by MICHAEL O'BRIEN

"GSM is wonderful."
–Graeme Sutherland

"GSM is a very complex standard..."
–John Scourias, "Overview of the Global Standard for Mobile Communications"

"Oh, turn that thing off."
–Someone with something better to do

Mr. Protocol Has Tea

Q: *Why do my friends from overseas keep snickering at me whenever I pull out my cellphone? It's the latest flip-phone from Japan, and it's smaller than a credit card. I think it's pretty neat!*

A: Don't worry, they do the same thing every time you turn on the TV, only worse. And it's for the same reason. If you're willing to be second, you get better pickings. Makes Mr. Protocol wonder what's going to happen if the Internet is ever reimplemented.

Here's a mindless exercise for you. Turn on the television set, and count the little bitty horizontal lines. Now, fly to England, settle into your average London flat, pay the television license fee so they don't haul you away while you're busy counting, and count the little bitty lines on one of their sets. You'll come out to 100 more.

Now, every time Zany Zebulon down at the corner TV & Refrigerator Emporium claims that his sets have "more lines of resolution" than anybody else's, he's only partly making it up. Wonderful work with digital filters has enabled today's TV sets to resolve very fine detail along the horizontal axis: upwards of 600 lines in some cases. Not that many signals are capable of actually carrying that sort of resolution. However, in the vertical direction, the United States is still limited to the same 425 lines that were laid out in the black and white days of the late '40s.

By the time the British got around to specifying what they were going to use for a TV standard, of course, the technology had been pushed that much further. So they got on board with a standard called PAL, which has 525 lines of vertical resolution. Today we can do much better than that, but everyone's still watching the same resolution they started with and will continue to do so until High Definition Television (HDTV) is finally rolled out into the marketplace.

It's the old problem with new standards, of course: No one's going to buy a new standard unless it's compatible with the old one, which is why the conversion to color didn't change the screen resolution–the signal had to be compatible with the old black and white one. In fact, the new HDTV signal can't be compatible with the old one, but broadcasters will continue to broadcast both until well into the next millennium.

This problem with standards plagues any mass medium. It plagues the Internet. The most successful application protocol yet developed, HTTP, uses the lower-level protocols in a manner almost opposite to that for which they were designed. The Internet is showing the strain, and will continue to do so, since deploying any changes to TCP or IP is almost impossible at this point.

And it plagues telephones.

Consider the fact that if you measure the voltages used in your wall phone, you'll get very screwy numbers. These numbers reflect the earliest days of telephony, when telephones were battery-powered devices. The voltages of these early batteries are carried forward into today's modern 900-MHz all-digital, all-singing, all-dancing cordless wonders, at least as far as the base unit is concerned. What comes out of the wall is still battery voltage. The only substantive

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change to hit the market in the last 70 years is the replacement of pulse dialing with tone dialing, and that took 40 years to filter through the marketplace. Only now are we beginning to see the services that tone dialing permits.

It's relatively easy to deploy new services back at the telephone central office. The hard part comes in introducing services that require changes to subscriber equipment. Caller ID only has a prayer of succeeding because it does not require everyone to change telephones. It only requires additional equipment for those who wish to use the service.

Now consider cellular telephones. We have 'em, and so does everybody else. What do you think the chances are that your cellphone will work in Europe? Right you are. Zippo. Well, why not?

Mr. Protocol is glad you asked.

Cellular phones in the United States are almost all of a single type, called AMPS, which Mr. Protocol is willing to bet stands for Analog Mobile Phone Service. What this means is that if you tune an FM radio across the relevant part of the radio spectrum, you will pick up phone conversations. You will also be committing a felony, a piece of legislation that ranks right up there with the barn door and the horse and all that, but the point is that the audio for American cellular phone services is good old analog FM.

Now, this is still a considerable improvement over the way mobile phone service started out, which had about 40 channels for an entire city or something like that, and when you got a channel, you kept that channel till you hung up or dropped out of the system by driving too far away.

The whole notion of cellular service allows reuse of frequencies across cells, and cellular phones are "frequency-agile," which means that they can retune themselves to acquire a different cell as they move across town, without dropping a call (unless the new cell is already fully occupied with calls, in which case, ka-BOINK!).

So, what do the English have that we don't, besides *Sandman* creator Neil Gaiman and really good ale?

Global Mobility

The answer is, same thing as happened with the television standards. They've got a new mobile phone standard, called GSM, which has to be seen to be believed. For one thing, you can pack your bag in London, fly to Perth, take your phone out of the bag, and it will work. Period. You might not, but it will. (Mr. Protocol, having not quite survived the London-to-LA part of his journey, emphasizes this.)

GSM, which stands for Groupe Special Mobile, is the name of the European standards group that developed a suite of protocols together with a technical specification for doing cellular telephony. They started from the position of the already-deployed American system, and so were able to build upon the shortcomings of that system and make use of digital technology a great

deal more sophisticated than was available when AMPS was designed.

The European standard was picked up worldwide, so GSM is now regarded as standing for Global System for Mobile communications. Even in this country, some of the new PCS services are being designed to a derivative of GSM called PCS1900.

Each GSM phone is a mobile digital terminal. Communication with the local cell site is by means of packets, and each phone is continually aware of a number of factors of which its American cousin is ignorant, having to do with the current state of the system.

GSM divides the radio spectrum into a series of 124 channels, spaced 200 kHz apart. This would seem like plenty of space, but they further divide each channel into time slots. The smallest unit of time is a *burst*. Eight bursts make up a *frame*, which is the basic unit of channel traffic.

We won't go into the details of how bursts and frames are laid out, nor of how they are mixed up with the channels. Suffice it to say that the phone doesn't stay on a single frequency channel: A "traffic channel" wanders over available frequencies and time slots in a pattern or coding scheme that repeats about every three hours. This has the effect of spreading ambient interference among all users in such a way that it's tolerable for everyone, and also makes interception of a call just about impossible.

Several things fall out in the wash almost immediately.

First, cellular modems are no longer necessary. The GSM phone is a digital device. It is ISDN-compatible, though it cannot carry a full 64-Kb/s B-channel data stream over the radio link because of insufficient bandwidth. Still, it can carry 9,600 baud just fine, either digitally, or, if you are communicating with an audio modem at the other end, via a cellular modem. The point is that if the other end is prepared to speak ISDN, you don't need the modem.

Second, the numbering system for phones is part of the standard and doesn't come from the same pool of numbers as ordinary telephones. Cellular phones are one big reason why so many parts of the United States keep having new area codes carved out of them. Under GSM, cellular phone numbers don't look like ordinary numbers, and are drawn from a different pool. This also helps the cellular network route calls.

Third, not all the channels on the phone are used for speech data. There is another service, called the Short Messaging Service, that allows owners of GSM phones to exchange short alphanumeric text messages between phones, somewhat like a pager. Such messages can also originate from computer users elsewhere in the network. The display on a typical GSM phone is a multiline LCD display, similar to that of an advanced pager, rather than the fairly simple display you find on an AMPS phone.

One reason for the multiline display

is that the GSM phone is a superstar at roaming. It can interoperate with any other GSM network anywhere, and the phone continually displays the names of the GSM systems that it is able to hear. In one startling display, Mr. P. observed a GSM phone owner standing on the cliffs of Dover acquire two different GSM systems in France.

This is exactly the sort of international roaming that the members of the European Union need to conduct their business, and they are profoundly thankful for it. It means that they can carry their phones with them everywhere, and they will work with no fuss or bother.

Calling Costs

Another major benefit is the charges. GSM phone users are only charged for outgoing calls. Incoming calls are charged to the caller. Because GSM numbers are organized out of a different number space, those calling a mobile number have some idea ahead of time what charges will accrue. The GSM user does pay any roaming charges, of course, from his home location to his actual location.

The only even remotely sticky situation comes when a user who is roaming internationally receives an incoming call from someone in a third country. In this case, both parties wind up paying for pieces of an international call, and courtesy dictates that the person with the GSM phone call the other party back to keep international charges down to a single party.

So how much does all this cost? Good question. In Los Angeles, where Mr. Protocol resides, cellular phone charges are among the highest in the country because a very significant fraction (some estimates range as high as 40%) of cellular phone traffic is fraudulent. The digital part of the AMPS signal, identifying the phone and the phone number, is easily intercepted, and phones may be easily reprogrammed to "steal" the cellular airtime of a legitimate subscriber.

With a GSM phone, the phone's own identity module is combined with a key that it obtains from a subscriber-owned Subscriber Identity Module, which uniquely identifies the subscriber as opposed to the phone. This SIM module contains a cryptographic key that is known to the GSM system, and is used in a typical challenge-response manner to encode a challenge message sent by the GSM system to the phone. The GSM system compares the encrypted result with the result expected from the key in its database and authenticates the transaction.

In fact, this key can be used to encrypt all of the packets used in the call, in case of rampant paranoia. The result is a level of piracy so low that GSM rates in London are actually lower than equivalent cellular phone rates in Los Angeles, despite the much greater capabilities of the GSM system.

New PCS services, some of which will be using the GSM derivative PCS1900, may give us even better technologies in the future, at least in urban centers.

Of course, there is not just one GSM provider. There are several, each with its own multitier charging structure, as in the United States. One difference is that there are more than two providers. There are now four, and counting, though two are upstarts building new networks to challenge the two "old-timers."

What about the phones themselves? Well, Mr. Protocol opines that they're chunky little buggers. They don't compare with his triband Icom ham radio handheld, known as the "dark alley radio" for its ability to fell a young steer if properly wielded. But for those whose attachment to the tailored lines of their suits has swelled the chorus of "thinner, thinner, thinner!" the new phones may be a disappointment. Their form factors are what anyone could wish in terms of small size as far as width and height goes, but there is a significant amount of silicon to be crammed into these things, and the result is that comparing phones of the same generation between GSM and AMPS will leave the GSM phones looking significantly thicker front to back.

Will GSM ever be installed in this country? Good question. AMPS will keep its spectrum for a long time, thanks to the huge installed base of AMPS phones, but if fraud keeps going the way it has been, there may be a backlash. The United States has never been overly sensitive to the technical convenience of others (now there's an understatement) so the pull toward sharing GSM roaming, while strong, will probably be insufficient to overcome inertia in the marketplace.

On the other hand, new PCS services, some of which will be using the GSM derivative PCS1900, may give us even better technologies in the future, at least in urban centers. Mr. Protocol doesn't think the idea of having a portable ISDN line in the pocket is such a shabby one.

For more information about GSM, see `http://ccnga.uwaterloo.ca/~jscouria/GSM/gsmreport.html`

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Mr. Protocol gratefully acknowledges the help of Mr. Graeme Sutherland in uncovering these marvelous toys. ➸

Mike O'Brien has been noodling around the UNIX world for far too long a time. He knows he started out with UNIX Research Version 5 (not System V, he hastens to point out), but forgets the year. He thinks it was around 1975 or so.

He founded and ran the first nationwide UNIX Users Group Software Distribution Center. He worked at Rand during the glory days of the Rand editor and the MH mail system, helped build CSNET (first at Rand and later at BBN Labs Inc.) and is now working at an aerospace research corporation.

Mr. Protocol refuses to divulge his qualifications and may, in fact, have none whatsoever. His email address is `amp@cpg.com`.