



SIMPLE CIRCUITS

Cellular Modem Technology for Traffic Application

By Jeff Alder, CET

Happy New Year to all, and welcome to Simple Circuits!

If there is one truth to the application of wireless technology, within the traffic and transportation industry, it is that one size does not fit all. The selection of frequency band, throughput requirements, differing topographies, budget considerations, etc., all impact what can be practically applied in any given system.

There are many wireless offerings, which range from simple point-to-point contact closure products to full MESH networks and satellite communications systems. Each has it's own advantages, and drawbacks, depending on the application.

In this issue I have chosen to explore the use of cellular technology in the traffic and transportation industry.

Several products already employ cellular technology, and there will surely be more to follow. These include devices such as school zone flashers, radar sensors and AVL (Automatic Vehicle Location) systems. There are many such opportunities to be exploited and excellent reasons for doing so.

An idyllic scenario might suggest that the entire continent would be "MESHed", with total broadband coverage from coast to coast. As budgets to achieve such a goal are likely decades away, it is interesting to note that, in a way, we have already partially met this objective through the use of cellular technology.

Billions of dollars have been spent building and maintaining the infrastructure, which affords the use of cellular phones, access to the Internet and which facilitates wireless data transfer. Considering the annual budgets required for the expansion and maintenance of cellular networks, costs associated with deploying cellular based products are surprisingly economical.

Today, many carriers are also internally set up to expedite the testing and deployment of products, other than cell phones, on their networks.

Many of the cellular products developed for use in North America, are also immediately deployable in other countries throughout the world. This is definitely an advantage for sales and marketing departments compared to, for example, a 900 MHz ISM type product.

The technology I have chosen to review in this edition is based on products manufactured by a US company called Multi-Tech Systems, Inc.

Multi-Tech manufactures cellular modems in several form factors and has significantly streamlined the process of adding cellular capability to products throughout the world.

Before we examine the details of Multi-Tech's product offering, it might be prudent to review the basics of cellular networks, the advantages of the technology for traffic application, and the process for "lighting up" equipment on a network.

There are two basic technologies available for cellular communications. They are known as GSM (Global System for Mobile communications), and CDMA (Code Division Multiple Access).

Network providers often employ one technology or the other, but there are also those who provide access to both types of networks. It is predominantly GSM technology that is used to provide cellular service world wide, including 3rd world countries.

There have been several technological developments to GSM, which currently include GPRS (General Packet Radio Service), EDGE (Enhanced Data Rates for GSM Evolution) and HSDPA (High-Speed Downlink Packet Access). These new technologies essentially provide higher packet data rates.

In simplified terms, GSM devices require a SIM card (Subscriber Identity Module) for activation, whereas CDMA products contain a unique ESN (Electronic Serial Number) and are usually activated OTA (Over-The-Air).

SIM cards make the upgrading of a cell phone, for example, as simple as a card transfer, whereas, users of CDMA products must resubmit their information along with the new product ESN to the network provider for activation. CDMA products must also be activated in their "home territory".

Until recently, data rates have not been astounding, although they are still more than adequate for many M to M (Machine to Machine) type applications.

Standard GSM/GPRS bit rates begin at 9600 baud, with newer EDGE technology providing bit rates of up to 240Kbps. HSDPA provides effective throughput rates of more than 750Kbps.

CDMA2000 bit rates range from 9600 baud to 153.6Kbps. New EVDO (Evolution Data Optimized - Rev A) technology is purported to provide bit rates of up to 1Mbps, although actual effective throughput is likely going to be quite a bit less.

These data rates do not describe the upload and download burst rates.

The advantages of cellular communications might be listed as follows:

- 1) Significant coverage from coast to coast
- 2) Access to communications networks anywhere inside a downtown core (LOS/repeaters not required)
- 3) Access to communications networks from inside parking complexes
- 4) Simplified site survey analysis
- 5) Antenna height and direction become non issues
- 6) Secure communications network
- 7) Equipment compatibility through-

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out North America

- 8) Economical network access plans
- 9) Inexpensive technology to implement
- 10) Interference free communications

There are many more advantages to the use of cellular, but these are probably the most significant to what we do in traffic. I will attempt to elaborate further on the advantages provided to our industry:

- 1) Reliable coverage from coast to coast is critical. Many products such as portable and permanent message signs can be remotely programmed. These signs can be deployed virtually anywhere, so it is nice to have a communications technology that is practical to the application.
- 2) Access to a communications network from inside a concrete jungle is hampered using alternate wireless technologies. Interference and line of site issues are usually nullified by employing cellular products.
- 3) The ability to monitor and control parking equipment is eased considerably with cellular technology.
- 4) No matter what the application, a simple cell phone call will indicate the integrity of the network. No bucket trucks, special band selection, antenna polarizations, or MESH networks required. Just look at the number of bars displayed on your cell phone!
- 5) Antennas are usually specified as short "rubber ducks", which are more than adequate for all but the most remote locations, and they can be mounted right at the equipments location. No lightning arrestors, etc. required.
- 6) Communications are secure. These applications are "point to point" through the cellular providers network. It is however, prudent to encrypt sensitive data throughout the application.
- 7) Cellular equipment can be activated anywhere. For GSM, simply insert a correctly configured SIM card and you're good to go throughout North America.
- 8) Cellular airtime has never been more economical. Competition is fierce and this has driven package pricing down substantially.
- 9) The technology itself has also

dropped in cost. In fact, for less than \$100.00, a complete cellular modem and antenna for basic GSM network access can be added to most any product.

- 10) Your connection is your own. No interference from new networks added to the surrounding area, no crossed signals or calls, just reliable, secure communications.

There are however two aspects to cellular technology, which must be reconciled when implementing a cellular modem into a new product. They are listed as follows

- 1) Network approval of the cellular modem
- 2) Network approval of the proposed product

These approvals are not universally addressed by cellular modem manufacturers, or network providers, and can present significant stumbling blocks when attempting to activate new products on various networks throughout North America and even worldwide.

Every network provider has a different set of rules that users must adhere to before activation will be permitted. Many of the cellular modems today, do not come with blanket network approvals for most providers in North America, let alone globally.

This means that considerable dollars will have to be spent obtaining approvals, with individual providers, when applying for network access. This can also significantly delay time to market.

Once the cellular modem itself is approved for a network, a second set of approvals is required to ensure that the application of the cellular modem is sound. After all, the network provider does not want a product to perform erratically on their network due to software glitches etc.

There are as many sets of rules as there are providers, so it can quickly become awkward to implement nation wide cellular capability into new products.

Fortunately, there is a manufacturer of cellular modem products that has addressed these difficulties, thereby streamlining the addition of cellular technology to customer applications.

The company is Multi-Tech Systems,

Inc. and they have a long history of manufacturing cellular and hardware modem products for worldwide application.

Multi-Tech's approach has always been that ease of implementation and deployment are paramount. To that effect, they have taken the extraordinary step of approaching virtually every network provider in North America (and many worldwide), investing significant resources, and obtaining pre-approvals for all their product offerings. This provides users of Multi-Tech products with fast time to market and substantially lower costs along the way.

Next comes the issue of network approval for the finished product.

Multi-Tech has established many strategic relationships with network providers. Some major network providers are pleased to offer reduced testing requirements for products containing MultiTech modems. There is even one major provider that does not require any new product testing for their network as long as the new product contains a MultiTech cellular modem!

Multi-Tech's cellular modems are available in two form factors:

- 1) A "universal" SocketModem@ embedded wireless modem
- 2) A "canned" MMCModem™ embedded wireless modem

The universal socket modem provides users with the ability to embed the solution on their printed circuit board using a universal footprint. "Universal" means that Multi-Tech modem products, including hardware and cellular modems, Blue tooth, Wi-Fi, etc. all fit in the same physical form factor (DIP style package). The products function within a common footprint, although not all pin functions are implemented on all products. Most important however is the hardware compatibility with new or upgraded product offerings. No PCB design changes are ever required. (See Figures 1 and 2 page 26)



Figure 1

TheMMC-Modem or "canned" modem is a small

metal canned device, which can be mounted at the most convenient location within a product. Serviceability,

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(I/O) Tip	1	○	○	64	SPKR (O)
(I/O) Ring	2	○	○	63	GND (O)
Safety Void	3	×	○	62	MICV (I)
(O) TX+	4	○	○	61	VCC (I)
(O) TX-	5	○	○	60	-LED SPD (O)
(I) RX+	6	○	○	59	-LED COL (O)
(I) RX-	7	○	○	58	-LED LINK (O)
Safety Void	8	×	○	57	-LED ACT (O)
	9		○	56	-LED FDX (O)
	10			55	
	11	○		54	
(O) TXCLK	12	○		53	
(O) RXCLK	13			52	
	14			51	GPIO (I/O)
	15			50	GPIO (I/O)
	16			49	GPIO (I/O)
	17			48	GPIO (I/O)
	18			47	
	19			46	
	20			45	
	21			44	
(I) Mic+	22	○	○	43	SPK+ (O)
(I) Mic-	23	○	○	42	SPK- (O)
(I) -Reset	24	○	○	41	GND (I)
(I) USB_VBUS	25	○	○	40	-DTR (I)
(I) GND	26	○	○	39	-DCD (O)
(I/O) USB_DP	27	○	○	38	-CTS (O)
(I/O) USB_DN	28	○	○	37	-DSR (O)
(O) LED DCD	29	○	○	36	-RI (O)
(O) LED RX	30	○	○	35	-TXD (I)
(O) LED DTR	31	○	○	34	-RXD (O)
(O) LED TX	32	○	○	33	-RTS (I)

Figure 2

antenna-mounting schemes, etc. can sometimes be best addresses using this separate modem device. (See Figure 3)



Figure 3

An AT command set over serial interface is used to configure and operate all cellular modem products.

The modems come with a built in IP Stack, but a user can write their own, depending on their applications requirements.

This leads to the very important aspect of “lighting up” a new product on a network. Once a product has been designed and prototyped, what are the steps required to getting it activated for testing on one of the major networks?

As it turns out, this is quite a simple process as well. Not only does Multi-Tech have excellent relationships with network providers, but they have also developed relationships with a number of MVNO’s or Mobile Virtual Network Operator’s.

MVNO’s afford the users of Multi-Tech products access to most major networks throughout North America. They are an excellent partner for many smaller scale cellular applications providing competitive rate plans and flexible access arrangements.

It is not that large network providers are uninterested in smaller cellular deployment opportunities. It is simply that there are a significant number of new products requesting access, and a business case must be made for each product.

MVNO’s combine new opportunities and this empowers
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them with the ability to obtain better rates than what their customers could achieve working directly with a large provider on a smaller scale.

MVNO’s also provide access to a “virtual network” for the testing of new products.

These services add significant value to cellular product development and deployment.

Let’s explore a potential application for cellular modems and portable message signs. There are already signs with cellular based programming capabilities, and the lower speed modems are more than adequate for simple data transfer.

What if we take this concept further and suggest an IP camera verification system for what the sign is actually displaying?

Are there non-functioning segments? Is the display bright enough? Was there a typo? A case could be made for liability without true confirmation of displayed data.

Fortunately, respectable video is now attainable from any cellular coverage area, using HSDPA GSM technology.

There is also an IP camera reference design, which was developed right here in Calgary by a company called Au-Zone Technologies Inc. Au-Zone designed this product for Freescale Semiconductor and the reference design and manual are available at no cost on the Freescale website.

Please visit the following link for further information:
http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=IMX27_IP_CAMERA&fsrch=1

The design is entitled **i.MX27 IP Camera**. (See Figure 4)



Figure 4

Several companies now manufacture this camera, including Au-Zone, and it is available in many form factors. It is an industrial design and therefore operates from -40C to +85C.

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Some manufactured versions of the camera come with a built in 802.11G wireless module, making it easy to send information from a camera/solar panel, to a DMS. The DMS will use an 802.11G transceiver to bring the streaming information into the sign controller module.

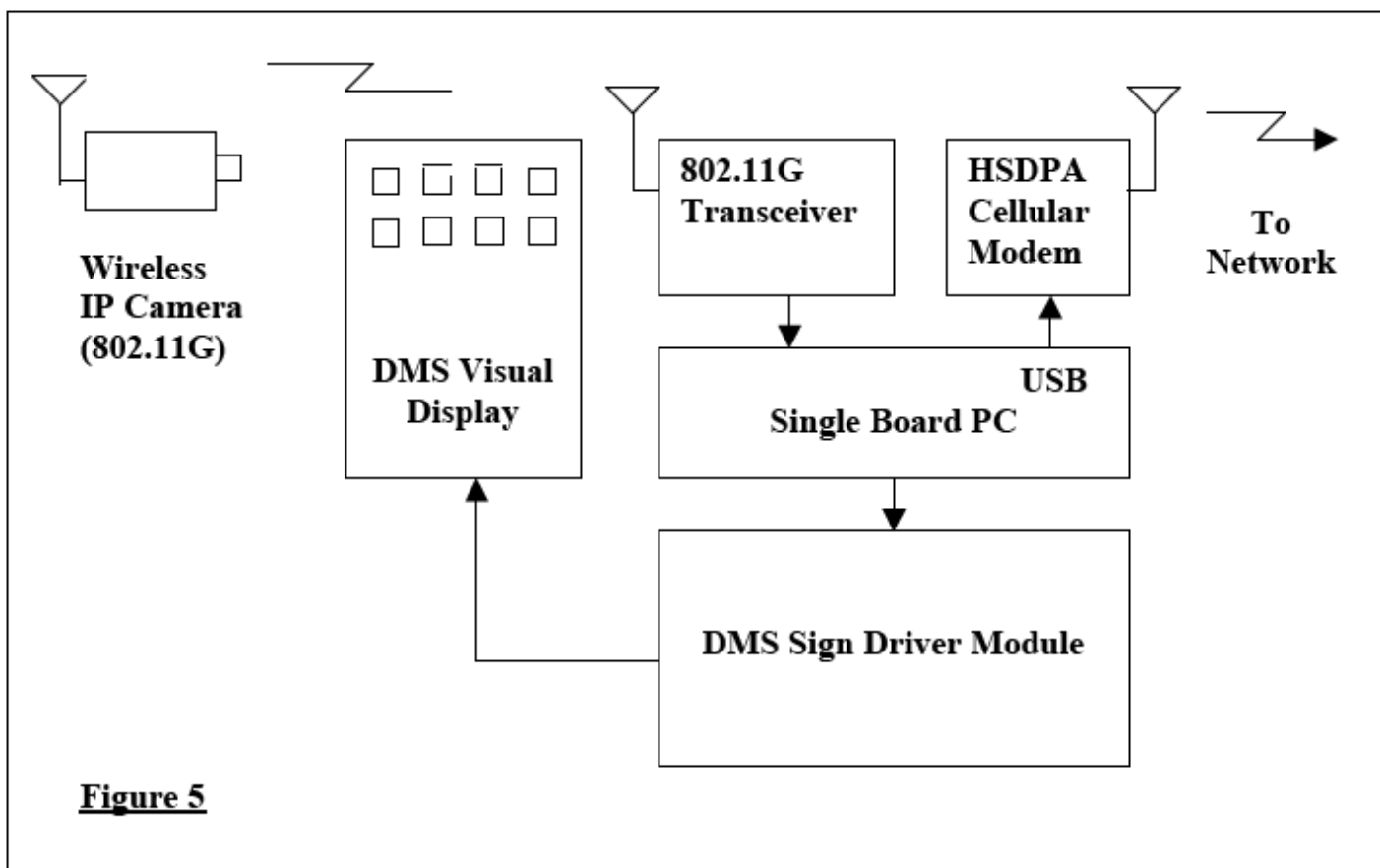
An easy and inexpensive way for a sign manufacturer to accomplish the video verification feature would be to employ an industrial single board PC for communications and processing. Driver board(s) would activate the display.

The PC would come with the 802.11G interface and would also possess a USB interface for high-speed data transfer of video information to the HSDPA cellular modem. (See Figure 5)

be dispatched to ensure compliance with the reduced speed limit.

There are many applications in which cellular technology can provide significant value at minimal expense. Be sure to visit Multi-Tech's website at www.multitech.com for further information.

I would like to thank the technical group and marketing department of Multi-Tech Systems, Inc., for their support, and use of the graphics within this article.



This information would then be available via the Internet and sign display verification would be complete.

Another application would be to place a camera inside the DMS itself. In portable signs for work zones, it would be easy to monitor the work zone to ensure, that it is indeed the left lane that is "closed ahead", as per displayed information. The camera's visual field could also include a radar speed indicator sign.

If it was observed that vehicles continually failed to slow down within the work zone, local law enforcement could

Thanks also to Au-Zone Technologies, Inc. for the picture of the non-industrial IP Camera based on their reference design.

Until next time,

Take care out there!

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