Wireless Data Transmission over GSM Short Message Service (GSM-SMS)

A White Paper on the Efforts of EACOMM Corporation Embedded Systems Division in Developing Wireless Data Transmission Systems utilizing existing Wireless Telecommunications Infrastructure.

EACOMM Corporation
12th Floor IBM Plaza Building
Eastwood City Cyberpark, Bagumbayan
Quezon City, PHILIPPINES 1110
Tel. (632) 438 2986 Fax. (632) 421 2860
Email: info@eacomm.com
URL: http://www.eacomm.com

EACOMM Embedded Systems Division
Suite 304 Eagle Star Condominium
Fabian de la Rosa St., Loyola Heights
Quezon City, PHILIPPINES 1108
Telefax. (632) 426 9312
Email: solutions@eacomm.com
URL: http://microcontrollerdesign.ph

I. Introduction:

Over the last few years, the GSM cellular phone has grown from a luxury item owned by the rich to something so common that one out of five Filipinos already owns one. This is amazing when we look at the fact that our country is a developing one with almost half our population living below the poverty line.

This continuously growing popularity of the GSM cell phone has spurred the growth of the country's cellular network infrastructure led by the two major players, Ayala owned Globe Telecom, and PLDT's Smart Cellular. All major urban areas are currently covered by both cellular providers, and soon every single corner of the Philippine Archipelago is a cell phone call away.

The primary reason we can see for this tremendous and unexpected cellular boom is the popularity of the short message service (SMS) in the Philippines. Locally called "text messaging," Filipinos send more text messages then the whole of Europe combined. The Filipino's need for constant communication with family and friends, coupled with the relatively cheap method of sending short text messages to them, has spurred a GSM revolution in the country. In fact, rarely will a Filipino actually use his cellphone to make a phone call, preferring to "text" anything and everything.

The "texting" boom has not come unnoticed to entrepreneurs. A variety of services have grown around "texting." Users will pay double or quadruple the normal SMS fee for a specific service such as chatting, news/traffic reports, and downloading of ring tones for their phones. These services ally themselves with one or more cellular network providers who will give them a special phone number that can receive and monitor the text messages that their customers send to them. This many-to-one network of SMS transmission has become quite popular and many a business has entered into this model with mixed results.

However, as of this writing, the vast majority of businesses that revolve around the GSM-SMS system have been targeted to consumers. This white paper aims to propose **industrial applications** that will utilize the distinct advantages of the GSM-SMS system over other possible technologies in the industrial setting.

II. GSM for Industrial Applications.

The primary appeal of the GSM network for industrial applications are in its following qualities:

- **Digital Transmission.** The GSM Network is inherently digital which makes it secure, relatively error-free, and jamming-proof.
- **Nationwide coverage.** The GSM networks offer nationwide access at a fixed fee regardless of location.
- **Future-proof.** The GSM network is designed to be compatible with future technology upgrades such as GPRS and third generation (3G) cellular telephony. Thus, investments in this area are relatively safe in the medium to long term.
- **Cheap.** GSM technology in terms of hardware and fees paid to providers will get cheaper as it grows more popular and as the technology matures.
- **Mobile.** GSM technology allows for a roaming system, wherein both transmitter and receiver can be move around the cellular network.

There are a variety of applications wherein the GSM network can be useful for industrial use, and most of these are in the realm of **Data Transmission.** This can be in the form of: *telemetry systems, remote access and control systems, remote display systems and others.* Being inherently digital, sending digital data with the GSM network is very simple and easy. Information transmission through the GSM network can be in the form of:

- **Voice Channel Transmission.** Much like how a regular fixed line modem works, data can be transmitted to the cell phone's voice channel at speeds comparable to a fixed line modem.
- **GPRS transmission.** The "2.5 G" GPRS technology that is slowly gaining popularity in the Philippines allows for high-speed data transmission for the newest cell phone models.
- **SMS transmission.** Using a 160-character text message, short commands can be sent via SMS and decoded by a receiver. This is ideal for *intermittent small packet data transmission.*

This Paper focuses on EACOMM Corporation Embedded Systems Division's efforts in developing a *generic* GSM-SMS controller that can be used for telemetry, control, and display systems.

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III. The "TextBox" GSM-SMS Controller System.

To tap the industrial applications market for GSM, EACOMM Corporation Embedded Systems Division developed the **TextBox**. *The TextBox is a multi-function, microcontroller-based device that is designed to receive and send data via the GSM network*. In its heart is a Zilog Encore! microprocessor with 64KB of Flash RAM and a Siemens GSM Cellular Engine. It is capable of receiving analog data from eight ten-bit analog to digital converters (ADC) and digital data through a serial port.

Figure 1. Shows the block diagram of the TextBox. Aside from the digital and analog input/output lines, the TextBox also has additional memory slots and an on-board LCD display. Standard access and control of the box is done by linking to a Personal Computer via serial port, but on-board control buttons can be installed as an upgrade to the generic design.

The TextBox is powered externally by an AC/DC adapter. It also has a back-up 9-volt rechargeable battery to ensure that it will continue functioning and retain its stored memory through short power failures.

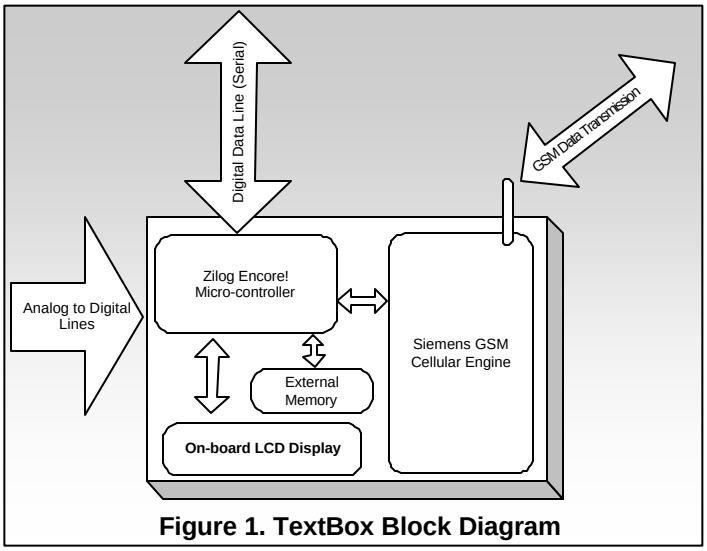

Figure 1. TextBox Block Diagram

The generic set-up shown above is easily configurable for use in telemetry systems (by using the ADC lines) or for remote instrumentation controls (through the serial port). The TextBox was designed in such a way that very minimal modification on the hardware needs to be done to *customize* it to a specific application. Much of the customization occurs in the operating system running in the microprocessor. Using the Zilog Encore! allows EACOMM's engineers to develop using ANSI-C rather than assembly programming. By programming in C, development time is reduced by almost half. Thus, the Embedded Systems Division can deploy a *fully customized* TextBox within weeks of the client's order rather than months.

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IV. Case Study: Use of the TextBox in a Wireless LED Moving Message Display System.

What follows is a case study of an application wherein the TextBox was the most viable system to be used.

Background of the Project.

The first deployment of the TextBox GSM Controller System was for the billboard company, AdSpace Specialists Incorporated. AdSpace was looking for an LED Moving Message Display System that can be remotely controlled. The challenge was that around several dozen of these display boards will be deployed all over the country, and so the control system must be readily expandable to accommodate a growing number of display boards.

Project Specifications.

The project called for a *data-broadcasting system* that can send data to *all* the boards at once or send a message to a *single* display board or a *subset* of display boards. The initial system proposed by EACOMM Corporation was a *FM Sub-carrier Data Transmission System*[1]. This system allowed for *continuous real-time data* to be broadcasted to the LED boards.

However, certain aspects of the project showed that the TextBox would be a better alternative for the project:

- **Broadcast of data to the LED boards are intermittent.** With a maximum of around five messages per hour, intermittent data transmission meant that the cost-savings between utilizing a FM sub-carrier system versus a GSM system were practically nullified.
- **The project aimed to go *nationwide* as early as possible**. Nationwide coverage was much easier with a GSM system since existing GSM networks already have nationwide urban area coverage.
- **The project called for a *centralized* control system.** With the FM sub-carrier system, an FM radio station must be equipped with the FM sub-carrier generator per area of deployment of the display boards. Using GSM allowed for complete centralized control without the need of any additional hardware buy the display boards themselves.

Due to the three factors above, it was decided that the TextBox is the most viable solution to AdSpace's requirements.

[1] For more information on the FM Sub-carrier Data Transmission System developed by EACOMM Corporation, visit http://www.radiosubcarrier.com

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Hardware Specifications.

The system defined by AdSpace called for intermittent display of text and special characters to a LED moving message display system. Aside from transmitting the text for these messages, the TextBox was also tasked to provide remote command and control of the other electronics equipment in each of the deployed billboards. For example, lights for the billboard can be turned on and off by sending additional control characters along with the message to be displayed in the LED display board.

The LED Display System

The LED Display system, also developed by EACOMM Corporation, was designed to be controlled through the serial port. This meant that it could be controlled directly through a personal computer, a pre-programmed micro-controller or remotely, by a device such as the TextBox. The initial implementation called for a 30 cm x 300 cm single line board with a 15-character display capacity. However, the system can accommodate practically any message board design, be it single, double or triple line, with any number of characters per line.

User Interface System (UIS)

For command and control of the whole system, a graphical user interface (GUI) application was developed. Called the User Interface System (UIS), this software controls all the message boards that are installed and will be installed *anywhere in the country*. The UIS was developed as a web-based application, providing the additional feature of allowing access to the system over the Internet from anywhere in the world. The combination of a GSM data transmission system with a web-based command and control application provides AdSpace Specialists absolute scalability and mobility with their display board system.

Figure 2 above shows the block diagram of the Wireless LED Display System.

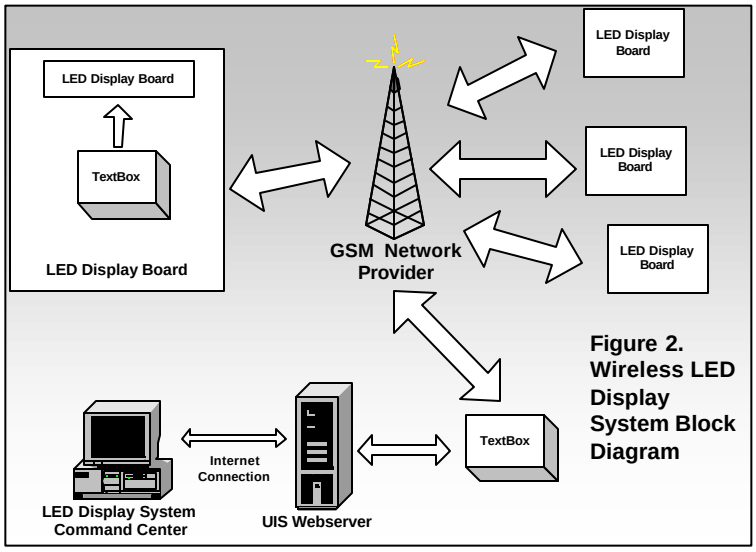

Figure 2. Wireless LED Display System Block Diagram

Comments and Conclusions

Use of the GSM-SMS system provided enormous benefits for the Wireless LED Display System of AdSpace Specialists:

- **Cost Savings.** By opting for a wireless system, AdSpace saved significant amounts of resources. The continued lowering cost of GSM-SMS transmission will also

make the system more cost-effective in the future.

- **Ease of Expansion.** No additional equipment needs to be installed when expanding to a new area or region. With the GSM-SMS system, AdSpace need only install new display boards *anywhere in the country* and it can be controlled by the centralized command center.
- **Ease of Upgrade.** The TextBox is designed with the future in mind. It could easily be upgraded to take advantage of new technologies, especially with the expected entry of 3G cellular technology in the next few years.
- **Mobility.** The system is not limited to fixed display locations. LED boards can be installed on buses or trains and still receive information from the central command center.

V. Future Opportunities

We see the TextBox as a first version of a continuously improving and innovating design that will keep up with the break neck pace of innovation in digital telecommunications. We see no limit to the potential of the TextBox for industrial applications, specifically in the realms of telemetry and remote command and control, and with improvements in telecommunications technology occurring every year, so will the TextBox improve and innovate.

In the near future, expect to see the following innovations to the TextBox:

- Direct access to the voice channel for data transmission.
- Utilization of GPRS for data transmission.
- Addition of parallel data lines and expanded memory and programming capacity.

Future products to be offered includes:

- Consumer version for remote household appliance control.
- Environmental Sensor Version with temperature and humidity readings.
- PLC version for remote factory control.
- Mobile Robotics Educational Module.

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Produced by EACOMM Corporation
Embedded Systems Division.

FOR MORE INFORMATION CONTACT THE EACOMM EMBEDDED SYSTEMS DIVISION:

Suite 304, Eagle Star Condominium, Fabian de la Rosa St., Loyola Heights, Quezon City, PHILIPPINES 1108.
Telefax. (632) 426 9312
Email: solutions@eacomm.com
Or visit our website:
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