

William C. Y. Lee

Mobile Cellular Telecommunications

ANALOG AND DIGITAL
SYSTEMS

SECOND EDITION



Mobile Cellular Telecommunications

Analog and Digital Systems

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Since the beginning of 1989, a lot of work has been done in the field of mobile communication and cellular systems. When Mr. C. accepted his thesis, he was joining in the field of mobile communication as a graduate student. In the field, he has been working on the topic of mobile communication for the last two years. He has been adding many new concepts, such as TDMA, CDMA, and CD2, CDPD, etc., to the existing knowledge. He has also been working on the concept of intelligent cell and intelligent network. In the future, he hopes to develop a new superhighway for mobile communication.

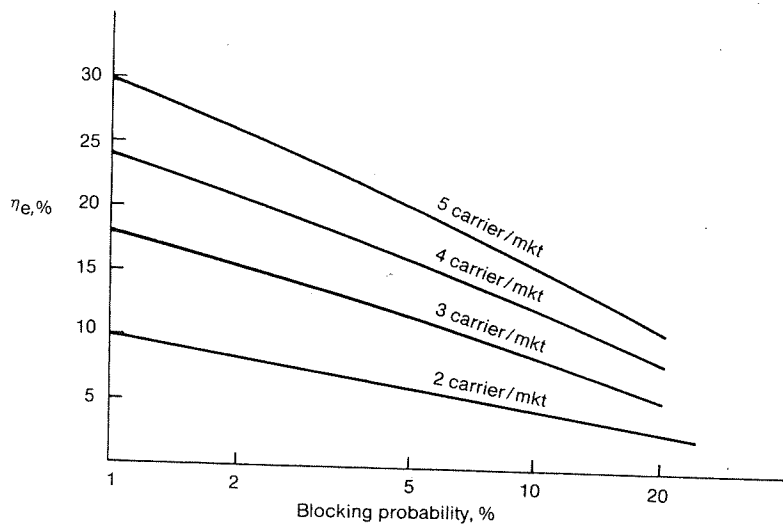


Figure 1.2 Degradation of trunking efficiency—comparing one carrier/market and other-than-one-carrier/market.

$$Q_i = \begin{cases} 2832.95 \text{ calls/h} & (1 \text{ carrier/market}) \\ 1295.45 \times 2 = 2590.9 \text{ calls/h} & (2 \text{ carriers/market}) \end{cases}$$

The trunking efficiency degradation factor can be calculated as

$$\eta_e = \frac{2832.95 - 2590.9}{2832.95} = 8.5\% \quad (1.3-3)$$

for a blocking probability of 2 percent. Figure 1.2 shows η_e by comparing one carrier per market with more than one carrier per market situations with different blocking probability conditions. The degradation of trunking efficiency decreases as the blocking probability increases. As the number of carriers per market increases the degradation increases. However, when a high percentage of blocking probability, say more than 20 percent, occurs, the performance of one carrier per market is already so poor that further degradation becomes insignificant, as Fig. 1.2 shows.

For a 2 percent blocking probability, the trunking efficiency of one carrier per market does show a greater advantage when compared to other scenarios.

1.4 A Basic Cellular System

A basic cellular system consists of three parts: a mobile unit, a cell site, and a mobile telephone switching office (MTSO), as Fig. 1.3 shows, with connections to link the three subsystems.

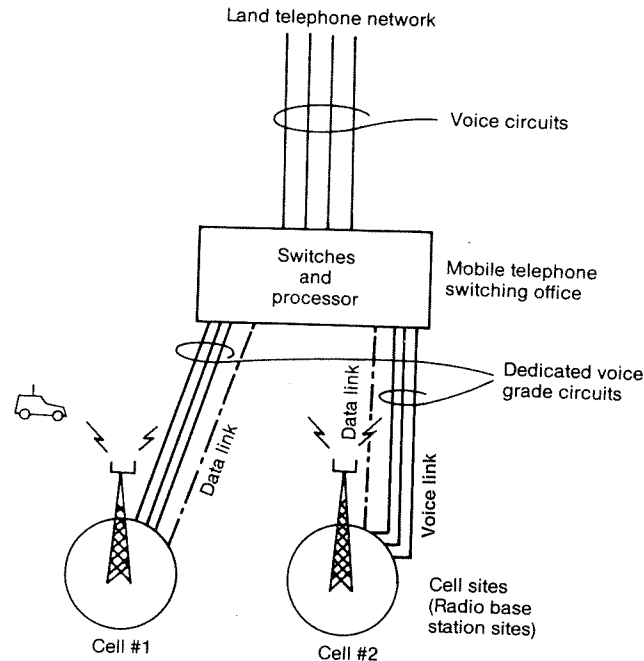


Figure 1.3 Cellular system.

1. *Mobile units.* A mobile telephone unit contains a control unit, a transceiver, and an antenna system.
2. *Cell site.* The cell site provides interface between the MTSO and the mobile units. It has a control unit, radio cabinets, antennas, a power plant, and data terminals.
3. *MTSO.* The switching office, the central coordinating element for all cell sites, contains the cellular processor and cellular switch. It interfaces with telephone company zone offices, controls call processing, and handles billing activities.
4. *Connections.* The radio and high-speed data links connect the three subsystems. Each mobile unit can only use one channel at a time for its communication link. But the channel is not fixed; it can be any one in the entire band assigned by the serving area, with each site having multichannel capabilities that can connect simultaneously to many mobile units.

The MTSO is the heart of the cellular mobile system. Its processor provides central coordination and cellular administration.

The cellular switch, which can be either analog or digital, switches calls to connect mobile subscribers to other mobile subscribers and to

the nationwide telephone company providing support between the voice and signal high-speed data phone trunks carriers (wire voice and data

1.5 Performance

There are three

1.5.1 Voice quality

Voice quality is an important factor in the design of a system with a high level of performance. In military communications, personnel must understand the

For any given system, the quality will be based on the percent of customers (to receiver) as five listed below

CM	Score
CM5	5
CM4	4
CM3	3
CM2	2
CM1	1

As the percentage cost of building

The average called mean opinion around MOS $\geq$

the nationwide telephone network. It uses voice trunks similar to telephone company interoffice voice trunks. It also contains data links providing supervision links between the processor and the switch and between the cell sites and the processor. The radio link carries the voice and signaling between the mobile unit and the cell site. The high-speed data links cannot be transmitted over the standard telephone trunks and therefore must use either microwave links or T-carriers (wire lines). Microwave radio links or T-carriers carry both voice and data between the cell site and the MTSO.

1.5 Performance Criteria

There are three categories for specifying performance criteria.

1.5.1 Voice quality

Voice quality is very hard to judge without subjective tests from users' opinions. In this technical area engineers cannot decide how to build a system without knowing the voice quality that will satisfy the users. In military communications, the situation differs: armed forces personnel *must* use the assigned equipment.

For any given commercial communications system, the voice quality will be based upon the following criterion: a set value x at which y percent of customers rate the system voice quality (from transmitter to receiver) as good or excellent, the top two circuit merits (CM) of the five listed below.

CM	Score	Quality scale
CM5	5	Excellent (speech perfectly understandable)
CM4	4	Good (speech easily understandable, some noise)
CM3	3	Fair (speech understandable with a slight effort, occasional repetitions needed)
CM2	2	Poor (speech understandable only with considerable effort, frequent repetitions needed)
CM1	1	Unsatisfactory (speech not understandable)

As the percentage of customers choosing CM4 and CM5 increases, the cost of building the system rises.

The average of the CM scores obtained from all the listeners is called *mean opinion score* (MOS). Usually the toll-quality voice is around $MOS \geq 4$.