WIRELESS M-BUS IN SMART GRID SCENARIO

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ABSTRACT

Energy demands increase day by day. Three main activities address this growing request: optimization of the energy mix, efficiency increases, and the Smart Grid. The Smart Grid improves energy management by increasing communication between utilities and their final users. This article describes the Wireless M-Bus standard and how STMicroelectronics implements it based on its own devices.

INTRODUCTION

The key player in the Smart Grid scenario is a smart meter – an energy, gas and water meter with Automatic Meter Reading (AMR) capability. It introduces the concepts of bi-directional communication with the local meter and the utility company. Using this technology, the energy customer is able to send in their consumer bill, on the other side the energy provider is able to schedule maintenance remotely.

One of the benefits of a smart metering system with communication capabilities is the ability to use real time metering data to analyze energy consumption patterns and peak energy demands of each individual consumer. This information can be used by the utility as well as the consumer. The utilities can offer dynamically varying peak and off peak tariffs. The consumers can schedule to run heavier loads at off peak periods and benefit from reduced tariffs. The utilities benefit from not having to operate power plants that produce power only during peak hours, thereby improving efficiency of the system. In addition, automatic data collection reduces the utility operator's efforts in local reading as well as reducing human errors.

Different kinds of network topology and connectivity are possible between smart meters and energy providers. The smart meters can exchange data, using Radio Frequency (RF) or Power Line Communication (PLC), with a local data concentrator, which can communicate in real time with the utility over GPRS. Various international standards are available for the implementation of AMR.

WIRELESS METER BUS (WM-BUS):

The M-Bus (Meter Bus) is a common standard used for AMR implementation, for remote energy meter reading. It's based on European standard (EN 13757-2 physical and link layer, EN 13757-3 application layer).

A radio variant of the M-Bus, the Wireless M-Bus (WM-Bus), is also specified in EN 13757-4. The Wireless M-Bus is an open standard for Automatic Meter Reading at RF sub 1 GHz. The relevant standards documents are the following:

- prEN13757-4:2011 Wireless meter readout
- EN13757-3:2004 (in common with M-Bus)
- ETSI EN 300 220 v2.3.1

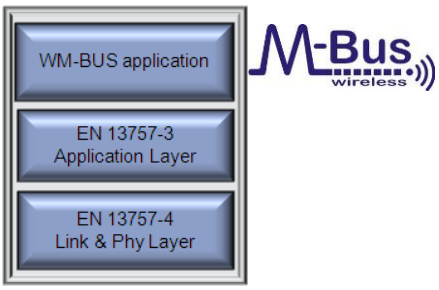

Fig1: Basic Wireless M-Bus Architecture

The standard defines the communication between remote meters and mobile readout devices, stationary receivers, and data collectors. The typical application scenario is shown below:

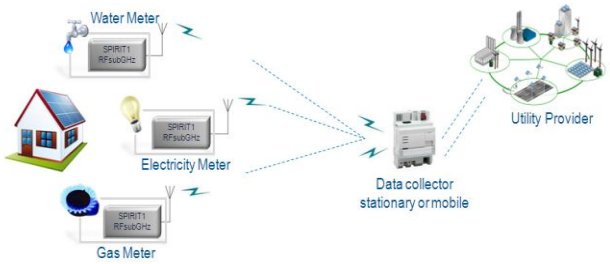

Fig 2: Application Scenario

Some of the salient features of the WM-Bus standard are

1. Support unidirectional and bi-directional communication.
2. Support different modes of communication (S, C, T, R, F, N).
3. Support AES-128 CTR encryption for data security
4. Operation in both the license-free ISM and SRD frequency bands at 169, 433, and 868 MHz
5. Longer battery life for battery operated systems
6. Provision for indicating faults and alarms.

More details can be found in the EN 13757-4 standard document.

For the physical layer, the EN 13757-4 standard also specifies various performance classes depending upon the maximum power to be transmitted and the lowest receiver sensitivity that the meter provides.

The data link layer of the EN 13757-4 standard supports two different frame formats: format A and B. In a standard WM-Bus frame received, the data link layer will immediately follow the preamble chip sequence. The data link layer carries link layer data plus optional application layer payload information.

STMicroelectronics has developed its own WM-Bus firmware stack implementation, based on dual chip platform: SPIRIT1 RF transceiver and STM32Lx microcontroller.

SPIRIT1: The SPIRIT1 is a very low-power and high performance RF transceiver, addressing applications in the sub-1 GHz band. It is designed to operate at 169, 315, 433, 868, and 915 MHz. It supports the following modulations: 2-FSK, GFSK, MSK, OOK, and ASK. The air data rate is programmable from 1 to 500 kbps, dependent on the selected modulation. It has an integrated SMPS that allows very low power consumption: 9 mA in Rx and 21 mA in Tx mode at +11 dBm. It uses a very small number of discrete external components and integrates a configurable baseband modem. It handles the data in the proprietary fully programmable packet format and also allows the M-Bus standard compliance format (all performance classes). It supports the low level of WM-Bus PHY protocol in hardware.

Fig 3: SPIRIT1

ST Ultra Low Power MCU: EnergyLite™ Family

In the WM-Bus scenario, meters are usually battery powered and require high energy efficiency devices for long battery life; the EnergyLite™ family, 8-bit (STM8L) and 32-bit (STM32L) MCUs, provides high performance combined with ultra-low power.

The STM8L and STM32L offer specific features for ultra low power applications, such as advanced ultra low power modes, optimized dynamic run consumption, and specific safety features.

The STM32 L1 series, based on the ARM® Cortex™-M3, offers a wide portfolio of features, memory sizes and package pin counts. The large number of embedded peripherals, such as the USB, LCD interface, OpAmp, comparator, ADC, DAC, and AES, give the STM32 L1 series an expandable platform to fit all requirements. This gives, designs more performance for a very low power budget.

ST Wireless M-Bus Stack implementation

ST's Wireless M-Bus stack supports the following modes:

Table 2: Wireless M-Bus Modes and Description

Mode	Communication	Frequency Band	Description
S1	Unidirectional	868 MHz	Stationary mode: metering devices send data several times a day.
S1-m	Unidirectional	868 MHz	Same as S1, but the data collector is mobile receiver
S2	Bidirectional	868 MHz	Bidirectional version of S1.
T1	Unidirectional	868 MHz	In the Frequent Transmit mode, the meter devices send the data to collectors after configurable duration.
T2	Bidirectional	868 MHz	Bidirectional version of T1.
R2	Bidirectional	868 MHz	The Frequent Receive mode permits multiple metering devices not to interfere using different frequency channels.
N1	Unidirectional	169 MHz	This mode is optimized for narrowband and long range
N2	Bidirectional	169 MHz	Bidirectional version of N1. It doesn't support N2g.

The SPIRIT1 implements part of the WM-Bus physical layer, whereas the PHY and LINK firmware stack layers are implemented by the STM32L15x.

STM32L role:

- WM-Bus Application Layer
- WM-Bus Link Layer: MAC packet and CRC handling, Encryption/Decryption initiate/read.
- WM-Bus PHY: Init PHY for WM-Bus, Interrupt Services

SPIRIT1 role:

- WM-Bus packet handlers
- Header, Sync and trailer fields, Sync detection
- Data modulation and demodulation, Manchester/3-out-of-6-encoding
- RF TX and RX functions, separate FIFOs

Below is the interface block diagram:

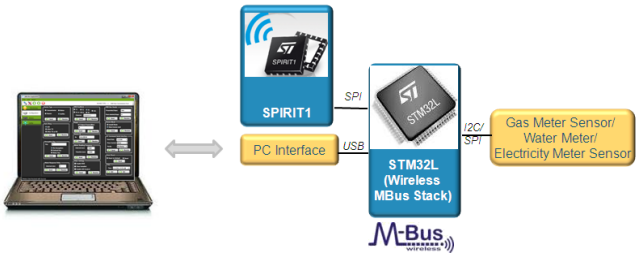

Figure 4: Application Diagram

The stack supports both meter and concentrator device types.

WM-Bus PC GUI software is also available. Using this PC-GUI makes it possible to monitor the status and related energy consumption of each meter in the WM-Bus network, The PC Software communicates with the concentrator board or meter board using the USB Protocol. The data is displayed on the PC Software as shown below.

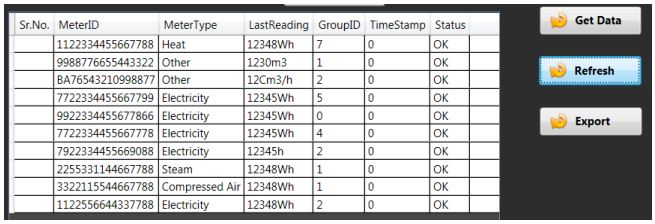

Figure 6: Data Display on the GUI