CARLO GAVAZZI
Automation Components

Long-range wireless metering:

Our solutions for public and private networks

White Paper

Controls

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ABSTRACT

The purposes of this document are:

- to give an overview to **LoRa®** and **LoRaWAN®**
- to present the **Carlo Gavazzi solutions** featuring **LoRaWAN® protocol** for Public (LoRaWAN®) and Private (UWP 3.0) networks.

System integrators and ESCOs looking for sub-metering and energy monitoring solutions will benefit by reading this document. In fact, it is meant for those companies that aim at:

- defining a process to **collect metering data from the field data in a secure, economic** and **automatic way**
- **limiting the commissioning impact for both new and retrofit installations.**

LoRaWAN® is designed to strengthen the standard wireless technologies battery lifetime, signal capacity, communication range, and to reduce the deployment and operating costs: everything, ensuring the data security.

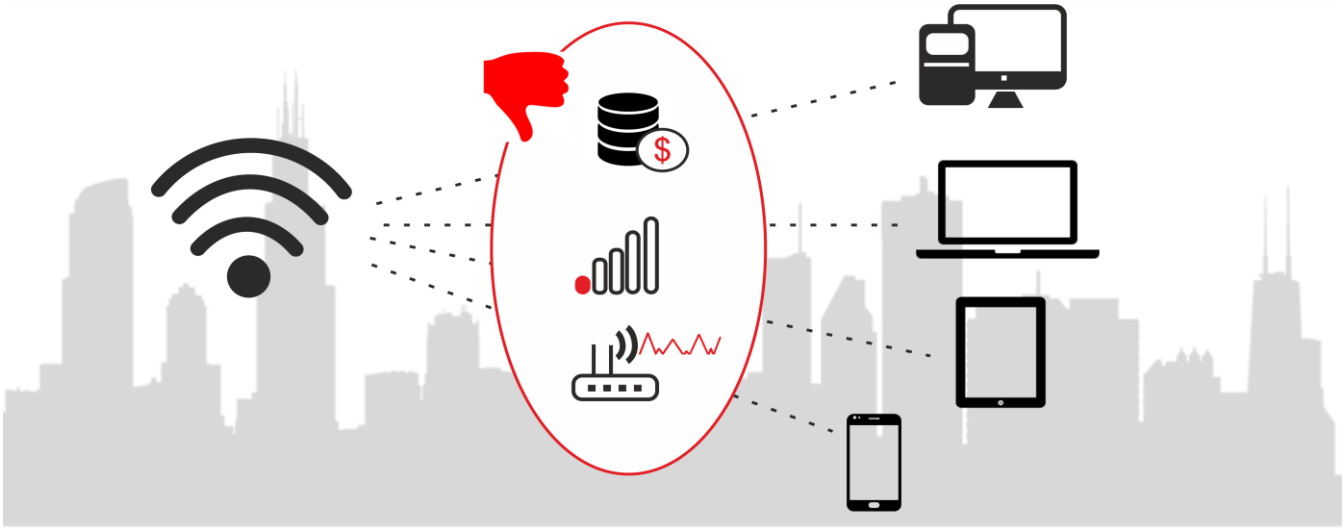
CHALLENGE

The monitoring of electricity, gas and water consumptions, carried out for sub-metering or energy efficiency purposes, is often a critical activity due to the difficulties in gathering data in a secure, automatic and economic way. Typically, the aim is to gather data from a huge number of meters on a wide area and concentrate these data in a single point.

There are many technologies that permit automizing this process but these technologies are often not feasible because of:

- the **operating and commissioning costs**
- the **constraints on the implementation** (in particular, in the retrofit applications where it is not possible to build a network facility).

In these cases, a wireless solution would be the ideal option.
However, the typically used technologies are limited in terms of signal range or disadvantageous in terms of economy since they require a mobile telephony contract for each measuring point. Moreover, in the urban areas the situation is particularly complicated due to the standards restrictions relating to the band occupation and interferences with other devices.



Typical wireless solutions

The **LoRa®**-based wireless technology has been implemented to transmit **small amounts of data** over **very long distances** (up to 10 km) in a **secure and protected way**, by using an **innovative signal modulation** technique. The user can install both the transceivers (end-devices) and the receiver (gateway) without any permission or annual fee. It is, therefore, the optimal solution for the previously described applications.

DISCOVERING LORA®

WHAT IS LoRa®

LoRa® (short of *Long Range*) is a wireless transmission technology based on a spread-spectrum modulation technique derived from the CSS (*Chirp Spread Spectrum*) technology.

Used worldwide for IoT (*Internet of Things*) networks, LoRa® features:

- Low power operation;
- Low data rate (50 kbps max);
- Long communication range (up to 5-10 km);
- Robustness against interferences.

LoRa®-based solution

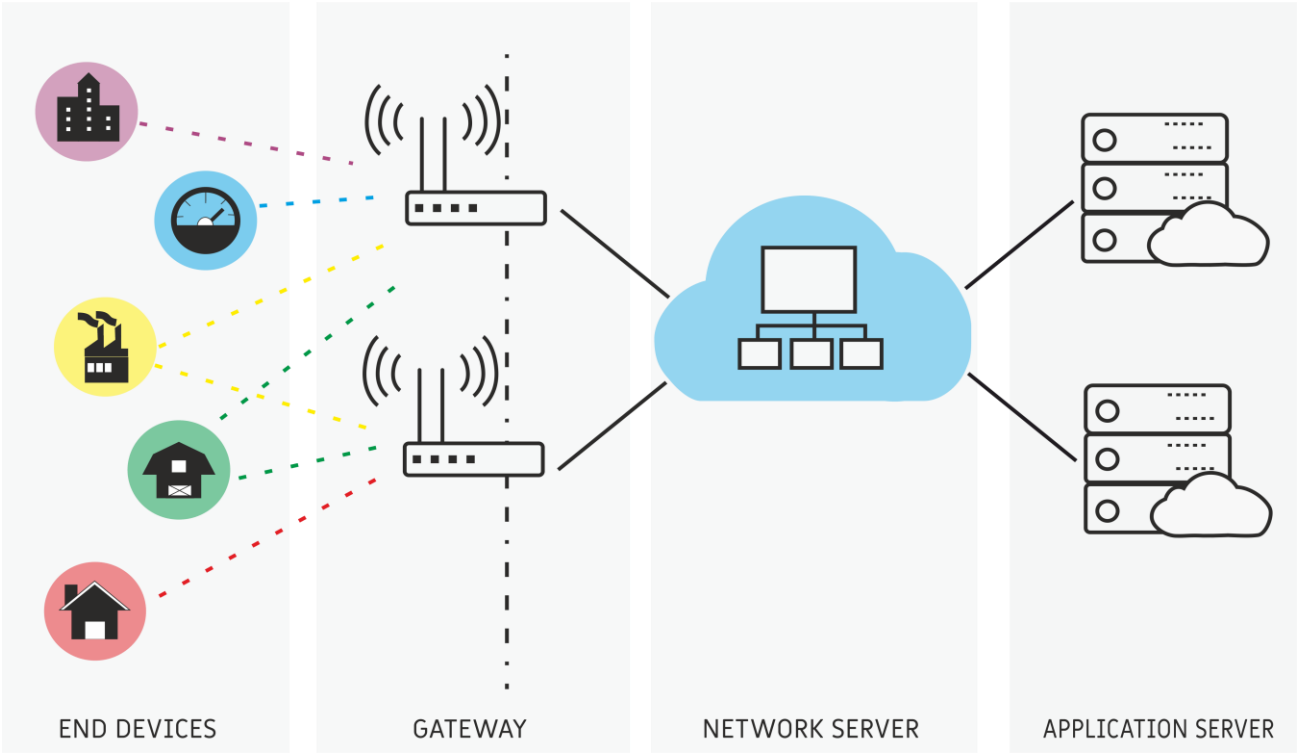
LoRaWAN® is an **LPWAN** (*Low Power, Wide Area Networking*) protocol based on LoRa® technology. Designed to wirelessly connect devices ('Things') to the Internet, the LoRaWAN® protocol leverages the unlicensed radio spectrum in the **ISM** (*Industrial, Scientific and Medical*) band. The specification defines the device-to-infrastructure of LoRa® physical-layer parameters and the LoRaWAN® protocol, providing interoperability between devices.

The LoRa Alliance™, a non-profit association, drives the standardization and global harmonization of the LoRaWAN® protocol.

The LoRaWAN® protocol meets the key requirements of IoT such as bi-directional communication and end-to-end security[1].

[1] *LoRa Alliance (2015). "LoRaWAN: What is it?" (PDF).*

LoRaWAN® ARCHITECTURE



The components that make up a LoRa®-based network architecture are described in the following paragraphs.

END DEVICE

An end device (also referred to as end node) is the sensor or the measuring device that transmits data wirelessly.

These devices are divided into three different classes (A, B and C), but most of end devices on the market are class A. It means that they:

- transmit data (**uplink**) according to their configuration, typically at fixed intervals or when a determined condition occurs
- can receive a message in **downlink** (for example, a clock synchronization) during the time period just after the transmission.

Some examples of end device are:

- temperature sensors
- electricity, water or gas meters
- carpark sensors.

GATEWAY

Gateways are devices that receive all the LoRa® data packages sent by the devices within their own range. Those data are then forwarded to the *network server* in a transparent manner, regardless of whether or not the devices are authenticated within the network and notwithstanding that the same signal has been received by another gateway.

NETWORK SERVER

After having removed the messages that are duplicated or that come from end devices not belonging to the network, the ***network server*** has:

- to forward the messages to the correct end application
- to manage the communications in downlink.

APPLICATION SERVER

An ***application server*** is the software framework responsible for:

- the handling of join-request
- the handling and encryption of application payloads.

It provides both facilities to create web applications and a server environment to run them.

LoRaWAN® ADVANTAGES

LOW COST

LoRa® reduces costs in three ways:

- Infrastructure investment
- Operating expenses
- End-node sensors

STANDARDIZED

Improved global interoperability speed adoption and roll out of LoRaWAN® networks and IoT applications

LOW POWER

Protocol designed specifically for low power consumption

LONG RANGE

Single base station provides deep penetration in dense urban/indoor regions, plus connects rural areas up to 10 KM away

SECURITY

Embedded end-to-end AES128 encryption

HIGH CAPACITY

Supports millions of messages per base station, ideal for public network operators serving many customers

COMPARING WIRELESS TECHNOLOGIES

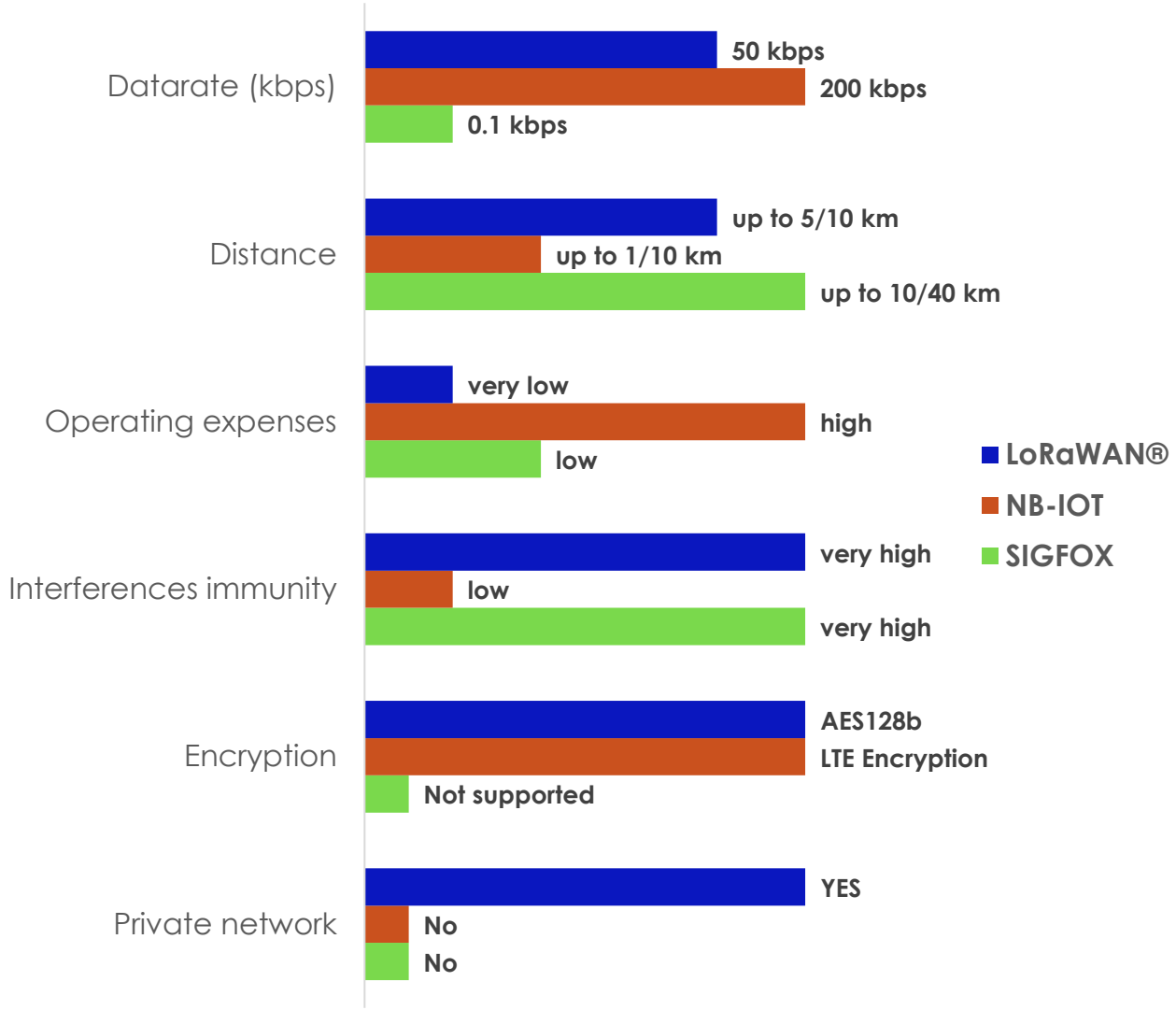
LOCAL AND PERSONAL AREA NETWORKS	LPWAN NETWORK	CELLULAR NETWORKS
Very low operating expenses High data rate *Bluetooth: 1 Mbps* *Zigbee: 250 kbps* *Wi-fi: 11 Mbps*	Wide area coverage *Urban: 5 km* *Rural: 10 km* Unlicensed ISM bands Very low operating expenses (no sim cards or annual fees)	Wide area coverage *3G: 35 km* *4G: 200 km* *5G: <15 km* High data rate *3G: 144- kbps – 2 Mbps* *4G: 3-10 Mbps* *5G: 1 Gbps >*
Short range communication *Bluetooth: 10 m* *Zigbee: 10 m (typical) / 100 m max.* *Wi-Fi: 10 m* Frequency *2.4 GHz*	Low data rate	Sim card costs and high annual fees Frequency *3G: 1.6 – 2.0 GHz* *4G: 2-8 GHz* *5G: 3-300 GHz*

ADVANTAGES

DISADVANTAGES

LOW POWER WIDE AREA (LPWAN) TECHNOLOGIES

In the following chart, a comparison of the different technologies features is shown[2].



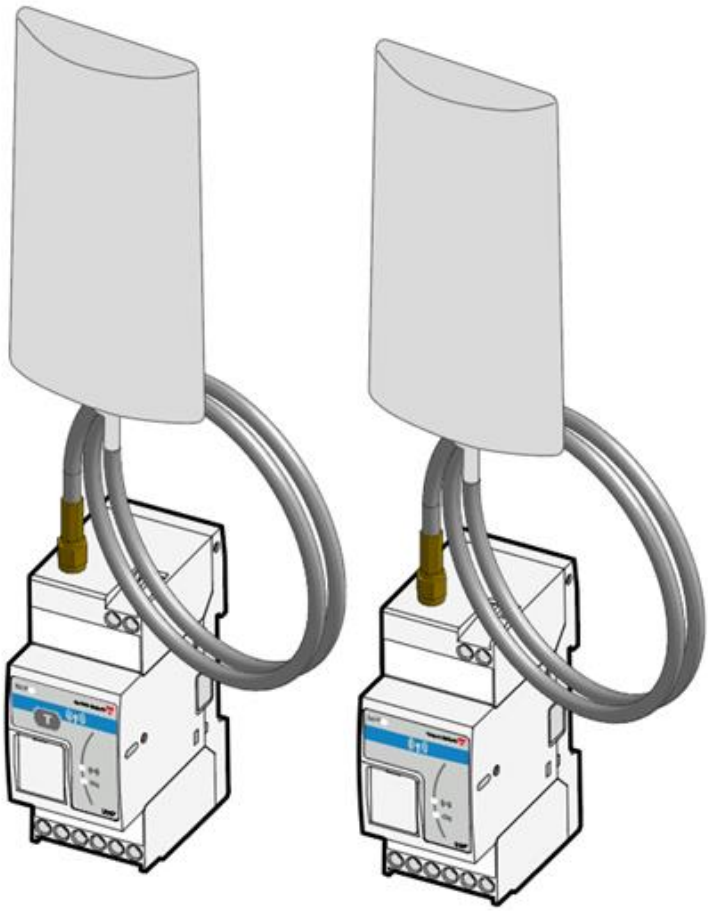
[2] Mekki, M., Bajic, E., Chaxel, F., & Meyer, F. (2019). A comparative study of LPWAN technologies for large-scale IoT deployment. *ICT Express, Elsevier*, 5 (1), pp.1-7, from https://www.sciencedirect.com/science/article/pii/S2405959517302953.

CARLO GAVAZZI LONG-RANGE WIRELESS SOLUTIONS

Carlo Gavazzi has developed a LoRa®-based solution that permits creating a wireless system gathering data from Carlo Gavazzi meters.

The solution consists of two devices:

- UWPA is an endpoint adapter that provides a long-range wireless communication and a LoRaWAN® communication to RS485 Carlo Gavazzi meters.
- UWPM is a master concentrator that permits UWP 3.0 to gather data from multiple UWPA via a long-range wireless communication.



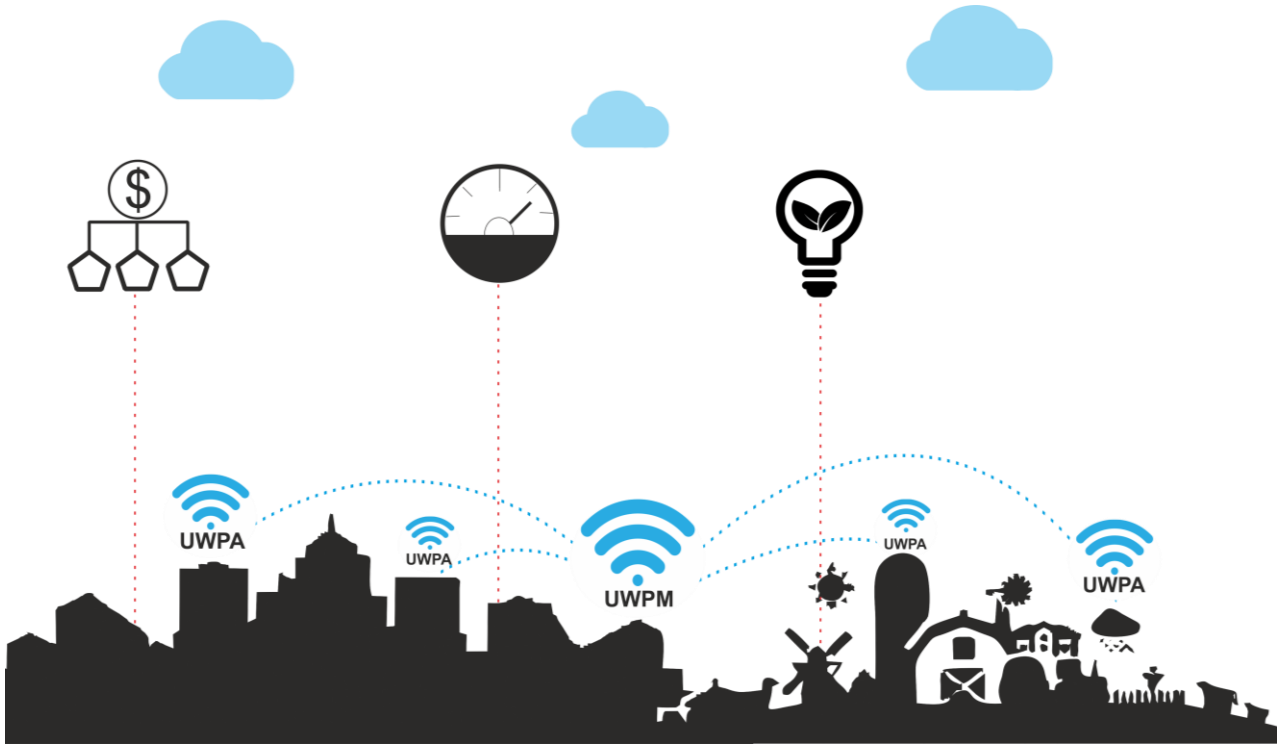
UWPA UWPM

It is necessary:

- a UWPA for integrating a Carlo Gavazzi meter into an existing LoRaWAN® network (see ***PUBLIC (LoRaWAN®) NETWORKS***);
- Both UWPM and UWPA for creating a wireless network made of Carlo Gavazzi devices only (see ***PRIVATE (UWP 3.0) NETWORKS***), by joining Carlo Gavazzi meters and the UWP 3.0 universal gateway and controller.

APPLICATIONS

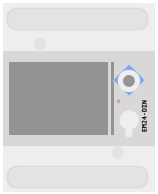
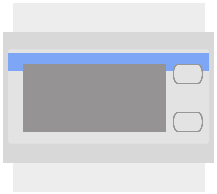
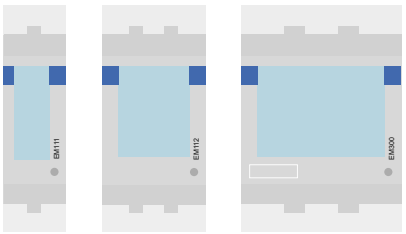
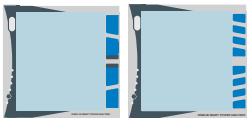
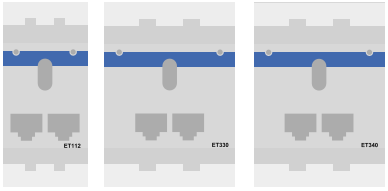
Energy efficiency monitoring and energy cost allocation, sub-metering in large buildings, big facilities, farms and city areas are the best use cases for long range wireless Carlo Gavazzi systems. Thanks to long communication range, security and robustness, wireless networks can be easily set-up, without the need of buying SIM cards or setting up expensive mobile networks.



COST ALLOCATION AND ENERGY EFFICIENCY (SMART CITY)

Whenever the user deals with a project focused on sub-metering or cost allocation, or in the energy efficiency monitoring realm, the need for minimizing the TCO (total cost of ownership) is always triggered on. Carlo Gavazzi long-range wireless solution helps fitting this scenario.

CARLO GAVAZZI COMPATIBLE COMPONENTS

ENERGY ANALYSERS	EM24 (FAMILY)	EM210 (FAMILY)
		
ENERGY METERS	EM100-300 (FAMILY)	
		
POWER QUALITY ANALYSERS	WM20-30-40 (FAMILY)	CPA (FAMILY)
		
POWER TRANSDUCERS	ET100-300 (FAMILY)	
		
PULSE CONCENTRATOR	VMU-MC / VMU-OC	
		

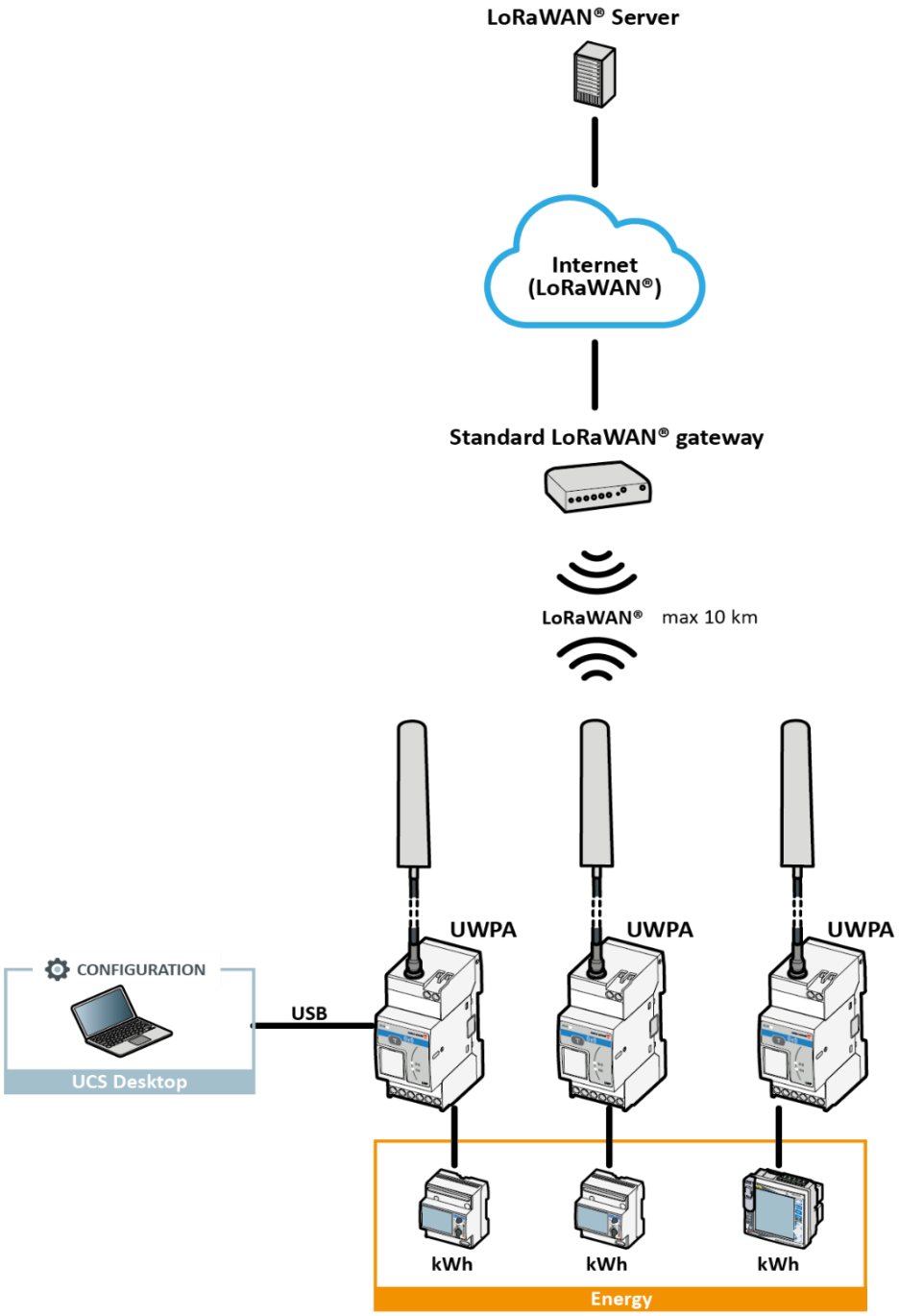
HOW MANY CARLO GAVAZZI DEVICES CAN I CONNECT TO A UWPA MODULE?

It is possible to connect one Carlo Gavazzi device to each UWPA.

PUBLIC (LoRaWAN®) NETWORKS

The LoRaWAN®-based device communicates with a gateway part of a public infrastructure (for example, utility city network).

ARCHITECTURE



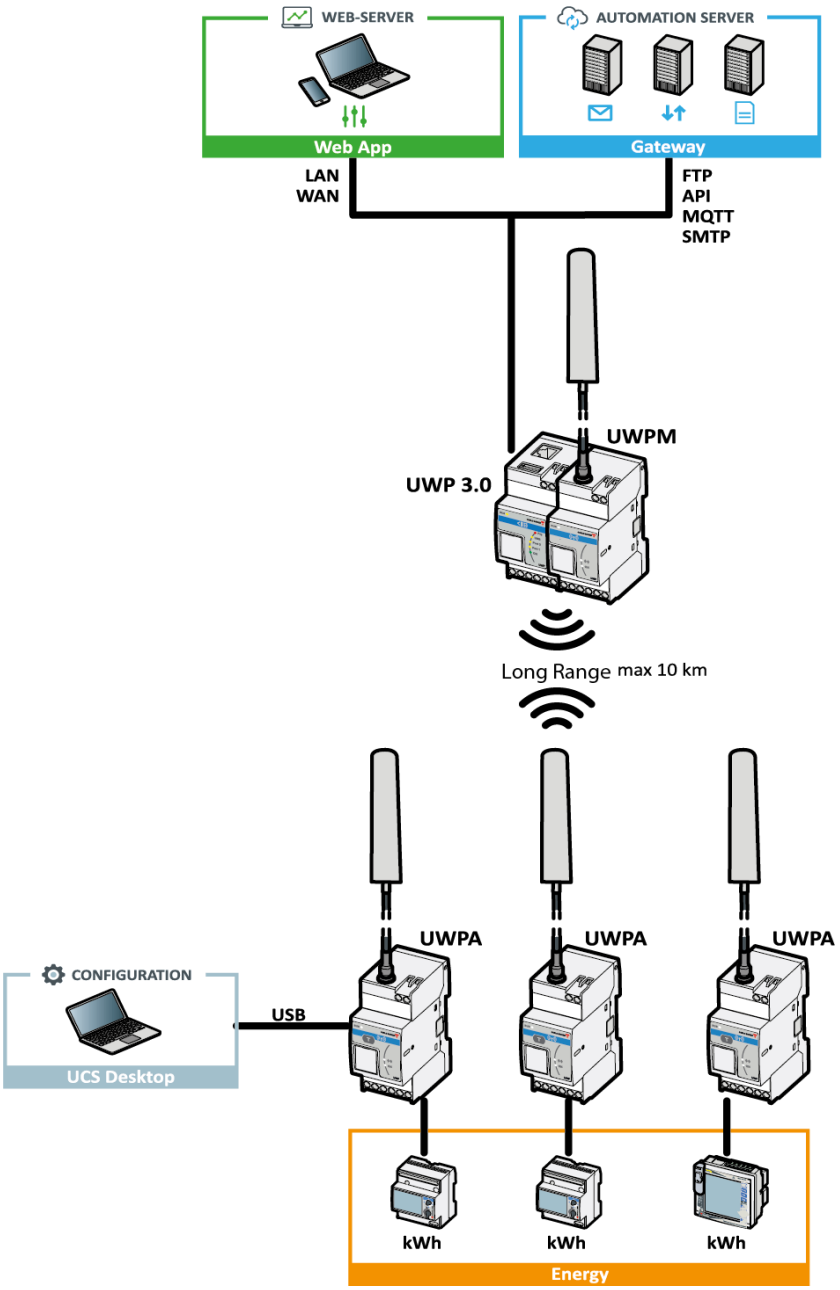
WHY SHOULD I CHOOSE THE PUBLIC (OPEN) NETWORK SOLUTION?

If you need to link your meters to an existing public or private LoRaWAN® network, via an existing LoRa®-based gateway.

PRIVATE (UWP 3.0) NETWORKS

The long-range wireless device communicates with a compatible gateway, both working in the free ISM band.

ARCHITECTURE



WHY SHOULD I CHOOSE THE PRIVATE (UWP) NETWORK SOLUTION?

If you need to setup your own independent long-range wireless network in the free unlicensed ISM band.

INTEGRATION OF UWP3.0

UWP 3.0 is a **gateway** that:

- Permits monitoring the devices connected by means of different buses and communication protocols
- Includes a web server that permits displaying charts and real time data
- Permits exchanging data locally or remotely by means of standard Internet protocols.

Thanks to **UWPM** - a **master concentrator** - UWP 3.0 is able to gather data from multiple UWPAs. Those UWPAs transmit the data gathered from Carlo Gavazzi meters via LoRa®-based wireless communication.

The **integration** is highly easy and intuitive since it is enough to import into the UWP 3.0 configuration a unique file generated by means of UCS software containing all the information about the configured UWPAs.

HOW MANY UWPA CAN I INTEGRATE INTO A UWP 3.0?

For each UWPM connected to UWP 3.0, you can connect up to 50 UWPA.

Like in a standard wireless system, the higher the number of devices and transmitted data, the higher the possibility of interferences is. In that case, you need to extend the transmission interval to guarantee the reliability.

To obtain the maximum distance and the interference resistance, we suggest using the SF12 spreading factor. Spreading factors other than SF12 can be used when the distance between UWPA and UWPM is lower than the distance reachable with SF12.

The following tables suggest you the UCS parameters that guarantee the correct data transmission.

1 PACKAGE (MAX. 8 VARIABLES*)

		UCS parameters	
Transmission interval	Max. number of UWPA per UWPM	Spreading factor	Retry
5 min	10	SF11	1
10 min	10	SF12	1
	50	SF11	2
≥ 15 min	50	SF12	2

2 PACKAGES (MAX. 16 VARIABLES*)

		UCS parameters	
Transmission interval	Max. number of UWPA per UWPM	Spreading factor	Retry
10 min	10	SF11	1
15 min	10	SF12	1
30 min	10	SF12	1
	50	SF11	2
≥ 1 h	50	SF12	2

3 PACKAGES (MAX. 24 VARIABLES*)

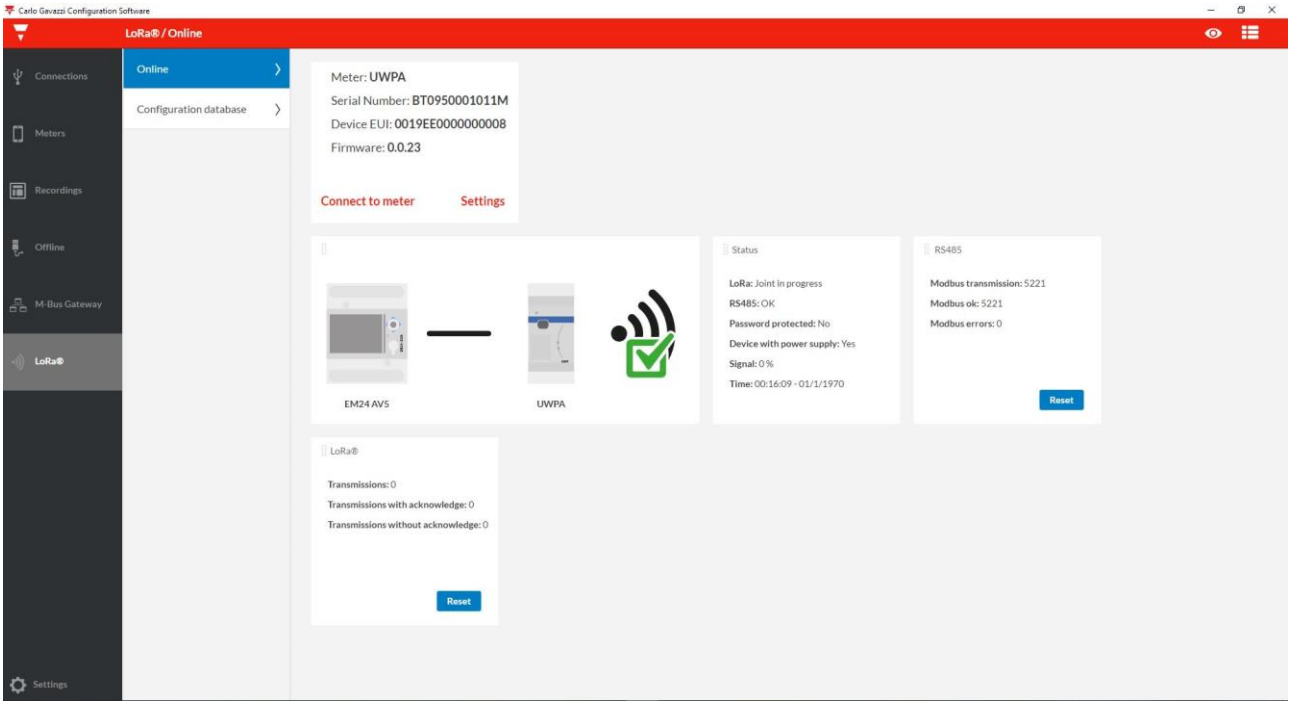
		UCS parameters	
Transmission interval	Max. number of UWPA per UWPM	Spreading factor	Retry
15 min	10	SF11	1
30 min	10	SF12	1
≥ 1 H	50	SF12	2

**The maximum number of variables for each package depends on their format. The indicated value refers to the real time variables (such as voltage, current, power); with hour counter variables (such as energy) that value has to be halved.*

The SF11 spreading factor, unlike the SF12, reduces the distance and the resilience to interferences of the signal. This reduction is more evident with spreading factors inferior to SF11.

CONFIGURATION SOFTWARE (UCS)

UCS (universal configuration software) is our free configuration software.



- Free software, compatible with Windows® PCs
- Intuitive user interface
- The same software for configuring UWPA and Carlo Gavazzi meters
- UWPA password management for protecting your LoRaWAN® network
- Configurations database for helping system integrators
- Real time diagnostics and data logging
- csv/xlsx file export of devices for easy integration in third-party systems
- File export of devices for automatic integration in UWP 3.0
- Export of .csv or Excel files from the configured devices list for an easy integration into a LoRaWAN® network
- Export of the configured devices file for the UWP network to import into UWP 3.0.

HOW TO CONFIGURE UWPA USING UCS

To configure UWPA, follow this procedure:

1 Connect UWPA to a compatible Carlo Gavazzi meter via RS485

2 Power UWPA on

3 Connect the PC to UWPA via USB cable

4 Start the UCS software

5 Select the **UWPA com port** and click **Connect** > to access the UWPA dashboard

6 Click **Settings**

7 Click **Go** to open the *Configuration Wizard*

8 Give the configuration a name (**Configuration name**)

9 Select the meter manually or using the *Auto-discovery*

10 Click **Next** to go to the next step

11 From the list, select the variables to transmit

12 Click **Next** to go to the next step

13 Set the wireless communication parameters (**LoRa® connection settings**):

LPWAN network

- **Network type**

If you want to connect UWPA to…	Then select…
UWP3.0 via UWPM Gateway	UWP 3.0 (UWPM Gateway)
Any LoRaWAN® Gateway	LoRaWAN® Network

- **Activation type** and the relevant keys*.

If you use…	Then you need to set…
OTAA (Over The Air Activation)	*the "application key" that the server uses for the join of UWPA to the network.*
ABP (Activation By Personalization)	*set the "Network session key" and the "Application Session Key", used by UWPA to encrypt the messages.*

***Note:** after the **LPWAN network** parameters, in the **LoRa® activation** part.*

*Click **Generate keys** (**LoRa® activation**) to set random keys without setting them manually.*

Transmission

- **Transmission interval.** If UWPA is set to communicate with UWP 3.0 via UWPM, select the proper data rate (for further information, please refer to the relevant part in this manual and in the UWP-A-M data sheet).

Downlink communication from server

- Enable the **Check server acknowledge after transmission** field.
- Enable the **Clock synchronization with the server** field.

14 Enable the **Transmission by pressing push button** and the **Connection to meter via UWPA**

15 Click **Save** or **Save and store** to write the configuration to UWPA.
Note: *If you click* ***Save and store,*** *the configuration becomes a template for future use in the configuration database.*

16 Repeat the same procedure for any UWPA you want to connect to the same LoRaWAN® network or to the same UWP 3.0.

17 Click ← on the top-left side to go back to the UWPA dashboard.

18 The last part of the procedure depends on the settings of the network type:

If you select...	Then…
LoRaWAN® Network	1. Click the tab **LoRaWAN® network devices** 2. Select the devices to integrate into the network 3. Click **Export to excel** or **Export to csv** to generate a file including UWPA unique identifiers (**DEVEui**) and the keys to share with the system integrator
UWP 3.0 (UWPM Gateway)	1. Click the tab **UWP 3.0 network devices** 2. Select the devices to integrate into the network 3. Click **Export file for integration into UWP** (top-right side) to generate the zip file. This file is automatically imported into UWP 3.0 by the UWP 3.0 Tool (see relevant manual)

ADVANTAGES

EASY AND FAST CONFIGURATION

Via free software (UCS).

EASY COMMISSIONING AND DIAGNOSTICS

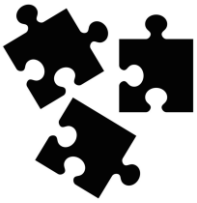
Thanks to the UCS software and the embedded testing push button.

SECURITY

Embedded end-to-end AES128 encryption and password protected configuration.

RELIABLE COMMUNICATION

Thanks to the high-performance antenna, interferences/obstacles immunity and downlink server acknowledge.



COMPATIBILITY

It permits interfacing Carlo Gavazzi meters with standard third-party LoRaWAN® networks or with the UWP 3.0 platform (in the private network solution).

CONCLUSION

The new long-range wireless technologies are the ideal solution for private networks or city-wide public networks where small amount of data must be transmitted by multiple devices and the total cost of ownership (TCO) of the system must be kept as low as possible.

The Carlo Gavazzi solution permits creating a long-range wireless network to gather data from Carlo Gavazzi meters.

The most critical factors of our solution are:

- Communication range (up to 10 km)
- Robustness to interference (immunity)
- Network security (AES 128 encryption)
- Two-way communication (acknowledge and clock synchronization)
- Variety of applications served (public and private).

This article is aimed to clarify the scope of LoRaWAN® by exploring the limits of the technology and describing the Carlo Gavazzi solution.

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ADDITIONAL LINKS

DOCUMENT	WHERE TO FIND IT
UWP 3.0 - Instruction manual	www.productselection.net/MANUALS/UK/uwp3.0_im.pdf
UWP 3.0 - Data sheet	www.productselection.net/PDF/UK/uwp3.0_ds.pdf
UWPA, UWPM - Data sheet	www.productselection.net/PDF/UK/UWPA-UWPM_DS.pdf
UWPA - Instruction manual	www.productselection.net/MANUALS/UK/UWPA_IM.pdf
UWPM - Instruction manual	www.productselection.net/MANUALS/UK/UWPM_IM.pdf
How to order	www.productselection.net/DOCUMENT/UK/UWP3_how_to_order.pdf
Our product selection	www.productselection.net

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