FDMA, TDMA and CDMA and Spread Spectrum decoding keys

FDMA: Frequency Division Multiple Access. FDMA allocates a specific carrier frequency to a communication channel, and the number of different users is limited to the number of slices in the frequency spectrum. FDMA is the least efficient in term of frequency-band usage. Methods of FDMA access include radio broadcasting, TV, AMPS, and TETRAPOLE.

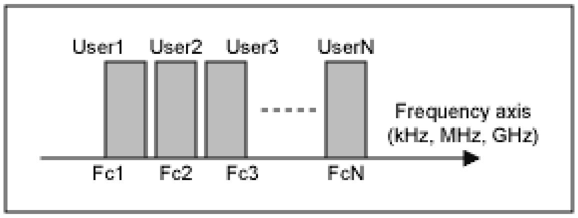

Figure 8.

TDMA: Time Division Multiple Access. Here, the different users speak and listen to each other according to a defined allocation of time slots. Different communication channels can then be established for a unique carrier frequency. Examples of TDMA are GSM, DECT, TETRA, and IS-136.

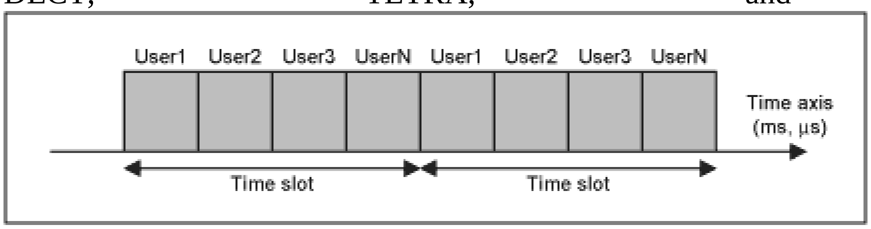

Figure 9.

CDMA: Code Division Multiple Access. CDMA access to the air is determined by a key or code. In that sense, spread spectrum is a CDMA access. The key must be defined and known in advance at the transmitter and receiver ends. Growing examples are IS-95 (DS), IS-98, Bluetooth, and WLAN.

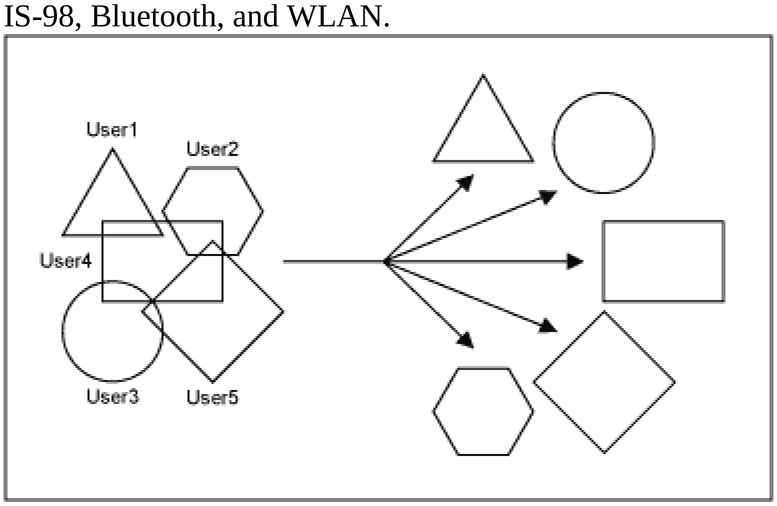

Figure 10.

One can, of course, combine the above access methods. GSM, for instance, combines TDMA and FDMA. It defines the topological areas (cells) with different carrier frequencies, and sets time slots within each cell.

Spread Spectrum and (De)coding "Keys"

At this point, we know that the main SS characteristic is the presence of a code or key, which must be known in advance by the transmitter and receiver(s). In modern communications, the codes are digital sequences that must be as long and as random as possible to appear as "noise-like" as possible. But in any case, they must remain reproducible. Otherwise, the receiver will be unable to extract the message that has been sent. Thus, the sequence is "nearly random." Such a code is called a pseudo-random number (PRN) or sequence. The method most frequently used to generate pseudo-random codes is based on a feedback shift register:

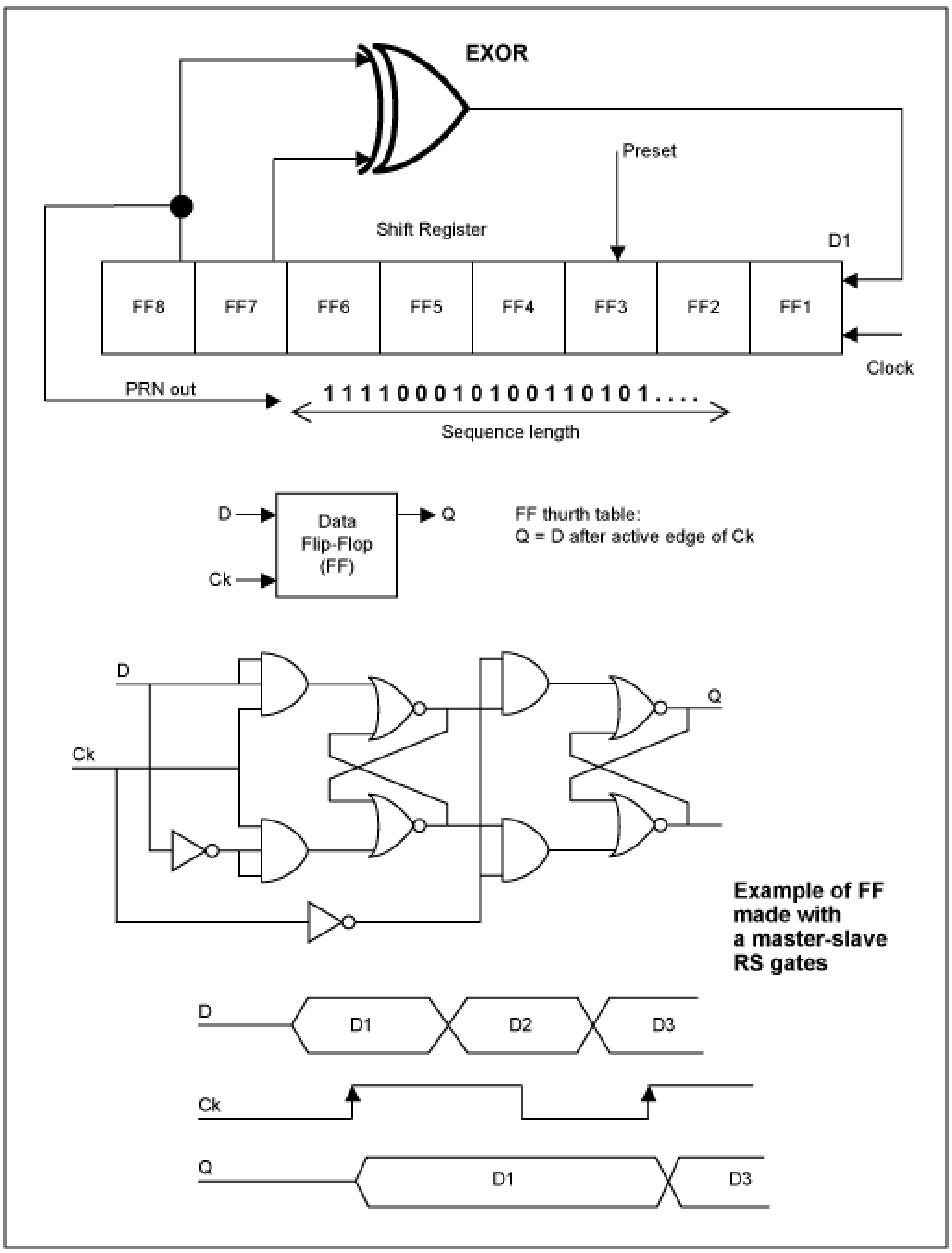

Figure 11.

Many books are available on the generation of PRNs and their characteristics, but that development is outside the scope of this basic tutorial. We simply note that the construction or selection of proper sequences (or sets of sequences) is not trivial. To guarantee efficient SS communications, the PRN sequences must respect certain rules, such as length, auto-correlation, cross-correlation, orthogonality, and bits balancing. The more popular PRN sequences have names: Barker, M-Sequence, Gold, Hadamard-Walsh, etc. Keep in mind that a more complex sequence set provides a more robust SS link. But, the price to pay is a more complex electronics (both in speed and behavior), mainly for the SS despreading operations. Purely digital SS despreading chips can contain more than several million equivalent 2-input NAND gates, switching at several tens of megahertz.