The Wize Protocol, LPWAN for Smart Cities

By P. M. Evjen

Wize is a novel approach to a wireless LPWAN network for Industrial IoT applications based on Wireless M-Bus at 169 MHz. Based on this well-established standard for reading utility meters, the Wize provides robust communication and wide area coverage for hard to reach Smart City objects, while offering a secure data channel and long battery lifetime. Some of the target applications are Smart City devices, recycling and waste management, infrastructure supervision and connected factories.

Introduction

The Wize protocol is the result of the development of a new LPWAN (Low Power Wide Area Network) solution based on Wireless M-Bus at 169 MHz. The technology was first utilized and developed for gas and water metering in France. Now this technology is made available for a wider market, not only in France and not only within smart metering, but in Smart City and Industrial IoT applications in general.

The idea is to use proven technology and established infrastructure already used in metering applications, in the growing IoT market. Especially in the more demanding end of the IoT market where range, robustness, security, low power consumption and low operation cost are critical success factors.

The Wize protocol provides

- Robust communication and wide area coverage using VHF frequency
- Secure transfer of data in terms of privacy, data integrity and authentication
- A low power battery operated solution with lifetime > 15 years
- A proven solution based on the established Wireless M-Bus standard
- Firmware download over-the-air as an integral part of the protocol

The Wize Alliance

The Wize Alliance was founded in France by GRDF, Sagemcom and Suez in 2017. The Alliance was created to secure the durability and sustainability of the 169 MHz technology already used in the water and gas smart metering network in France. Further the aim is to export the technology and enter new markets outside utility metering, particularly smart cities applications, as well as outside France.

The Wize Alliance aims to

- Improve interoperability between connected objects using LPWAN technology
- Educate the IoT market
- Create an ecosystem of start-ups, developers and product suppliers
- Contribute to the development of the Wireless M-Bus standard

Radiocrafts joined as one of the first members, after being an active and contributing member of the CEN TC294 standardizing the use of 169 MHz in Europe for many years. Today the Alliance comprises over 40 members in 8 countries.

Gas and water metering using 169 MHz

The Wize technology was first used in gas and water metering. These are some of the most demanding applications within smart metering as the meters are often installed in locations with difficult radio penetration such as basements, underground installations, pits or steel cabinets. Further, these meters do not have access to main power, requiring battery operation.

A pilot study was done by GRDF in 2010/11, which also used the 169 MHz radio system already developed by Ondeo systems (later Suez Smart Solutions). Compared to other radio technologies at 433 and 868 MHz, the 169 MHz solution proved superior in terms of coverage and reliability.

The physics of electromagnetic signal propagation tells us that lower frequencies give longer range and will have better ability to penetrate into buildings and where line-of-sight is not possible. In the pilot study several technologies were compared, some also using repeaters. The 169 MHz solution gave the best radio coverage, with the lowest number of receivers (base stations) and even without repeaters. The drawback of technologies using repeaters or mesh technology is the installation and maintenance of such repeaters, and the higher power consumption of mesh networking devices. Gas and water meters do not have access to mains power and must run off batteries. This prevents the meters to act as a router in a mesh network. Establishing dedicated routers or repeaters is complicated with respect to getting access to installation sites and access to mains power at these sites, as well as the maintenance of such devices. The main benefit of 169 MHz based radio is the simplicity of the point-to-point network, and hence reduction of operational cost.

Further, there is no license cost with respect to the use of the frequency band. The 169 MHz frequency band was made available for license free operation in Europe after the paging services were closed down and the spectrum was freed up for other use such as automatic meter reading.

The use of 169 MHz for metering applications was first standardized in the EN 13757-4:2013. The new mode N defined 6 channels in the VHF band, and combined with low bandwidth (12.5 kHz) and high transmission power (500 mW) it achieve superior radio performance.

It might seem contradictory to describe a narrowband radio system with low data rate, and hence long transmission duration (several hundred milliseconds), combined with high radio transmission power (500 mW), a low power solution. However, with the infrequent transmissions typically used in LPWAN systems (typically 5-10 transmissions per day), the power consumption is still within the capability of small lithium batteries cells (AA, A or C) with lifetime of 15-20 years.

Smart City applications

The Wize technology is aimed at Industrial Internet of Things (IIoT) applications such as

- Smart Metering
- Smart Cities
- Waste Management
- Connected Factory
- Renewables

As mentioned, gas and water meters were the first applications for the 169 MHz technology. However, it is equally available for other applications within the Smart City space. Waste management by supervision of garbage containers and recycling points for metal and glass, is an example of where Wize is used today.

As long as the amount of data is “fairly small”, and the number of transmissions per day is limited, Wize can be used. In water and gas the typical number of daily transmission are up to 10, and the amount of data is typically 30-80 bytes.

Wize and Wireless M-Bus technology

The Wize protocol is based on EN13757-4 Wireless M-Bus mode N, operating at 169 MHz. These are the basic radio parameters being used:

- 2.4, 4.8, 6.4 kbps data rate

- 6 channels
- 12.5 kHz channel bandwidth
- 500 mW output power
- Bi-directional

The Wize protocol then defines its own application layer and security modes. Also it offers some new services such as installation (ping/pong) and firmware download.

The Wize protocol uses a unique Control-Information field (CI = 0x20) to identify the new transport and application layer.

The transport layer (sometimes referred to as the presentation layer) provides the security services of privacy, integrity, authentication and protection against replay. The security is based on AES-128 using the CTR mode for encryption and CMAC for authentication. Actually there are two authentication hash tags appended to the message; one is used by the base station to authenticate and allow messages for further processing, and the other is an end-to-end authentication. Each message is using a unique message counter and a time stamp based on an EPOCH second counter.

The application layer support the services of

- Device installation using a ping/pong mechanism between the device and the available base stations
- Configuration and administration of devices through command/response messages
- Firmware download by broadcast to devices that have been time synchronized
- Data collection using dedicated frames for the different profiles (such as gas and water)

There are some deviations from the Wireless M-Bus standard in the use of the C-field, link layer addressing, and the new frame format in the data link layer used for firmware download over-the-air. The C-field has been modify to also signal “priority” messages, typically used in alarm situations. The link layer address in Wize is always using the device address, as it was in the original EN13757-4 from 2005, but which was later changed in the standard (2013).

The bi-directional communication, while keeping the current consumption to a minimum, is realized using a short listening window 5 seconds after the transmission for any of the data rates. The updated version of EN13757-4 to be released 2018/2019 will specify the same timing.

The firmware download over-the-air use a broadcast protocol. First all devices that are intended for the FW upgrade is notified on a one-to-one basis about the rendezvous time at which the broadcast transmission start. A large number of devices can therefore be upgraded in a short time, utilizing the somewhat narrow bandwidth available. The same physical layer as Wireless M-Bus is used, but a new frame format has been defined for the download messages. The download takes place in the “blackout period”, typically 4 hours during the night, where no Wize devices are allowed to transmit in order not to interfere with the download.

Range of 169 MHz

Many of the benefits of using Wize, or Wireless M-Bus at 169 MHz, comes from the radio properties. The range and therefore the radio area coverage come as a result of combining several features:

- Narrowband radio, using 12.5 kHz channels increase the sensitivity
- Low data rate (2.4/4.8/6.4 kbps) increase sensitivity
- Narrowband radio also improve the selectivity, reducing interference and blocking

- High RF transmission power, up to 500 mW of radiated power is allowed in this band and increase the range
- The relatively low frequency at 169 MHz gives good penetration in buildings and deflects around obstacles
- The relatively low frequency yields a lower path loss due to larger antenna area (but means the antenna structure will be larger)

The benefits of Wize

The Wize protocol brings all the advantages of the Wireless M-Bus protocol in terms of range and power efficiency, in addition to the new services descried above.

Further benefits of Wize and Wireless M-Bus when used in Smart City / IIoT applications are:

- a standardized framework for a complete communication stack
- an optimized solution for battery operation
- security in terms of privacy, integrity and authentication of data
- a power efficient two-way communication protocol for sensor reading and control
- availability of data readers and gateways

The Radiocrafts solution

Radiocrafts already provides a range of products based on Wireless M-Bus at 169 MHz. The RC1701HP-MBUS4 radio modem, RC1701HP-MPC1 pulse counter, and RC1701HP-MSM sensor interface module are such products.

This family is now extended with RC1710HP-WIZE that supports the new Wize protocol. Radiocrafts also develop custom specific variants of the module for operation in the Wize network.

Document Revision History

Document Revision	Changes
0.1	Draft
1.0	First release

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Contact Information

Web site: www.radiocrafts.com
Email: radiocrafts@radiocrafts.com

Address:
Radiocrafts AS
Sandakerveien 64
NO-0484 OSLO
NORWAY

Tel: +47 4000 5195
Fax: +47 22 71 29 15
E-mail: sales@radiocrafts.com