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PUBLIC SAFETY

PSWN PROGRAM

WIRELESS NETWORK

Saving Lives and Property Through Improved Interoperability

Commercial Services Report #1: Cellular Telephone and Personal Communications Service Assessment

Final

August 2001

Foreword…

THE CELLULAR TELEPHONE AND PERSONAL COMMUNICATIONS SERVICE (PCS) ASSESSMENT REPORT PROVIDES THE CURRENT STATUS OF VARIOUS ASPECTS OF THE ANALOG CELLULAR, DIGITAL CELLULAR, AND PCS TELECOMMUNICATIONS MARKETPLACE FROM THE PUBLIC SAFETY VIEWPOINT (MEETING THE COMMON WIRELESS NEEDS OF PUBLIC SAFETY)

- This report provides a broad assessment of the current state of the cellular telephone (referred to hereafter as simply “cellular”) and PCS industries. It is not intended to reflect a government position nor is it intended to offer Public Safety Wireless Network (PSWN) Program endorsement for any particular service provider
- Originating from two PSWN Year 1 (1997) documents about Cellular and PCS services, this consolidated report is intended to serve as an update and a replacement for those documents. **Note:** Where industry information is unchanged, but is still relevant, that information is included here for ease of reference
- Comments regarding the information provided in this document may be directed to the PSWN Program Management Office (PMO) at 1-(800)-565-PSWN, or by e-mail to information@pswn.gov
- For additional PSWN Program information and research, visit the home page at http://www.pswn.gov

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PUBLIC SAFETY AGENCIES THROUGHOUT THE UNITED STATES USE COMMERCIAL COMMUNICATIONS SERVICES TO SUPPLEMENT THEIR LAND MOBILE RADIO (LMR) SYSTEMS

- Cellular and PCS phones are used by agencies while operating in an out-of-office environment
- These phones are used in non-emergency applications such as non-tactical communications and administrative functions
- Cellular service is used as a last resort in emergency situations when the existing LMR infrastructure is either difficult to gain access to or is completely unavailable
- Using these services provides added convenience allowing users to place calls without wasting time returning to the office or searching for a public phone

COMMERCIAL COMMUNICATIONS SERVICES IN THE UNITED STATES USE THREE MAIN TYPES OF WIRELESS TECHNOLOGY: ANALOG, DIGITAL, AND PCS

- Analog cellular, introduced in 1983, is the oldest and most widespread service available in the United States
  - The principles of analog cellular communication are very similar to frequency modulation (FM) radio
    - » An audible voice is input to a microphone and modulated into a transmitted radio frequency (RF) signal
    - » The signal is transmitted from the subscriber unit (e.g., cellular phone) and then received elsewhere on a base station antenna
    - » The base station demodulates the signal back to audio and then relays the audio through the public switched telephone network (PSTN) to the required destination
    - » Analog cellular operates in the 800 to 900 megahertz (MHz) frequency band
  - Now considered legacy infrastructure, analog systems are secondary systems where digital coverage is deployed

- Digital cellular is a newer type of technology with service area coverage similar to that of analog cellular
  - Digital communication is accomplished by converting audio to digitized bits of information through an analog-to-digital converter at about 8,000 samples per second
    - » The digital samples, compiled as 1s and 0s, represent time-varying voltage levels
    - » The samples are transmitted as RF signals, which typically range in the 800 and 900 MHz frequency bands
  - A base station receives the digital signal, which is processed and converted back to voltage levels to obtain an acceptable representation of the original transmission
  - The sampling process reduces the amount of information sent through the airwaves, enabling the use of more channels at one time (compared with analog cellular), thus allowing more users per site
  - Another advantage of digital processing is clearer conversation between parties, reducing the static associated with analog cellular
  - Digital services are typically offered in metropolitan areas or along busy roadways, but are less pervasive in rural areas because of lower user volume
  - Carriers are slowly converting to digital technology in rural areas or near less-traveled roadways
    - » In general, areas with low traffic needs are served only by analog cellular

COMMERCIAL COMMUNICATIONS SERVICES IN THE UNITED STATES USE THREE MAIN TYPES OF WIRELESS TECHNOLOGY: ANALOG, DIGITAL, AND PCS (CONT'D)

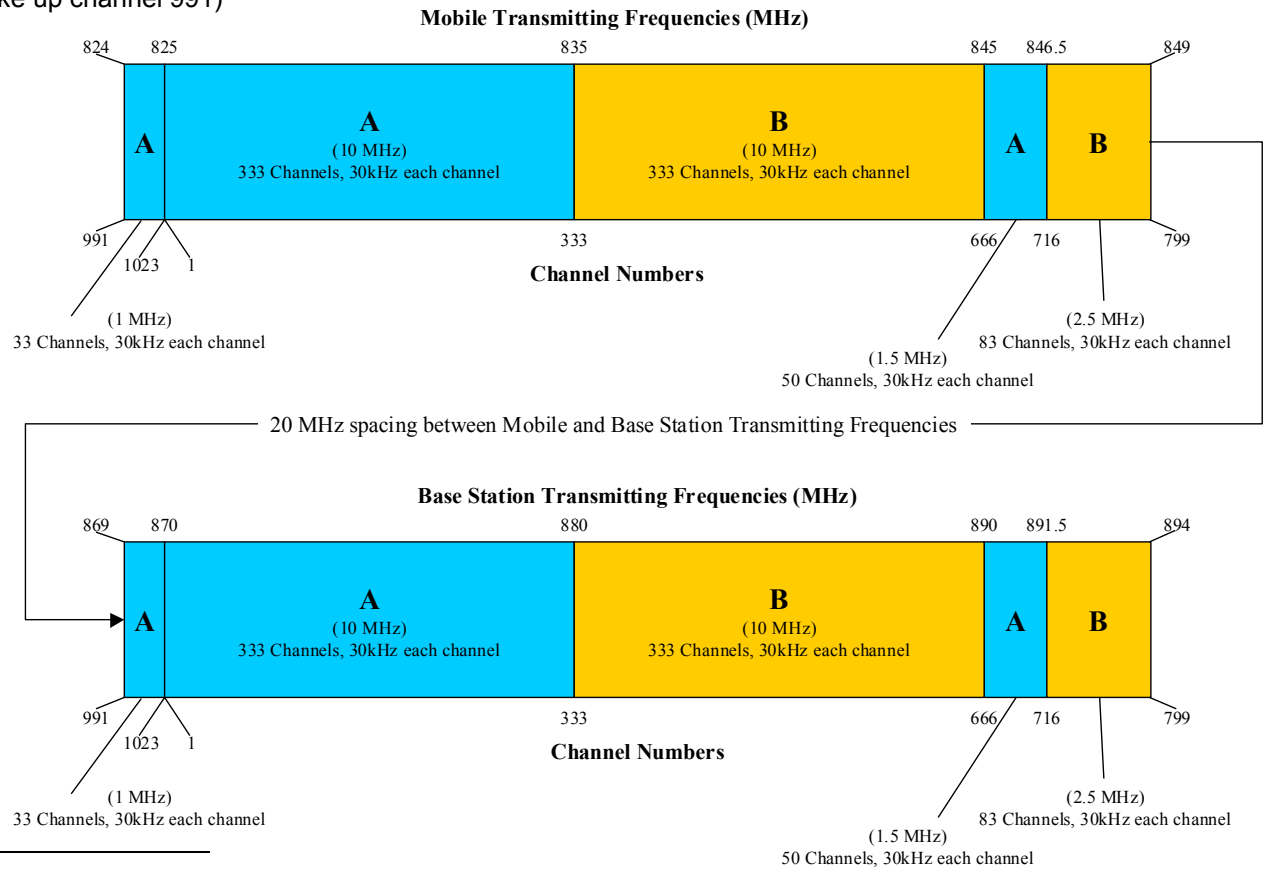
- PCS, the newest addition to the commercial voice services arena, offers a wide variety of mobile, portable, and ancillary communications services to individuals and businesses
  - PCS protocols are very similar to digital communications
  - PCS systems were the first to offer advanced features such as voice mail, call waiting, call forwarding, paging, and data services
    - » Digital cellular now offers these same types of services
    - » Analog cellular offers very limited features
  - The main difference between digital cellular and PCS is their operation in different radio bands
    - » PCS generally operates in the 1.8-2.0 GHz frequency band
    - » Therefore, PCS is used less to define a particular type of wireless service and more to specify companies providing wireless service in a particular segment of spectrum
  - The Federal Communications Commission (FCC) has assigned three categories of PCS licenses: narrowband, unlicensed, and broadband. Broadband, however, is the only license used for cellular-type communications

- Another form of wireless technology, which is distributed by Nextel, merges cellular telephony and land mobile radio, all while using Nextel's handsets and infrastructure. This type of system will be discussed in further detail in the Commercial Services Report #3: Specialized Mobile Radio

CELLULAR (ADVANCED MOBILE PHONE SERVICE [AMPS]) LICENSES WERE DRAWN BY LOTTERY AND ISSUED TO COMPANIES OR INDIVIDUALS THAT COMPLETED APPLICATIONS AND MET THE ENTRY CRITERION

- Two bands were established: 1) A-Band was set aside for Non-wire line carriers, and 2) B-band was set aside for Wire line carriers

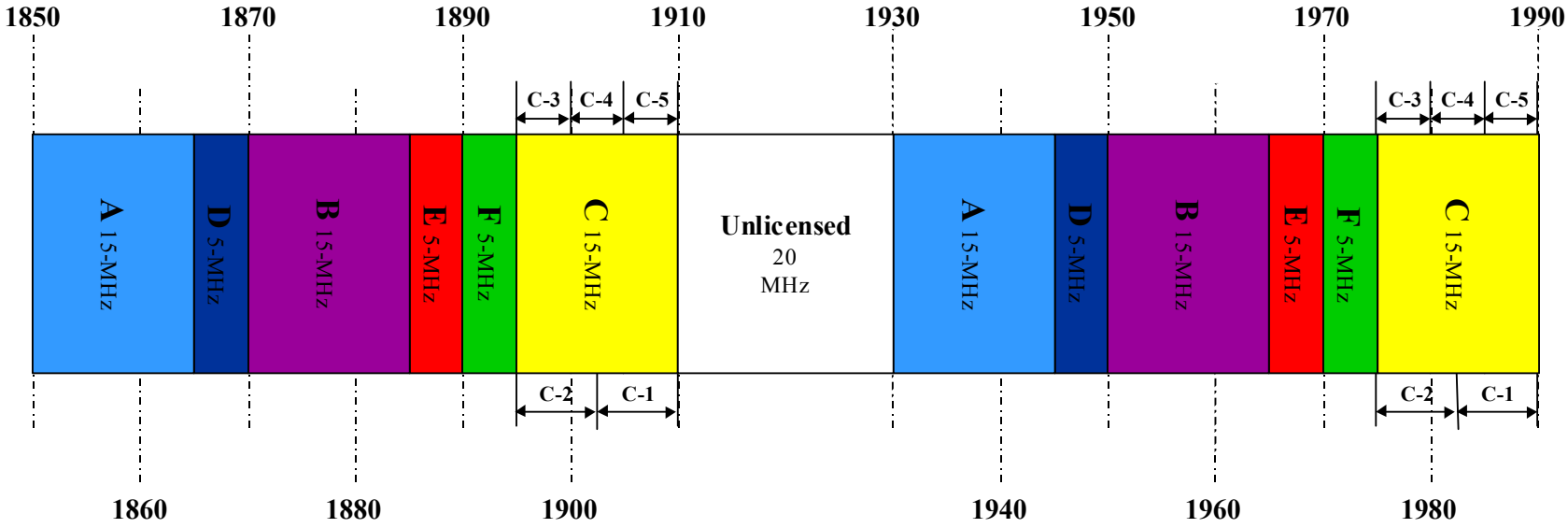
Channels are composed of two frequencies; therefore channel numbers repeat themselves, but frequencies do not (e.g., 824-MHz and 869-MHz collectively make up channel 991)[1]



[1] TelecomWriting.com. "Digital Wireless Basics" <http://www.privateline.com/PCS/CellPCSchart.html>.December, 2000.

PCS LICENSES WERE AUCTIONED TO THE HIGHEST BIDDER WITH EACH LICENSE COVERING A SPECIFIC "BLOCK" OF FREQUENCIES IN THE PCS SPECTRUM

- Shown below is the FCC Broadband PCS Band Plan diagram[2] with the six blocks of allocated PCS frequencies
  - Some of the original C Block licenses were split from an original 30 MHz block into multiple licenses of 10–15 MHz



Channel Block	Bandwidth (MHz)	Frequencies	
C	30	1895 - 1910	1975 - 1990
C1	15	1902.5 - 1910	1982.5 - 1990
C2	15	1895 - 1902.5	1975 - 1982.5
C3	10	1895 - 1900	1975 - 1980
C4	10	1900 - 1905	1980 - 1985
C5	10	1905 - 1910	1985 - 1990

[2] Federal Communications Commission, "FCC Broadband PCS Band Plan", < http://www.fcc.gov" >

MOBILE COMMUNICATIONS TECHNOLOGY IN THE UNITED STATES HAS PRODUCED SEVERAL COMMON AIR INTERFACE TECHNOLOGIES

- Advanced Mobile Telephone Service (AMPS)
  - The oldest technology of all cellular phones, this analog system organizes calls through the use of frequency division multiple access, which separates 416 channels in each cell site's 12.5 MHz allocation into 30 kHz slots
- Time Division Multiple Access (TDMA) [3]
  - A digital wireless technology that divides a narrow radio channel into framed time slots and allocates a slot to each user
- Global System for Mobile Communications (GSM)
  - GSM is a digital communications technology developed in the early 1980s to allow roaming throughout Europe. This technology is a TDMA-based approach in which voice transmissions are digitally encoded via a unique encoder designed to emulate the characteristics of human speech. This method of transmission permits a very efficient ratio of data rate-to-information content
- Code Division Multiple Access (CDMA)[4]
  - A digital technology, which uses "spread spectrum" technology to break up speech into small, digitized segments and encodes them to identify each call. A large number of users can share the same band of spectrum, greatly increasing system capacity
- Third Generation (3G) wireless communications are currently being developed to converge these technologies in to a common air interface. This will provide the user with the ability to roam globally [5]
  - First generation was analog cellular, and second generation was digital cellular
  - 3G is discussed in further detail later in this report

[3] Qualcomm Inc. “About CDMA” < http://www.qualcomm.com/ cda/tech/aboutcdma/ >. January, 2001.
[4] Ibid.
[5] 3G Newsroom.com “Introduction to 3G” < http://www.3gnewsroom.com/html/intro_3g/index.shtml > June, 2001.

CELLULAR AND PCS COMMUNICATIONS SYSTEMS ARE WIRELESS TELEPHONE NETWORKS COMPOSED OF LOW-POWER TRANSMITTER SITES, WITH SMALL COVERAGE FOOTPRINTS, COMMONLY REFERRED TO AS "CELLS"

- Mobile coverage is provided to users travelling within the cells (i.e., service coverage area) of a particular service provider

- Cellular and PCS communications towers typically transmit at power levels of approximately 100-Watts

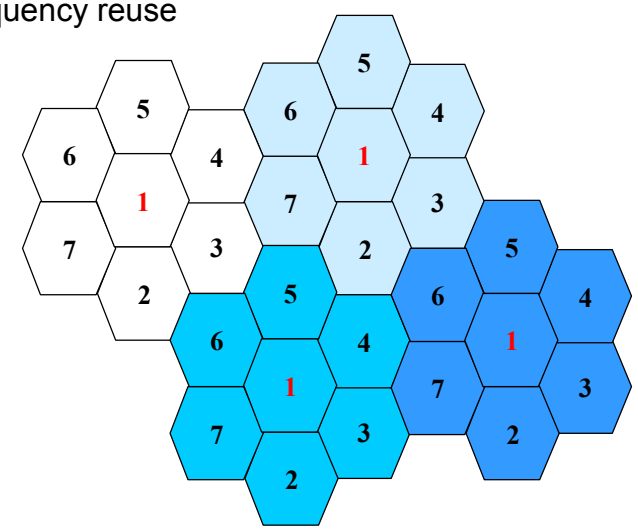
- Cellular and PCS subscriber equipment typically transmits at 0.3-Watts
  - Digital signaling techniques allow for variable transmission power from handsets (power-control)
    - » Handsets that include power-control can dynamically change transmit power levels to ensure optimum communications between the handset and serving base station and maximize handset battery life

- Wireless networks use the concept of dividing a geographical area into a series of small coverage area cells
  - User terminals communicate with antenna sites (or base stations) covering each geographical region
  - The antenna sites are connected to a control point, the mobile switching center (MSC), by conventional telephone lines or via microwave RF links
  - The MSC constantly monitors signal strength
    - » When the user crosses a cell boundary, the MSC can "hand off" the call from one base station to the next, without disruption in conversation
    - » The MSC also routes calls to other PCS subscribers or to the PSTN
    - » Because PCS cells cover a smaller area than do cellular cells (due to their higher frequency), more sites are required to cover a given area. This cell configuration is often referred to as microcell infrastructure
    - » As a result of differing topography, population density of the area served, and other limiting factors, the radius of a cell can range from 500 feet to 10 miles

EACH CELL IS DESIGNED WITH CAREFUL CONSIDERATIONS FOR SPECTRUM EFFICIENCY, INTERFERENCE, AND CAPACITY

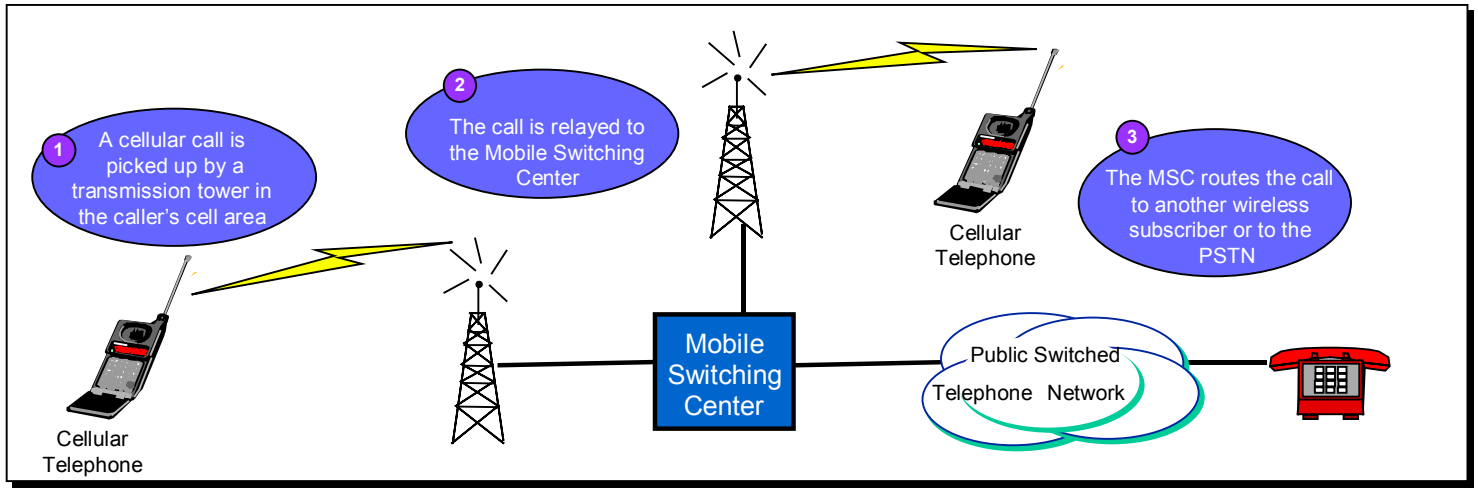
- In a densely populated area (e.g., metropolitan settings), many cell sites exist close to one another (1 - 3 miles)
  - Small coverage footprints are used to increase the number of calls that can be handled on the system
  - Wireless providers can increase capacity by using a larger number of smaller sites to cover the same area

- Radio frequencies are limited and are operated with finite resources, especially in public cellular and PCS networks where the growth and demand has been widespread. Channels must therefore be re-used within the network during the frequency planning of a system to minimize and control interference
  - Increasing the distance between cells using the same frequencies (reuse distance) minimizes two types of interference (co-channel and adjacent channel interference). [6]
- Frequency reuse is not as critical in CDMA systems due to spread-spectrum technology
- The figure on this page depicts an idealized model for cellular frequency reuse
  - Ideally, a cluster of adjacent cells are grouped in sets of seven
- Each number in the group represents a set of frequencies
  - For example, channels 1-145 are in “Group1”. Channels 146-390 are in “Group 2”, etc.
  - A channel from each group is chosen and allocated to a specified cell
  - Channels from each group are reused in cells separated by a distance of three cells
  - The scheme to the right shows a "3-cell reuse pattern”[7]

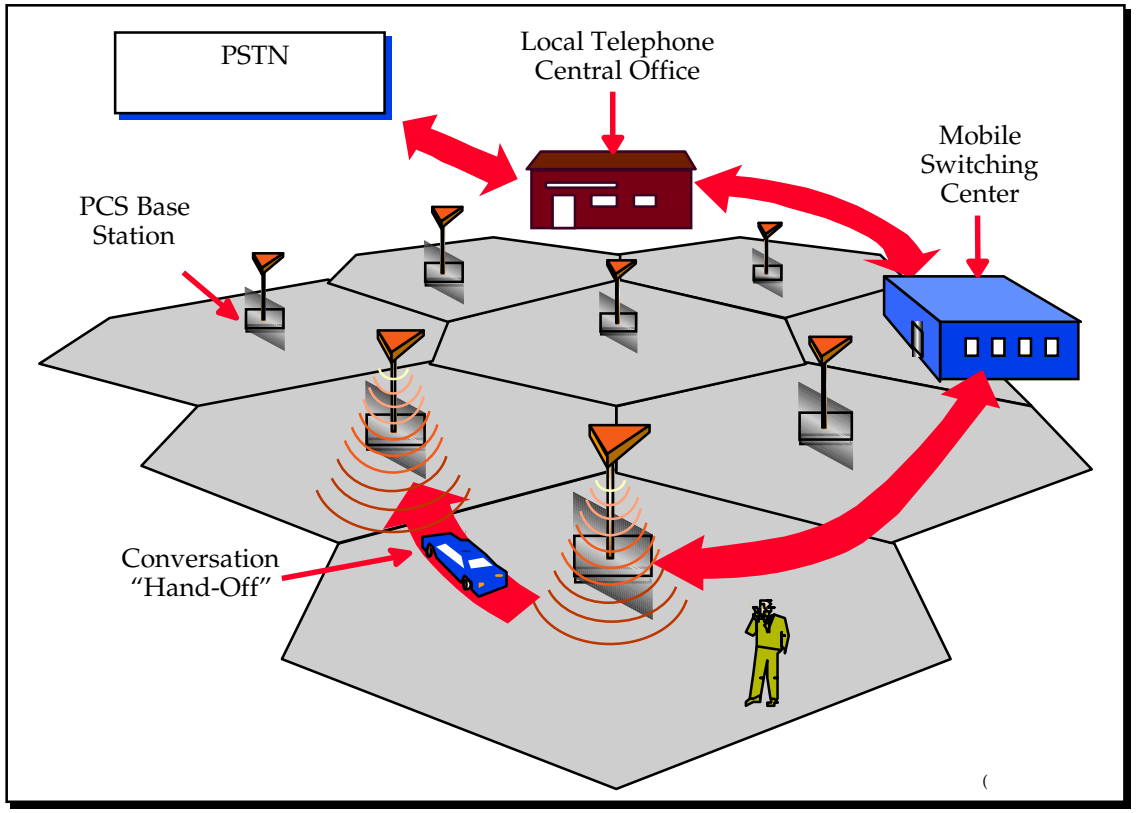


[6] Gibson, Jerry, The Mobile Communications Handbook, 2nd Edition, CRC Press LLC, 1999
[7] University of Birmingham, “User Mobility” < http://web.bham.ac.uk/eee1roj8/wbe/g4c3a.htm > January, 1999

THE FOLLOWING DIAGRAMS DEPICT VIEWS OF A MOBILE SWITCHING CENTER AND A CELLULAR SYSTEM



THE FOLLOWING DIAGRAMS DEPICT VIEWS OF A MOBILE SWITCHING CENTER AND A CELLULAR SYSTEM (CONT'D)



TO ASSESS THE ABILITY OF MOBILE PHONE SERVICES TO SUPPORT THE PUBLIC SAFETY MISSION, KEY PARAMETERS IMPORTANT TO THE PUBLIC SAFETY COMMUNITY AT LARGE SHOULD BE ANALYZED

- Coverage
- Handset technology
- Accessibility
- Security
- Enhanced service options
- Cost
- Status of upcoming third-generation (3G) technology
- Future Bluetooth Technology

CELLULAR AND PCS COVERAGE SPANS NEARLY THE ENTIRE CONTINENTAL UNITED STATES, ALTHOUGH SUBSCRIBERS MAY STILL EXPERIENCE GAPS IN SERVICE

- Depending on the service provider, “home area” coverage can be provided in a local, metropolitan, or nationwide setting

- Coverage is established on the basis of potential users in a specified area
  - Cellular carriers may not provide coverage in rural areas away from major roadways because of low levels of demand, and hence low potential revenue

- Coverage gaps have several causes
  - Terrain or building interference can weaken or block signals
  - Rain and other environmental characteristics can weaken a signal
  - Interference can be caused by other nearby frequencies, power sources, or unidentified natural occurrences
  - As networks and service providers mature, the occurrence of these coverage gaps may be reduced

- Traveling long distances could lead to use of systems operated by other service providers
  - Service providers in different areas often have mutual agreements to allow subscribers to roam on adjacent systems
    - » Lack of these mutual agreements inhibits the use of services by roaming parties

- Roaming is a technique that allows cell phones to be used outside of a pre-defined home area
  - A cell phone can identify a foreign cell site and use the frequencies associated with that site if no home service is available
  - Roaming is usually more expensive but can be advantageous if coverage is limited
    - » The subscriber equipment can automatically choose the system with the stronger coverage

- Multimode handsets are available to further expand coverage. Handsets equipped with this technology can search for multiple sets of frequencies, thus providing more available connections

SEVERAL MANUFACTURERS PROVIDE PHONES THAT FUNCTION WITH ALL SERVICE PROVIDERS. PHONES VARY IN SIZE, WEIGHT, SHAPE, BATTERY TECHNOLOGY, RANGE OF SERVICE, ENHANCED FEATURES, AND DISPLAY TYPE

- The size of a currently manufactured mobile phone ranges from the size of a simple deck of cards to about twice that size. Semiconductor technology has advanced, thus substantially decreasing the size of integrated circuits needed to produce mobile phones

- Battery technology has also evolved substantially in the past few years. Nickel metal hydride, lithium ion, and polymer batteries have replaced basic alkaline and nickel-cadmium batteries. These batteries have less memory effect and are smaller in size
  - The memory effect of a battery is the degradation in charging capability after numerous charging cycles

- Some mobile phones can adjust their transmit and receive power when the distance between a cell site and the phone increases. The power a cell phone emits is important to the range of service available in the specified area

- Many enhanced features are only available on certain phones
  - For example, Web-based messaging is only available in a phone with that type of service programmed into the phone's software

SUBSCRIBERS TODAY HAVE A CHOICE BETWEEN ANALOG CELLULAR, DIGITAL CELLULAR, AND PCS PHONES. TO INCREASE THE CHANCES OF AVAILABLE COVERAGE, DUAL- AND TRI-MODE PHONES HAVE BEEN DEVELOPED TO AUTOMATICALLY SWITCH BETWEEN DIFFERENT TECHNOLOGIES

- Multimode phones can dynamically choose the technology having the strongest coverage in a given area
- Roaming agreements are crucial to multimode operation
- Dual-mode phones can operate on analog cellular and either digital cellular or PCS
- Tri-mode phones can operate on analog cellular, digital cellular, and PCS

CELLULAR SUBSCRIBERS SHARE THE AIRWAVES AND COMPETE FOR CAPACITY ON THE NETWORK. AT TIMES, DEMAND AT A SITE WILL EXCEED CAPACITY

- Congestion occurs when all available channels are taken at a particular cell site
  - Call attempts cannot be made until resources (channels) are free

- Congestion can likely be caused by the following
  - Major events such as sporting events, concerts, and business conferences
  - Natural or manmade disasters and other emergency response incidents
  - Rush hour (i.e., during the hours of 7–9 a.m. and 5–7 p.m.)

- Capacity is different for certain air interfaces
  - Analog cellular has the lowest capacity
  - Digital capacity is approximately three times the size of analog technology
  - CDMA/PCS technology is approximately 10 times that of analog systems

SECURITY IS A MAJOR CONCERN FOR WIRELESS USERS. NOT ALL OF THE TECHNOLOGIES ADDRESSED IN THIS DOCUMENT HAVE SECURITY FEATURES

- Analog cellular
  - Because analog cellular operates by "broadcasting" audio between phone and antenna site, it is relatively easy to intercept and eavesdrop on calls
  - Analog cellular is susceptible to "cloning" of phones
  - Analog cellular service is extremely vulnerable to fraud

- Digital cellular and PCS
  - Because digital schemes, such as CDMA or TDMA, are encoded, communications using these technologies are less likely to be intercepted, although these communications technologies still can and have been intercepted
    - » CDMA technology in particular has a low probability of detection and interception

SEVERAL SERVICE OPTIONS ARE AVAILABLE THAT MAY PROVE USEFUL FOR PUBLIC SAFETY AGENCIES WHEN PURCHASING PLANS FOR MOBILE PHONES

- Enhanced features are usually provided at added cost, although digital cellular and PCS companies usually include a few enhanced features in basic packages
- Enhanced features vary by service provider in terms of availability as well as cost
- A list of popular features is included below. These features may be dependent on the service provider, the type of air interface, or the specific phone being purchased

Caller ID	Function help
Call Waiting	Theft alarm
Call Forwarding	Call restrictions
Voice Messaging	Time (clock)
Numeric Messaging	Any key answer
Text Messaging	Air time call timers
Web Access	Silent ringer/vibrate mode
Roadside Assistance	Battery charge status
Last number/multiple number redial	Voice activated dialing
Free long distance	Directory Assistance / 411
Clear last digit/clear display	Missed call indicator
Volume control (voice and/or ringer)	Hearing aid compatibility
Display contrast	External earpiece/microphone interface
Keypad illumination	Fax/modem interface
Keypress volume/muting	External power interface
Display scrolling	Multiple ring types
Phone Book Storage/Speed dial/One touch dialing	Language selection
Phone lock theft protection	Calculator
911 dedicated dial	Own number display
3-way calling	

THE BASIC CATEGORIES OF COSTS INCLUDE THE PRICE OF A TELEPHONE, SERVICE FEES, AND CHARGES FOR ENHANCED FEATURES NOT INCLUDED IN A PLAN. AGENCY PACKAGE DEALS MAY ALSO BE AVAILABLE

- Plans usually include a one-time charge for setup and the cost of the phone
  - A service plan is usually set up for monthly billing or as a yearly contract
  - Usage-based pricing typically covers a specified number of airtime minutes for the monthly service charge
  - Users pay incrementally, on a per-minute basis, for usage beyond the fixed limit
  - Costs for service may range from around $.10 per minute to $.40 per minute depending on the plan used
  - Package discounts are usually available at discounted rates
  - Plans quite often vary by demand, service provider, and region

- Cost of phones
  - The cost of phones varies from $0 to approximately $500. The cost of the phone depends on the package cost established by the service provider and the complexity of the actual phone being purchased

- Roaming calls placed or received outside the user's local region may be charged
  - The likelihood of placing this type of call should be considered when analyzing pricing packages
  - If desired, roaming can typically be turned off on a handset

THE BASIC CATEGORIES OF COSTS INCLUDE THE PRICE OF A TELEPHONE, SERVICE FEES, AND CHARGES FOR ENHANCED FEATURES NOT INCLUDED IN A PLAN. AGENCY PACKAGE DEALS MAY ALSO BE AVAILABLE (CONT'D)

- Included below are examples of typical package deals indicating “per unit” rates. Because of a rapidly changing market, and differing sizes and needs of public safety agencies, package costs may differ. The plans shown below are offered to provide radio managers with an expectation of average rates

PCS Service Rates

Monthly Service Charge[8]	$19.99	$29.99	$49.99	$69.99	$99.99	149.99	$199.99
Included Minutes	20	180	400	700	1000	1500	2000
Each Additional Minute	$0.39	$0.35	$0.30	$0.25	$0.25	$0.25	$0.25
Plans Include	Voicemail with numeric paging, Caller ID, Call Waiting, and Call Forwarding						

Digital Service Rates

Monthly Service Charge[9]	$29.99	$39.99	$49.99	$69.99	$99.99	$149.99	
Included Minutes	100	175	350	550	900	1500	
Each Additional Minute	$0.35	$0.35	$0.35	$0.35	$0.35	$0.35	
Plans Include	Call Waiting, Caller ID, Call Forwarding, 3 Way Calling, Voice Mail						

Digital Service Rates

Monthly Service Charge[10]	$35.00	$55.00	$75.00	$100.00	$150.00	$200.00	
Included Minutes	150	400	600	900	1500	2000	
Each Additional Minute	$0.40	$0.35	$0.35	$0.25	$0.25	$0.20	
Plans Include	2000 Weekend Minutes, Call Waiting, Caller ID, Call Forwarding, 3 Way Calling, Voice Mail						

[8] Sprint PCS, “Sprint PCS Service Rates”, < http://www.sprintpcs.com > May 2001
[9] Cingular Wireless, Inc. “Cingular Digital Service Rates”, < http://www.cingular.com > May, 2001
[10] Verizon, Inc. “Digital Service Rates”, < http://www.verizon.com > May, 2001

THIRD GENERATION (3G) WIRELESS SERVICES MAY SOON BE AVAILABLE TO THE GENERAL PUBLIC

- Analog Cellular is considered the first generation of wireless technology
- Digital Cellular and PCS are considered the second generation of wireless technology
- Added services such as wireless data will be used for the third generation of wireless technology
  - 3G promises to offer all the services associated with current second generation technology
  - The added advantage of 3G will be wireless high-speed, wideband data communications
  - Currently there are some data communications via the second generation networks
    - » These data communications are limited and slow
    - » These interim 3G-style services are sometimes referred to as 2.5G
- Any new, large-scale purchases of wireless services should take into consideration the need for 3G services and capabilities
  - Subscribers should note that 3G is not yet available, and new purchases would require an upgrade to be compatible with the 3G networks
  - 3G is currently expected to be offered using GSM and CDMA signaling techniques
- The timeline for 3G implementation has been pushed back several times
  - NTT DoCoMo (Japan) is expecting to launch it's 3G offering in the 4th quarter of 2001 (possibly September)
  - British Telecom and Deutsche Telekom have partnered and will most likely deploy their 3G offering soon after NTT DoCoMo
  - There are no hard timelines set for a US provider to deploy 3G services

3G WIRELESS SERVICES WILL EVENTUALLY HAVE A LARGE IMPACT ON THE WAY WIRELESS SUBSCRIBERS (INCLUDING THE PUBLIC SAFETY COMMUNITY) WILL USE WIRELESS TELECOMMUNICATIONS

- 3G capabilities in the commercial wireless networks will enhance functionality for all users, including the public safety community

- 3G will give users the capability to access data on their handsets. Some anticipated applications on 3G networks are:
  - High-speed modem capabilities for PCs or Personal Data Assistants (PDAs)
  - Internet browsing from the handset
  - Information services
    - On-line directory services
    - Location-based services
      - Local information (e.g., restaurants, movie theaters, etc.)
      - Push-based services (e.g., weather based on location)
    - Non-location based, pay-for-service
      - News
      - Stock Quotes
      - Sports Scores
  - Wireless Gaming

- As these 3G services become ubiquitous, it is expected that the capacity of commercial wireless networks will be pushed to their limits
  - Commercial providers are currently designing their networks to handle the large capacities of users expected with the roll-out of 3G services
  - The access technologies planned to deliver 3G services have unique, flexible algorithms designed to address capacity issues

FUTURE USES OF THE NEWLY CREATED BLUETOOTH TECHNOLOGY MAY PRESENT SEVERAL ENHANCEMENTS FOR PUBLIC SAFETY COMMUNICATIONS

- Bluetooth technology is a high bandwidth, short distance communications air interface technology that eliminates the need for inconvenient cable attachments for connecting desktop computers, mobile computers, mobile phones, and handheld devices together in the same network

- Uses for Bluetooth include Three-in-one Phones, Internet Bridges, Interactive Conferences, Enhanced Headsets, and Automatic Synchronizers
  - Three-in-One Phone – A device planned to function as a portable phone in the home or office (attached to a fixed line base station and charging unit from the home or office), as a mobile phone (attached to a cellular type infrastructure), or as an ad hoc “walkie talkie” for communications with another Bluetooth enabled device
  - Internet Bridges – Internet connection without a link through a mobile phone, or a wired link such as PSTN, ISDN, LAN, or DSL.
  - Interactive Conferences – Seamless, wireless data and voice transfer for conferences or meetings when participants are located in close proximity
  - Enhanced Headsets – Mobile phone connection via smaller headsets, for hands-free communications
  - Automatic Synchronizers – Simultaneous data entry into desktop computers, mobile computers, and mobile phones connected to the initial data input device[11]

[11] Adcore Pyramid (2001) "Bluetooth Guide Usage Models", < www.bluetooth.com >

PUBLIC SAFETY AGENCIES SHOULD CONSIDER SEVERAL FACTORS WHEN ASSESSING HOW COMMERCIAL SERVICES CAN SUPPORT THEIR OPERATIONAL REQUIREMENTS

- Operational Requirements
  - Requirements differ from agency to agency, and may include nontactical, administrative, backup, emergency, or personal use

- Availability
  - Analog cellular service is available almost everywhere in the United States
  - Digital cellular service is also widely available; however, it may still be unavailable in some rural areas
  - Multimode phones will likely solve many coverage and availability issues

- Packages and Billing Structures
  - Costs for cellular services and equipment have declined substantially due to increased competition and economies of scale
  - Package costs vary by size of organization, usage rates, and monthly allowance

- Data Capabilities
  - E-mail, Web service, and data available via the phone
  - Data services, using the cell phone as a modem

- Accessibility
  - If call demand exceeds call capacity in a single cell, users may not be able to access cellular service, or may experience call setup delays

PUBLIC SAFETY AGENCIES SHOULD CONSIDER SEVERAL FACTORS WHEN ASSESSING HOW COMMERCIAL SERVICES CAN SUPPORT THEIR OPERATIONAL REQUIREMENTS (CONT'D)

- Dialing Requirements
  - To begin a call, a user must either dial or use the "speed dial" option
    - » This could be a problem for public safety users who sometimes do not have the time to "dial" individual numbers during emergency response scenarios

- Privacy and Security
  - In a public safety scenario, unauthorized monitoring or fraudulent use of a signal may inhibit safety or confidentiality

IN A SERIES OF ORDERS SINCE 1996, THE FCC HAS TAKEN ACTION TO IMPROVE THE QUALITY AND RELIABILITY OF 911 EMERGENCY SERVICES FOR WIRELESS PHONE USERS. THESE RULES GOVERN THE AVAILABILITY OF BASIC 911 SERVICES AND THE IMPLEMENTATION OF ENHANCED 911 (E911) FOR WIRELESS SERVICES

- Basic 911 rules require wireless carriers to transmit all 911 calls to a Public Safety Answering Point (PSAP) without regard to validation procedures intended to identify and intercept calls from non-subscribers. Under the rules, both subscribers and non-subscribers can dial 911 and reach emergency assistance providers without having to prove their subscription status
- Phase I E911 requirements state that as of April 1, 1998, or within six months of a request by the PSAP, cellular and PCS service providers are required to provide the PSAP with the telephone number of the originator of a 911 call and the location of the cell site or base station receiving the 911 call. This information provides some general location information for the call being received, and permits emergency call-takers to re-establish a connection with the caller should the call be disconnected. This is also referred to as Automatic Number Identification (ANI)
- Phase II requirements state that wireless carriers are to provide Automatic Location Identification (ALI) beginning October 1, 2001. ALI technology enables carriers to locate handsets using technologies such as GPS. The wireless carriers are required to begin selling and activating ALI-capable handsets no later than October 1, 2001 and to ensure that at least 25 percent of all new handsets activated are ALI-capable no later than December 31, 2001. The percentage of ALI-capable handsets is required to increase incrementally up to 95 percent by December 31, 2005
  - Network-based solutions are also in the developmental stage. The approach for utilizing a network-based solution calls for base stations to locate a desired user. This solution will allow current handsets to work with an updated network solution
  - The standards for Phase II location accuracy and reliability are the following:
    - For network-based solutions: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls
    - For handset-based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls[12]

[12] Federal Communications Commission (1999) "FCC Acts to Promote Competition and Publis Safety in Enhanced Wireless 911 Services" < http://www.fcc.gov/ >

IN A SERIES OF ORDERS SINCE 1996, THE FCC HAS TAKEN ACTION TO IMPROVE THE QUALITY AND RELIABILITY OF 911 EMERGENCY SERVICES FOR WIRELESS PHONE USERS. THESE RULES GOVERN THE AVAILABILITY OF BASIC 911 SERVICES AND THE IMPLEMENTATION OF ENHANCED 911 (E911) FOR WIRELESS SERVICES (CONT'D)

- According to several Reuters Press Releases in late July 2001, several of the larger cellular and PCS providers have asked for waivers in regards to the October 2001 deadline
  - Currently, the FCC is considering waiver requests from eight carriers, and has granted one extension to VoiceStream Wireless[13]
  - Carriers have stated that factors such as delays by infrastructure companies in providing the necessary switching software to support the new devices, have slowed the expected deployment of the new systems

- New evidence suggests that local law enforcement agencies are also delayed in meeting the federal deadline
  - According to the Association of Public Safety Communications Officials (APCO), less than 10 percent of the 4,300 police departments in the United States have the service up and running
  - Less than half of these same police departments, where one-third of the 911 calls are from cell phones, have asked carriers to provide E911
  - Other concerns exist within 911 centers, such as the E911 feature adding an increased workload for already overworked dispatching staff[14]

[13]CNET News.com, July 2001, "Sprint PCS Wants Extension on 911 Rule" < http://news.cnet.com/news/0-1004-200-6721459.html >
[14] CNET News.com, July 2001, "Are Police Ready for Wireless 911 Calls?" < http://news.cnet.com/news/0-1004-200-6605792.html >

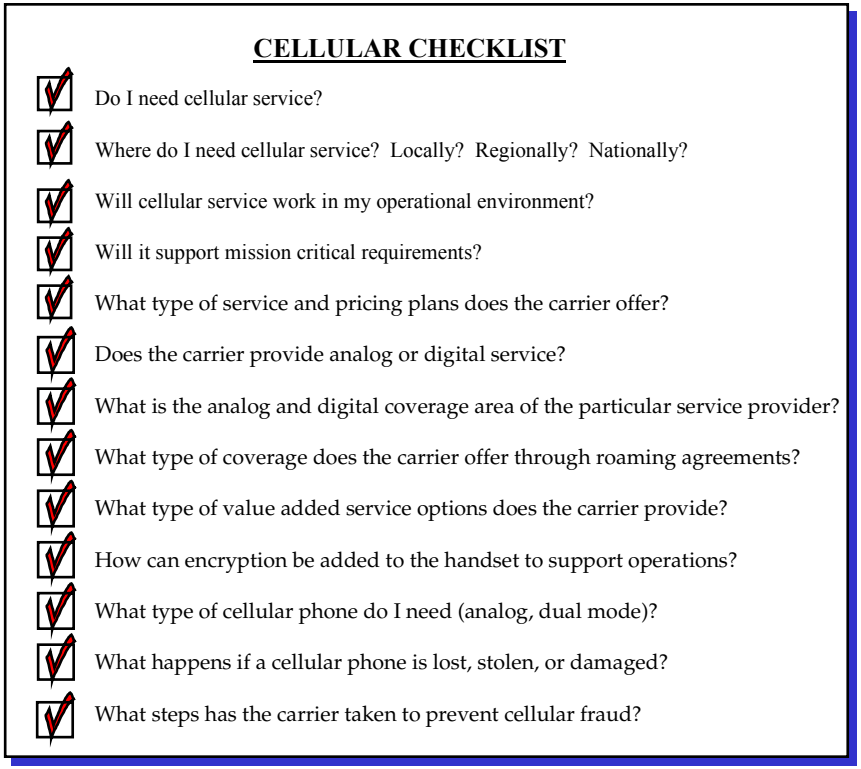
SEVERAL FEDERAL USER REQUIREMENTS FOR WIRELESS PRODUCTS HAVE BEEN CHARACTERIZED BY THE FEDERAL WIRELESS POLICY COMMITTEE (FWPC) IN SUPPORT OF WIRELESS OPERATIONAL NEEDS OF VARIOUS GOVERNMENT AGENCIES

- The FWPC is a cross section of federal agencies chaired by the National Telecommunications and Information Administration. The committee authored the document, "*Current and Future Functional Requirements for Federal Wireless Services in the United States*", which was originally approved on August 12, 1994. Since then, the document has been revised, and the most up-to-date version was approved by the FWPC on May 21, 1999. From this revised document comes one of the main goals of the FWPC, which is to support five requirements known as DUITS (digital, ubiquitous, interoperable, transparent, and secure)
  - Digital - service supported by high performance, digital communication link protocols. Such protocols enable enhanced radio link communications and the addition of higher layer services to support data, security, and other advanced network features
  - Ubiquitous - support for wide coverage areas. Ubiquitous service requirements include geography, compatibility, and service provisioning. Each of these requirements must be addressed to support mobile users of one or more air interface (radio) technologies
  - Interoperable - the direct compatibility between user and service provider and local network domains. Interoperability can include multi-mode operation and/or service internetworking
  - Transparent - the maintenance of service features, performance, and operation is “transparent” to the user across service and network boundaries
  - Secure - the suite of information security features provided by the network and/or available in the user terminal. Security features include the following traditional requirements:
    - » Confidentiality – the protection of user data, signaling, identification, and location
    - » Integrity – the protection from insertion, deletion, modification, or replay of data
    - » System availability – ability to obtain access to the service and the prevention of accidental or malicious denial of service
    - » Authentication – the assured identification of the user, terminal, and carrier
    - » Accountability – the ability to verify transactions[15]

[15] Federal Wireless Policy Committee (1999) "Federal Functional Requirements for Commercial Wireless Services" <http://snad.ncsl.nist.gov/fwuf/fwpc.html >

USER CHECKLIST OF QUESTIONS TO BETTER UNDERSTAND CELLULAR SERVICE

- The checklist below is intended for any radio managers or system administrators investigating a cellular or PCS purchase. This checklist should be used only as a preliminary guideline for covering the most important services



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3G	Third Generation
ALI	Automatic Location Identification
AMPS	Advanced Mobile Phone Service
ANI	Automatic Number Identification
CDMA	Code Division Multiple Access
E911	Enhanced 911
FCC	Federal Communications Commission
FM	Frequency Modulation
FWPC	Federal Wireless Policy Committee
GSM	Global System for Mobile Communications
LMR	Land Mobile Radio
MHz	Megahertz
MSC	Mobile Switching Center
NTIA	National Telecommunications and Information Administration
PCS	Personal Communications Services
PDA	Personal Data Assistant

PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
PSWN	Public Safety Wireless Network
RF	Radio Frequency
TDMA	Time Division Multiple Access