An Introduction to Wireless M-Bus

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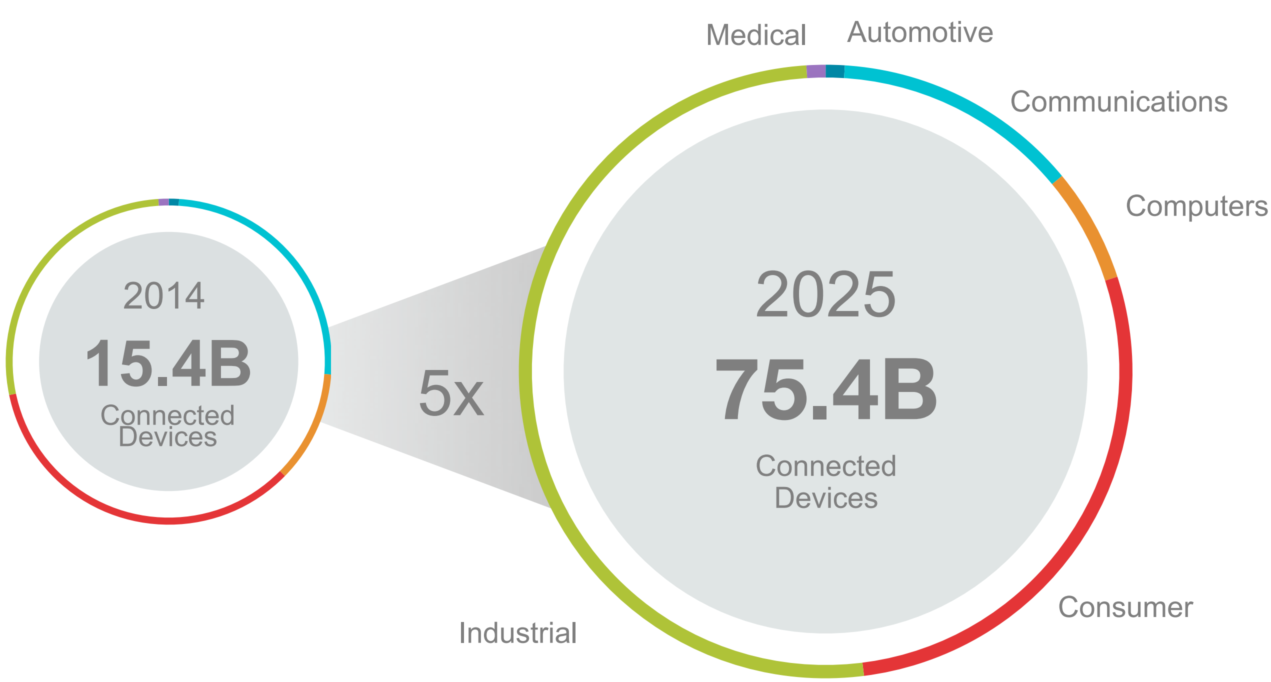
Connectivity and the IoT

The term **Internet of Things (IoT)** has gained enormous popularity with the explosion of wireless sensor networks, smart meters, home automation devices and wearable electronics. This explosion growth is projected to hit 74.5 billion connected devices by 2025.

The IoT spans long-range outdoor networks such as the smart grid and municipal lighting as well as shorter-range indoor networks that enable the connected home, residential security systems and energy management. Wireless connectivity and standards-based software protocols provide critical enabling technology for the IoT. A case in point is wireless connectivity for smart metering systems. One of the most useful wireless protocols for smart metering to emerge in recent years is **Wireless M-Bus**, which is widely used for metering applications across Europe.



Source: IHS Technology, June 2015

Wireless M-Bus Overview

Wireless M-Bus or Wireless Meter-Bus is the European standard (EN 13757-4) that specifies the communication between utility meters and data loggers, concentrators or smart meter gateways.

Developed as the standard to fill the need for a system for the networking and remote reading of utility meters in Europe, Wireless M-Bus is being used as a basis for new Advanced Metering Infrastructure (AMI).

Wireless M-Bus and Sub GHz frequencies have been used for several years but continue to evolve to adapt to a changing environment and to take advantage of technology improvements including the emergence of the Internet of Things.

2.4GHz vs License Free Bands

Smart grid devices require robust, long range wireless communication. The frequencies most commonly specific are around 868MHz, 434MHz and 169MHz which are license free bands in Europe and provide better propagation for radio waves compared to 2.4GHz.

Using one of these license free bands allows wireless radio waves to reach difficult areas such as underground meters or locations in buildings that have several walls and obstructions. Another benefit of operating in license free bands is the lower solution cost for utility companies.

Standards & Organizations

There are three main bodies setting standards for use across all European countries. Of these, Wireless M-Bus follows CEN and ETSI which is the regulatory body in Europe and is similar to FCC in the US. ETSI has various standards published or in draft state for all frequencies and applications in Europe. All designs must comply with some ETSI standard to be legally used in Europe.

Specifically for Wireless M-Bus in the sub GHz frequency bands, there are three main documents to reference: ETSI EN 300-220, EN13757, EN13757-4

ETSI EN 300-220

The first is ETSI EN 300-220 which specifies allowable frequencies, bandwidths, emission limits etc. for all sub GHz wireless products. This applies to all products and not just to wireless M-Bus.

EN13757

More specific to M-Bus is the EN13757 which is made up of 6 parts and published by CEN. Each of these parts addresses a specific part of the solution from the physical layer to the application layer.

Standards & Organizations

Summary of Parts for EN13757 Standard

EN13757	Purpose
1	Basic data communication between meters and collectors
2	Physical layer requirements for wired M-Bus
3	Application layer
4	Physical and Data Link layers for wireless M-Bus
5	Relaying and routing for range enhancement
6	Local bus for short distance wired links

EN13757-4

EN13757-4 was approved in 2013 with improved (tighter) RF specifications and supersedes the previous 2005 version of the standard. The market is moving towards the 2013 specification requirements and this will be deployed in all future roll outs.

In addition to the standards documents, there are regional organizations that specify the use of wireless M-Bus. One challenging aspect is that each of these regions has unique requirements on top of the standard and may pick specific modes from the standard to suit the needs of their environment. GrDF in France, CIG in Italy and the OMS group are examples of the groups. GrDF and CIG requirements are discussed in further detail later in this e-book.

Frequencies & Modes

There are 3 frequencies used in Wireless M-Bus: 868MHz, 433MHz and 169MHz.

There are several modes specified at various frequencies as shown in the table below. Modes S, T, C and N are most commonly used with mode N gaining popularity in the 169MHz band. Modes R and F are less common while modes P and Q are not used today. These modes have unidirectional and bi-directional sub modes.

Mode	Frequency(MHz)	Notes
S (Stationary)	868	Meters send data few times a day
T (Frequent Transmit)	868	Meters send data several times a day
C (Compact)	868	Higher data rate version of mode T
N (Narrowband)	169	Long range, narrow band system
R (Frequent Receive)	868	Collector reads multiple meters on different frequency channels
F (Frequent Tx and Rx)	433	Frequent bi-directional communication

Certifications

Despite its growing popularity, Wireless M-Bus continues to remain a “standard” without an independent certification authority to certify products that are WM-Bus compliant. This remains an ‘honor system’ and various parties work together to resolve interoperability issues during lengthy field trials.

Because there are multiple options available, each region or country selects specific options from the EN13757 standard and in some cases they enhance the requirements to optimize it for their needs and environment. Thus smart meters may not be truly interoperable across all of Europe. While this may not be an issue for region specific utility companies, it does pose a challenge to meter manufacturers and silicon providers who serve various regions.

To facilitate the development of smart meters that can be used in multiple regions, consideration needs to be given to a common hardware platform that supports modular software to adapt to specific regional requirements and protest the investment of development skills and time.

Region-Specific Requirements

Each European country defines its own requirements best suited to the environment and infrastructure available. This works well for region-specific utility companies but adds additional requirements for suppliers including semiconductor designers, meter manufacturers and software developers.

To provide a common platform, the entire solution including hardware and software must be architected to be flexible and modular so it can adapt to the unique regional requirements. Security and radio performance are critical areas for metering applications, which is reflected in the additional requirements specified by these various regions. Let's consider the example of France and Italy and highlight some of the key features in these regions.

France

GrDF in France owns the specification and has made special enhancements to the meter requirements. They are similar to the EN13757-4 2013 version and use the 169MHz frequency band using the 'N' modes of operation. They require improved sensitivity and blocking by 2-3dB compared to the WM-Bus specification and have an optional high speed option using 4GFSK modulation. They also require a minimum sensitivity across temperature (-20C to +55C) and have specific AFC and ppm accuracy requirements.

France GrDF

- Uses N mode at 169MHz
- Efficient use of frequency spectrum
- High Speed 4GFSK mode defined in 12.5KHz channel
- Broadcast mode to update meters
- Advanced Security Requirements

Region-Specific Requirements

Italy

Italy has led the way in smart electric meter deployments several years ago and continues to push ahead in gas and water meter deployments. CIG owns the specification and mandates compliance with UNI TS 11291-4 which defines channel access mechanism with ALOHA, Listen Before Talk or LBT to minimize collisions, broadcast firmware download and has specific access modes for the meters. In addition, the specification is optimized to use DLMS/COSEM as the application layer. On the hardware side, they allow a high power transmission at +27dBm and also specify at least a 3dB step size from -27 to +27dBm.

Italy CIG

- Follows Italian UNI TS 11291 specification
- Based on N modes at 169MHz
- Application Layer based on DLMS/COSEM*
- ALOHA channel access method
- Listen Before Talk
- Broadcast window for firmware download

Rest of Europe

Other countries such as Germany follow the OMS application layer which is different than the French and Italian requirements. In the end, countries may have different requirements which are all based on wireless M-Bus but yet different.

Wireless M-Bus vs. Other Protocols

There are several wireless protocols for a variety of Internet of Things metering applications. Besides Wireless M-Bus, there's ZigBee, Wi-SUN and other proprietary protocols.

Wireless M-Bus has gained traction in the European market due to its relative simplicity. It's a basic star type of network on sub GHz frequencies that offers longer range with a small software stack size. As a star network which is not IP or mesh enabled, the software stack requirements can be kept to a minimum.

The low data rates ensure a spectrally efficient system with no certification requirements besides regulatory compliance.

And, as it is based on standards and proven technology, there are multiple suppliers in this very competitive market.

Wireless M-Bus is relatively simple compared to other metering protocols.

- Star network, no IP or mesh required
- Sub-GHz propagation benefits over 2.4GHz achieves longer range
- Small stack size
- Spectrally efficient
- Lower solution cost – ISM bands, no industry alliance certification, small stack
- Multiple suppliers as it uses standard technology

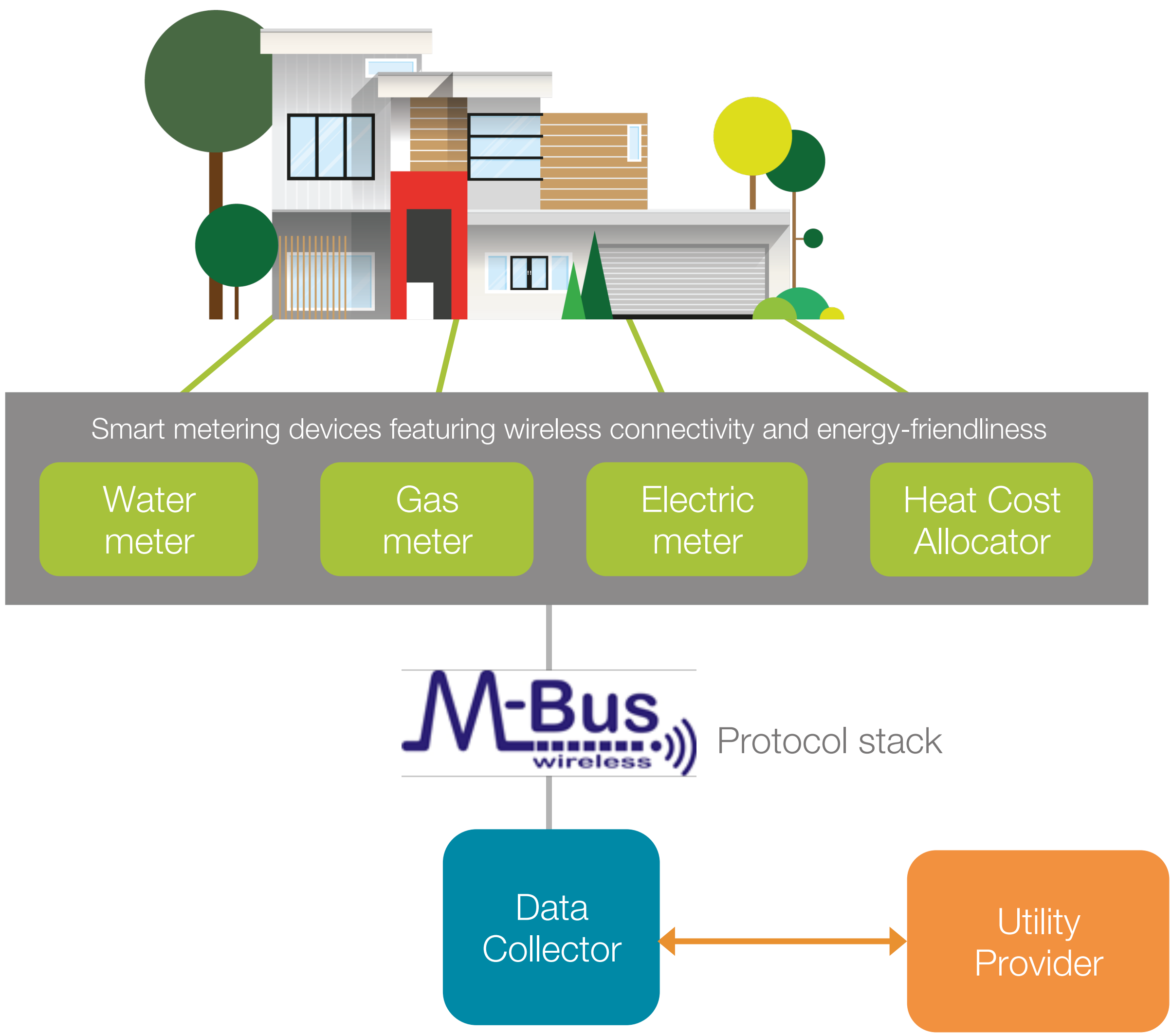
No IP or mesh required

Operates on sub-GHZ frequencies

IP-based Mesh Networking

Metering System Architecture

As smart metering grows in importance across the world's energy markets, one highly significant topic is the architecture design of AMI systems. Below is an example of a metering system architecture featuring Wireless M-Bus. As you can see the protocol stack lies between the energy-efficient, wirelessly connected smart metering devices and the utility data collector.



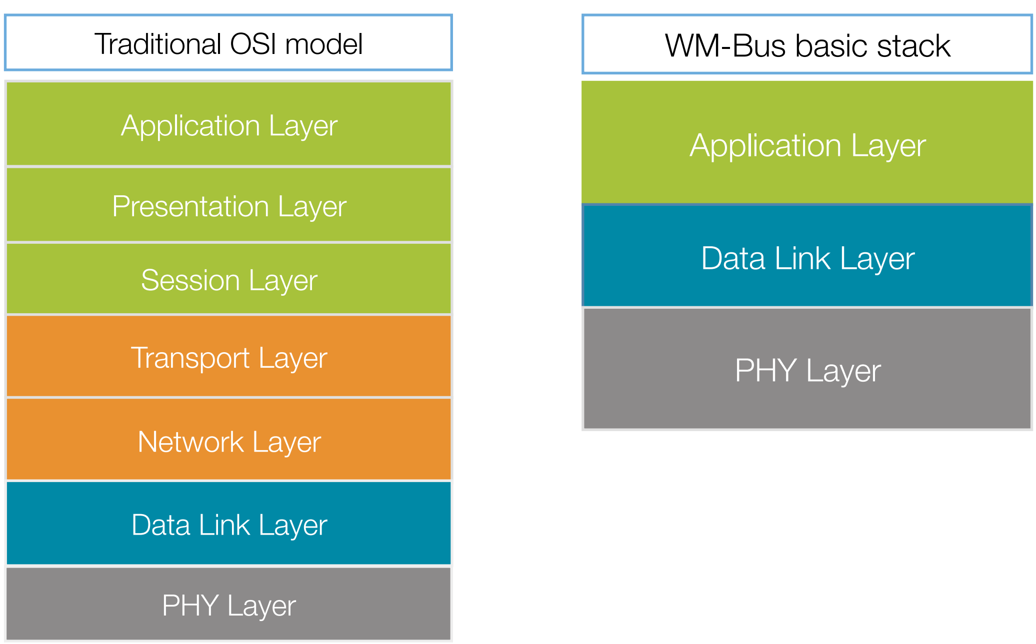
Wireless M-Bus Stack

Wireless M-Bus requires a software stack to support the various modes and options. The software stack runs on a host MCU which also controls the radio transceiver. Depending on the hardware capabilities, the stack may rely on the hardware for certain functions or implement those functions in the stack itself.

The traditional OSI model shown on the left hand side of the figure below is commonly used to depict stack architecture for various protocols where each layer has specific functions. This is commonly used to depict stack architecture for various protocols where each layer has specific functions.

Wireless M-Bus is slightly different and has fewer requirements on these layers. The three main layers are the application layer, the data link layer and the physical layer. We are gradually starting to see the use of transport layer and network layer which add advanced security in the form of authentication as well as routing for larger networks.

Depending on the specific implementation of hardware and software, the stack size will vary. Typically larger stacks will drive costs up as higher memory resources are needed in hardware.



Implementing a Solution

There are several options available for wireless M-Bus metering solutions, ranging from semiconductor components to software stacks to modules. The core components required for a high-performance wireless M-Bus solution include an energy-friendly microcontroller (MCU), a high-performance sub-GHz transceiver that can offload the host processor, and a modular stack architecture, which provides flexibility to support various wireless connectivity requirements. Comprehensive development tools must also be available to design and configure the metering system.

Four Core Components to create a Wireless M-Bus Solution

1) Low-Power MCU
2) High performance radio transceiver
3) Wireless M-Bus Software Stack
4) Development tools to evaluate and deploy the solution

The previous page highlights a high-level comparison of the wireless M-Bus stack and the traditional OSI model, highlighting the fewer layers required by the stack.

The stack size can be implemented with less than 32 KB flash depending on the mode and device type, which translates to a lower cost MCU solution based on reduced flash and RAM requirements. The application layer is user-defined and may follow OMS, DSMR, DLMS/COSEM or any other custom application layer as well. The open hardware application layer (HAL) enables low-level hardware configuration for peripherals such as GPIOs or UART baud rates. This type of modular architecture allows maximum flexibility to support a wide variety of devices with a common stack version.

Select the Right MCU and Radio Transceiver

Selecting the right MCU and radio transceiver is a key design consideration when designing smart metering devices featuring wireless connectivity and energy-efficiency. As an example, Silicon Labs provides a platform solution for Wireless M-Bus including a software stack developed by Stackforce GmBH optimized to run on Silicon Labs' EFM32 ARM M0+, M3 and M4 cores and EZRadioPRO transceivers. A highly integrated small form factor single chip platform, EZR32, combines the stack, MCU and radio, and is ideal for space constrained designs wireless designs.

EZR32™ Wireless MCUs

Integrated single chip small factor

IEEE 802.15.4g transceiver with 142 MHz – 1050 MHz frequency range

High performance ARM® Cortex®-M3 and M4 MCUs

Low-power MCUs and transceivers
Unified software development

EZRadioPRO® (Si446x)

Sub-GHz radio transmitters, receivers and transceivers

Worldwide frequency coverage

Excellent blocking and selectivity

EFM32™ 32-bit MCUs

ARM® Cortex® M0+, M3 and M4 cores

Energy-friendly peripherals and energy modes

Over 240 memory, peripheral and package variants

SILICON LABS

Silicon Labs Wireless M-Bus Solution

Silicon Labs provides the most complete wireless M-Bus solution with a free of charge software stack developed by our stack partner, Stackforce. The software stack and PC tools are available for download on the Silicon Labs website.

The stack is a truly portable solution across a wide variety of Silicon Labs MCUs and RF transceivers. With an efficient modular architecture, the stack is highly optimized to fit in as small as 32KB depending on the mode of operation.

Key Solution Features

1) Free stack download
2) Portable Solution
3) Small memory footprint
4) Industry leading RF

EN13757-4 specification in 2013 specifies wider frequency error tolerance and deviation error tolerance as high as +/-30% while requiring good sensitivity. This allows for a more error tolerant system but also requires a much better performance radio to be able to meet sensitivity requirements at the same time.

The specification also requires ultra fast preamble detection as the preamble length in some modes is just 2 bytes or 16 bits. Traditional sub GHz systems use several bytes of preamble to acquire the signal, so again, the radio performance needs to be significantly better than legacy devices. The N2g mode requires support for 4 GFSK modulation to support a higher data rate at extremely narrow bandwidths.

Based on years of industry experience in metering and RF, the Silicon Labs EZR32 and EZRadioPRO platforms meet or exceed the challenging wireless M-Bus RF requirements.

Benefits of Silicon Labs Wireless M-Bus solution

Solution Feature	Benefit
WM-Bus software stack	Proven WM-Bus stack from Silicon Labs partner, Stackforce
Desktop development tools	Simple, powerful development tools for WM-Bus mode configuration and embedded MCU software development
EZR32 Wireless MCU integrated solution	All-in-one wireless MCU for excellent RF performance and cost-optimized solution
EZRadioPRO + EFM32 MCU 2-chip solution	Easy expansion to support additional MCU memory, functionality and I/O
Integrated packet processing in radio	Offloads MCU processing requirements
142 MHz - 1050 MHz frequency support	Covers all WM-Bus defined frequencies in one device
+20 dBm integrated power amplifier	Highly efficient, low cost options to reach +27 dBm
18 mA for +10 dBm	Long battery life (several years depending on duty cycle)
-121 dBm sensitivity at 2.4kbps 2GFSK (0.1% BER)	Long range solution

Wireless M-Bus Resources

First Complete Wireless M-Bus Solution for the European Market

Comprehensive smart metering solution includes the Wireless M-Bus software stack and wireless starter kits.

www.silabs.com/wmbus

Wireless M-Bus for the European Smart Grid

Watch this on-demand presentation covering Wireless M-Bus and the Silicon Labs solution

Watch Webinar

Meter-Bus

The Meter Bus website features an overview of the standard plus technical documentation for the layer specifications.

www.m-bus.com

About the Author

Vivek Mohan is a Senior Product Manager for wireless connectivity products including sub-GHz radios in Silicon Labs' Embedded Systems group. He joined Silicon Labs in 2010 and previously served as an Applications Engineering Manager for short-range wireless products focused on Silicon Labs' EZRadio and EZRadioPRO transceiver product families. Prior to Silicon Labs, he held applications engineering and design verification roles for wireless SoC products at Marvell Semiconductor. Mr. Mohan holds a Master of Science in electrical engineering from the University of Southern California.