Personal Communication System

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Differences Between Cellular Systems and PCS

- Based on the same idea as the first-generation cell phone systems, PCS have significant differences which justify the use of a different term.
- The system described here often called second generation personal communication systems; in other words, the analog cell phone system is really the first generation of PCS.
Frequency Range

- The broadband PCS band consists of 120 MHz in the 1900-MHz region.
- The term broadband here is relative. It refers to bandwidth sufficient for voice communication and distinguishes this service from such narrowband as paging.
- See table 11.1 for the PCS band plan [1].
  - There are six frequency allocations, so up to six licenses can be awarded in any given area.
  - There are three 30-MHz and three 10-MHz allocations.
  - The reverse channel or uplink (mobile to base) is 80 MHz above the forward channel or downlink (base to mobile) frequency.
  - Reverse and forward channel allocations are separated by a 20-MHz band, from 1910 to 1930 MHz, which is allocated for unlicensed services like short-range voice communication.
### Broadband PCS Band Plan [1]

<table>
<thead>
<tr>
<th>Allocation</th>
<th>Base Transmit (Forward Channel or Downlink)*</th>
<th>Mobile Transmit (Reverse Channel or Uplink)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1850–1865</td>
<td>1930–1945</td>
</tr>
<tr>
<td>B</td>
<td>1870–1885</td>
<td>1950–1965</td>
</tr>
<tr>
<td>D</td>
<td>1865–1870</td>
<td>1945–1950</td>
</tr>
<tr>
<td>E</td>
<td>1885–1890</td>
<td>1965–1970</td>
</tr>
<tr>
<td>F</td>
<td>1890–1895</td>
<td>1970–1975</td>
</tr>
</tbody>
</table>

*Frequencies are in MHz
Smaller Cell Size
- PCS cells are typically smaller than AMPS cells to accommodate more traffic and low-power handheld phones.
- They must hand off calls very quickly to handle users in moving cars.

All-Digital System
- Current digital technology is more efficient than analog FM in its use of bandwidth.

Extra Features
- Digital system allow a substantial amount of data transmission in their control channels, making all sorts of enhancements possible.
Coverage
- The coverage for any PCS is much less universal than it is for AMPS cell phones.

Rate Structure
- One of the arguments for PCS is that they should be less expensive than analog cellular radio.
- The utilization of spectrum space is more efficient, for example.
IS-136 (TDMA) PCS

- Most people just refer to it as TDMA (*Time division multiple access*) when they are talking about PCS, though GSM is also a TDMA system.

- The most important difference between the 800-MHz and 1900-MHz version of TDMA is that there are no analog control channels in the PCS bands.
TDMA Digital Control Channel

- The digital control channel (DCCH) uses two of the six time slots in a TMDA frame.
- Normally only one DCCH is required per cell or sector.
- Figure 11.1 shows how the time slot is divided up for both forward and reverse channels [1].
Forward channel:

- The SYNC (synchronizing) bits have the same function as for the voice channels, allowing the mobile receiver to lock on the beginning of the transmission.
- The SCF (shared channel feedback) bits perform several functions. They provide acknowledgement of messages from mobiles and inform the mobiles of the status of the reverse control channel.
- CSFP (code superframe phase) bits identify the location of this time slot in a large frame that extends over 16 TDMA frames or 32 blocks of control-channel data, representing a time period of 640 ms.
- Table 11.2 summarizes the logical channels, and a brief description of each channel [1].
<table>
<thead>
<tr>
<th>Name of Channel</th>
<th>Function</th>
<th>Time Slots per Superframe</th>
</tr>
</thead>
</table>
| Broadcast Channel (BCCH)                    | Urgent information for all mobiles, transmitted once per superframe, at beginning of superframe:  
|                                            | • Superframe structure                                                  | 3–10                      |
|                                            | • System identification                                                 |                           |
|                                            | • Access parameters                                                     |                           |
|                                            | • Registration parameters                                               |                           |
| Fast Broadcast Channel (F-BCCH)             |                                                                         |                           |
| Extended Broadcast Channel (E-BCCH)         | Less urgent information for all mobiles (transmitted over several superframes):  
|                                            | • Neighbor lists (control channel frequencies in nearby cells)          | 1–8                       |
|                                            | • Regulatory configuration (spectrum allocation)                        |                           |
|                                            | • Mobile assisted-channel allocation (frequencies mobiles should monitor) |                           |
| Reserved                                    | As needed by system                                                    | 0–7                       |
| Short Message Service, Paging, and Access Channel (SPACH) |                                                                         | Remaining Slots           |
| Short Message Service Channel (SMSCH)       | • Short message service                                                 |                           |
|                                            | • Remote phone programming                                              |                           |
| Paging Channel (PCH)                       | Paging (ringing mobile phone)                                           |                           |
| Access Response Channel (ARCH)              | Control messages to individual phones                                   |                           |
GSM

- GSM is the system used in Europe and most of Asia for both cellular and PCS bands.
- GSM is another TDMA system but the details are different.
- GSM also has some unique features that make it arguably more sophisticated and versatile than IS-136.
- It is not compatible with existing IS-136 cell site equipment.
GSM RF Channels and Time Slots

- GSM channels are 200 kHz wide (compared with 30 kHz for IS-136 TDMA).
- The total bit rate for an RF channel is 270.833 kb/s; the modulation is a variant of FSK called GMSK (Gaussian minimum shift keying) using a frequency deviation of 67.708 kHz each way from the carrier frequency.
- Voice channels are called traffic channels (TCH) in GSM. One RF channel is shared by eight voice transmissions using TDMA.
- In terms of spectral efficiency, GSM works out to 25 kHz per voice channel, compared to about 30 kHz for AMPS and about 10 kHz for TDMA.
- A GSM phone should have longer battery life than a phone using either AMPS or TDMA.
– Figure 11.2 shows the structure of an RF channel and its division into time slots (called bursts in GSM) [1].

– Control information in GSM is on two logical channels called the broadcast channel (BCCH) and the paging channel (PCH).
The broadcast information is transmitted first, followed by paging information. See Figure 11.3 for an illustration [1].

- **F** = Frequency correction (sine-wave carrier)
- **S** = Synchronizing
- **C** = Contents list
- **BCCH** = Broadcast control channel
Voice transmission

- Each voice transmission is located at 13 kb/s and is allocated one time slot per frame.
- A frame lasts 4.615 ms so each time slot is approximately 577 µs in duration. To allow time for transmitters to turn on and off, the useful portion of the time slot is 542.8 µs, which allows time for 147 bits. Figure 11.4 shows the structure of a voice channel [1].
Frequency Hopping in GSM

- When multipath fading is a problem, the GSM system allows for frequency hopping, a type of spread-spectrum communication.
- The system can hop only among the frequencies that are assigned to the cell, so there will be only a few hopping possibilities (on the order of three frequencies).
- Thus GSM is not really a true spread-spectrum system, but rather a TDM/FDM system with some spread-spectrum capability added on. This feature is unique to GSM; IS-136 TDMA has nothing like it.
Subscriber ID Module

- The **subscriber ID module** (SIM) is unique to the GSM system. It is a **smart card** with eight kilobytes of memory that can be plugged into any GSM phone.
- The SIM contains all subscriber information including telephone number (called the **International Mobile Subscriber Identification** (IMIS) in GSM), a list of networks and countries where the user is entitled to service, and other user-specified information such as memories and speed dial numbers.
- The SIM also offers some protection against fraudulent use. A GSM phone is useless without a SIM; if the user removes the card when leaving the phone in a car, for example, the phone cannot be used unless the thief has a valid SIM.
The GSM SIM is only a part of the effort that has gone into securing this system.

The security in GSM is better than in IS-136 and much better than in analog AMPS.
i-mode mobile communication [2]

- i-mode by NTT docomo in 2/1999
- EZweb by KDDI/Tsuka in 4/1999
- J-SKY by J-Phone in 10/1999
Gateway [2]
- i-mode packets communication [2]
Webページのしくみ

HTMLの例

```html
<HTML>
<HEAD>
<TITLE>なななんとページ</TITLE>
</HEAD>
<BODY>
<P>なななんとページ</P>
<P><IMG SRC="logo.gif"/>
<P>なななんとページ</P>
<P><A HREF="prof.html">リンク1</A></P>
</BODY>
</HTML>
```
Graphics [2]
WAP & HTML [2]
References
