COMMONWEALTH OF MASSACHUSETTS
SUPREME JUDICIAL COURT

BERKSHIRE, ss. CASE NO. SJC-11277

COMMONWEALTH
Appellee

v.

CORY A. MOODY, ET. AL.
Appellant

ON APPEAL FROM THE JUDGMENT OF THE BERKSHIRE SUPERIOR COURT

BRIEF OF AMICI CURIAE JORGE AREIZA, HECTOR DEJESUS PUERTA, ALEJANDRA GOMEZ, DARNEY GOMEZ-MESA, THE MASSACHUSETTES ASSOCIATION OF CRIMINAL DEFENSE LAWYERS, AND THE NATIONAL ASSOCIATION OF CRIMINAL DEFENSE LAWYERS, AND RECORD APPENDIX

WHITE & ASSOCIATES, P.C.
VERONICA J. WHITE, ESQ.
BENJAMIN LEATHERMAN, ESQ.
101 TREMONT STREET, SUITE 1010
BOSTON, MA 02108
TEL: (617) 338-9507

PETER ETTENBERG, ESQ.
GOULD & ETTENBERG, P.C.
370 MAIN STREET
WORCESTER, MA 01608
TEL: 508-752-6733

FRANK CAMERA, ESQ.
LAW OFFICE OF FRANK CAMERA
70 SOUTH MAIN STREET
FALL RIVER, MA 02721
TEL: (617) 413-9382

PETER CLIFFORD, ESQ.
LAW OFFICE OF PETER CLIFFORD
47 HARVARD STREET
WORCESTER, MA 01609
TEL: (508) 757-8338

MAX D. STERN, ESQ.
PRESIDENT
MASSACHUSETTS ASSOCIATION OF
CRIMINAL DEFENSE LAWYERS, INC.
STERN, SHAPIRO, WEISSBERG & GARIN,
L.L.P.
90 CANAL ST., SUITE 500
BOSTON, MA 02114
TEL: (617) 742-5800

MICHAEL J. IACOPINO, ESQ.
NATIONAL ASSOCIATION OF CRIMINAL
DEFENSE LAWYERS
BRENNAN, CARON, LENEHAN & IACOPINO
85 BROOK STREET
MANCHESTER, NH 03104
TEL: (603) 668-8300

Table of Contents

Table of Authorities

RULES, STATUTES, AND OTHER AUTHORITIES

Issue Presented

I. Whether G.L. Ch. 272 § 99 authorizes a Superior Court judge to issue a warrant permitting state law enforcement officers to intercept cellular calls and/or text messages

Statement of Interest of Amici Curiae

Jorge Areiza, Darney Gomez-Mesa, Alejandra Gomez, and Hector DeJesus Puerta are currently facing various drug charges in Worcester Superior Court (Comm. v. Areiza, No. WOCR2011-00765, Comm. v. Gomez-Mesa, No. WOCR2011-00766, Comm. v. Gomez, WOCR2011-00764, and Comm. v. DeJesus Puerta, WOCR2011-00767) During the investigation of these cases, law enforcement officers applied for and were granted multiple wiretaps for various cellular phones, and intercepted a myriad cellular phone calls and text messages. These intercepted calls and messages were the backbone of the probable cause which led to the issuance of various search and arrest warrants, eventually leading to the charges faced by the amici curiae. Mr. Areiza has filed a Motion to Suppress Evidence Obtained from Electronic Surveillance in his case based on similar arguments as those presented in this case (and that motion will be joined by Gomez-Mesa, DeJesus Puerta and Gomez), to wit that the issuing court did not have the legal authority to issue a warrant allowing

state law enforcement officers to intercept cellular phone calls and text messages. Thus, Mr. Areiza, Mr. Gomez-Mesa, Ms. Gomez, and Mr. DeJesus Puerta's cases will be seriously impacted by the decision in this case. Because amici curiae have such a vested interest in the outcome of this case, and because this case will have a serious impact on the due process and privacy rights of the citizens of the Commonwealth, we have filed this Amicus Brief the behalf of the amici curiae.

The Massachusetts Association of Criminal Defense Lawyers (MACDL), as amicus curiae, submits this brief in support of defenant-appellants Cory Moody and David Newman. MACDL is an incorporated association of more than 1,000 experienced trial and appellate lawyers who are members of the Massachusetts Bar and who devote a substantial part of their practices to criminal defense.

MACDL is dedicated to protecting the rights of the citizens of the Commonwealth guaranteed by the Massachusetts Declaration of Rights and the United States Constitution. MACDL seeks to improve the criminal justice system by supporting policies and procedures to ensure fairness and justice in criminal matters. MACDL devotes much of its energy to identifying, and attempting to avoid or correct, problems in the criminal justice system. It files *amicus*

curiae briefs in cases raising questions of importance to the administration of justice.

The National Association of Criminal Defense Lawyers ("NACDL") is a non-profit organization with direct national membership of over 10,000 attorneys, in addition to more than 40,000 affiliate members from all 50 states. Founded in 1958, NACDL is the only professional bar association that represents public defenders and private criminal defense lawyers at the national level. The American Bar Association recognizes NACDL as an affiliated organization with full representation in the ABA House of Delegates.

NACDL's mission is to ensure justice and due process for the accused; to foster the integrity, independence, and expertise of the criminal defense profession; and to promote the proper and fair administration of criminal justice, including issues involving the Bill of Rights.

Statement of the Case

Amici adopt the Statements of the Case as set forth in the Appellants' opening brief.

Statement of Facts

Amici adopt the Statements of the Facts as set forth in the Appellants' opening brief.

Argument

A Massachusetts Superior Court does not have the legal authority to issue a warrant allowing state law enforcement officers to intercept cellular telephone calls nor text messages.

I. CELLULAR PHONE COMMUNICATIONS AND TEXT MESSAGES ARE NOT "WIRE COMMUNICATIONS" UNDER G.L. c. 272, § 99

a. Tenets of statutory construction require that G.L. c. 272, § 99 be construed to state that Massachusetts Superior Courts are not authorized to issue wiretap warrants of cellular phone communications

Title III of the Omnibus Crime Control and Safe Streets Act of 1968, codified at 18 U.S.C. § 2510 *et seq.* ("Title III"), prohibits the interception of electronic, wire and oral communications except under carefully delineated circumstances and only after securing judicial approval. The Act imposes strict preconditions that must be met before any wiretap warrant can be issued:

> Congress legislated in considerable detail in providing for applications and orders authorizing wiretapping and evidenced the clear intent to make doubly sure that the statutory authority be used with restraint and only where the circumstances warrant the surreptitious interception of wire and oral communications. These procedures were not to be routinely employed as the initial step in criminal investigation. Rather, the applicant must state and the court must find that normal investigative procedures have been tried and failed or reasonably appear to be unlikely to succeed if tried or to be too dangerous.

United States v. Giordano, 416 U.S. 505, 514-515 (1974). Section 2516(2) of Title III authorizes the states to enact their own wiretap statutes.

Any such statutes, however, must meet the minimum standards reflected in the federal statute. *Commonwealth v. Vitello*, 367 Mass. 224, 247 (1975). That is, while the states may adopt legislation more restrictive than Title III, or no legislation at all, they may not adopt less restrictive legislation. *Id.* As such, a wiretap order must comply with state as well as federal law. *United States v. Moore*, 41 F.3d 370, 373 n. 1 (8th Cir. 1994), rehearing denied, (Jan. 19, 1995), cert. denied, 514 U.S. 1121 (1995). Where evidence is obtained under a state statute that is less restrictive than Title III, the evidence is inadmissible in state courts. *Vitello*, 367 Mass. at 247.

The warrant in this case was authorized pursuant to G.L. c. 272, § 99, the Massachusetts wiretap statute, and Massachusetts State Courts do not have the authority to issue warrants for the electronic surveillance of cellular phone conversations.

When Congress enacted Title III, it endeavored to bring uniformity to procedures for the issuance of wiretaps and the protection of privacy. Sen. Rep. 1097, 1968 U.S.Code and Admin.News, p. 2194. Section 2516(2), which provides

authorization for the states to enact similar statutes, requires that state statutes be at least as protective as the federal statute. *Commonwealth v. Vitello*, 367 Mass. 224, 247 (1975) ("[A] state may not adopt standards that are less restrictive than those set forth in Title III"). Where evidence is obtained under a state statute that is less restrictive than Title III, the evidence is inadmissible in state courts. *Id.*

In *Schneidewind v. ANR Pipeline Co.*, 485 U.S. 293, 299-300 (1988), the Supreme Court recognized that federal pre-emption of state law occurs when, even though Congress has not entirely displaced state regulation of the particular field, a state law conflicts with federal law. Such a conflict is found "when it is impossible to comply with both state and federal law, or where the state law stands as an obstacle to the accomplishment of the full purposes and objectives of Congress." *Id.* (internal citations omitted).

As originally enacted in 1968, Title III defined "wire communication" as

> [A]ny communication made in whole or in part through the use of facilities for the transmission of communications by the aid of wire, cable, or other like connection between the point of origin and the point of reception furnished or operated by any person engaged as a common carrier in providing or operating such facilities for the transmission of interstate or foreign communications.

18 U.S.C. (S) 2510 (1968). In 1986, Congress passed the Electronic Communications Privacy Act (the "Privacy Act"), thereby extending Title III's privacy protections to persons communicating via cellular phone. *Bartnicki v. Vopper*, 532 U.S. 514, 524 (2001) (holding that one purpose of federal wiretap law is to protect privacy of wire and oral communications.) In so doing, Congress recognized that cellular telephone communications did not come within the definition of "wire communications" as originally defined.[1] As stated in the Senate Report to the Privacy Act,

> When a caller dials a number on a cellular telephone, a transceiver sends signals *over the air on a radio frequency* to a cell site. From there, the signal travels over phone lines *or a microwave* to a computerized mobile telephone switching office (MTSO) or station. The MTSO automatically and inaudibly switches the conversation from one base station and one frequency to another as the portable telephone . . . moves from cell to cell.

Sen.Rep. 99-541 (1986) 3563 (emphasis added). The Privacy Act therefore amended Title III's definition of "wire communication," which now reads:

> any aural transmission made in whole or in part through the use of facilities for the transmission of communications by the aid of wire, cable, or other like connection between the point of origin and the point of reception *(including the use of such connection in a*

[1] See Sen. Rep. 99-541 (1986) 3559: "[T]here are no comparable Federal statutory standards to protect the privacy and security of communications transmitted by new noncommon carrier communications services or new forms of telecommunications and computer technology."

> *switching station)* furnished or operated by any person engaged in providing or operating such facilities for the transmission of interstate or foreign communications or communications affecting inter-state or foreign commerce.

18 U.S.C. § 2510 (1). Additionally, the statute went on to further define an "aural transfer" as "a transfer containing the human voice at any point **between and including** the point of origin and the point of reception." Id § 2510 (18). Finally, the statute carefully defines electronic communications[2] as separate and distinct from wire communications. Id § 2510 (12). The Federal Legislature carefully crafted these new amendments to reflect the changing technology, clearly believing that the original 1968 statute was inadequate.

The current definition of "wire communication" under G.L. c. 272, § 99 does not follow the amended federal statute, but rather the original version. A "wire communication" in Massachusetts is:

> any communication made in whole or in part through the use of facilities for the transmission of communications by the aid of wire, cable, or other like connection between the point of origin and the point of reception.

In construing the wiretap statute, Massachusetts courts look to the interpretation provided in federal case law of "the cognate provisions" of the federal statute." *O'Sullivan*

[2] "any transfer of signs, signals, writing, images, sounds, data, or intelligence of any nature transmitted in whole or in part by a wire, radio, electromagnetic, photoelectronic or photooptical system"

v. Nynex Corp., 426 Mass. 261, 264 (1997). Although the Supreme Court explicitly stated that it was the enactment of the Privacy Act that extended Title III protections to cellular phone communications in *Bartnicki*, 532 U.S. at 524, it is noteworthy that other federal courts interpreting Title III prior to the enactment of the Privacy Act concluded that cellular phone communications were not protected "wire communications." For instance, in *Edwards v. State Farm Ins. Co.*, 833 F.2d 535, 540 n.8 (5th Cir. 1987), the court determined that the Privacy Act did not retroactively apply to cellular phone communications. *See also United States v. Carrazana*, 921 F.2d 1557, 1563 (11th Cir. 1991) (indicating Florida statute modeling original definition of "wire communication" under Title III did not apply to cellular phone communications) *United States v. Suarez*, 906 F.2d 977, 980 (1990)("Voice communications transmitted via common carrier were protected under the 1968 act, but 'there [were] no comparable Federal statutory standards to protect the privacy and security of communications transmitted by … new forms of telecommunications and computer technology.'" (*quoting* Sen. Rep. No. 541, 99th Cong., 2d Sess. 5, *reprinted in* 1986 U.S.Code No. 541, 99th Cong., 2d Sess. 5, *reprinted in* 1986 U.S.Code Cong. & Admin.News 3555, 3589.) Therefore, because

the federal courts have construed Title III's original definition of "wire communication" as inapplicable to cellular phones, and it is that original definition on which G.L. c. 272, § 99 is based, it follows that in construing the "cognate provisions" of G.L. c. 272, § 99, those provisions do not apply to cellular communications.

Moreover, rules of statutory construction demonstrate that the phrase "by the aid of wire, cable, or other like connection" as contained within G.L. c. 272, § 99 cannot be said, in itself, to include signals sent "over the air on a radio frequency" or by microwave. The principle of *ejusdem generis* is employed to ascertain the correct meaning of words by limiting the general terms in a statute that follow specific terms to matters similar to those specified." *Powers v. Freetown-Lakeville Regional School Dist. Committee*, 392 Mass. 656, 660 n.8 (1984). The words "wire" and "cable" indicate some kind of tangible line of transmission. As such, "other like connection" cannot broaden the definition of "wire communication" to include signals sent by radio or microwave, nor the myriad communication methods beyond what was possible or even imagined when the statute was written. Additionally, criminal statutes are construed narrowly, and courts must "resolve in favor of criminal defendants any reasonable

doubt as to [a] statutes meaning." *Comm. v. Bolling*, 72 Mass.App.Ct. 618, 623 (2008) (citing *Comm. v. Pagan*, 445 Mass. 161, 167 (2005).

G.L. c. 272, § 99, in describing what a wiretap application must contain, requires that all applications must state that the communications being intercepted will "occur in a specifically described place and premises or over particularly described telephone or telegraph lines." G.L. 272, § 99 F 2c. This language serves to yet again demonstrate how beholden G.L. c. 272, § 99 is to a 1960's understanding of communication technology, as by their very nature it is impossible to describe with particularity the place or premises where a cellular phone will be used due to their mobile nature, nor the telephone lines over which the communication will travel. The reason that the telephone lines over which cellular phone calls will travel cannot be specified is because, as a cell phone travels from place to place, it will connect with a different cellular tower (each of these towers has a zone, or "cell," in which all calls from cellular phones on that network will be routed to that specific tower), and each of these towers has its own wired connection to a mobile telephone switching office (MTSO). Marshall Brain et al., *How Cell Phones Work*, November 2000, http://electronics.howstuffworks.com/cell-phone.htm, R. 6.

Each cell is generally not larger than ten square miles. Id at R. 4. Thus, as one travels, they move from cell to cell, which means that the cell phone connects to different towers all connecting to the MTSO via a different wire. Further, if one travels beyond the MTSO's area or begins roaming, the tower to which he/she is connected will be transmitting to a different MTSO. Id at R. 6. Thus, it would be impossible for a cellular phone wiretap application to describe with particularity either the place and premises where the calls will occur or specific telephone lines as required by the statute. Notably, the updated federal wiretap statute no longer requires the specificity of the location where the device will be used or the specific line, but instead simply requires a description and location of the place where the communication is to be intercepted. 18 U.S.C. § 2518 (1)(b).[3] Thus, under the federal statute, law enforcement agents can simply name the switching office where the communications will be intercepted. While there could perhaps be an argument that "telephone line" simply

[3] Specifically, the statute requires the following: a full and complete statement of the facts and circumstances relied upon by the applicant, to justify his belief that an order should be issued, including (i) details as to the particular offense that has been, is being, or is about to be committed, (ii) except as provided in subsection (11), a particular description of the nature and location of the facilities from which or the place where the communication is to be intercepted, (iii) a particular description of the type of communications sought to be intercepted, (iv) the identity of the person, if known, committing the offense and whose communications are to be intercepted;

refers to a telephone number rather than a specific physical line, lumping telephone lines in with telegraph lines in the manner in which the statute does strongly suggests that the legislators at the time were referring to a physical line, and the intrusion on the privacy rights of individuals that the broader reading would create demands that the statute must be construed narrowly and in favor of the criminal defendant. *Bolling,* 72 Mass.App.Ct. at 623.

"The words of a statute are the main source for the ascertainment of a legislative purpose. They are to be construed according to their natural import in common and approved usage." *Comm. v. Welosky,* 276 Mass. 398, 401-402 (1931.) The plain English reading of the requirement in this statute makes it clear that in the statement "telephone or telegraph lines" both telephone and telegraph are being used as adjectives to describe the noun "lines." G.L. 272, § 99 F 2c. Attempting to read this section as stating that the application had only to describe with specificity the telephone used would leave a singular noun floating in the sentence with no article to identify it, which is clearly not just the form of language used to write the statute as earlier in the section the statute refers to "*the* particularly described person or persons" (emphasis added). G.L. 272, § 99 F 2c. Thus, the statute, by its plain English

meaning, clearly requires a particular telephone line or location of use to be specified in order to obtain a wiretap. Further, with the way cellular phone calls jump between cell towers and switching stations as an individual moves about, describing with anywhere near the particularity required by the statute the specific telephone line or lines on which the interception would take place would be impossible. Marshall Brain et al., *How Cell Phones Work* at R. 6. Thus, reaching the level of particularity required by the statute is simply not possible when dealing with cellular phone communications.

When a statute *does* require interpretation, it should be "interpreted ... in connection with their development, their progression through the legislative body, the history of the times, prior legislation, contemporary customs and conditions and the system of positive law of which they are part." *EMC Corp. v. Commissioner of Revenue*, 433 Mass. 568, 570 (2001.) The language in this statute was created in the context of 1960's communication technology – telephones and telegraphs. The legislature in 1968 could not have possibly imagined the impact that cell phone technology (which did not even exist in the 1960's) would have in the way we communicate – neither in the frequency of calls nor in the rise and proliferation of text messaging services (which

were intercepted under the wiretap in this case) and email communication to and from cellular phones which blur the line between telephone communication and written correspondence. Further, individuals donate to charities via text message, receive reminders about medical appointments, receive bulletins from organizations of which they are members, and send links to websites they are reading and want others to read. None of this could have even been contemplated with the telephone technology that existed in the 1960's, and all of which can be intercepted by a wiretap authorized by this statute written in the context of that technology. Finally, as smart phones (which today are essentially used as personal computers) become more and more commonplace, even more information and communications could fall under this increasingly broad interpretation of "wire communications" - private data synced via cloud services including personal contacts, photographs, videos, and documents, websites visited, online purchases, WebMD symptom searches, Google searches, dating site information, and much, much more, all of which travel over the cellular phone networks, all of which involve travelling over wires at some point in their transmission, and all of which could be just as much a "wire communication" under the incredibly flexible definition that has been utilized by Massachusetts courts

thus far in stretching this statute to fit changing technology.

With regard to *Company v. United States* 349 F.3d 1132 (9th Cir. 2003,) which the Commonwealth cites as standing for the proposition that cellular phone calls are considered wiretap communications, in the same footnote quoted by the Commonwealth the court explains that this is true because the "addition of "switching station" as part of the definition of wire communication was meant to incorporate cellular communications." *Company*, 346 F.3d at 1138. G.L. c. 272, § 99 contains no such reference to a switching station. Further, it is clear from the cited footnote that *Company* is deciding this issue under Title III as amended in 1986, not definitions that mirror G.L. c. 272, § 99. *Id.* The other cases cited by the Commonwealth in support of this position similarly contemplate the post-amendment language of the federal statute (with the exception of *United States v. Santiago*, 2011 U.S. Dist. Lexis 112993, * 9 (D. Mass. Sept. 30, 2011), which was a federal district court case addressing this issue.) *See In re United States for an Order Directing Provider of Elec. Comm.*, 620 F.3d 304, 310 (3rd Cir. 2010.)

The confluence of the requirement that criminal statutes be construed narrowly and in the favor of the

criminal defendant and the requirement that all warrants be particular to limit the scope of any search or seizure exists to preserve the privacy rights of the people of Massachusetts and to protect individuals against "general exploratory rummaging" by the police. *Bolling,* 72 Mass.App.Ct. at 623 and *Comm. v. Pope,* 354 Mass. 625, 629 (1968.) If the 1960's language of this statute can be construed to allow the interception of communications not even contemplated by the authors of the statute and that contain information that could not be transmitted by telephone when the statute was written, then these protections are effectively meaningless. Such a broad interpretation of a statute would allow a court to simply flex statutes to fit whatever situation presents itself, turning judges into de facto legislators instead of the legislature amending existing laws or drafting new laws as necessary. Society has a vested interest in having clear, explicit laws especially when said laws are criminal statutes or laws that relate to privacy rights, and that interest is thrown aside when courts construe meanings further and further afield from the original language of the statute. The bottom line is that, with respect to intercepting cellular phone communications, be they audio or text, courts "cannot infer that the Legislature intended

[the statute] to apply to communications technologies to be developed after the time of enactment or amendment...Any change in the statute is for the Legislature, not the courts." *Comm. v. Richards*, 426 Mass. 689, 691 (1991) (holding that G.L. c. 269, § 14A, prohibiting using a telephone to harass or annoy another, does not apply to facsimile transmission, showing that outdated statutes should not be construed to include new technologies.)

b. Cellular phone communications and text messages are not "wire communications" under G.L. c. 272, § 99 because there is no transmission of human voice between the point of origin and the point of reception, as required by the statute

A cellular phone call is never transmitted as audio, but is only transmitted as digital data. (See attached Affidavit of Michael Verronneau R. 1, attached to Brief for David Newman as R.240.) When an individual makes a call on his or her cellular phone, software on the cellular phone converts the audio into binary code. (Id.) The *binary code* is then transmitted to the cellular tower, across the cellular network, and then eventually reaches the recipient's cellular phone. (Id.) Software (called a codec) on the recipient's phone then converts that binary data back into audio, and plays that audio for the user. (Id.) Thus, at no point is anything but *binary data* ever transmitted anywhere in the cellular network. No audio or voice is ever

transmitted. If this binary data was determined to be a transmission of human voice simply because it can, with the proper software, be turned back into an audio projection, then under that definition any file containing audio, a movie file, an mp3 file, any recording that contains data which can be converted by software back into a human voice would be a wire communication. A 1960's statute that contemplates the interception of telephone lines and telegraph communications simply cannot simultaneously be construed to allow the interception of encrypted binary data that can be converted to audio by software.

G.L. c. 272, § 99 mirrored the Federal Wiretap Act, 18 U.S.C. § 2510, which defined a wire communication as noted above. Cellular phone calls and text messages are not "oral communications" as contemplated by the statute, as oral communications involve the overhearing of a conversation or an "utterance" by a person. *Comm. v. Hyde*, 434 Mass. 594, 596-597 (2001.) Neither are cellular phone calls or text messages "wire communications." As noted above, in 1986, with the passage of the Electronic Communication Privacy Act, Congress amended the 1968 statute and discussed its sections in detail. See Sen. Rep. 99-541 1986 U.S.C.C.A.N 3555, 3566. These reports make it clear that "wire communication" means the transfer of a communication

including the human voice at some point, stating that "The term 'wire communication' includes existing telephone service and digitized communication to the extent that they contain the human voice." Id. Although these reports go on to note that this definition would now include a human voice which had been converted to data, it is important to note that these reports refer to the discussion of the new statute, and the definitions that would be present in that statute. Id. The ECPA also defined a "wire communication" to require an "*aural* transfer." 18 U.S.C. § 2510. Congress further went on to carefully define an aural transfer as "a transfer containing the human voice at any point ***between and including*** the point of origin and the point of reception." 18 U.S.C. § 2510 (18.) Congress was careful to note that this definition could include **both** the point of origin and the point of reception, not simply the points in between. However, G.L. c. 272, § 99 defines wire communication as **only** encompassing communications ***between*** the point of origin and the point of reception. As noted above, all the transfers between the origin and recipient cellular phone is *data*, the human voice is never transferred. Thus, cellular phone data is not a "wire communication," as contemplated under the statute, as it never involves the transmission of the human voice, only binary data. This same line of

reasoning demonstrates why text messages cannot be intercepted under G.L. c. 272, § 99.

c. Interpreting G.L. c. 272, § 99 to allow the interception of cellular phone calls and text is improper judicial legislation and a violation of the due process and privacy rights of citizens of the Commonwealth

Legislators, both federally and *here in Massachusetts* have taken note of the fact that the language used in G.L. c. 272, § 99 (and its federal counterpart) is woefully inadequate to deal with the vast changes in technology in the last half century. As noted above, the federal statute that originally had language similar to G.L. c. 272, § 99 was amended after the advent of cellular phone technology to a more specific definition to encompass that technology. Additionally, various bills have come before the Massachusetts senate to update the language of the statute to comport with the technological realities of today. 2011 MA S.B. 2080[4], *see also* 2011 MA S.B. 2059 *and* 2011 MA S.B.

[4] Specifically, 2011 MA S.B. 2080 would amend the language to the following: The term "wire communication" means any transfer made in whole or in part through the use of facilities for the transmission of communications by the aid of wire, cable, or other like connection between the point of origin and the point of reception, including the use of such connection in a switching station, furnished or operated by any person engaged in providing or operating such facilities for the transmission of such communications and shall include: any transfer of signs, signals, writing, images, sounds, data or intelligence of any nature transmitted in whole or in part by a wire, radio, electromagnetic, photo-electronic or photo-optical system, but shall not include: (i) any communication made through a tone-only paging device; (ii) any communication from a tracking device, defined as an electronic or mechanical device which permits the tracking of the movement of a person or object; or (iii) electronic funds transfer information stored by a

2054. Those bills are the proper vehicle for an altering of the statute to incorporate more forms of communication than the legislators originally intended. Insofar as superior courts (and the U.S. District Court of Massachusetts in *U.S. v. Gianelli*, 585 F.Supp.2d 150, 163 (2008)) have found that the language of G.L. c. 272, § 99 can be construed to alow for the interception of cellular communications, their improper jury-rigging of G.L. c. 272, § 99 to make it fit technologies increasingly far afield from those anticipated by the authors is, to be frank, improper hijacking of the legislative process by the courts and effectively unilateral amendment of a statute by the court system. *See e.g. Commonwealth v. Miranda*, Criminal Action 09-10935 and 10936 (Suffolk Superior Court, January 19,2011) (Kaplan, J.); *Commonwealth v. Cariello*, Criminal Action 08-918 (Middlesex Superior Court, August 17,2009) (Roach, J.); *Commonwealth v. Wedderburn*, Criminal Action No. 08-944 (Hampden Superior Court, January 6,2011) (Agostini, 1); *Commonwealth v. Alleyne*, Criminal Action 06-1982 (Essex Superior Court, November 1, 2007) (Kern, 1.); *Commonwealth v. Aldanaf* Criminal Action 02-0216 (Middlesex Superior Court, September 25, 2003) (Hamlin, 1.); *Commonwealth v. Sanders*, Criminal

---

financial institution in a communications system used for the electronic storage and transfer of funds.

Action 2000-1533 (Middlesex Superior Court, August 18,2003) (Donovan, J.)

Comm. v. Wyatt, 30 Mass.L.Rptr 270 (2012), serves to show yet another of the myriad problems in equating cellular phone technology with that of traditional telephones. In *Wyatt*, the Commonwealth had requested court orders for cellular tower site location information (CSLI) for various cellular phone numbers used by the defendants in the case without supporting applications demonstrating probable cause. *Id* at 1. Because cellular phones will periodically automatically connect to nearby wireless antennas at base stations whenever they are on (even when not making a call), as well as connecting whenever a call is made or the phone moves out of one base station's zone and into another, any cellular phone can be used as a de facto GPS to track an individual's movement throughout the day. *Id* at 2. Although *Wyatt* was a case about GPS tracking using cellular phones, it stands for the broader proposition that lawmakers before the near past could not possibly have foreseen the uses to which modern people put cell phones, and the sort of information which could be gathered from monitoring the phones. *Wyatt*, 30 Mass.L.Rptr 270 at 7. The *Wyatt* court was correctly concerned with what sort of data could be garnered from tracking a person's movement through their phone, data

like "trips to the psychiatrist, the plastic surgeon, the abortion clinic, the AIDS treatment center, the strip club, the criminal defense attorney, the by-the-hour motel, the union meeting, the mosque, synagogue or church, the gay bar and on and on." *Wyatt*, 30 Mass.L.Rptr. 270 at 7, quoting *People v. Weaver*, 12 N.Y. 3d 433, 441-442 (2009.) As discussed above, much of that same data could be obtained through the monitoring of text messages and internet data, all of which travels through the cellular network.

In short, trying to shoehorn modern communication technology into the language of a statute written in a time when the people still used rotary phones and which is far enough out of touch with modern technology that it contemplates the interception of *telegraph* communications is simply far too removed from the principal of narrow statutory construction. G.L. c. 272, § 99.

II. EVEN IF THE LANGUAGE OF THE MASSACHUSETTS WIRETAP ACT COVERS CELLULAR PHONE COMMUNICATIONS, MASSACHUSETTS STATE COURTS HAVE NO AUTHORITY TO ISSUE WIRETAP WARRANTS FOR SUCH COMMUNICATIONS BECAUSE THE LEGISLATURE DID NOT UPDATE THE STATUTE AS MANDATED BY CONGRESS

When Congress passed the Privacy Act in 1986, it provided for a "grace period" during which the states could amend their laws to conform with federal law, but after which, if no such amendments were made, federal law took effect. That is, where a state failed to amend its wiretap

statute within the provided grace period, then federal authorization to intercept is required. *Brown v. Waddell*, 50 F.3d 285, 289-290 (1995.) Specifically, Congress provided:

> Any interception pursuant to section 2516(2) of title 18 of the United States Code which would be valid and lawful without regard to the amendments made by this title shall be valid and lawful notwithstanding such amendments if such interception occurs during the period beginning on the date such amendments take effect and ending on the earlier of - (1) the day before the date of the taking effect of State law conforming the applicable State statute with chapter 119 of title 18, United States Code, [18 U.S.C. 2510 *et seq.*] as so amended; or (2) the date of two years after the date of the enactment of [the Privacy Act].

Pub. L. 99-508, § 111(b) (1986).

For example, in *United States v. Carrazana*, 921 F.2d 1557, 1563 (11th Cir. 1991), the court concluded that the state court had authority to wiretap the defendant's cellular phone, even though the statute modeled the original version of Title III because the authorization had been made in 1987, during the two-year "grace period." By contrast, in *Waddell*, 50 F.3d at 290 n.5, the court concluded that the North Carolina state court had no power to issue the wiretap order because it was issued after the two-year grace period, but before North Carolina had updated its statute to comply with the Privacy Act. Even if the definition of "wire communication" within § 99 can be interpreted to cover such communications without the need to amend it, Congress

clearly thought the definition was insufficient to protect privacy rights and maintain national uniformity for wiretap procedures. When Congress amended Title III in 1986, it was surely aware that most state wiretap statutes modeled their definition of "wire communication" on the federal statute. Nonetheless, it required the states to update their respective statutes, lest their courts lose power to authorize such wiretap orders. In so doing, it denied the courts of those states that did not update their statutes the power to even consider whether their respective statutes cover cellular phone communications.

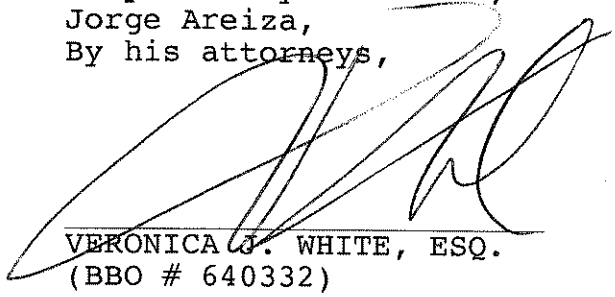
Massachusetts has not updated its wiretap statute to comply with the Privacy Act's protection for cellular phone communications. Even if the definition of "wire communication" within G.L. c. 272, § 99 can be interpreted to cover such communications without the need to amend it, Congress clearly thought the definition was insufficient to protect privacy rights and maintain national uniformity for wiretap procedures. When Congress amended Title III in 1986, it was surely aware that most state wiretap statutes modeled their definition of "wire communication" on the federal statute. Nonetheless, it required the states to update their respective statutes, lest their courts lose power to authorize such wiretap orders. In so doing, it

denied the courts of those states that did not update their statutes the power to even interpret their respective statutes to cover cellular phone communications.

CONCLUSION

In conclusion, the court in this case had no authority to issue the wiretap warrant. Allowing courts to mold their interpretation of an antiquated statute to allow for wiretapping of cellular phones permits law enforcement to trample on the privacy rights of the residents of Massachusetts and consists of improper de facto legislation by the courts of the Commonwealth. If the legislature intends for G.L. c. 272, § 99 to allow the wiretapping of cellular phones and all of the communications they transmit, far beyond the capacities of any phone in existence at the time of the statutes writing, then the proper method to do so is through an amendment of the statute, not through increasingly broad judicial interpretations far surpassing the intent of the legislators in 1968.

Respectfully Submitted,
Jorge Areiza,
By his attorneys,



VERONICA J. WHITE, ESQ.
(BBO # 640332)

BENJAMIN F. LEATHERMAN, ESQ.
(BBO # 680267)
White & Associates, P. C.
101 Tremont Street
Suite 1010
Boston, MA 02108
Tel: (617) 338-9507

Hector DeJesus Puerta,
By his attorney,

PETER ETTENBERG, ESQ.
Gould & Ettenberg, P.C.
370 Main Street
Worcester, MA 01608
Tel: (508) 752-6733

Alejandra Gomez,
By her attorney,

FRANK CAMERA, ESQ.
Law Office Of Frank Camera
70 South Main Street
Fall River, Ma 02721
(617) 413-9382

Darney Gomez-Mesa,
By his attorney,

PETER CLIFFORD,ESQ.
Law Office Of Peter Clifford
47 Harvard Street
Worcester, MA 01609
Tel: (508) 757-8338

Massachusetts Association of
Criminal Defense Lawyers, Inc.
By its attorney,

MAX D. STERN, ESQ.
President
Massachusetts Association Of
Criminal Defense Lawyers, Inc.
Stern, Shapiro, Weissberg &
Garin, L.L.P.
90 Canal St., Suite 500
Boston, Ma 02114
Tel: (617) 742-5800

National Association of
Criminal Defense Lawyers,
By its attorney,

VERONICA J. WHITE, ESQ.
On behalf of,
MICHAEL J. IACOPINO, ESQ.
National Association of
Criminal Defense Lawyers
Brennan, Caron, Lenehan &
Iacopino
85 Brook Street
Manchester, NH 03104
Tel: (603) 668-8300

Dated: March 18, 2013

CERTIFICATE OF SERVICE

I, VERONICA J. WHITE, ATTORNEY FOR JORGE AREIZA, HEREBY STATE THAT I HAVE DULY SERVED A COPY OF THIS MOTION FOR LEAVE TO FILE TO A.D.A. JOSEPH A. PIEROPAN, ATTORNEY TIMOTHY M. FARRIS, COUNSEL FOR DAVID NEWMAN, AND ATTORNEY EDUMND R. ST. JOHN III, COUNSEL FOR CORY MOODY VIA FIRST CLASS MAIL ON THIS 18TH DAY OF MARCH IN THE YEAR OF 2013.

VERONICA J. WHITE, ESQ.

CERTIFICATE OF COMPLIANCE PURSUANT TO RULE 16(K) OF THE MASSACHUSETTS RULES OF APPELLATE PROCEDURE

I, VERONICA J. WHITE, HEREBY CERTIFY THAT THE FOREGOING BRIEF COMPLIES WITH THE RULES OF COURT THAT PERTAIN TO THE FILING OF BRIEFS, INCLUDING, BUT NOT LIMITED TO:

MASS. R. A. P. 16(A)(6) (PERTINENT FINDINGS OR MEMORANDUM OF DECISION)

MASS. R. A. P. 16(E) (REFERENCES TO THE RECORD);

MASS. R. A. P. 16(F) (REPRODUCTION OF STATUTES, RULES, REGULATIONS);

MASS. R. A. P. 16(H) (LENGTH OF BRIEFS);

MASS. R. A. P. 18 (APPENDIX TO THE BRIEFS);

AND MASS. R. A. P. 20 (FORM OF BRIEFS, APPENDICES, AND OTHER PAPERS).

VERONICA J. WHITE, ESQ.
BBO # 640-332
White & Associates, P. C.
101 Tremont Street
Suite 1010
Boston, MA 02108
(617) 338-9507

COMMONWEALTH OF MASSACHUSETTS
SUPREME JUDICIAL COURT

BERKSHIRE, ss. CASE NO. SJC-11277

COMMONWEALTH
Appellee

v.

CORY A. MOODY, ET. AL.
Appellant

ON APPEAL FROM THE JUDGMENT OF THE BERKSHIRE SUPERIOR COURT

RECORD APPENDIX OF BRIEF OF AMICI CURIAE JORGE AREIZA, HECTOR DEJESUS PUERTA, ALEJANDRA GOMEZ, DARNEY GOMEZ-MESA, THE MASSACHUSETTES ASSOCIATION OF CRIMINAL DEFENSE LAWYERS, AND THE NATIONAL ASSOCIATION OF CRIMINAL DEFENSE LAWYERS

Table of Contents

Commonwealth of Massachusetts

Berkshire, ss.

Superior Court
Department of
The Trial Court
Indictment No. 10-260

Commonwealth

v.

Devin Newman

Affidavit of Michael W. Verronneau

I, Michael W. Verronneau, make this my affidavit and say:

1. I am president of MWV Multi-Media Forensic Investigative Services, Inc. Based on my education, training, and experience, I have acquired a working knowledge of the process of cellular technology.

2. When a cellular phone caller speaks into his or her phone, the cellular phone uses software to convert the analog audio into digital data in binary code, known as Pulse Code Modulation (PCM).

3. The cellular phone then transmits the digital data to a cellular site within its area (also known as a cellular tower), an antenna that receives data from a cellular phone.

4. A Home Locator Registry (HLR) (software loaded onto the cellular site) verifies that the caller has a valid account with a particular carrier and records the duration, type of the call and locates the recipient (receiving) cellular phone.

5. A Mobile Switching Center (MSC), located in the base of the cellular site, transmits the data to the proper wireless carrier.

6. A software encryption process then encrypts the data for transmission over the cellular network in order to prevent its theft and interception.

7. The wireless carrier then sends the data within its network to the cellular site in whose locale the receiving cellular phone then is.

8. The receiving cellular site then transmits the data to the receiving cellular phone.

9. When the phone rings, and the person receiving the call answers his or her phone, the cellular phone uses software to convert the digital data back into analog audio.

Subscribed and sworn, under the pains and penalties of perjury, July 26, 2011

Michael W. Verronneau

How Cell Phones Work

by Marshall Brain, Jeff Tyson and Julia Layton
Browse the article **How Cell Phones Work**

Introduction to How Cell Phones Work

Millions of people in the United States and around the world use **cellular phones**. They are such great gadgets -- with a cell phone, you can talk to anyone on the planet from just about anywhere!

These days, cell phones provide an incredible array of functions, and new ones are being added at a breakneck pace. Depending on the cell-phone model, you can:

- Store contact information
- Make task or to-do lists
- Keep track of appointments and set reminders
- Use the built-in calculator for simple math
- Send or receive e-mail
- Get information (news, entertainment, stock quotes) from the Internet
- Play games
- Watch TV
- Send text messages
- Integrate other devices such as PDAs, MP3 players and GPS receivers

But have you ever wondered how a cell phone works? What makes it different from a regular phone? What do all those terms like PCS, GSM, CDMA and TDMA mean? In this article, we will discuss the technology behind cell phones so that you can see how amazing they really are.

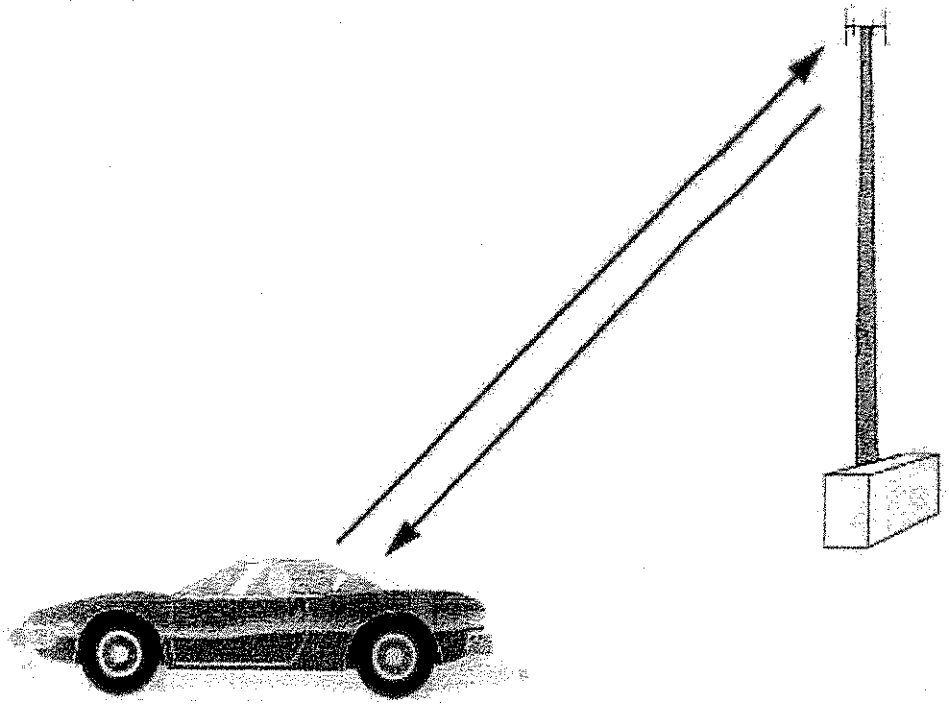
To start with, one of the most interesting things about a cell phone is that it is actually a radio -- an extremely sophisticated radio, but a radio nonetheless. The telephone was invented by Alexander Graham Bell in 1876, and wireless communication can trace its roots to the invention of the radio by Nikolai Tesla in the 1880s (formally presented in 1894 by a young Italian named Guglielmo Marconi). It was only natural that these two great technologies would eventually be combined.

Cell-phone Frequencies

In the dark ages before cell phones, people who really needed mobile-communications ability installed **radio telephones** in their cars. In the radio-telephone system, there was one central antenna tower per city, and perhaps **25 channels** available on that tower. This **central antenna** meant that the phone in your car needed a powerful transmitter -- big enough to transmit 40 or 50 miles (about 70 km). It also meant that not many people could use radio telephones -- there just were not enough channels.

The genius of the cellular system is the division of a city into small **cells**. This allows extensive **frequency reuse** across a city, so that millions of people can use cell phones simultaneously.

A good way to understand the sophistication of a cell phone is to compare it to a CB radio or a walkie-talkie.



In full-duplex radio, the two transmitters use different frequencies, so both parties can talk at the same time. Cell phones are full-duplex.

- **Full-duplex vs. half-duplex** - Both walkie-talkies and CB radios are **half-duplex** devices. That is, two people communicating on a CB radio use the same frequency, so only one person can talk at a time. A cell phone is a **full-duplex** device. That means that you use one frequency for talking and a second, separate frequency for listening. Both people on the call can talk at once.
- **Channels** - A walkie-talkie typically has one channel, and a CB radio has 40 channels. A typical cell phone can communicate on 1,664 channels or more!
- **Range** - A walkie-talkie can transmit about 1 mile (1.6 km) using a 0.25-watt transmitter. A CB radio, because it has much higher power, can transmit about 5 miles (8 km) using a 5-watt transmitter. Cell phones operate within **cells**, and they can switch cells as they move around. Cells give cell phones incredible range. Someone using a cell phone can drive hundreds of miles and maintain a conversation the entire time because of the cellular approach.

In a typical analog cell-phone system in the United States, the cell-phone carrier receives about **800 frequencies** to use across the city. The carrier chops up the city into cells. Each cell is typically sized at about **10 square miles** (26 square kilometers). Cells are normally thought of as hexagons on a big **hexagonal grid**, like this:

Because cell phones and base stations use low-power transmitters, the same frequencies can be reused in non-adjacent cells. The two purple cells can reuse the same frequencies.

Each cell has a **base station** that consists of a tower and a small building containing the radio equipment. We'll get into base stations later. First, let's examine the "cells" that make up a cellular system.

Cell-phone Channels

A single cell in an analog cell-phone system uses one-seventh of the available duplex voice channels. That is, each cell (of the seven on a hexagonal grid) is using one-seventh of the available channels so it has a unique set of frequencies and there are no collisions:

- A cell-phone carrier typically gets **832 radio frequencies** to use in a city.
- Each cell phone uses two frequencies per call -- a duplex channel -- so there are typically **395 voice channels** per carrier. (The other 42 frequencies are used for**control channels** -- more on this later.)

Therefore, each cell has about **56 voice channels** available. In other words, in any cell, 56 people can be talking on their cell phone at one time. Analog cellular systems are considered first-generation mobile technology, or **1G**. With digital transmission methods (2G), the number of available channels increases. For example, a **TDMA-based** digital system (more on TDMA later) can carry three times as many calls as an analog system, so each cell has about 168 channels available.

Cell phones have **low-power transmitters** in them. Many cell phones have two signal strengths: 0.6 watts and 3 watts (for comparison, most CB radios transmit at 4 watts). The base station is also transmitting at low power. Low-power transmitters have two advantages:

- The **transmissions** of a base station and the phones within its cell do not make it very far outside that cell. Therefore, in the figure above, both of the purple cells can **reuse the same 56 frequencies**. The same frequencies can be reused extensively across the city.
- The **power consumption** of the cell phone, which is normally battery-operated, is relatively low. Low power means small batteries, and this is what has made handheld cellular phones possible.

The cellular approach requires a large number of base stations in a city of any size. A typical large city can have hundreds of towers. But because so many people are using cell phones, costs remain low per user. Each carrier in each city also runs one central office called the **Mobile Telephone Switching Office** (MTSO). This office handles all of the phone connections to the normal land-based phone system, and controls all of the base stations in the region.

CELL PHONE CODES

Electronic Serial Number (ESN) - a unique 32-bit number programmed into the phone when it is manufactured

Mobile Identification Number (MIN) - a 10-digit number derived from your phone's number

System Identification Code (SID) - a unique 5-digit number that is assigned to each carrier by the FCC

Cell-phone Codes

All cell phones have special codes associated with them. These codes are used to identify the phone, the phone's owner and the service provider.

Let's say you have a cell phone, you turn it on and someone tries to call you. Here is what happens to the call:

- When you first power up the phone, it listens for an **SID** (see sidebar) on the **control channel**. The control channel is a special frequency that the phone and base station use to talk to one another about things like call set-up and channel changing. If the phone cannot find any control channels to listen to, it knows it is **out of range** and displays a "no service" message.
- When it receives the SID, the phone **compares it** to the SID programmed into the phone. If the SIDs match, the phone knows that the cell it is communicating with is part of its **home** system.
- Along with the SID, the phone also transmits a **registration request**, and the MTSO keeps track of your phone's location in a database -- this way, the MTSO knows which cell you are in when it wants to ring your phone.
- The **MTSO** gets the call, and it tries to **find you**. It looks in its database to see which cell you are in.
- The MTSO **picks a frequency pair** that your phone will use in that cell to take the call.
- The MTSO communicates with your phone over the **control channel** to tell it which frequencies to use, and once your phone and the tower switch on those frequencies, the call is **connected**. Now, you are talking by two-way radio to a friend.
- As you move toward the edge of your cell, your cell's **base station** notes that your **signal strength** is diminishing. Meanwhile, the base station in the cell you are moving toward (which is listening and measuring signal strength on all frequencies, not just its own one-seventh) sees your phone's signal strength increasing. The two base stations coordinate with each other through the MTSO, and at some point, your phone gets a signal on a control channel telling it to change frequencies. This **hand off** switches your phone to the new cell.

As you travel, the signal is passed from cell to cell.
Let's say you're on the phone and you move from one cell to another -- but the cell you move into is covered by another service provider, not yours. Instead of dropping the call, it'll actually be handed off to the other service provider.

If the SID on the control channel does not match the SID programmed into your phone, then the phone knows it is **roaming**. The MTSO of the cell that you are roaming in contacts the MTSO of your home system, which then checks its database to **confirm** that the SID of the phone you are using is valid. Your home system**verifies** your phone to the local MTSO, which then tracks your phone as you move through its cells. And the amazing thing is that all of this happens within seconds.

The less amazing thing is that you may be charged insane rates for your roaming call. On most phones, the word "roam" will come up on your phone's screen when you leave your provider's coverage area and enter another's. If not, you'd better study your coverage maps carefully -- more than one person has been unpleasantly surprised by the cost of roaming. Check your service contract carefully to find out how much you're paying when you roam.

Note that if you want to roam internationally, you'll need a phone that will work both at home and abroad. Different countries use different cellular access technologies. More on those technologies later. First, let's get some background on analog cell-phone technology so we can understand how the industry has developed.

Analog Cell Phones

In 1983, the analog cell-phone standard called **AMPS** (Advanced Mobile Phone System) was approved by the FCC and first used in Chicago. AMPS uses a range of frequencies between 824 megahertz (MHz) and 894 MHz for analog cell phones. In order to encourage competition and keep prices low, the U. S. government required the presence of two **carriers** in every market, known as A and B carriers. One of the carriers was normally the **local-exchange carrier** (LEC), a fancy way of saying the local phone company.

Carriers A and B are each assigned **832 frequencies**: 790 for voice and 42 for data. A pair of frequencies (one for transmit and one for receive) is used to create one **channel**. The frequencies used in analog voice channels are typically **30 kHz** wide -- 30 kHz was chosen as the standard size because it gives you voice quality comparable to a wired telephone.

The transmit and receive frequencies of each voice channel are separated by **45 MHz** to keep them from interfering with each other. Each carrier has 395 voice channels, as well as 21 data channels to use for housekeeping activities like registration and paging.
A version of AMPS known as **Narrowband Advanced Mobile Phone Service** (NAMPS) incorporates some digital technology to allow the system to carry about **three times as many calls** as the original version. Even though it uses digital technology, it is still considered analog. AMPS and NAMPS only operate in the 800-MHz band and do not offer many of the features common in digital cellular service, such as e-mail and Web browsing.

Along Comes Digital

Digital cell phones are the second generation (2G) of cellular technology. They use the same radio technology as analog phones, but they use it in a different way. Analog systems do not fully utilize the signal between the phone and the cellular network -- analog signals cannot be compressed and manipulated as easily as a true digital signal. This is the reason why many cable companies are switching to digital -- so they can fit **more channels within a given bandwidth**. It is amazing how much more efficient digital systems can be.

Digital phones convert your voice into binary information (1s and 0s) and then compress it (see How Analog-Digital Recording Works for details on the conversion process). This **compression** allows between three and 10 digital cell-phone calls to occupy the space of a *single* analog call.

Many digital cellular systems rely on **frequency-shift keying** (FSK) to send data back and forth over AMPS. FSK uses **two frequencies**, one for 1s and the other for 0s, **alternating** rapidly between the two to send digital information between the cell tower and the phone. Clever modulation and encoding schemes are required to convert the analog information to digital, compress it and convert it back again while maintaining an acceptable level of voice quality. All of this means that digital cell phones have to contain a lot of processing power.

Inside a Digital Cell Phone

On a "complexity per cubic inch" scale, cell phones are some of the most intricate devices people use on a daily basis. Modern digital cell phones can process **millions of calculations per second** in order to compress and decompress the voice stream.

If you take a basic digital cell phone apart, you find that it contains just a few individual parts:

- An amazing circuit board containing the brains of the phone
- An antenna
- A liquid crystal display (LCD)
- A keyboard (not unlike the one you find in a TV remote control)
- A microphone
- A speaker
- A battery

The circuit board is the heart of the system. The **analog-to-digital** and **digital-to-analog** conversion chips translate the outgoing audio signal from analog to digital and the incoming signal from digital back to analog. You can learn more about A-to-D and D-to-A conversion and its importance to digital audio in How Compact Discs Work. The **digital signal processor** (DSP) is a highly customized processor designed to perform signal-manipulation calculations at high speed.

The microprocessor handles all of the housekeeping chores for the keyboard and display, deals with command and control signaling with the base station and also coordinates the rest of the functions on the board.

The ROM and Flash memory chips provide storage for the phone's operating system and customizable features, such as the phone directory. The radio frequency(RF) and power section handles power management and recharging, and also deals with the hundreds of FM channels. Finally, the **RF amplifiers** handle signals traveling to and from the antenna.

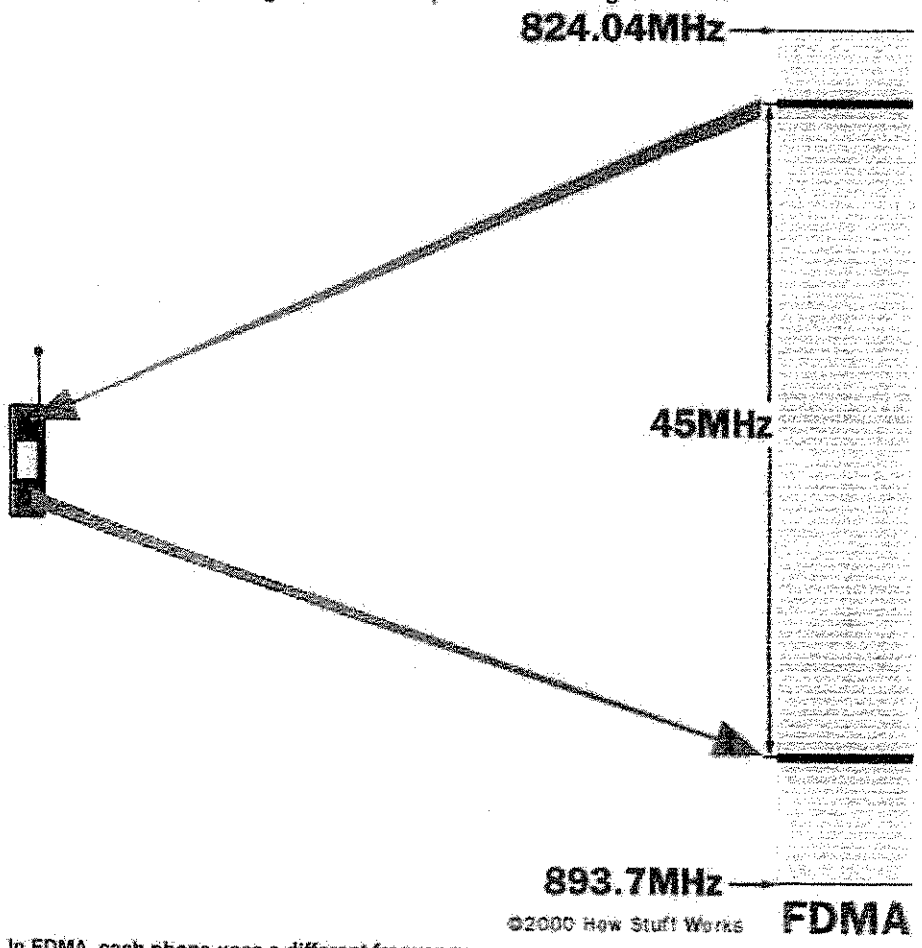
The display has grown considerably in size as the number of features in cell phones have increased. Most current phones offer built-in phone directories, calculators and games. And many of the phones incorporate some type of PDA or **Web browser**.

Some phones store certain information, such as the SID and MIN codes, in internal Flash memory, while others use external cards that are similar to SmartMedia cards.

Cell phones have such tiny speakers and microphones that it is incredible how well most of them reproduce sound. As you can see in the picture above, the speaker is about the size of a dime and the microphone is no larger than the watch battery beside it. Speaking of the watch battery, this is used by the cell phone's **internal clock chip**.

What is amazing is that all of that functionality -- which only 30 years ago would have filled an entire floor of an office building -- now fits into a package that sits comfortably in the palm of your hand!

In the next section, we'll get into the cell-phone networking methods.



In FDMA, each phone uses a different frequency.

Cell Phone Network Technologies: 2G

There are three common technologies used by 2G cell-phone networks for transmitting information (we'll discuss 3G technologies in the 3G section):

- **Frequency division multiple access** (FDMA)
- **Time division multiple access** (TDMA)
- **Code division multiple access** (CDMA)

Although these technologies sound very intimidating, you can get a good sense of how they work just by breaking down the title of each one.

The first word tells you what the **access method** is. The second word, **division**, lets you know that it splits calls based on that access method.

- FDMA puts each call on a separate **frequency**.
- TDMA assigns each call a certain portion of **time** on a designated frequency.
- CDMA gives a unique **code** to each call and spreads it over the available frequencies.

The last part of each name is **multiple access**. This simply means that more than one user can utilize each cell.

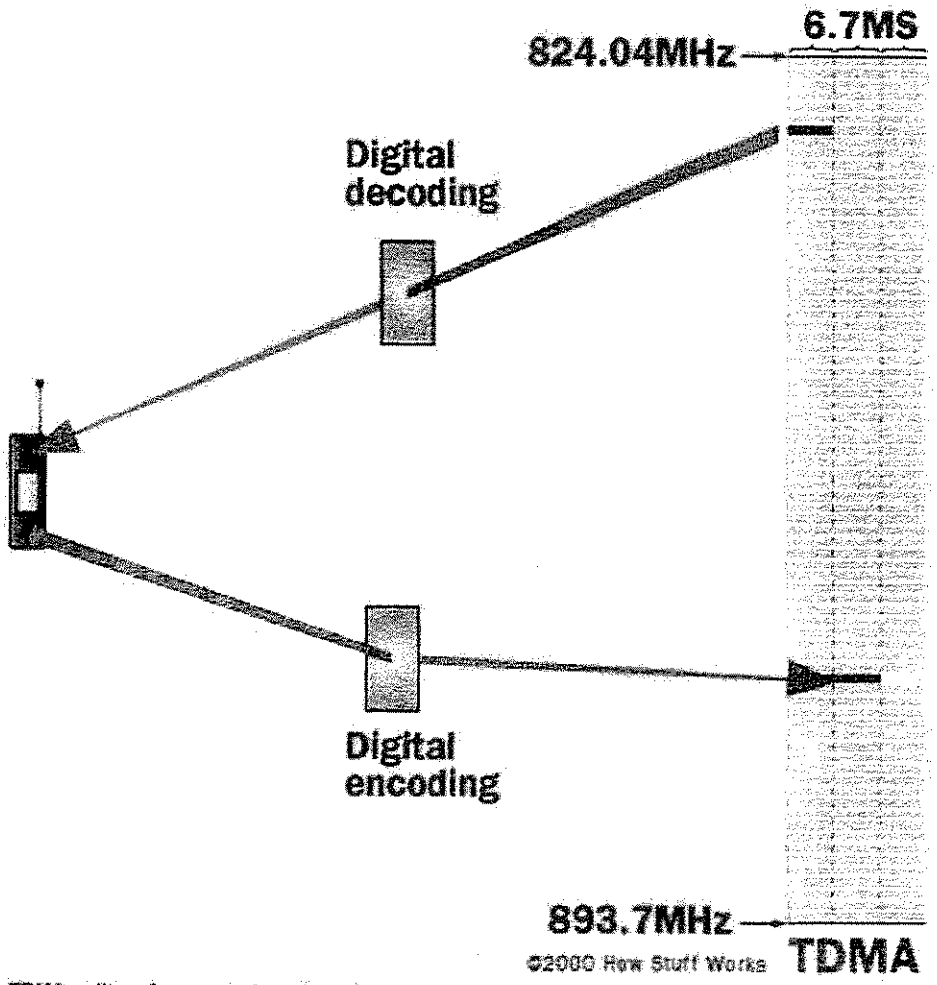
FDMA

FDMA separates the spectrum into distinct voice channels by splitting it into **uniform chunks of bandwidth**. To better understand FDMA, think of radio stations: Each station sends its signal at a different frequency within the available band. FDMA is used mainly for **analog transmission**. While it is certainly capable of carrying digital information, FDMA is not considered to be an efficient method for digital transmission.

TDMA

TDMA is the access method used by the Electronics Industry Alliance and the Telecommunications Industry Association for **Interim Standard 54** (IS-54) and**Interim Standard 136** (IS-136). Using TDMA, a **narrow band** that is 30 kHz wide and 6.7 milliseconds long is split time-wise into **three time slots**.

Narrow band means "channels" in the traditional sense. Each conversation gets the radio for one-third of the time. This is possible because voice data that has been converted to digital information is compressed so that it takes up significantly less transmission space. Therefore, TDMA has **three times the capacity** of an analog system using the same number of channels. TDMA systems operate in either the **800-MHz** (IS-54) or **1900-MHz** (IS-136) frequency bands.



TDMA splits a frequency into time slots.

GSM

TDMA is also used as the access technology for Global System for Mobile communications(GSM). However, **GSM** implements TDMA in a somewhat different and incompatible way from IS-136. Think of GSM and IS-136 as two different operating systems that work on the sameprocessor, like Windows and Linux both working on an Intel Pentium III. GSM systems use**encryption** to make phone calls more secure. GSM operates in the 900-MHz and 1800-MHz bands in Europe and Asia and in the 850-MHz and 1900-MHz (sometimes referred to as 1.9-GHz) band in the United States. It is used in digital cellular and **PCS-based** systems. GSM is also the basis for **Integrated Digital Enhanced Network** (IDEN), a popular system introduced by Motorola and used by Nextel.

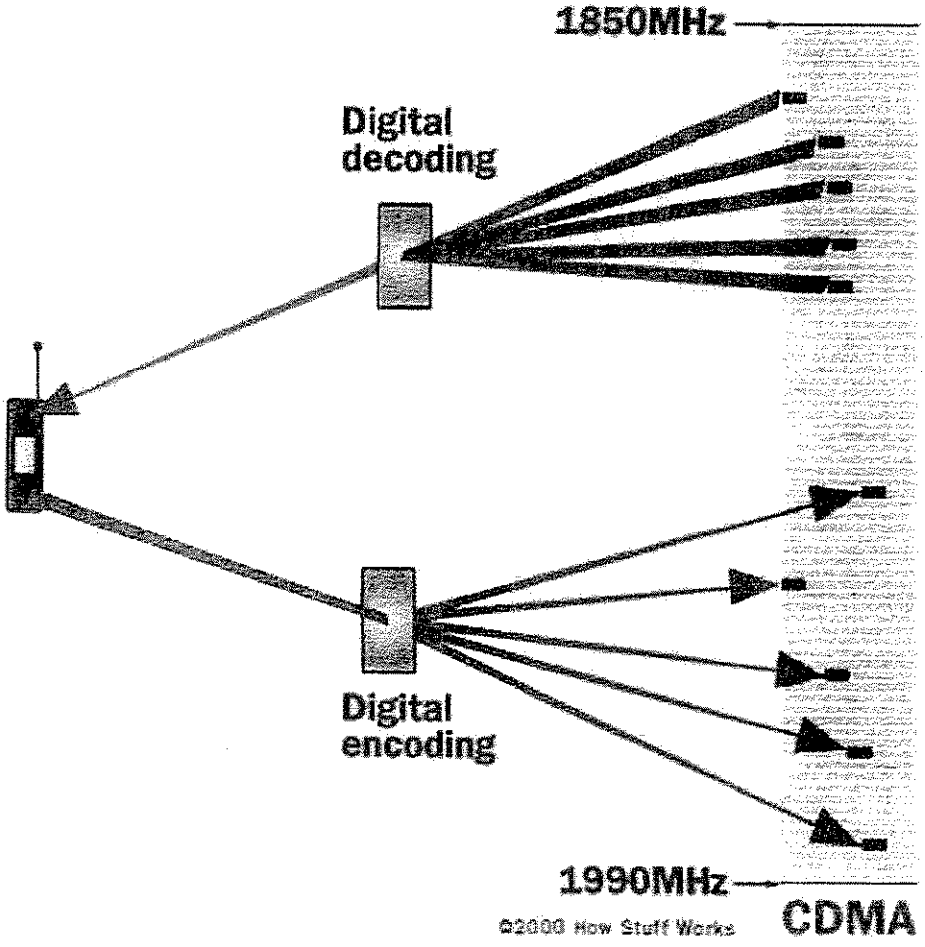
GSM is the international standard in Europe, Australia and much of Asia and Africa. In covered areas, cell-phone users can buy one phone that will work anywhere where the standard is supported. To connect to the specific service providers in these different countries, GSM users simply switch **subscriber identification module (SIM)** cards. SIM cards are small removable

disks that slip in and out of GSM cell phones. They store all the connection data and identification numbers you need to access a particular wireless service provider.

Unfortunately, the 850MHz/1900-MHz GSM phones used in the United States are **not compatible** with the international system. If you live in the United States and need to have cell-phone access when you're overseas, you can either buy a tri-band or quad-band GSM phone and use it both at home and when traveling or just buy a GSM 900MHz/1800MHz cell phone for traveling. You can get 900MHz/1800MHz GSM phones from Planet Omni, an online electronics firm based in California. They offer a wide selection of Nokia, Motorola and Ericsson GSM phones. They don't sell international SIM cards, however. You can pick up prepaid SIM cards for a wide range of countries at Telestial.com.

CDMA

CDMA takes an entirely different approach from TDMA. CDMA, after digitizing data, **spreads it out** over the entire available bandwidth. Multiple calls are **overlaid** on each other on the channel, with each assigned a **unique sequence code**. CDMA is a form of spread spectrum, which simply means that data is sent in small pieces over a number of the discrete frequencies available for use at any time in the specified range.



In CDMA, each phone's data has a unique code.

All of the users transmit in the same **wide-band** chunk of spectrum. Each user's signal is spread over the entire bandwidth by a **unique spreading code**. At the receiver, that same unique code is used to recover the signal. Because CDMA systems need to put an accurate time-stamp on each piece of a signal, it references the GPS system for this information. Between eight and 10 separate calls can be carried in the same channel space as one analog AMPS call. CDMA technology is the basis for **Interim Standard 95** (IS-95) and operates in both the 800-MHz and 1900-MHz frequency bands.

Ideally, TDMA and CDMA are transparent to each other. In practice, high-power CDMA signals raise the noise floor for TDMA receivers, and high-power TDMA signals can cause overloading and jamming of CDMA receivers.

2G is a cell phone network protocol. Click here to learn about network protocols for Smartphones.

Now let's look at the distinction between multiple-band and multiple-mode technologies.

UNLOCKING YOUR GSM PHONE

Any GSM phone can work with any SIM card, but some service providers "lock" the phone so that it will only work with their service. If your phone is locked, you can't use it with any other service provider, whether locally or overseas. You can unlock the phone using a special code -- but it's unlikely your service provider will give it to you. There are Web sites that will give you the unlock code, some for a small fee, some for free.

CELLULAR VS. PCS

Personal Communications Services (PCS) is a wireless phone service very similar to cellular phone service, but with an emphasis on ***personal***service and extended mobility. The term "PCS" is often used in place of "digital cellular," but true PCS means that other services like paging, caller ID and e-mail are bundled into the service.

While cellular was originally created for use in cars, PCS was designed from the ground up for greater user mobility. PCS has **smaller cells** and therefore requires a **larger number of antennas** to cover a geographic area. PCS phones usefrequencies between 1.85 and 1.99 GHz (1850 MHz to 1990 MHz).

Technically, cellular systems in the United States operate in the 824-MHz to 894-MHz frequency bands; PCS operates in the **1850-MHz to 1990-MHz** bands. And while it is based on TDMA, PCS has **200-kHz channel spacing** and **eight time slots** instead of the typical 30-kHz channel spacing and three time slots found in digital cellular.

Multi-band vs. Multi-mode Cell Phones

Dual Band vs. Dual Mode

If you travel a lot, you will probably want to look for phones that offer multiple bands, multiple modes or both. Let's take a look at each of these options:

- **Multiple band** - A phone that has multiple-band capability can **switch frequencies**. For example, a dual-band TDMA phone could use TDMA services in either an 800-MHz or a 1900-MHz system. A quad-band GSM phone could use GSM service in the 850-MHz, 900-MHz, 1800-MHz or 1900-MHz band.

- **Multiple mode** - In cell phones, "mode" refers to the **type of transmission technology** used. So, a phone that supported AMPS and TDMA could switch back and forth as needed. It's important that one of the modes is AMPS – this gives you analog service if you are in an area that doesn't have digital support.
- **Multiple band/Multiple mode** - The best of both worlds allows you to switch between frequency bands and transmission modes as needed.

Changing bands or modes is done automatically by phones that support these options. Usually the phone will have a **default option** set, such as 1900-MHz TDMA, and will try to connect at that frequency with that technology first. If it supports dual bands, it will switch to 800 MHz if it cannot connect at 1900 MHz. And if the phone supports more than one mode, it will try the digital mode(s) first, then switch to analog.

You can find both **dual-mode** and **tri-mode** phones. The term "tri-mode" can be deceptive. It may mean that the phone supports two digital technologies, such as CDMA and TDMA, as well as analog. In that case, it is a true tri-mode phone. But it can also mean that it supports one digital technology in two bands and also offers analog support. A popular version of the tri-mode type of phone for people who do a lot of international traveling has GSM service in the 900-MHz band forEurope and Asia and the 1900-MHz band for the United States, in addition to the analog service. Technically, this is a dual-mode phone, and one of those modes (GSM) supports two bands.

In the next section, we'll take a look at 3G mobile-phone technology.

Cell-phone Network Technologies: 3G

3G technology is the latest in mobile communications. 3G stands for "third generation" – this makes analog cellular technology generation one and digital/PCS generation two. 3G technology is intended for the true multimedia cell phone -- typically called smartphones -- and features increased bandwidth and transfer rates to accommodate Web-based applications and phone-based audio and video files.

3G comprises several cellular access technologies. The three most common ones as of 2005 are:

- CDMA2000 - based on 2G Code Division Multiple Access (see Cellular Access Technologies)
- WCDMA (UMTS) - Wideband Code Division Multiple Access
- TD-SCDMA - Time-division Synchronous Code-division Multiple Access

3G networks have potential transfer speeds of up to 3 Mbps (about 15 seconds to download a 3-minute MP3song). For comparison, the fastest 2G phones can achieve up to 144Kbps (about 8 minutes to download a 3-minute song). 3G's high data rates are ideal for downloading information from the Internet and sending and receiving large, multimedia files. 3G phones are like mini-laptops and can accommodate broadband applications like video conferencing, receiving

streaming video from the Web, sending and receiving faxes and instantly downloading e-mail messages with attachments.

Of course, none of this would be possible without those soaring towers that carry cell-phone signals from phone to phone.

3G is a cell phone network protocol. Click here to learn about network protocols for Smartphones.

Cell-phone Towers

A cell-phone tower is typically a steel pole or lattice structure that rises hundreds of feet into the air.

Pictured here is a modern tower with three different cell-phone providers riding on the same structure. If you look at the base of a tower, you can see provider equipment.

The box houses the **radio transmitters and receivers** that let the tower communicate with the phones. The radios connect with the antennae on the tower through a set of thick cables.

If you look closely, you will see that the tower and all of the cables and equipment at the base of the tower are heavily**grounded**.

One sure sign that multiple providers share a tower is a five-way latch on the gate. Any one of five people can unlock this gate to get in.

Like all consumer electronics, cell phones come with their share of problems. In the next section, we'll take a look at some of the issues facing cell phones.

Problems with Cell Phones

A cell phone, like any other electronic device, has its problems:

- Generally, non-repairable internal **corrosion** of parts results if you get the phone wet or use wet hands to push the buttons. Consider a protective case. If the phone does get wet, be sure it is totally dry before you switch it on so you can try to avoid damaging internal parts.
- Extreme **heat** in a car can damage the battery or the cell-phone electronics. Extreme cold may cause a momentary loss of the screen display.
- Analog cell phones suffer from a problem known as "**cloning**." A phone is "cloned" when someone steals its ID numbers and is able to make fraudulent calls on the owner's account.

  Here is how cloning occurs: When your phone makes a call, it transmits the ESN and MIN to the network at the beginning of the call. The MIN/ESN pair is a unique tag for your phone -- this is how the phone company knows who to bill for the call. When your phone transmits its MIN/ESN pair, it is possible for nefarious sorts to listen (with a scanner) and capture the pair. With the right

equipment, it is fairly easy to modify another phone so that it contains your MIN/ESN pair, which allows the nefarious individual to make calls on your account.

For more information about cell phones and related topics, check out the links on the next page and be sure to read How Buying a Cell Phone Works for loads of helpful consumer tips.

Lots More Information

Related HowStuffWorks Articles

- How Buying a Cell Phone Works
- How the iPhone Works
- How Smartphones Work
- Cell Phone Quiz
- How TV Phones Work
- How Radio Works
- How Microprocessors Work
- How Telephones Work

More Great Links

- Cell Phone Reviews and Stuff Guide
- 3G Newsroom: What is 3G?
- Cellular Telephone Basics
- Digital Wireless Basics
- The Travel Insider: Global Roaming
- Wireless Communications Glossary

Sources

- 3G Newsroom: What is 3G? http://www.3gnewsroom.com/html/about_3g/what_is_3g.shtml
- O'Reilly: Unlocking Your Nokia Phone http://www.oreillynet.com/pub/wlg/3935
- The Travel Insider: Global Roaming http://www.thetravelinsider.info/2002/1101.htm
- The Travel Insider: Dual, Tri, or Quad Band GSM Phone? http://www.thetravelinsider.info/roadwarriorcontent/quadbandphones.htm
- The Travel Insider: Unlock Your Cell Phone http://www.thetravelinsider.info/roadwarriorcontent/nokiaunlocking.htm