Efficient Mobile Communication Solutions for Remote Data Acquisition, Supervisory and Control Systems

MARIANA JURIAN, IOAN LITA, DANIEL ALEXANDRU VISAN
Electronics, Communications and Computers Department
University of Pitesti
Str. Targul din Vale, Nr.1, Pitesti
ROMANIA
m_jurian@yahoo.com, lita@upit.ro, visan@upit.ro, http://www.upit.ro

Abstract: - Wireless technologies (mobile communications or other radiofrequency transmission methods) represent reliable and efficient solutions for remote data acquisition, supervisory and control systems. The correct selection of the proper transmission method from the wide variety of radio transmission methods and standards represents an important issue. For this reason in the firs part of this paper are presented briefly, the newest and most efficient wireless technologies suitable for remote data acquisition, supervisory and control systems. After that, the paper is focus on the GPRS method as solution for implementing such distributed systems. Are presented in detail the GM862 GSM/GPRS modules and the development boards used for tests. In the last part of the paper are listed few basic AT command that shows the operation of presented modules.

Key-Words: - mobile communications, wireless sensor network, Bluetooth, General Packet Radio Service, transmission distance, power consumption**.**

1. Introduction

The current trend in instrumentation is to distribute measurement and control away from the computer and into the field. Distributed data acquisition, supervisory and control systems allow central monitoring of parameters measured in different, often widely separated, locations. The wide adoption of Internet and wireless networks has permitted the creation of measurement networks that could span large regions, even countries without excessive development of infrastructure.

In this context the concept of wireless sensor network (WSN) has emerged and is nowadays the subject of an tremendous development.

A wireless sensor network (WSN) is a network made of thousands of nanocomputers with onboard sensor boards. The sensor nodes, currently the size of a 35 mm or smaller, are self-contained units consisting of a battery, RF adapter, microcontroller, and sensor board. The nodes self-organize their networks, rather than having a pre-programmed network topology.

Because of the limitations due to battery life, nodes are built under constraint of power conservation, and generally spend large amounts of time in a low-power "sleep" mode or processing the sensor data.

A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm (several nodes may forward data packets to the base station).

Unique characteristics of a WSN for remote data acquisition, supervisory and control systems include:

- Limited power they can harvest or store
- Ability to withstand harsh environmental conditions
- Ability to cope with node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity of nodes
- Large scale of deployment
- Unattended operation

A mobile wireless sensor network owes its name to the presence of mobile sink or sensor nodes within the network. The advantages of mobile WSN over static WSN are better energy efficiency, improved coverage, enhanced target tracking and superior channel capacity [5].

2. Radio Solutions for Remote Data Acquisition, Supervisory and Control Systems

Bluetooth is a wireless protocol utilizing short-range communications technology facilitating data transmissions over short distances from fixed and/or mobile devices, creating wireless personal area networks (PANs). In the table presented below is summarized the maximum transmission distances and the power levels for different class of implementation:

Table 1

Class	Maximum Power mW (dBm)	Range
Class 1	100 mW (20 dBm)	~100 meters
Class 2	2.5 mW (4 dBm)	~10 meters
Class 3	1 mW (0 dBm)	~1 meter

The key features of Bluetooth technology are robustness, low power, and low cost. The Bluetooth specification defines a uniform structure for a wide range of devices to connect and communicate with each other. Also, Bluetooth technology has achieved global acceptance such that any Bluetooth enabled device, almost everywhere in the world, can connect to other Bluetooth enabled devices in proximity. Bluetooth enabled electronic devices connect and communicate wirelessly through short-range, ad hoc networks known as piconets. Each device can simultaneously communicate with up to seven other devices within a single piconet. Each device can also belong to several piconets simultaneously. Piconets are established dynamically and automatically as Bluetooth enabled devices enter and leave radio proximity.

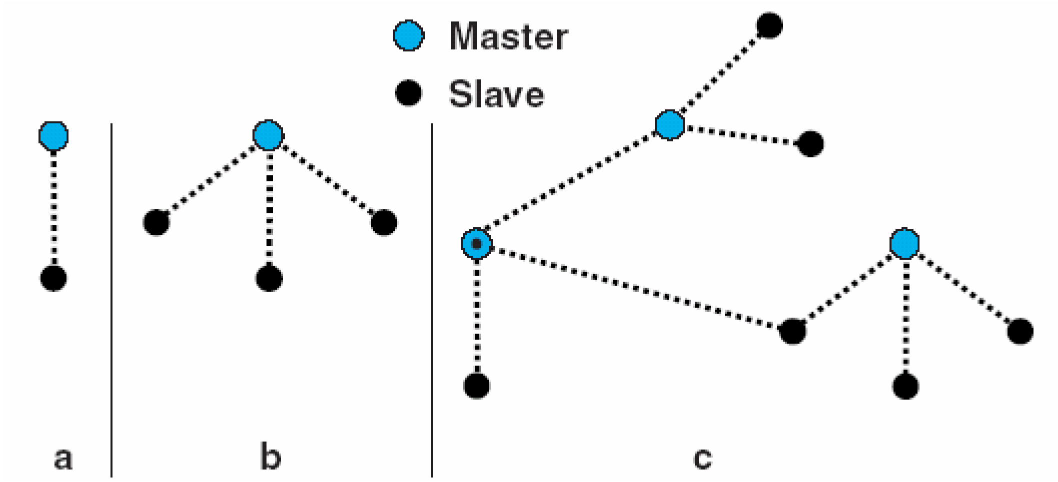

Fig.1 Piconets with a single slave operation (a), a multi-slave operation (b) and a scatternet operation (c).

A fundamental Bluetooth wireless technology feature is the ability to simultaneously handle both data and voice transmissions. This enables a variety of innovative communication solutions including wireless data acquisition.
Bluetooth technology operates in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485 GHz, using a spread spectrum, frequency hopping, full-duplex signal at a nominal rate of 1600 hops/sec. The 2.4 GHz ISM band is available and unlicensed in most countries.
Bluetooth technology's adaptive frequency hopping (AFH) capability reduces interference between wireless technologies sharing the 2.4 GHz spectrum. AFH works within the spectrum to take advantage of the available frequency. This is done by detecting other devices in the spectrum and avoiding the frequencies they are using. This adaptive hopping allows for more efficient transmission within the spectrum, providing users with greater performance even if using other technologies along with Bluetooth technology. The signal hops among 79 frequencies at 1 MHz intervals to give a high degree of interference immunity.
In Bluetooth can be identified several important protocols:

– Lower layer protocols: Baseband, LMP, L2CAP, service discovery
– protocol (SDP)
– Interfacing protocols: RFCOMM
– Applicative control specifications: TCS Binary, AT Commands
– Applicative protocols: PPP, TCP/IP, OBEX, WAP, vCard, VCal, WAE

One major interesting feature of Bluetooth is that it is not dependent on the IP. Auto configuration is hence much easier.
The logical channel is mapped onto a physical one.
It is represented by the pseudo-random sequence hopping chosen among the 79 or 23 channels RF available in the 2.4 GHz band. The Bluetooth devices which use the same sequence form a piconet. The hopping sequence is unique for each piconet except if it is adapted for a channel. The

clock of the master is to be used of course. The channel is divided into intervals of time or slots. Each interval of time corresponds to an RF frequency among the hopping sequence so that two consecutive slots correspond to two frequencies. Normally the master uses a frequency downstream to the slave and the slave uses the following slot for the upstream communication. The multiplexing technique uses time division time division duplex (TDD), (the master and slaves transmit alternatively) (a master transmits in the even slots and the slaves in the odd slots). The intervals of time or slots are numbered and last 625 µs each one. A transmission can be done only between the master and a slave or a slave and his master. The direct slave–slave communications cannot take place except for discovery. The classification of the slots corresponds to the value of the Bluetooth clock of the master. This 27 bits wide clock helps to number the slots from 0 to $2^{27}-1$ in a cyclic way.

The data transmitted out by the Bluetooth units are using packets. A packet corresponds to the juxtaposition of 1–5 consecutive time slots. When a packet has a size of 1 slot, one speaks about single-slot transmission/reception, and when a packet has a size higher than 1 time slot (3 or 5 slots), one speaks about multi-slot transmission. The frequency hopping rules applied to the packets mandate that the beginning of packet will be aligned on the beginning of the slot.

The frequency hopping remains fixed all the duration of the packet transmission.

Wi-Fi is similar to a traditional Ethernet model, and requires configuration to set up shared resources, transmit files, and to set up links (for example, headsets and hands-free devices). It uses the same radio frequencies as Bluetooth, but with higher power resulting in a stronger connection. Also, Wi-Fi requires more expensive hardware in comparison with Bluetooth [1], [4].

Wi-Fi networks evolve as well as how the 802.11 standard (with his new versions b/g) is evolving to supply higher data rates and better quality of service. Wi-Fi requires more setup, but is better suited for operating full-scale networks because it enables a faster connection, better range from the base station, and better security than Bluetooth.

Wi-Fi also allows connectivity in peer-to-peer (wireless ad-hoc network) mode, which enables devices to connect directly with each other.

The list of standards and those derived from Wi-Fi are quoted below:

– IEEE 802.11: the original version with speeds of 1 and 2 Mbps, in the 2.4 GHz industrial scientific and medical (ISM) band, and infrared (IR) standard (1999).
– IEEE 802.11b: enhancements to IEEE 802.11 to support 5.5 and 11 Mbps (1999).
– IEEE 802.11a: represents a standard that operates in the 5 GHz band and allows throughputs from 6 to 54 Mbps.
– IEEE 802.11g: allows reaching higher data rates (54 Mbps, identical to IEEE 802.11a) in the 2.4 GHz band. The orthogonal frequency-division multiplexing (OFDM) modulation is used. It provides backwards compatibility with 802.11b (2003).
– IEEE 802.11e: enhancements (2005), standard for the quality of service (QoS), which defines the specifications of the QoS mechanisms to support multimedia applications. Apply to IEEE 802.11b/a/g.
– IEEE 802.11n: higher throughput improvements; it rates (108–600 Mbps) in the 2.4 and 5 GHz bands.

In the Wi-Fi systems are defines three types of operation modes: an infrastructure mode, an ad hoc mode and a mesh mode.

Within the infrastructure mode, the wireless network consists of at least an AP (access point) connected to the fixed network infrastructure and a set of wireless client stations. This configuration is based on a cellular architecture where the system is subdivided into cells. Each cell (called Basic Service Set – BSS), in the IEEE 802.11 is controlled by a base station (called AP). The stations within a BSS execute the same MAC protocol and compete for access to the same shared wireless medium.

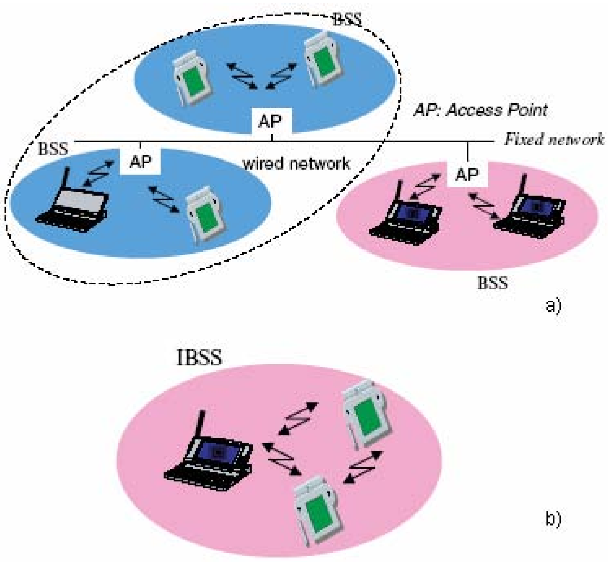

Fig.2 Wi-Fi operation modes: a) Infrastructure mode; b) ad-hoc mode.

Access points used in home or small business networks are generally small, dedicated hardware devices featuring a built-in network adapter, antenna, and radio transmitter.
As was reminded in the above paragraph, the ad hoc mode simply represents a group of wireless equipments that communicate directly between them without having a connection with an access points.
Mesh configurations, the third type of operation for the WiFi devices implies a hybrid configuration combining infrastructure and ad hoc modes.
Different physical layers (radio interfaces) are defined in the basic standard for Wi-Fi devices (IEEE 802.11 reference architecture):

– radio physical layer using the FHSS (frequency hopping spread spectrum) technique
– radio physical layer using a DSSS (Direct sequence spread spectrum) technique operating in the 2.4 GHz ISM band.
– physical layer for the IR transmission, that operates in baseband at wavelength between 850 and 950 nm.
– high rate DSSS physical layer (HR/DSSS) based on complementary codes keying (CCK) modulation in the case of the IEEE 802.11b
– orthogonal frequency multiplexing division case of IEEE 802.11a and 802.11g systems
– MIMO (multiple input - multiple output) techniques in IEEE 802.11n.

The following table shows approximate Wi-Fi transmission distances, measured in feet. These distances are only estimates since antenna, radio's sensitivity, obstructions and other factors must also be considered. The table also illustrates the tradeoff between frequency and free space loss. 802.11a operates at a higher frequency than 802.11b and g, and, as you see, distances are greater in the lower frequency bands

Table 2

Wi-Fi Speed (Mbps)	802.11a	802.11b	802.11g
1	-	300	300
2	-	250	250
5.5	-	195	-
6	200	-	210
9	170	-	185
11	-	160	-
12	150	-	170
18	125	-	165
24	85	-	140
36	75	-	115
48	50	-	75
54	35	-	60

The existing equipment on the market support a physical layer with the capacity to reduce their throughput if the quality of the signal becomes bad. This is good because far devices still can emit and receive data, but it is also bad because in such case the channel is monopolized more time slowing down the overall cell performance.
ZigBee was designed specifically for remote monitoring and control. It comprises a personal area network based on the IEEE 802.15.4 standard. ZigBee can support thousands of nodes in a star or mesh network. In a star network all devices communicate with the controlling node, as is used by WiFi and Bluetooth. In a mesh network, messages can be passed from node to node such that if any of the nodes fail, the message can still reach the destination. Once associated with a network, a ZigBee node can wake up and communicate with other ZigBee devices then return to sleep. This and its low power means that a device's battery can last a very long time [4], [5].
The ZigBee Alinace (an industry consortium) defines: "the software" for ZegBee, Network, Security & Application layers and Brand management while the IEEE 802.15.4 standard defines "the hardware" and Physical & Media Access Control layers.

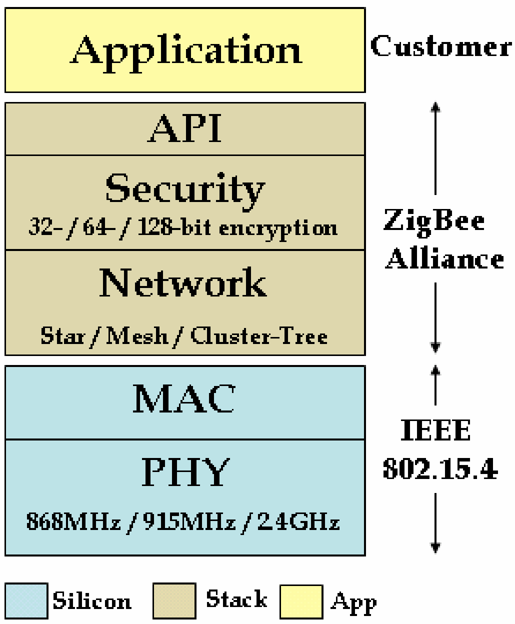

Fig.3 IEEE 802.15.4 & ZigBee layers of protocol stack.

There are two physical device types for the lowest system cost:

- full function device (FFD) that can function in any topology, is capable of being the network coordinator, can communicate to any other

device and also is capable of being a coordinator.
- reduced function device (RFD): are limited to star topology, cannot become a network coordinator, communicate only to a network coordinator and are very simple implementation.

Some of the most important characteristics of the ZigBee are:
- channel access is via Carrier Sense Multiple Access with collision avoidance and optional time slotting
- message acknowledgement and an optional beacon structure
- DSSS modulation (direct sequence spread spectrum) with 11 chips/ symbol
- 4 bits/ symbol
- multi-level security based on AES-128 algorithm
- three bands, with 27 channels specified:
    - 2.4 GHz: 16 channels, 250 kbps
    - 868.3 MHz : 1 channel, 20 kbps
    - 902-928 MHz: 10 channels, 40 kbps
- works well for long battery life, selectable latency for controllers, sensors, remote monitoring and portable electronics
- optimized for low duty-cycle applications (<0.1%)
- addressing space of up to: 2^{64} or 2^{16} devices 64-bit IEEE address & 16-bit short addresses)
- 65,535 networks, capable of connecting 255 devices per network.
- optional guaranteed time slot for applications requiring low latency
- the range of operation of ZigBee is 50m typical but can vary between 5-500m based on environment.
- typical traffic types addressed: periodic data, application defined rate (sensors), intermittent data, application/external stimulus defined rate (light switch for example), repetitive low latency data.

Each of traffic types mandates different attributes from the MAC (Media Access Control). The IEEE 802.15.4 MAC can handle each of these types. Periodic data are handled using the beaconing system whereby the sensor will wake up for the beacon, check for any messages and then go back to sleep.

Intermittent data can be handled either in a beaconless system or in a disconnected state. In a disconnected operation the device will only attach to the network when it needs to communicate saving significant energy.

Low latency applications may use the guaranteed time slot (GTS) option. GTS is a method of QoS in that it allows each device a specific duration of time each super-frame to do whatever it wishes to do without contention or latency.

An IEEE 802.15.4/ZigBee network requires at least one full function device as a network coordinator, but endpoint devices may be reduced functionality devices to reduce system cost.

All devices must have 64 bit IEEE addresses but short (16 bit) addresses can be allocated to reduce packet size. Addressing modes is: network + device identifier (star configuration) and source/destination identifier (peer-peer configuration).

The specification supports data transmission rates of up to 250 Kbps at a range of up to 30 meters. ZigBee's technology is slower than 802.11b (11 Mbps) and Bluetooth (1 Mbps) but it consumes significantly less power.

In the case of ZigBee, when a device connects or disconnect to the network, the following performances are obtained:
- network join time = 30ms typically
- sleeping slave changing to active = 15ms typically
- active slave channel access time = 15ms typically

For comparison, in the case of Bluetooth data transmission results the following performances:
- network join time = >3s
- sleeping slave changing to active = 3s typically
- active slave channel access time = 2ms typically

	Bluetooth	ZigBee
AIR INTERFACE	FHSS	DSSS
PROTOCOL STACK	250 kb	28 kb
BATTERY	rechargeable	non-rechargeable
DEVICES/NETWORK	8	255
LINK RATE	1 Mbps	250 kbps
RANGE	~10 meters (w/o pa)	~30 meters

Fig.4 ZigBee-Bluetooth comparison.

From the above analysis clearly results that ZigBee protocol is optimized for timing critical applications. Bluetooth and 802.15.4 transceiver physical characteristics are very similar but protocols are substantially different and designed for different purposes. While 802.15.4/ZigBee is suitable for low to very low duty cycle static and dynamic environments with many active nodes the Bluetooth is designed for high QoS, variety of duty cycles, moderate data rates in fairly static simple networks with limited active nodes

WiMax, the Worldwide Interoperability for Microwave Access, aims to provide wireless data over long distances in a variety of ways. It is based on the IEEE 802.16 standard, which is also called Wireless MAN.
Typically it has a range with a radius of 3 to 10 km.

- 802.16-2004 (802.16d) is also frequently referred to as "fixed WiMAX" since it has no support for mobility.
- 802.16e-2005 (802.16e) introduced support for mobility, amongst other things and is therefore also frequently called "mobile WiMAX".

The original version of the standard on which WiMAX is based (IEEE 802.16) specified a physical layer operating in the 10 to 66 GHz range. 802.16a, updated in 2004 to 802.16-2004, added specifications for the 2 to 11 GHz range.
A commonly-held misconception is that WiMAX will deliver 70 Mbit/s over 50 kilometers. In reality, WiMAX can do one or the other — operating over maximum range (50 km) increases bit error rate and thus must use a lower bit rate. Lowering the range allows a device to operate at higher bit rates.

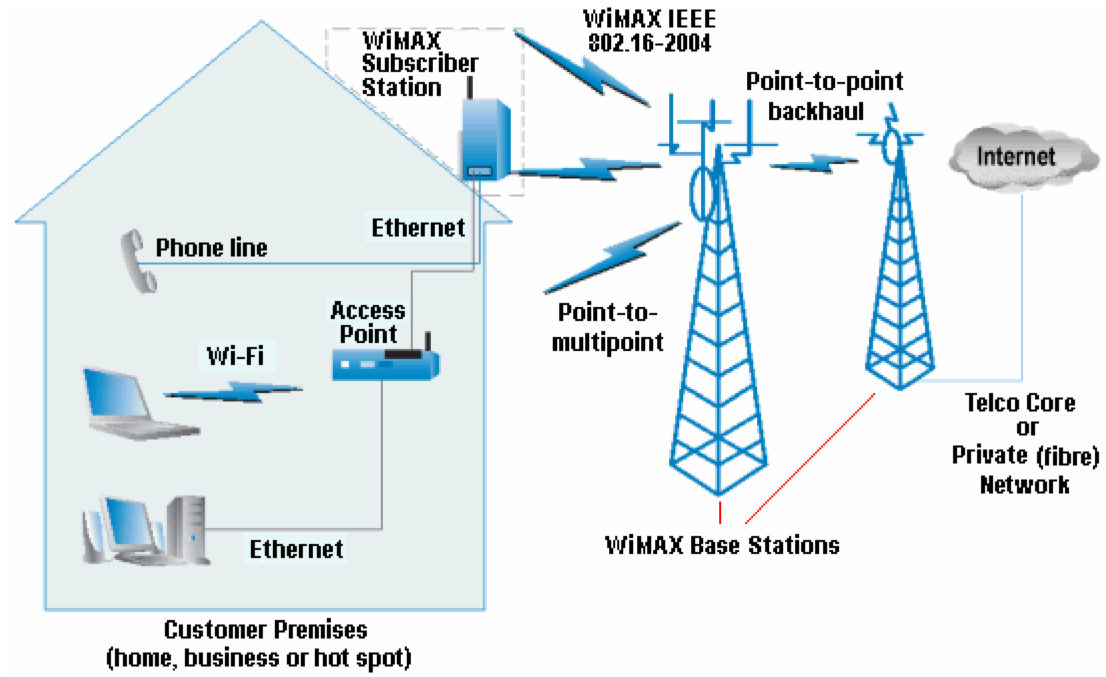

Fig.5 WiMax architecture.

The standard 802.16 defines three WiMAX network topologies: point-to-point (PTP) and point-to-multipoint (PMP) and mesh. The PTP link refers to a dedicated link that connects only two nodes: BS and subscriber terminal. It utilizes resources in an inefficient way and substantially causes high operation costs.
The PMP topology, where a group of subscriber terminals are connected to a BS separately, is a better choice for users who do not need to use the entire bandwidth. Under PMP topology, sectoral antennas with highly directional parabolic dishes (each dish refers to a sector) are used for frequency reuse. In this case the available bandwidth is shared between a group of users, and the cost for each subscriber is reduced
In addition to PTP and PMP, 802.16a introduces the mesh topology, which is a more flexible, effective, reliable, and portable network architecture based on the multi-hop concept.
The network architecture consists of a base station in the center of the city, with the base station communicating with all the substations or access points. Each sector can provide broadband connectivity to dozens of administrative buildings and hundreds of homes. WiMAX can further be connected to one or more Wi-Fi access points to connect with aWi-Fi enabled laptop, or a standard Ethernet cable attached to a computer or LAN (local area network).
WiMAX can use variable channel bandwidth. The channel bandwidth can be an integral multiple of 12.5, 1.5, and 1.75MHz with the maximum of 20 MHz. The bandwidth request and grant mechanism is scalable, efficient, and self-correcting.
Also, WiMAX supports “network-optimized hard handoff’’ for bandwidth efficient handoff with

reduced delay, achieving a handoff delay of less than 50 ms. WiMAX also supports fast base station switch and macro diversity handover as an option to further reduce the handoff delay.
In the below table are presented in a concise manner some of the most important characteristics of the existent WiMax versions.

Table 3

	802.16	802.16d	802.16e
Frequency range	10–66 GHz	2–11 GHz, 10–66 GHz	2–6 GHz
Channel conditions	Line-of-sight only	Nonline-of- sight	Nonline-of- sight
Channel bandwidth	20, 25, and 28 MHz	1.25–28 MHz	1.25–20 MHz
Modulation scheme	QPSK, 16QAM 64QAM	OFDM, QPSK, 16QAM, 64QAM	OFDM, QPSK, 16QAM, 64QAM
Network architecture supported	PTP, PMP	PTP, PMP, mesh	PTP, PMP, mesh
Bit rate	32–134 Mbps	Up to 75 Mbps	Up to 15 Mbps
Mobility	Fixed	Fixed	Max. mobility 125 km/h
Typical cell radius	1–3 miles	Max. 30 miles	1–3 miles

The IEEE 802.16a/d standard defines three different PHY (physical) layers that can be used in conjunction with the MAC layer to provide a reliable end-to-end link:

- WMAN-SC: A single carrier modulated air interface.
- WMAN-OFDM: It is a 256 carrier orthogonal frequency division multiplexing scheme. It uses the time division multiple access (TDMA) technology.
- WMAN-OFDMA: It is a 2048 carrier OFDM scheme. Multiple access is provided by assigning a subset of the carriers to an individual receiver. This is also referred to as orthogonal frequency division multiple access (OFDMA). The OFDMA-based systems are more suitable for nonline-of-sight operation. The WiMAX architecture is based on a packet switched framework, including native procedures based on the IEEE 802.16 standard and its amendments. It allows modularity and flexibility to accommodate a broad range of deployment options such as licensed or license-exempt frequency bands, co-existence of fixed, nomadic, portable, and mobile usage models, etc [6].

As already was presented, Wi-Fi works in unlicensed spectrum using the 2.4 and 5GHz bands. Wi-Fi is a cheap and easy way of providing local connectivity at high speed. For comparison WiMAX uses licensed spectrum and has strong authentication mechanisms built in. It has considerably greater range than Wi-Fi.
The WiMAX specification improves upon many of the limitations of the Wi-Fi standard by providing increased bandwidth and stronger encryption.
GSM (2G) networks are used for voice calls from mobile (cell) phones. They are limited when it comes to sending or receiving data as it can take up to 30 seconds to make a connection to the network.
GPRS is a method of enhancing GSM. GPRS (General Packet Radio Service) devices can transfer data immediately and at higher speeds. GPRS uses the existing GSM network to transmit and receive TCP/IP based data to and from GPRS mobile devices. GPRS devices are always on, as opposed to dial-up modems.
GPRS is a packet oriented Mobile Data Service available to users of Global System for Mobile Communications (GSM) and IS-136 mobile phones. It provides data rates from 56 up to 114 kbit/s.
GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access.
Class A - Can be connected to GPRS service and GSM service (voice, SMS), using both at the same time. Such devices are known to be available today.
Class B - Can be connected to GPRS service and GSM service (voice, SMS), but using only one or the other at a given time [6], [7].

Table 4

Technology	Download (kbit/s)	Upload (kbit/s)
CSD	9.6	9.6
HSCSD	28.8	14.4
HSCSD	43.2	14.4
GPRS	80.0	20.0 (Class 8 & 10 and CS-4)
GPRS	60.0	40.0 (Class 10 and CS-4)
EGPRS (EDGE)	236.8	59.2 (Class 8, 10 and MCS-9)
EGPRS (EDGE)	177.6	118.4 (Class 10 and MCS-9)

3. The Experimental Conditions and the Tests Realized With GSM/GPRS Modules

3.1 The GM862 module

The wireless data module used in the tests is Telit Gm862. It represents an enhanced solution for remote data acquisition, supervisory and control systems but also for other remote wireless applications, machine to machine or user to machine and remote data communications.

The operating frequencies in GSM, DCS, PCS modes are conform to the GSM specifications.

The GM862-GPRS transceiver module in GSM–900 operating mode are of class 4 in accordance with the specification which determine the nominal 2W peak RF power (+33dBm) on 50 Ohm.

The GM862-GPRS transceiver module in DCS–1800 operating mode are of class 1 in accordance with the specifications which determine the nominal 1W peak RF power (+30dBm) on 50 Ohm.

The sensitivity of the GM862-GPRS transceiver module according to the specifications for the class 4 GSM–900 portable terminals is better than –102dBm in all the operational conditions.

As main characteristics of this module we can mention:

- Dual band GSM 900/1800 MHz
- Data, voice, SMS and fax
- Data speed up to 57,6 kbps
- Low power consumption
- Full type approval
- GPRS class 8
- Compliant to GSM phase 2/2+
- Voltage range: 3,4 v/4,2 v
- Industrial pluggable interface

The Telit wireless module family can be driven via the serial interface using the standard AT commands. The Telit wireless module family is compliant with:

- Hayes standard AT command set, in order to maintain the compatibility with existing SW programs
- ETSI GSM 07.07 specific AT command and GPRS specific commands.
- ETSI GSM 07.05 specific AT commands for SMS (Short Message Service) and CBS (Cell Broadcast Service)
- FAX Class 1 compatible commands

Moreover Telit wireless module family supports also Telit proprietary AT commands for special purposes.

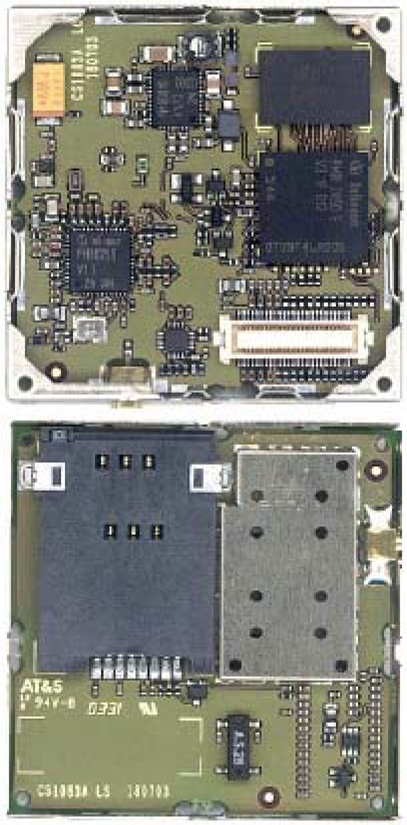

Fig.6 The internal structure of the GM862 GSM/GPRS module used in the tests.

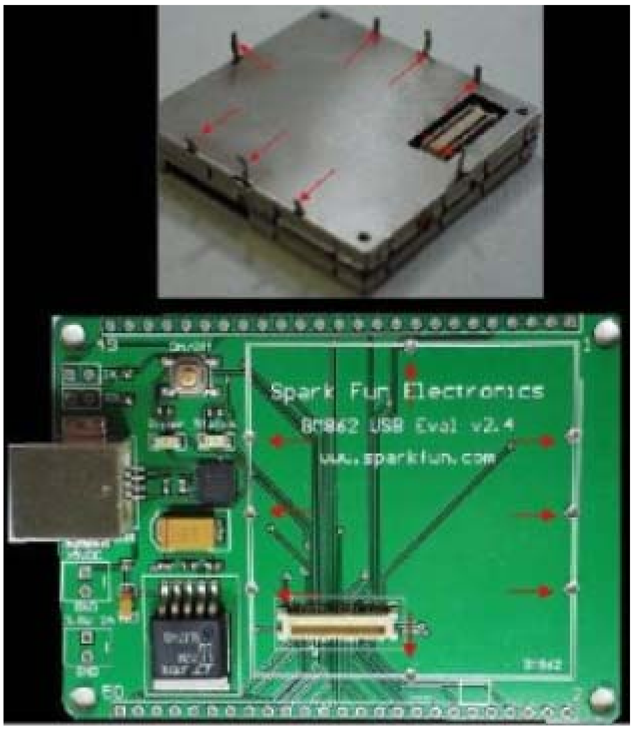

Fig.7 The test board for GM862 GSM/GPRS module.

3.2 The development board

The communication between two GM862 GSM/GPRS modules was tested using two simple test boards having only the interface circuitry with the PC and the power connectors. Also, for mor sophisticated tests and applications it was used the EVK2 development board from Telit manufacturer.
This wireless data module together with the development board represents the ready solution for remote wireless applications, machine to machine or user to machine and remote data communications in an multitude of applications [2], [3].
The kit is formed by a motherboard, on top of which an adapter board with the related module is plugged. This concept allows using it across the boundaries of various form factors and product generations, also in future. On the motherboard are placed all basic interfaces, like several power input facilities, SIM holder, audio monitor outputs, 2 x RS232 and USB 1.1, as well as Reset and ON keys, representing a reference design for this peripheral circuitry of the module. Jumper settings define the routing of the serial interfaces, audio signals and power supply. The PC or DTE sending and receiving information over the AT-Command interface can be connected to a USB or RS232 socket. Adapter boards convert the connection technology of the module (board-toboard or BGA solder) into a PTH pin connector.

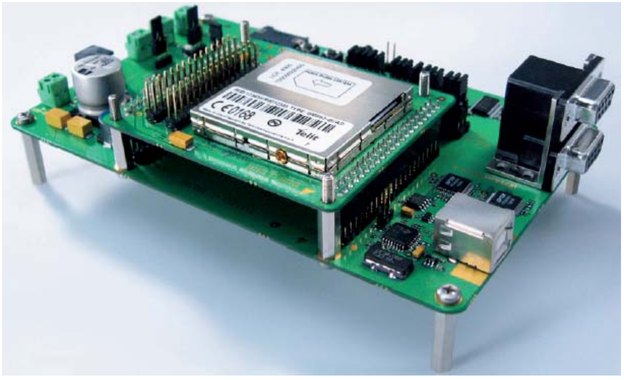

Fig.8 The EVK2 development board used for tests.

The part of the basic interfaces is served by the motherboard, whereas specific interfaces according to the type of the module (antenna, general purpose inputs/outputs (GPIO), ADC/DAC, UART etc.) are available on the adapter board to connect to the user's application, extension boards or other development tools or measurement equipment. An extension board allows connecting a VGA Camera component which is directly supported by the Telit modules is available [3].
The interface of the development board with PC is realized through serial interface or through USB.

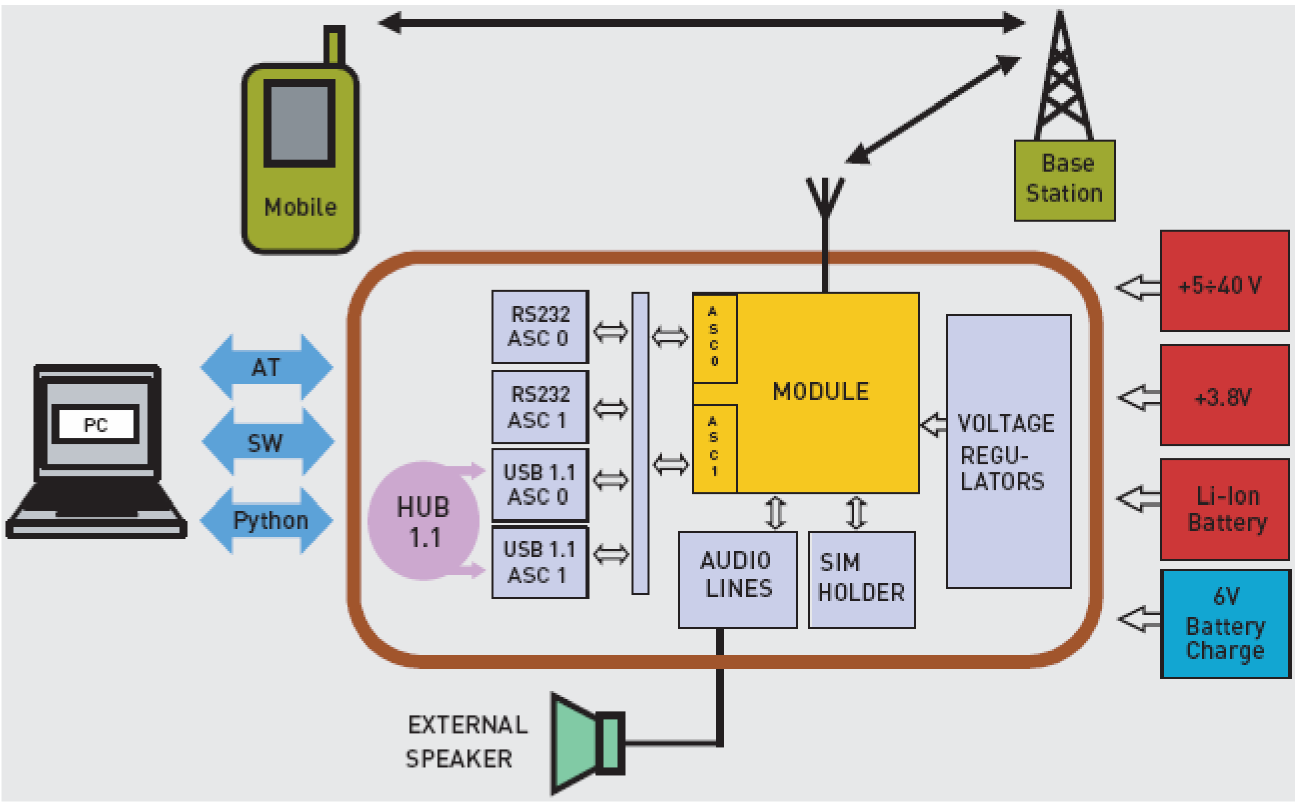

Fig.9 The block diagram for the used development board.

3.3 The presentation of some tests realized with the modules

The chain Command -> Response shall always be respected and a new command must not be issued before the GM862-GPRS has terminated all the sending of its response result code (whatever it may be). Here are presented few commands for verification of the proper operation of the connection between the modules. This simple applications can be developed and implemented in an more attractive programming software such is LabVIEW for example. Instead of sending the SMS text (Figure 8), we can send very well some data regarding an physical process for example. The GPRS mode allows easy and robust implementation of remote data acquisition, supervisory and control systems using the hardware setup presented in this paper.

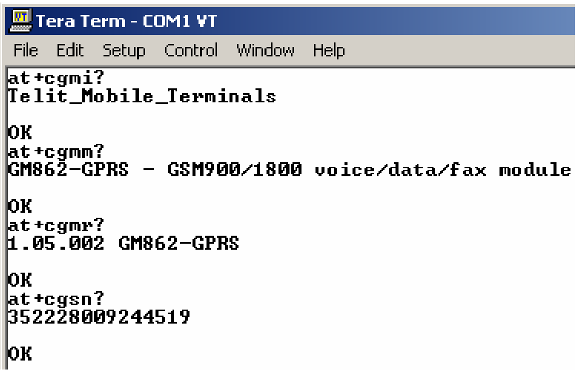

Fig.10 The module interrogation for identification of the information regarding the manufacturer parameters.

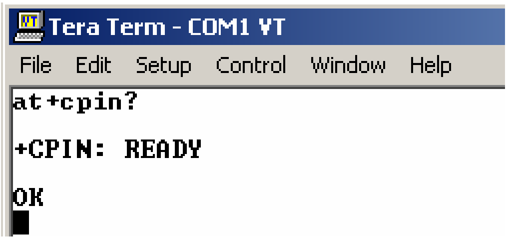

Fig.11 Verification of the PIN state.

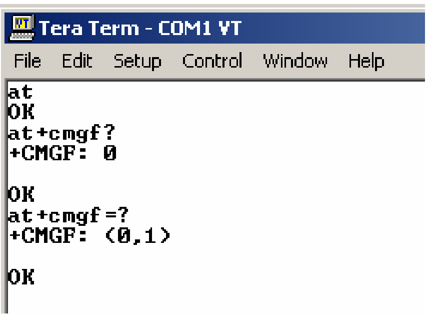

Fig.12 The command used for identification of the SMS transmission mode (text or PDU) of the radio module.

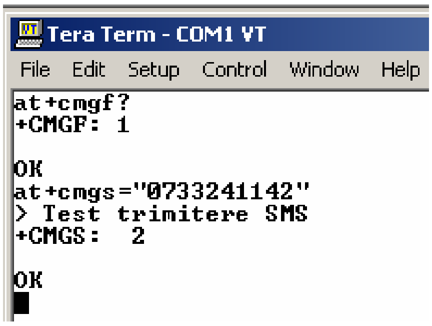

Fig.13 Sending an SMS in text mode.

4 Conclusion

The current trend in remote data acquisition, supervisory and control systems is to use wireless sensor network (WSN) distributed in the area monitored area. The radio technology used in such cases depends on the dimension of this monitored area, distance between sensors and base station with processing unit, the power constrain and also depends on the quantity of data acquired from the sensors. In function of these factors can be used short range transmission technologies such as ZigBee, Bluetooth, WiFi or, for long distances and better mobility, can be used GPRS and WiMax solutions. It was preferred GPRS because of the unlimited mobility that offers in applications.

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