Time Division Multiple Access (TDMA)

TDMA systems divide the channel time into frames. Each frame is further partitioned into time slots. In each slot only one user is allowed to either transmit or receive.

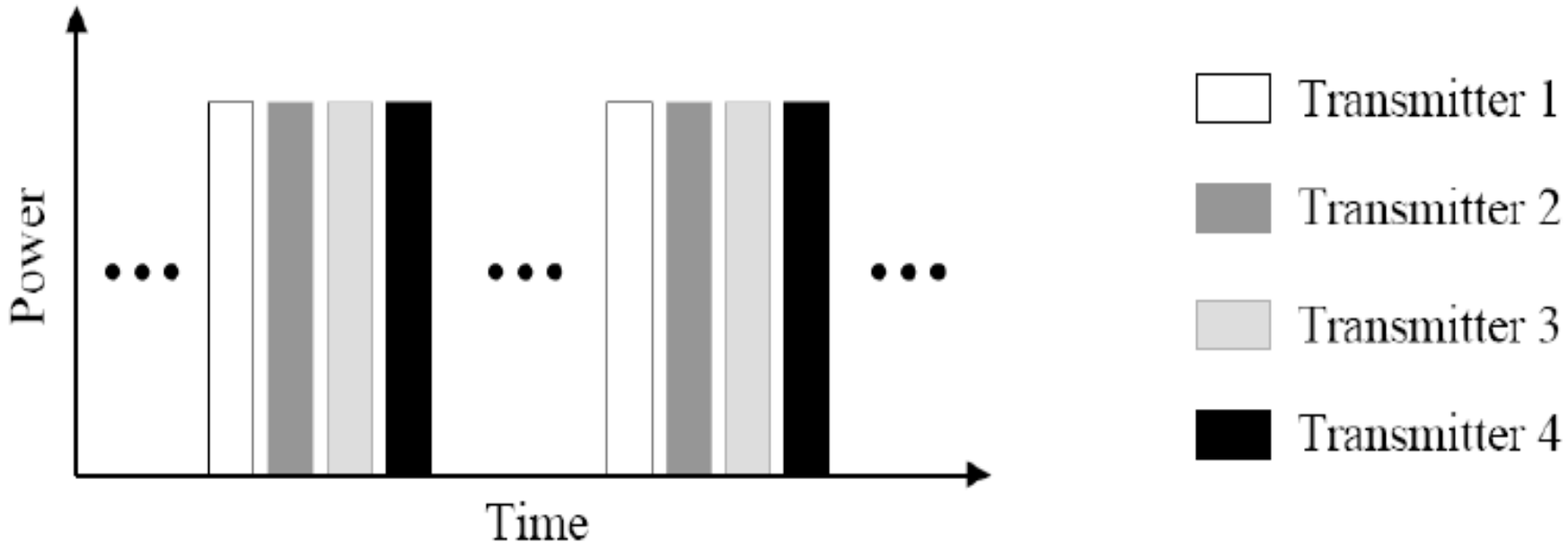
Unlike FDMA, only digital data and digital modulation must be used.

Time Division Multiple Access (TDMA)

- Transmitters share a common channel.
- Only one transmitter is allowed to transmit at a time.
  - Synchronous TDMA: access to the channel is restricted to regular.
  - Asynchronous TDMA: a station may transmit at any time that the channel is free.

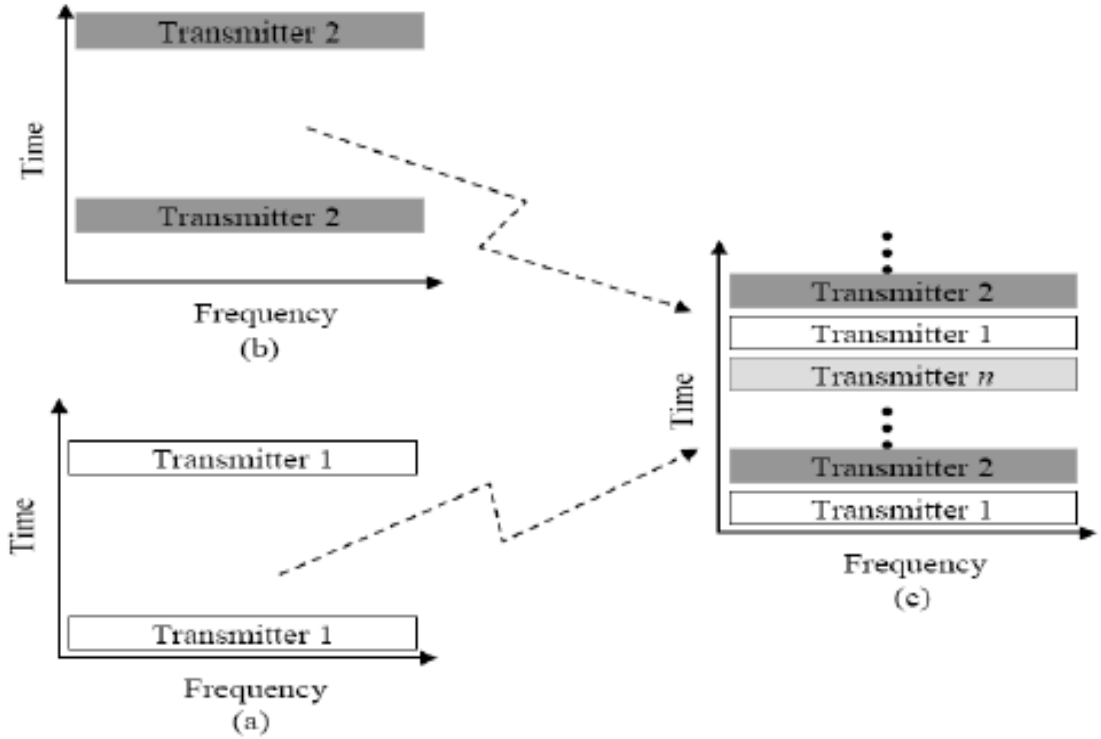
Time Division Multiple Access (TDMA)

- Allocation of time slot in TDMA



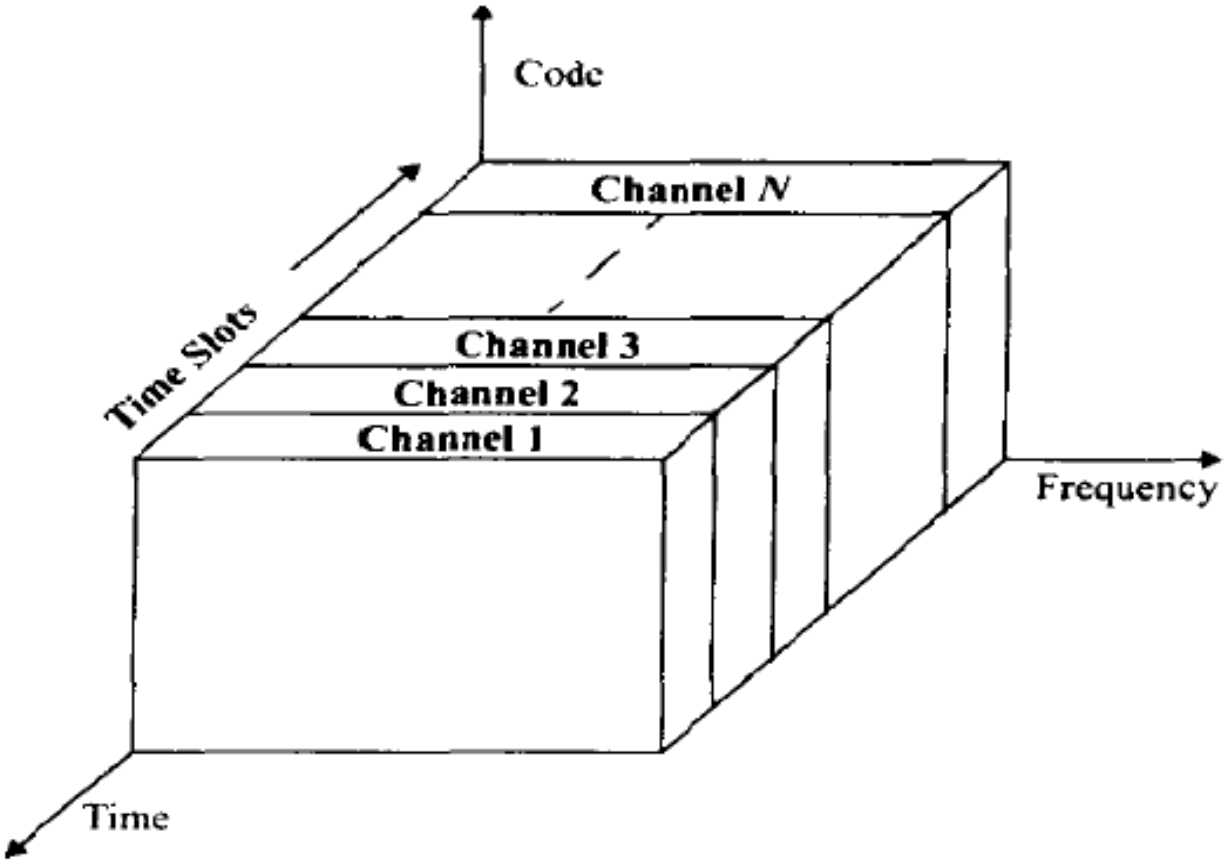
Time Division Multiple Access (TDMA)

- Time-frequency characteristic of synchronous TDMA



Time Division Multiple Access (TDMA)

- Allocation of time slot in TDMA



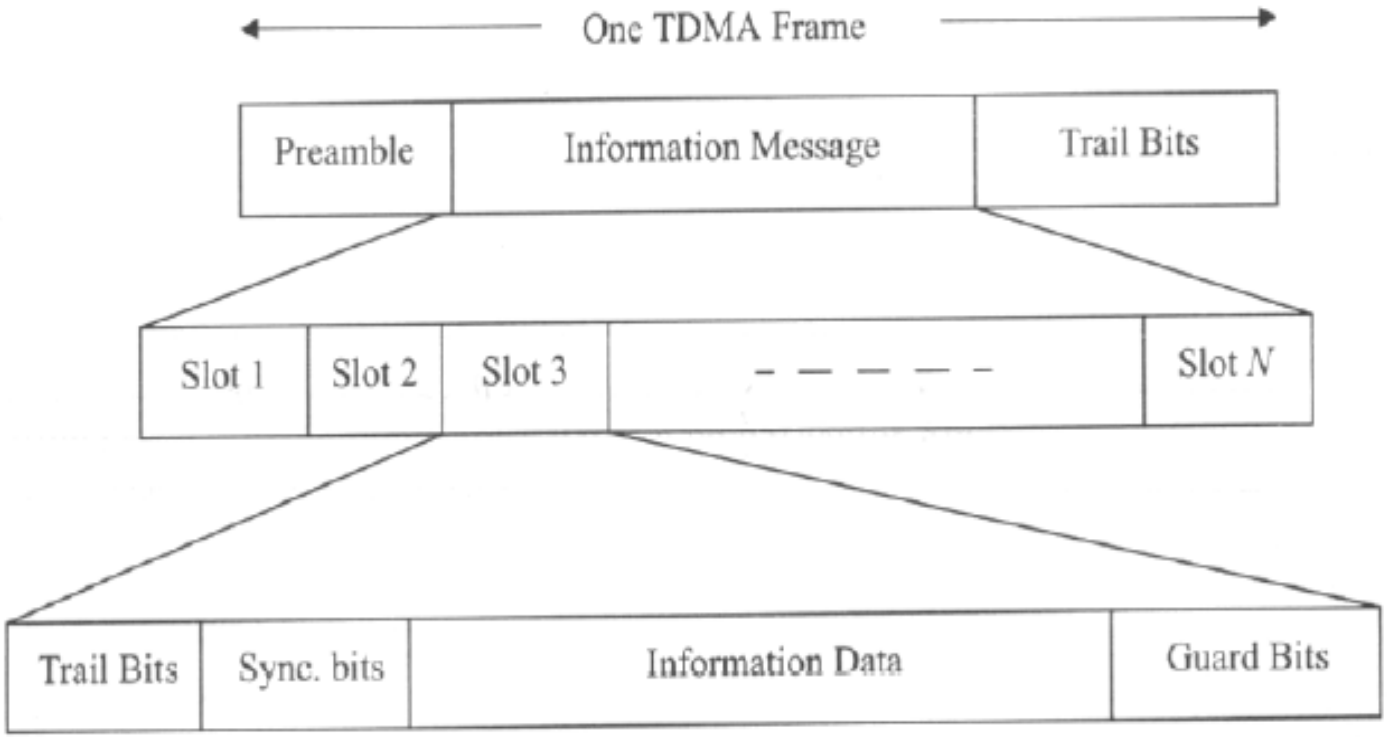
Time Division Multiple Access (TDMA)

- Features of TDMA
  - TDMA systems divide the radio spectrum into time slots.
  - Each user occupies a cyclically repeating time slot.

    So a channel may be thought of as a particular time slot of every frame, where *N time slots comprise a frame.*
- Transmit data in a buffer-and-burst method, thus the transmission for any user is not continuous. Transmitter can be turned off during idle periods.
  - TDMA has TDD and FDD modes.

Time Division Multiple Access (TDMA)

- TDMA Frame Structure



Time Division Multiple Access (TDMA)

- TDMA Frame Structure (Cont.)
  - In TDMA, the preamble contains the address and synchronization information that both the base station and the mobiles use to identify each other.
  - Different TDMA standards have different TDMA frame structures.

Number of channels in TDMA system – The number of TDMA channel slots that can be provided in a TDMA system is found by multiplying the number of TDMA slots per channel by the number of channels available and is given by

$$N = \frac{m\,(B_{tot} - 2B_{guard})}{B_c} \tag{8.5}$$

where m is the maximum number of TDMA users supported on each radio channel. Note that two guard bands, one at the low end of the allocated frequency band and one at the high end, are required to ensure that users at the edge of the band do not "bleed over" into an adjacent radio service.

Time Division Multiple Access (TDMA)

- Features of TDMA (Cont.)

  Multiple channels per carrier or RF channels.

  Share a single carrier frequency with several users.

  Narrow or wide bandwidth – depends on factors such as modulation scheme, number of voice channels per carrier channel.

  High ISI – Higher transmission symbol rate, hence resulting in high ISI. Adaptive equaliser required.

  - High framing overhead – A reasonable amount of the total transmitted bits must be dedicated to synchronization purposes, channel identification. Also guard slots are necessary to separate users.

Time Division Multiple Access (TDMA)

- Features of TDMA (Cont.)

- The use of digital technology permits the inclusion of several facilities in the mobile unit, increasing its complexity. One example is the use of slow frequency hopping to counteract multipath fading.
- - Flexible data rates by assigning multiple time slots to different users based on their demand.
  - No duplexers is required since users employ different time slots for transmission and reception.
  - TDMA can allocate different numbers of time slots per frame to different users, allowing bandwidth be supplied on demand to different users.

Time Division Multiple Access (TDMA)

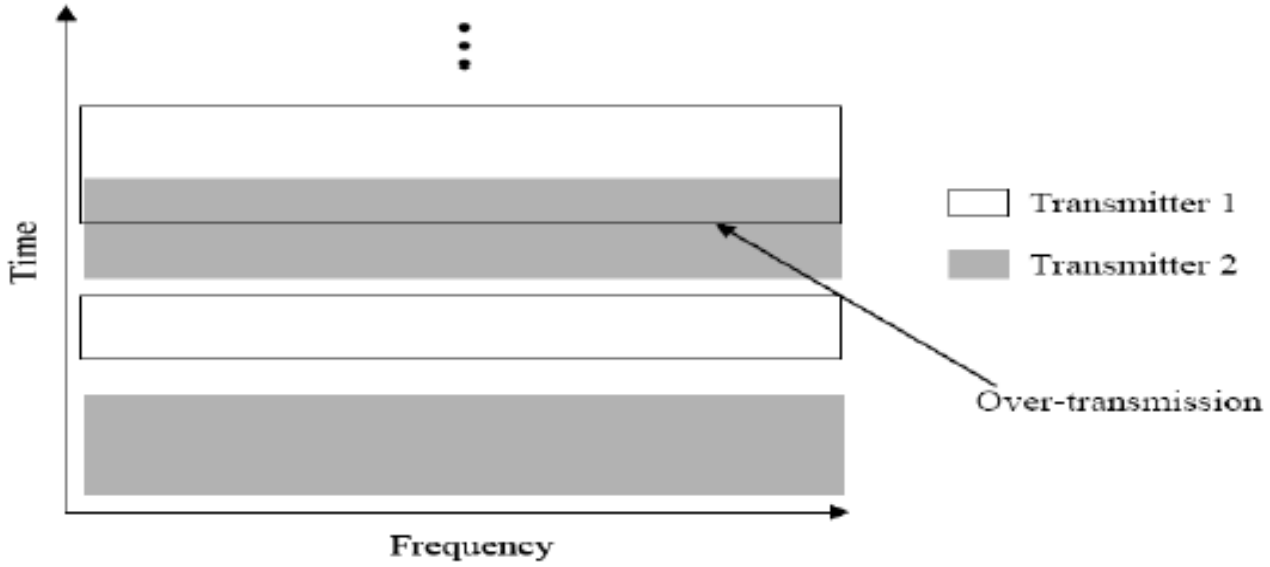
- Features of TDMA (Cont.)
- **Efficiency of TDMA, η_f** *: is a measure of the percentage* of bits per frame which contain transmitted data. The transmitted data include source and channel coding bits.

$$\eta_f = \frac{b_T - b_{OH}}{b_T} \cdot 100\%$$

b_{OH} includes all overhead bits such as preamble, guard bits, etc.

Time Division Multiple Access (TDMA)

- Asynchronous TDMA: Carrier-Sense Multiple Access (CSMA)
  - Allows a transmitter to access the channel at any time that is not being used by another transmitter.



TDMA Pros and Cons

Advantages

- flexible bit rate
  - channels may have varying data rates
- efficient use of channels

Disadvantages

- Synchronization
  - must lock on to your time slot (signal processing)
- Overhead
  - processing required for buffering...