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An Embedded Application in Wireless Meter Reading and Billing System Using SML

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Abstract: *Smart Message Language (SML) which is the definition of the German national standard for Automatic Meter Reading System, the SML system is mainly used in various metering devices like meter reading and billing systems. "SML is a wireless communication system which is based upon the Wi-Fi technology". In this, the Wireless Meter Reading system acts as a monitoring terminal of the hardware platform made up of Marvell 88W8686, the ARM7 processor and peripheral circuits, using micro C/OS-II operating system and LwIP protocol, . VC++ and MDB database is used to develop management software. SML protocol is adopted to design the format of the data frame to create a unified data structure for data procurement. The Wi-Fi communication module collects the information of the meter reading data from hardware which is then sent to the Access Point after being processed. Access Point transmits the data to the control center where the data is processed and stored into the database via wired network. Users can know the data or billing information by using the PC management software and the Users can pay the bills by using their Credit card. Thus SML system proves that this type of data structure improves the transmission efficiency and the performance of the system and is suitable for implementation in low-power embedded systems.*

Keywords: *Smart Message Language; Wireless Meter Reading; Data Structure*

I. Introduction

Wireless Meter Reading is a process that the meter data is read and processed automatically via special equipment using wireless communication and computer network technology. Compared with the traditional meter reading, it effectively saves human resources and can get real-time consumption of every user, helping the management department find problems in time and take appropriate measures to deal with[1][2]. However, the main problem of wireless meter reading is that products of manufactures are lack of interoperability, so it is necessary to define a unified communication protocol for wireless system, e.g. the data structure and equipment parameters, etc. must be specified. Smart Message Language [3][4] is created against .the background of drawing up a specification that lays down a communication protocol for applications in the environment of data procurement and equipment parameterization. The goal involved in drawing up the specification was the primary wish to find a maximally simple structure also suitable for implementation in low-power embedded systems that can be used for data procurement over wide-area. Therefore the efficiency of network transmission is improved [3]. The outline of the paper is as follows. The Wireless Meter Reading system is given in section 2. In section 3, described SML System. The design of the data frame based on SML is described in details in section 4. Conclusions are summarized in section 5.

II. The Wireless Meter Reading System

The Wireless Meter Reading System which is based on WI-FI is made up of Intelligent Data Procurement Terminal, Wireless Repeater, Access Point and Control centres. Figure1 illustrates the overall structure of the system

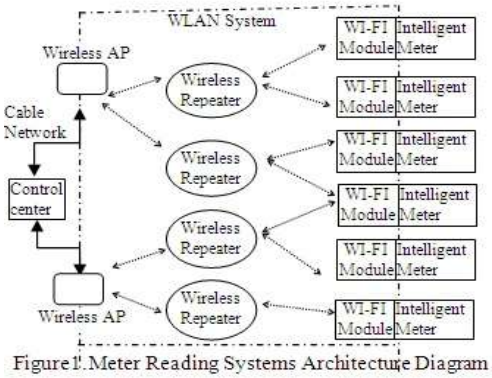

Figure1. Meter Reading Systems Architecture Diagram

The system can be divided into three main parts: Intelligent meter, WI-FI WLAN and Control Center. The WI-FI communication module collects the information of the meter which is then sent to the Access Point after being processed. Access Point transmits the data to the control center where the data is processed and stored into the database via wired network. Users can know the data information by using the PC management software. Control Center sends commands such as data procurement, data storage, and so on to control the whole system [7].

The function of each part of the system is as follows: AT91SAM7X256 is the control center of communication module whose main function is connecting the intelligent meter and the WI-FI Wireless LAN, transmitting the meter data and state information to the Wireless LAN and receiving commands via WLAN. To guarantee the communication quality and rate, the communication rate is set to 100kpbs and the size of data is limited to 512byte/point. Considering the privacy and security, WPA and Address Code Check is used.

A. The Hardware Platform

The Hardware Platform mainly includes Wireless Access Point, Wireless Repeater and Wireless Communication Module. Wireless Access Point transmits the command sent by the Control Center to the Wireless Communication Module which then sends the meter data back to the Wireless Access Point. Taking into account the real-time and low power consumption of the meter reading system, the data of users are collected every 15 minutes. The Wi-Fi Communication Module is made up of Wi-Fi transceiver using WM-G-MR-09 module constituted of SoC 88W8686 low power consumption chips of Marvell Company and ARM [8]. Figure2 is the Hardware Design Diagram of Access Point.

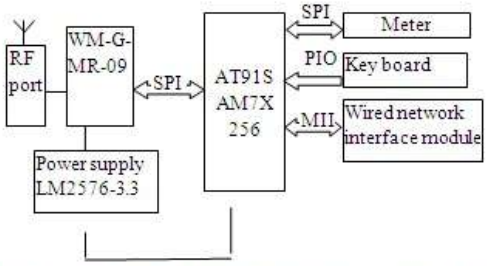

Figure2.Hardware Design Diagram of Access Point

The system specifications are described in Table I:

TABLE I THE SYSTEM SPECIFICATIONS

TYPE	SPECIFICATION	PARAMETER
Smart Grid LAN	Communication standard	802.11
	Communication Rate	100kbps
	Communication Distance	>=2KM
	Communication Data	512Byte/Point
	Communication Cycle	15Minutes/Point
	System Points	1000 Points in Theory
	System Addressing	IP Addressing, IP Address allocation
Wireless Network of Wired Control System	Communication standard	802.11
	Communication Rate	<=54Mbps
	Communication Distance	>=100m
	Communication Data	512Byte/point
	Communication Cycle	10ms/point
	System Points	32 Points

The communication module meets the 2.4GHz WI-FI standards, with a small package size, low power, Multi - interface and OS support, provided SDIO and G-SPI host interface and WPA encryption mode, supporting DSSS, OFDM, DBPSK, DQPSK, CCK and QAM technology. The Control Chip adopts the AT91SAM7X256 chip of Atmel having 256KB Flash, 64KB SRAM, a 10/100 Base-T Ethernet interface, two SPI peripheral interface.

B. The PC Management Software

The PC Management Software constitutes of three parts: Control Interface, Network Communication and Database Operation. Control Interface can call the Network Communication module and Database Module.

1) Control Interface

The Control Interface is mainly made up of two parts: Start Interface and System Interface. In the Start Interface, users enter their accounts and passwords to login into the System Interface. Users include administrator and ordinary users, given different access competence. The System Interface is constituted of three parts: Information Management, data transmission and additional function. Figure3 illustrates the Function System of the System Interface.

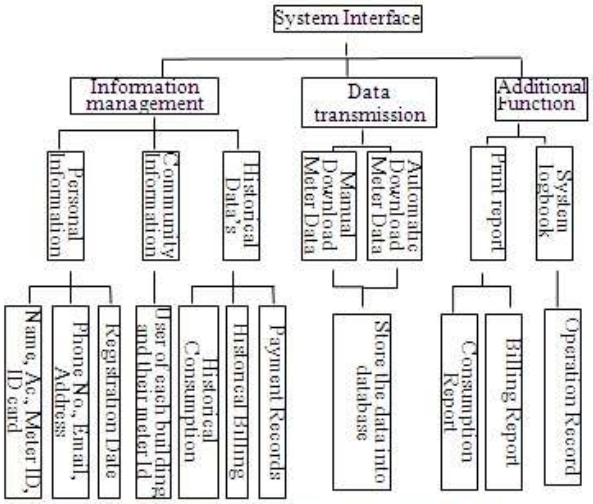

Figure3. Function System of the System Interface

2) Communication Module

In this paper,, the commands and data are transmitted via TCP/IP protocol which is Connection-oriented, reliable and can check the retransmission of data's. All these characters of TCP/IP are suitable for the high reliability of data transmission of Wireless Meter Reading System. The operating system of hardware is based on Linux while the PC Management Software is based on Windows, so the communications between hardware and software have to be realized via Network Programming Interface accessing network protocols. The application program of PC Management Software is developed by Winsock of Windows which means that the communication between the hardware and software can be realized by operating socket [9].

3) Database Module

Access is used to develop database module for data storage and management with ODBC database access technology [10].

III. Sml System

A. SML System Concept

Smart Message Language was drawing up by the companies EnBW AG, E.ON Energies AG and RWE AG who have accordingly joined forces in order to develop a new meter system for measuring electricity within the framework of a project. The paramount aim of this project is the fundamental development of a modularized metering system for measuring electricity for commercial and industrial customers. The advantage is obvious that the technical specifications for the devices and protocols are available without a license and the new concept can also be used for metering gas, water or heat quantities [3]. The system concept of SML is illustrated in Figure4 [4]. The SML protocol for remote meter reading possesses an optimized structure for use in both assical communication routes (PSTN, GSM, etc.) and in package-oriented network operation [5][6].

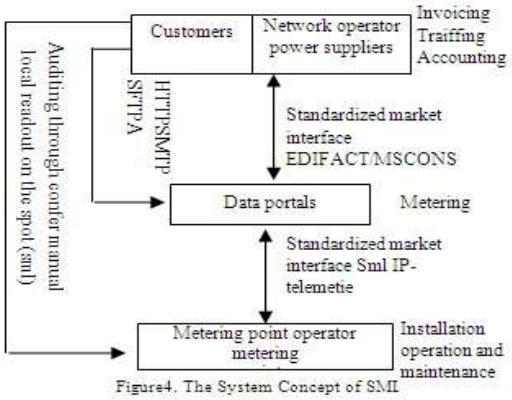

Figure4. The System Concept of SML

B. SML Message Structure

The basic structure of SML system is divided into four main elements:

(1) Smart Message Language defines a file structure/ document structure for recording the useful loads between the end points.
(2) SML Binary Encoding defines a packed binary coding for SML.
(3) SML XML Encoding defines the coding of SML in XML
4) SML Transport Protocol, required for serial point-to-point links.

In this paper, the SML file structure is used in the design of data structure. SML file denotes an information unit that, completely detached from the transport technology involved (internet, telephone,), is self-contained. An SML file is always structured as a chain of SML messages..SML messages are transmitted based on SML communication model which is illustrated in Figure5. In this communication model, SML messages can be transferred through a variety of transmission technology, having nothing to do with the content. In addition, SML messages can, like an email, be transported over stateless, secure communication paths.

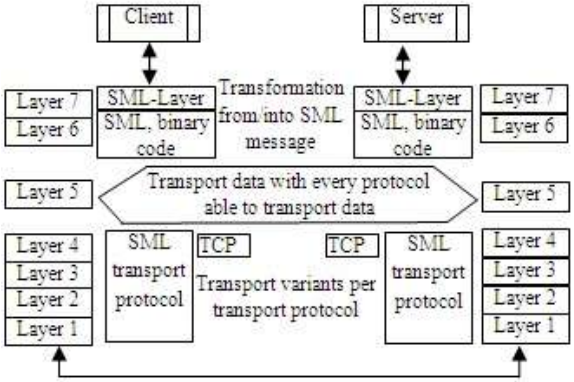

Figure5. SML Communication Model

An SML messages is either a 'Request message' or a 'Response message' and the 'Response message' respond to the command of 'Request message' .The structure is as follows[4]:

```
SML Message   {
               Transaction Id
              Group No
              Abort On Error
              Message body
              crc16
              End Of Sml Msg
               }
```

1) Transaction-Id

The 'transaction-Id' is formed by the client in an unambiguous form at generation of request messages'. Each 'response message' reflects back the transaction number belonging to its 'request', so that a 'response' can always be assigned to the associated 'request'.

2) Group-No

The 'group-No' attribute permits the formation of SML message groups. This mechanism shall be used for stating which SML messages must be processed in particular sequence, and which may be executed on the side. As a general principle, the groups are processed sequentially, in the same order as they occur within an SML file, mixing SML messages from different groups is not permissible. Table II gives an example for using the "Group Number" feature.

3) The Checksum

The checksum (element 'crc16') must be calculated as CRC16. Calculation begins with the first byte of 'SML Message' and ends with the last byte of 'message Body'

TABLE II EXAMPLE FOR USING GROUP NUMBER FEATURE

T Id	G No	Message body	comment
0	1	OPEN	Is executed first
1	3	GET_ProfilPack	First group is executed as second block. For example, read out three load files
2	3	GET_ProfilPack	
3	3	GET_ProfilPack	
4	3	GET_ProfilPack	
5	6	GET_ProfilList	Second group, is executed as third action, For example, read out a load file, the billing list and the logbook
6	6	GET_ProfilList	
7	8	SET_ProcParameter	Is executed as fourth action. For example, correct the reference time
8	8	CLOSE.Req	Is processed last

IV. THE DESIGN OF DATA FRAME Upon SML

According to the SML message structure, the data frame in this wireless meter reading system is designed as follows:

TABLE III THE DATA FRAME

Head of the frame	Command	Transaction Id	Group No	Message body	Crc16	Error process	End

(1) Head of the Frame:0x68:Contain the type and length of the data

(2) TABLE IV illustrates the information of transaction Id, Group No and Message body:

TABLE IV INFORMATION OF TRANSANTIONID, GROUP NO AND MESSAGE BODY

transaction Id	Group No	Message body
0	1	sml_open
1	2	sml_getprofilepack: peak,flat and valley electric energy
2	2	sml_getprofilepack: Three type of rates
3	2	sml_getprofilepack: The ID of the meter
4	2	sml_getprofilepack: Active power
5	2	sml_getprofilepack: voltage
6	2	sml_getprofilepack: current
7	2	sml_getprofilepack: forward active electric energy
8	2	sml_getprofilepack: backward active electric energy
9	3	sml_close

(3) Command:
0x10: sml_open.req : Every 'Request Message' startswith sml_open.req
0x11: sml_open.res: Every 'Response Message' starts with sml_open.res
0x20: sml_GetProfilePack.req : Request for data transmission
.0x21: sml_GetProfilePack.res : Response to data transmission 0x30: sml_close.req: Every 'Request Message' ends with sml_open.req
0x31: sml_close.res: Every 'Response Message' ends with sml_open.res.
(4) Check: Crc16
(5) Error Process:
0x00: Continue execution
0x01: Continue execution as from next group
0x02: Continue execution of the ongoing group, then
do not execute any more
0xFF: abort execution immediately
(6) End: 0x16

V. Conculsion

This dissertation introduces a scheme for the application of Smart Message Language in a Wireless Meter Reading System, giving the introduction of Smart Message Language and the composition of the Wireless Meter Reading Systems is utilized to design the format of data frame transmitted between the hardware and software, aiming to make data communication maximally simple and suitable for implementation in low-power embedded systems. The System achieve the function of meter reading ,data display and storage. The performance in the test certificates that the data frame can improve the transmission efficiency and the performance of the whole system, helping the meter reading become more accurate and efficient.

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