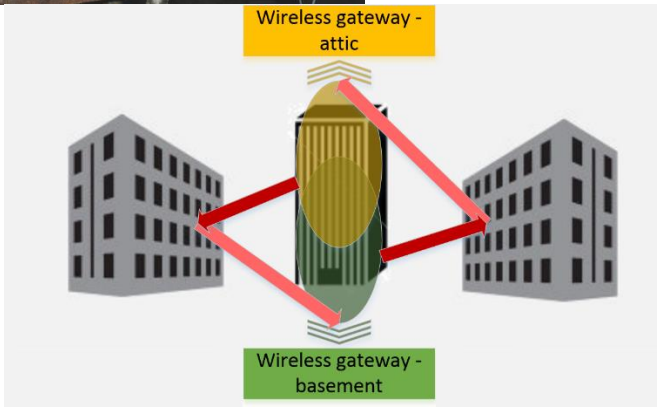
ARROWHEAD

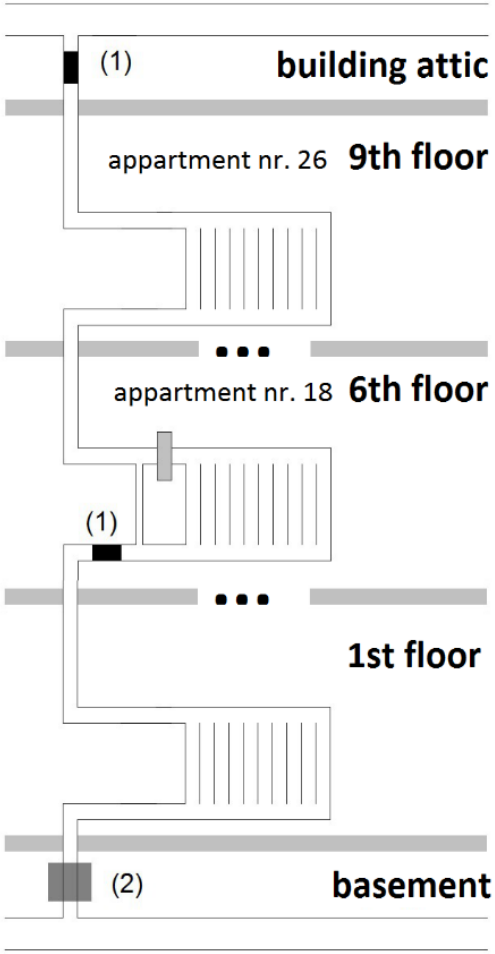
Applications – test deployments 2







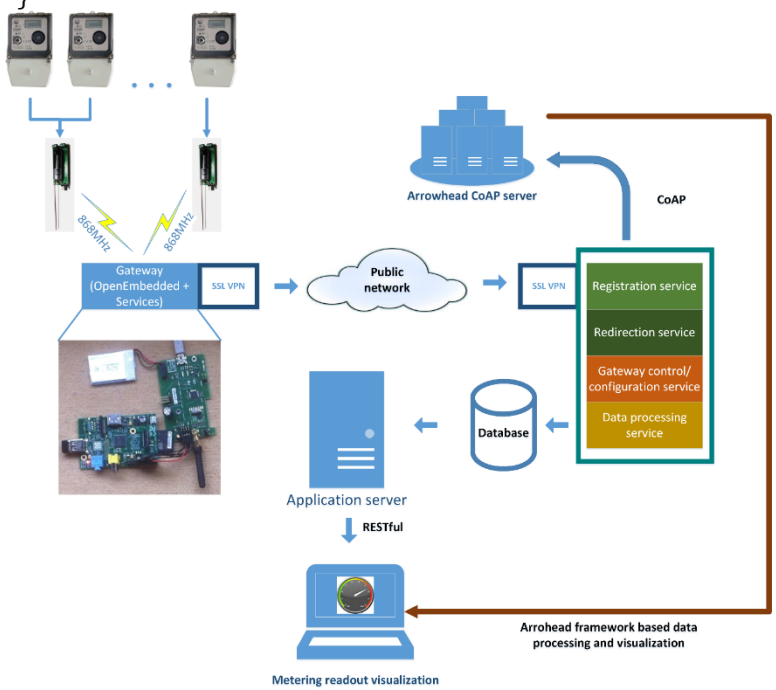




ARROWHEAD

Data tranmission and processing

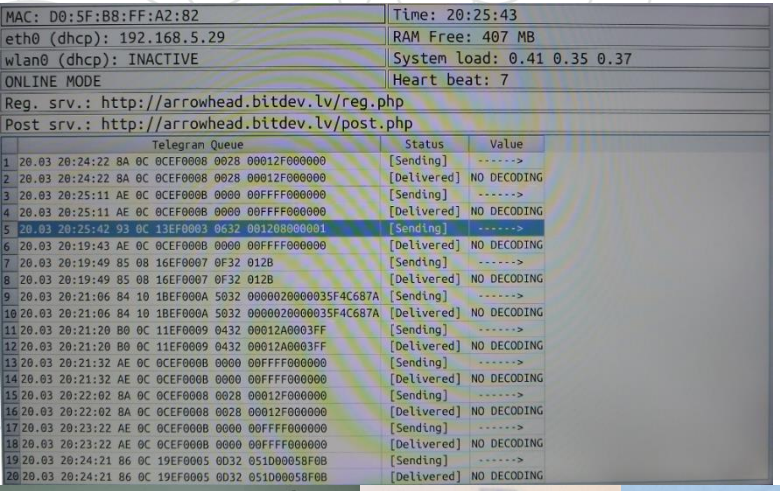

```
{"e":[
    { "n": "1.8.1*0", "t": 0, "u": "kWh", "v": 0 },
    { "n": "1.8.2*0", "t": 0, "u": "kWh", "v": 1.2622 }],
    { "n": "1.8.3*0", "t": 0, "u": "kWh", "v": 0 }],
    { "n": "1.8.4*0", "t": 0, "u": "kWh", "v": 0.0512 }],
    { "n": "1.8.0*0", "t": 0, "u": "kWh", "v": 1.3134 }],
    { "n": "3.8.0*0", "t": 0, "u": "kWh", "v": 0.3134 }],
    { "n": "4.8.0*0", "t": 0, "u": "kWh", "v": 0.1351 }],
  "bn": "urn:dev:egm5epqs:00a0b10000001a1a/",
  "bt": 1392126364,
  "ver": 1,
  "bu": "kWh"
}
```

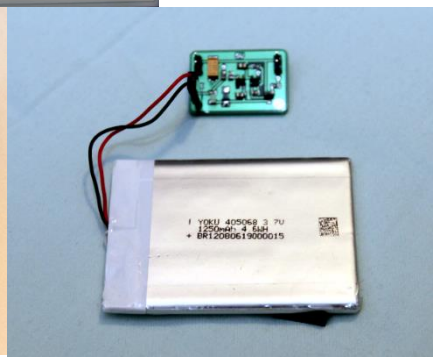



- Sensor data transmitter to gateway
  - Queue management if network connection lost
  - Queue verification of delivery via selective queue clearing
  - Automatic data dumping to database in offline mode or in walk-by-mode
- Repeater nodes – channel switching or sinking principle
- Radio channel optionally secured
- Gateway backend server communication using HTTP optional SSL VPN for gateway/site grouping
- Gateways control and online decoding scheme transfer
  - **Heartbeats**
  - **Registration requests**
  - **Post requests**
  - **Decode reply**
  - **Redirection service**

ARROWHEAD

Gateway modes and operation



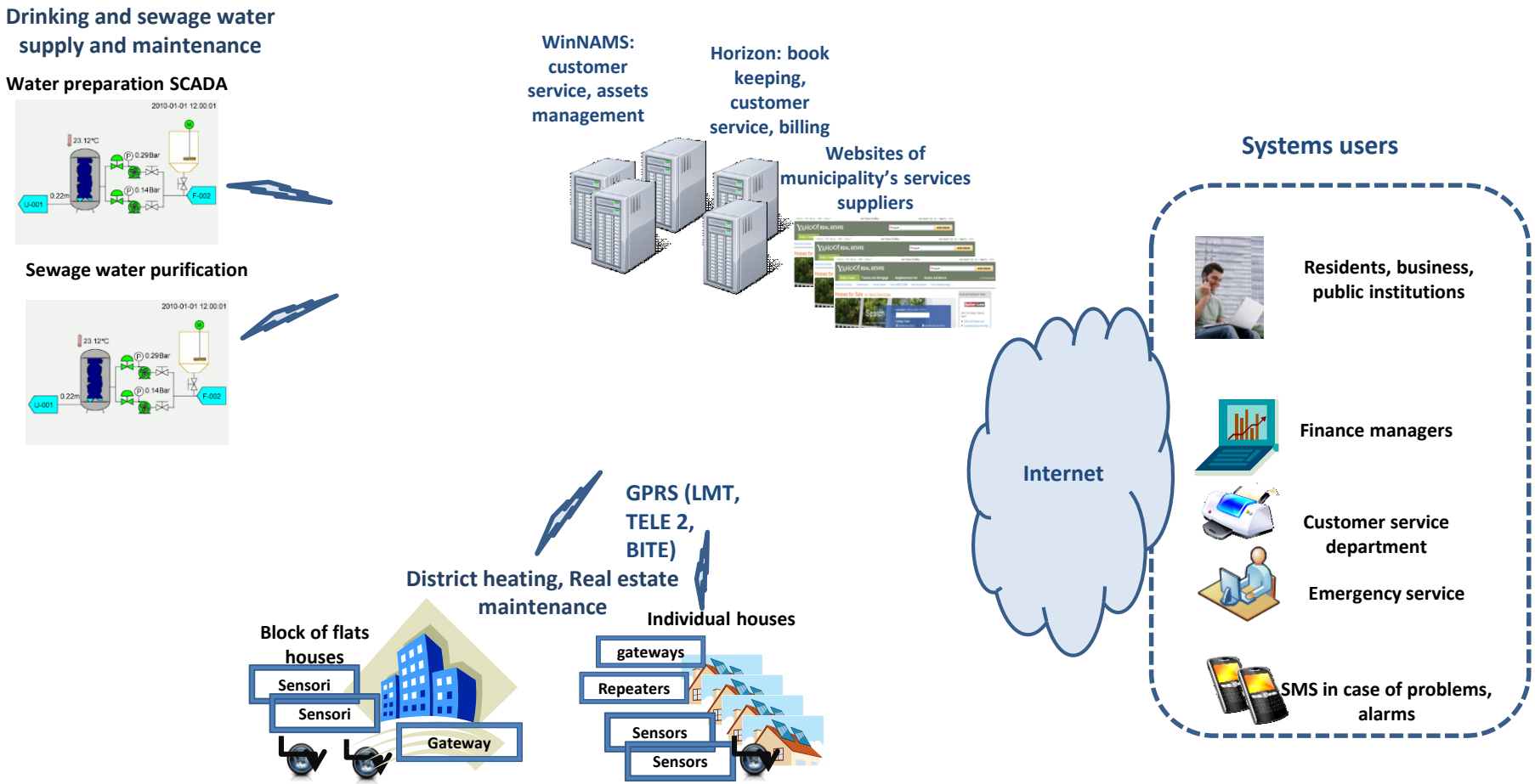


- Based on custom OpenEmbedded build
- Custom service and self monitoring capability
- Option to use LiPo UPS system with monitoring options – power outage handling
- Gateways have video output for onsite diagnostics – receiving, post, system status, networking
- USB RF dongle for mobile diagnostic terminal usage and active monitoring

ARROWHEAD

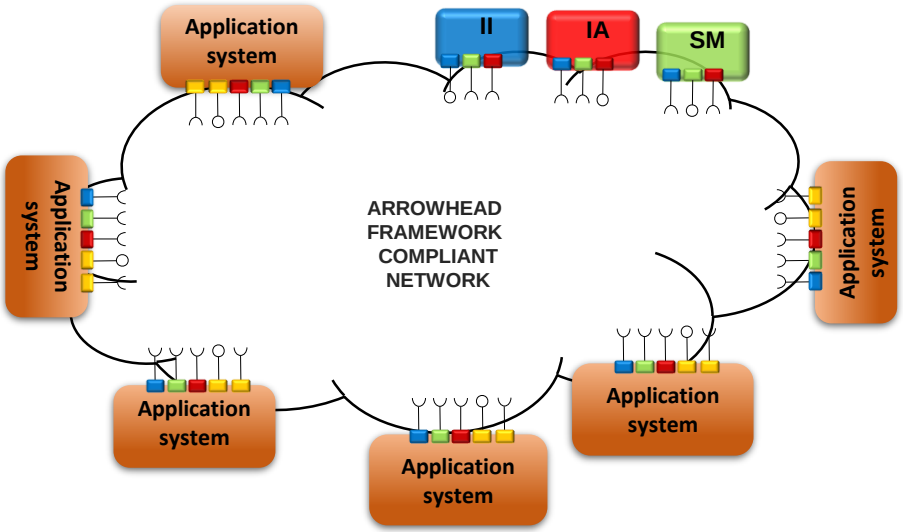
Co-funded by the Erasmus+ Programme of the European Union

Control systems of the utilities network in municipality

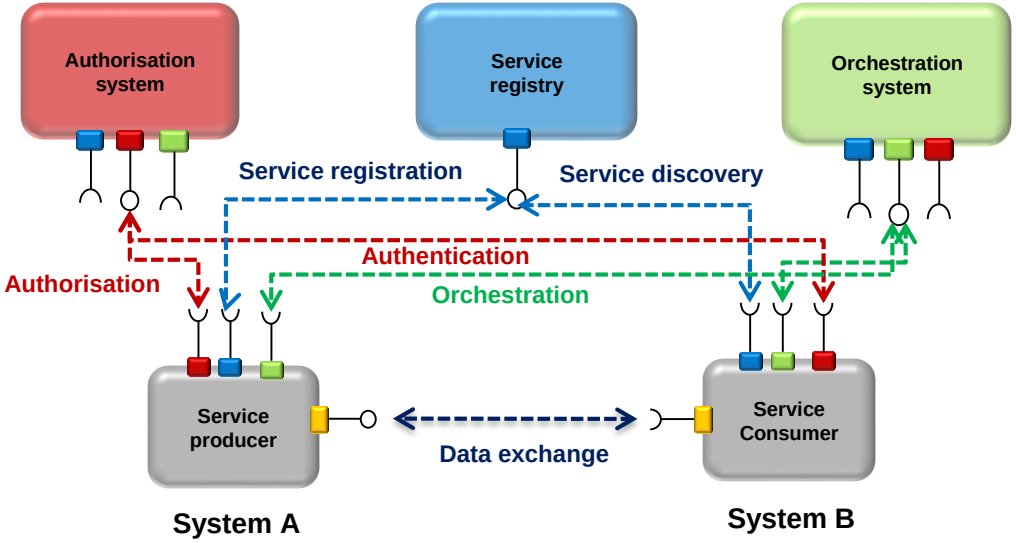


Arrowhead Framework - support for: System of systems in a local cloud

- Mandatory core systems:
  - Information infrastructure
  - System management
  - Information assurance



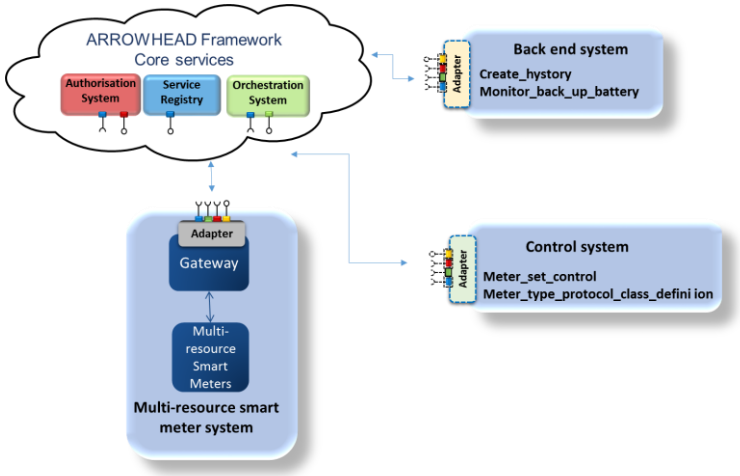
SOA implementation according to Arrowhead approach



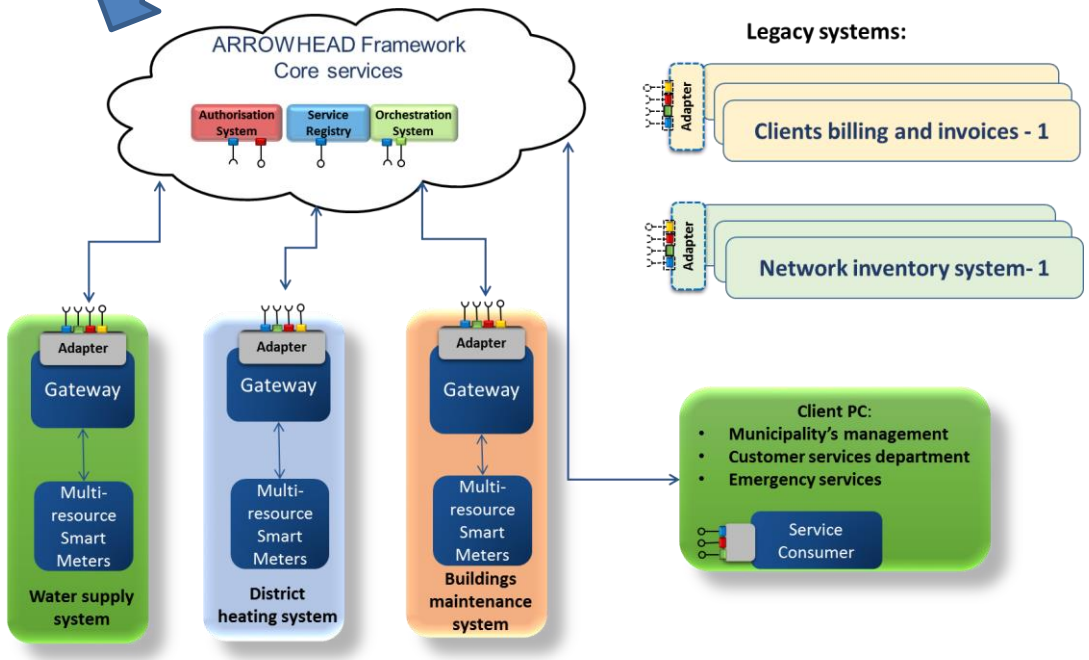
Co-funded by the
Erasmus+ Programme
of the European Union

Two stages of research

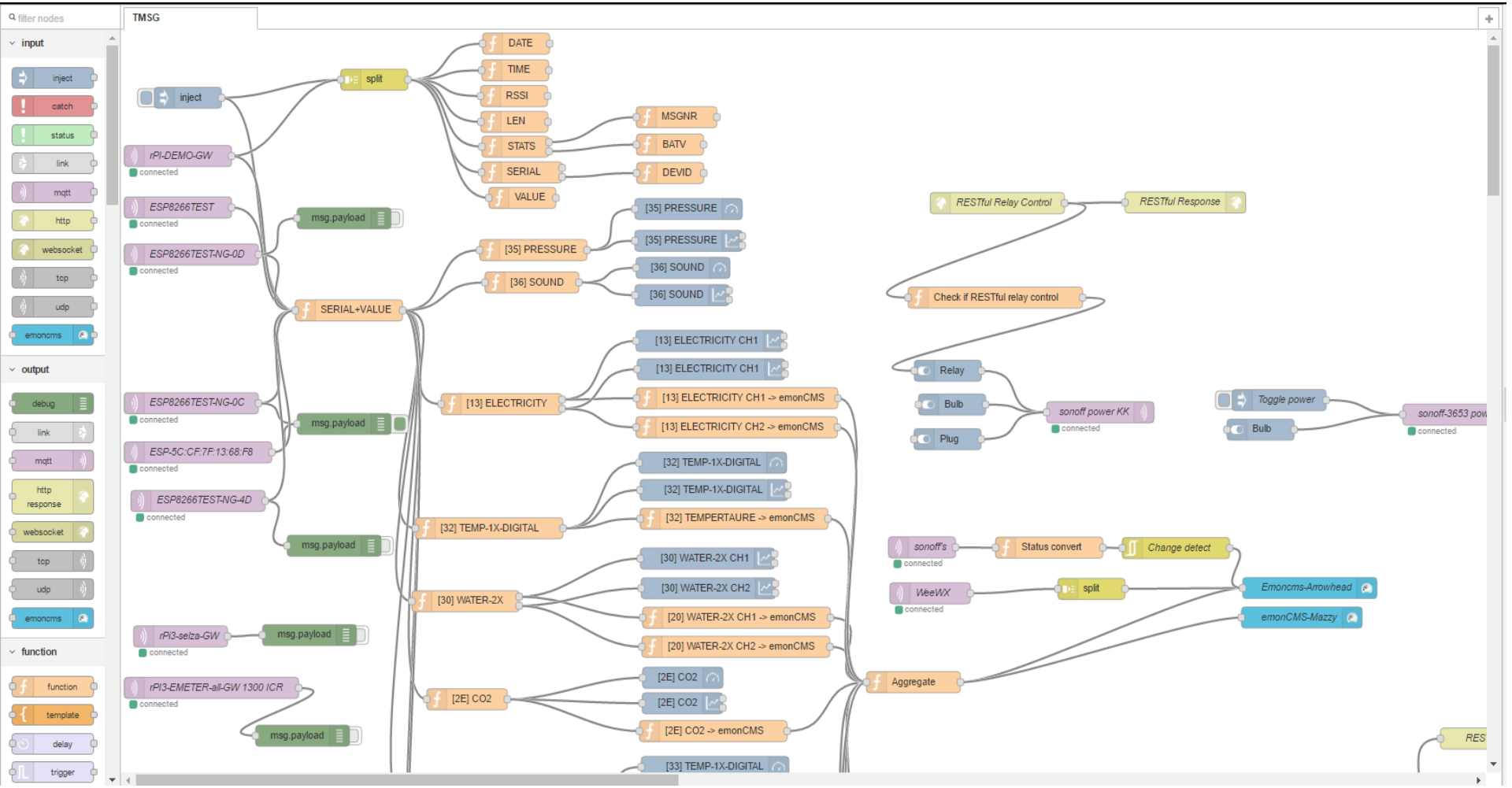
1st stage



2nd stage



Co-funded by the
Erasmus+ Programme
of the European Union



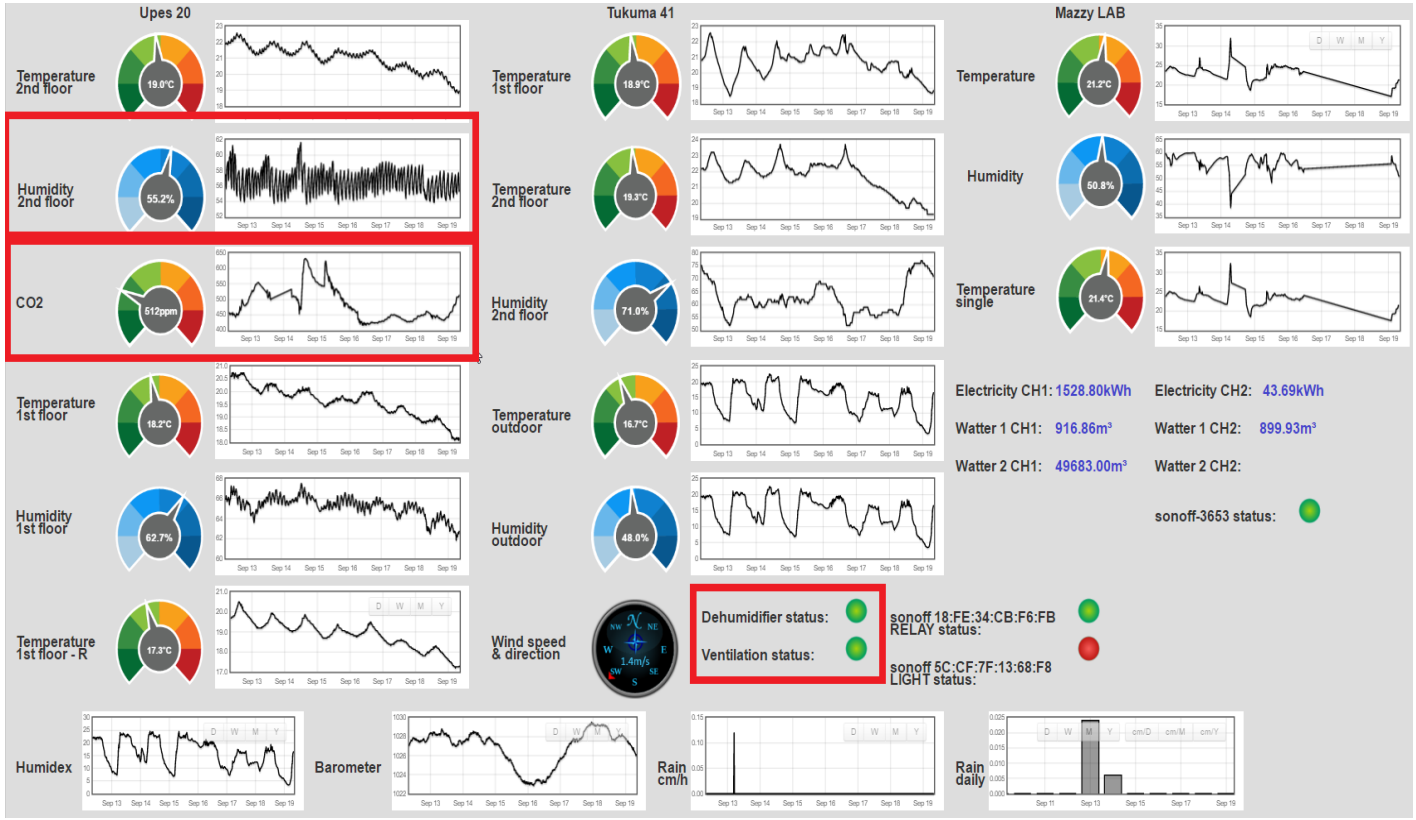
Co-funded by the
Erasmus+ Programme
of the European Union

Development of CO2 and Humidity by selected sensors

- For the purpose of the overall system demonstration and dashboard has been created to visualize different sensor feeds. All feeds are Subscribed services to the Core Service systems and the frontend is reusing the data streams by access restrictions from the authorization services.
- For the ventilation and humidity control application two Core System services are used: CO2 and Humidity by selected sensor location that is needed to be controlled. A third party control application that is not an internal development has been selected do demonstrates IoT system intercommunication using other independent service providers. For the purpose of demonstration power control hardware from ITEAD was used
- This Wi-Fi enabled relay is able to communicate using MQTT or CoAP protocols with are of interest in the scope of the demo application.
- EmonCMS is used as the Orchestration service by processing incoming data feeds and triggering response events or response streams by controlling external applications or providing new data as status or combined measurement results.

Co-funded by the
Erasmus+ Programme
of the European Union

An example of service humidity control



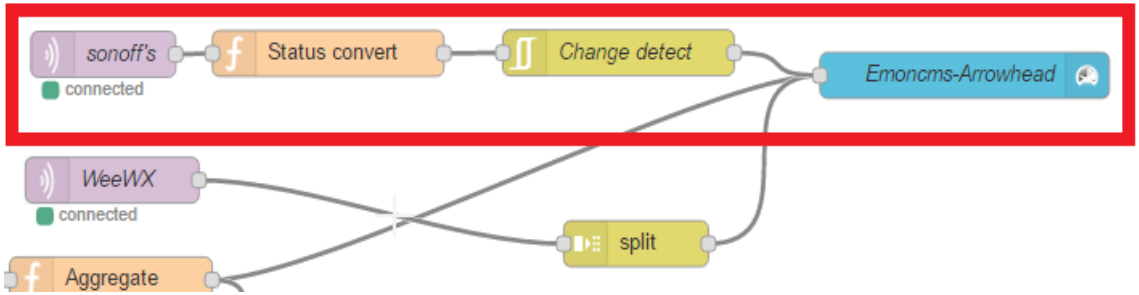
Co-funded by the
Erasmus+ Programme
of the European Union

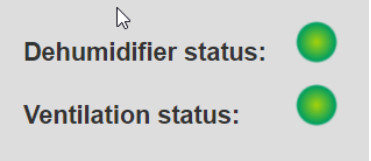
An example of service humidity control

- For the ventilation and humidity control application two Core System services are used: CO2 and Humidity by selected sensor location that is needed to be controlled. A third party control application that is not an internal development has been selected do demonstrates IoT system intercommunication using other independent service providers. For the purpose of demonstration power control hardware from ITEAD was used (https://www.itead.cc/smart-home.html). The power relay Sonoff is capable of handling loads up to 10A with a maximum rating of 2200Watts.
- This Wi-Fi enabled relay is able to communicate using MQTT or CoAP protocols with are of interest in the scope of the demo application.
- The 3rd part system is integrated into RTU demo system by so creating a System of Systems interacting in a bidirectional way and performing smart monitoring and control applications.
- For the demo application two systems are controlled – a TwinFresh Comfo RA1-50 ventilator with regeneration system and a dehumidifier Ballu BDH-35L.
- EmonCMS is used as the Orchestration service by processing incoming data feeds and triggering response events or response streams by controlling external applications or providing new data as status or combined measurement results.

Co-funded by the
Erasmus+ Programme
of the European Union

An example of service humidity control

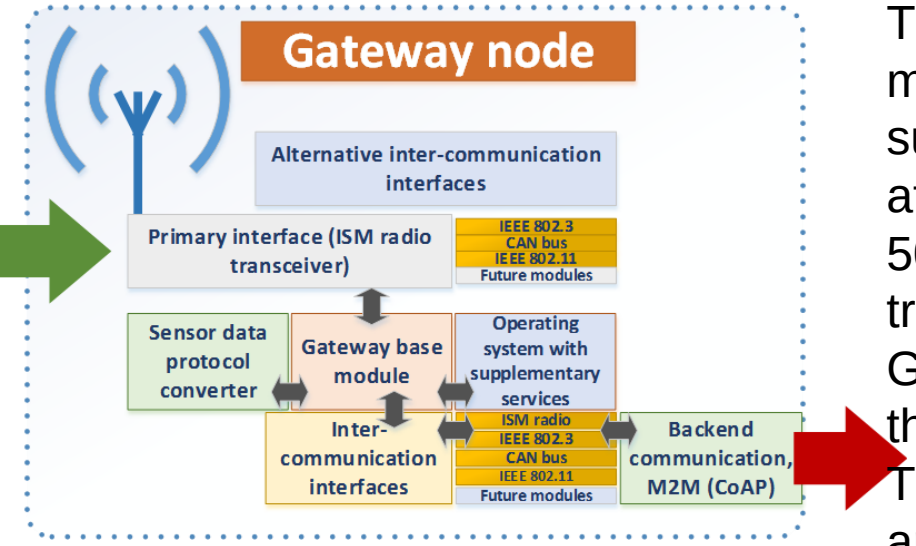




- The application logic receives periodic MQTT messages that after decoding are injected into EmonCMS inputs
- Status convert node – extracts the MAC address and builds a new MQTT message with a corrected structure by stripping colon symbols that might interfere with automatic processing systems
- Change detect node – blocks repeated MQTT messages an allows the flow only if the last message topic and payload differ from the previous.

Co-funded by the
Erasmus+ Programme
of the European Union

Hardware implementation



The metering units consists of a microcontroller, readout interface, power supply and ISM band radio module operating at 868MHz. Transmission ranges of up to 500m are possible. The coded telegrams are transmitted using Manchester coding and GFSK modulation. To one or multiple gateway that provide area coverage.

The gateway nodes consist or a radio module and 802.11b/g/n Wi-Fi module that integrates a microcontroller (ESP8266). The Wi-Fi module supports both station (Wi-Fi client mode) and access point modes.

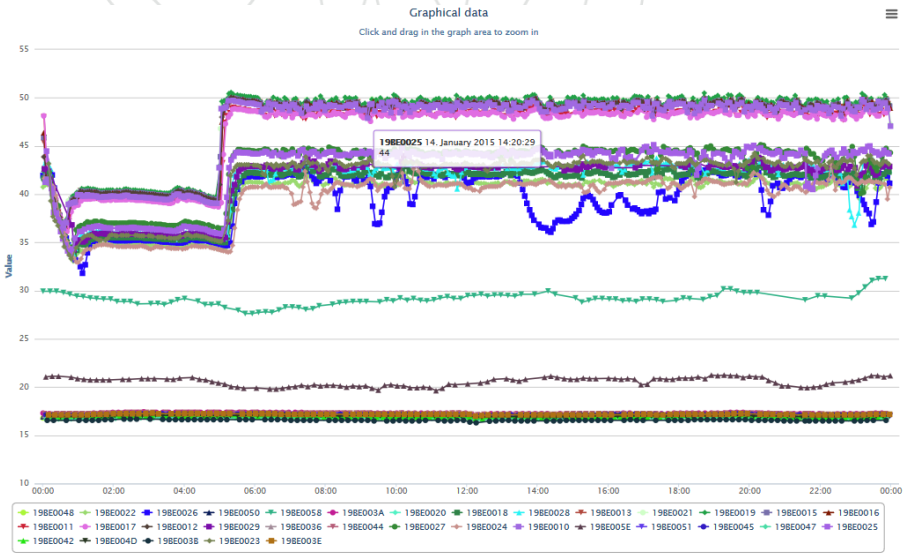
Co-funded by the
Erasmus+ Programme
of the European Union

Sensors and gateway developed by RTU

The implemented system consists of a set of custom designed Smart Metering units providing different types of telemetry data and control applications:

- Pressure measurements – water supply systems
- Water flow – water flow for domestic meters
- Electricity meters – impulse interface for common electricity meters
- Temperature meters
- Humidity meters
- CO2 meters
- Strain meters – usable for deformation registration and scale applications

Demo frontend



Serial Nr: Start Date: End Date: Clear Date | Clear All | Draw | Add | Destroy | Export XLS

Name	Date Time	Serial Nr.	Position	Type	Count1	Meter1	Count1 Calc	Count2	Meter2	Count2 Calc	Stat	Stat Calc
arrowheadgw001	20.03.2015 12:29:46	16EF0007		Temperatūra °C		19.875	**19.875**		0	**encoding missing**	0632	**encoding missing**
arrowheadgw001	20.03.2015 12:29:09	0CEF0008		Temperatura + Spiediens bar		19.875	**19.875**		-1.5	**-1.5**	0028	**encoding missing**
arrowheadgw001	20.03.2015 12:29:07	0CEF000B		Temperatura + Spiediens bar		0	**0**		-1.5	**-1.5**	0000	**encoding missing**
arrowheadgw001	20.03.2015 12:26:56	1BEF000A		2 Impulsi + Temperatura + Mitrums		20.6645	**20.6645**		44.0221	**44.0221**	0D32	**encoding missing**
arrowheadgw001	20.03.2015 12:26:49	0CEF0008		Temperatura + Spiediens bar		19.875	**19.875**		-1.5	**-1.5**	0028	**encoding missing**
arrowheadgw001	20.03.2015 12:25:33	11EF0009	Basement heating system	Temperatura + Pārplūdes sensors (<1000)		19.625	**19.625**		1023	**1023**	0332	**encoding missing**
arrowheadgw001	20.03.2015 12:25:28	0CEF000B		Temperatura + Spiediens bar		0	**0**		-1.5	**-1.5**	0000	**encoding missing**
arrowheadgw001	20.03.2015 12:24:46	19EF0005		Kumulatīvā temeratūra		19.63	**19.63**		19.63	**19.63**	0332	**0**
arrowheadgw001	20.03.2015 12:24:30	0CEF0008		Temperatura + Spiediens bar		19.8125	**19.8125**		-1.5	**-1.5**	0028	**encoding missing**
arrowheadgw001	20.03.2015 12:23:50	13EF0003	Electricity - server room	Elektroenerģijas patēriņš impulsu kWh		1.601 ↑	**1.6010**		0.0005 ↑	**0.0005**	0A32	**encoding missing**
arrowheadgw001	20.03.2015 12:23:11	16EF0001		Temperatūra °C		19.3125	**19.3125**		0	**encoding missing**	0A32	**encoding missing**
arrowheadgw001	20.03.2015 12:22:58	18EF0004		Plūsmas impulsi		12	**12**		2	**2**	0632	**encoding missing**
arrowheadgw001	20.03.2015 12:22:09	0CEF000B		Temperatura + Spiediens bar		19.875	**19.875**		-1.5	**-1.5**	0028	**encoding missing**
arrowheadgw001	20.03.2015 12:20:00	0CEF000B		Temperatura + Spiediens bar		0	**0**		-1.5	**-1.5**	0000	**encoding missing**
arrowheadgw001	20.03.2015 12:19:52	1BEF000A		2 Impulsi + Temperatura + Mitrums		20.4714	**20.4714**		44.3654	**44.3654**	0C32	**encoding missing**

Go to page: 1 Show rows: 15 1-15 of 132110

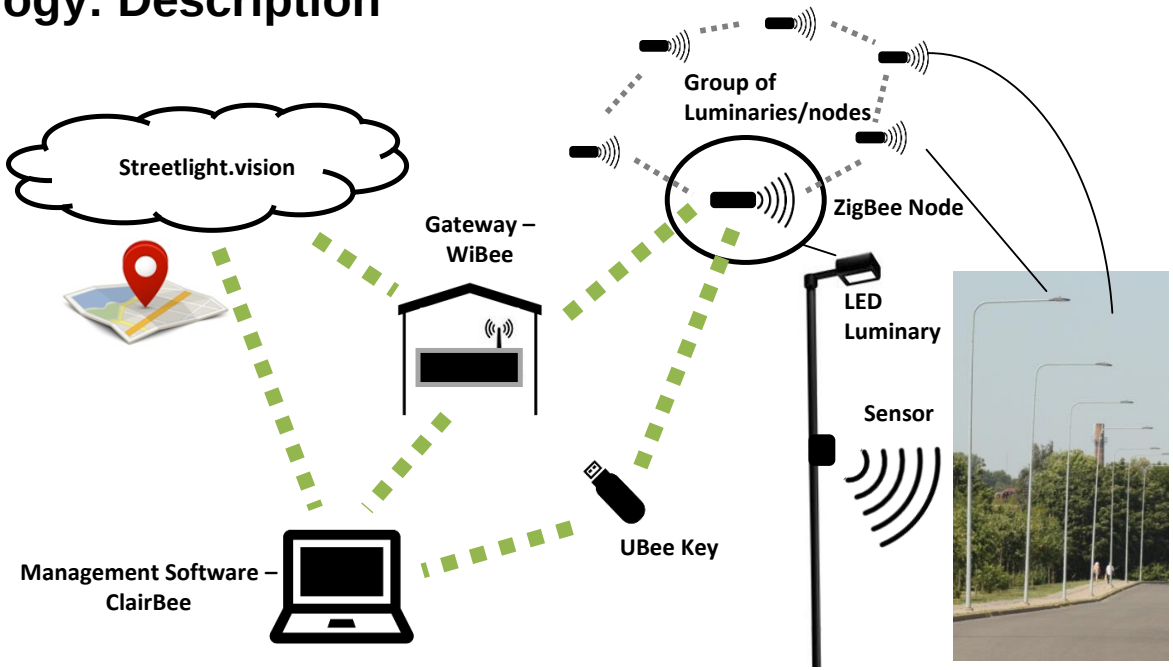
- Data decoding library
- Gateway control interface
- Gateway factory **registration/ delegation** service control
- Simple decoding and graphing
- API for Arrowhead integration

Technical report

Co-funded by the Erasmus+ Programme of the European Union

Summary of LITES Technology: Description

- The LITES technology consists of three main blocks:
  - Luminary, sensor and communication node
  - Gateway and Network infrastructure
  - Local management tool and online management tool Streetlight vision



Management software Streetlight vision ↔ **Gateway and Network** ↔ **Luminary, sensor, node**

Co-funded by the
Erasmus+ Programme
of the European Union

Thank you for your attention!

Prof. Dr. sc. Ing. Nadezhda Kunicina
Nadezda.Kunicina@rtu.lv