5.5 FREQUENCY DIVISION MULTIPLE ACCESS

In FDMA, each user is allocated a unique frequency band or channel. During the period of the call, no other user can share the same frequency band.
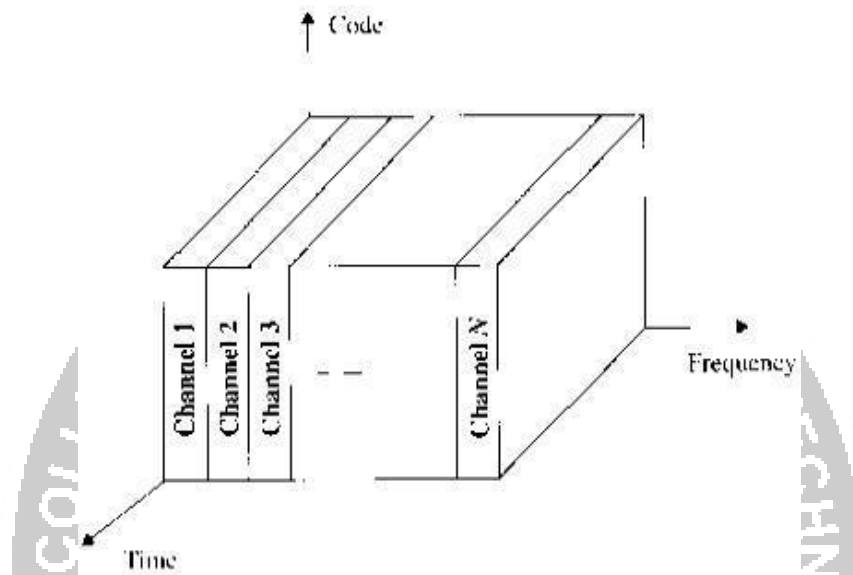

Figure 5.5.1 FDMA Channel

- All channels in a cell are available to all the mobiles. Channel assignment is carried out on a first-come first- served basis.

- The number of channels, given a frequency spectrum BT, depends on the modulation technique (hence Bw or Bc) and the guard bands between the channels $2Bguard$. These guard bands allow for imperfect filters and oscillators and can be used to minimize adjacent channel interference.
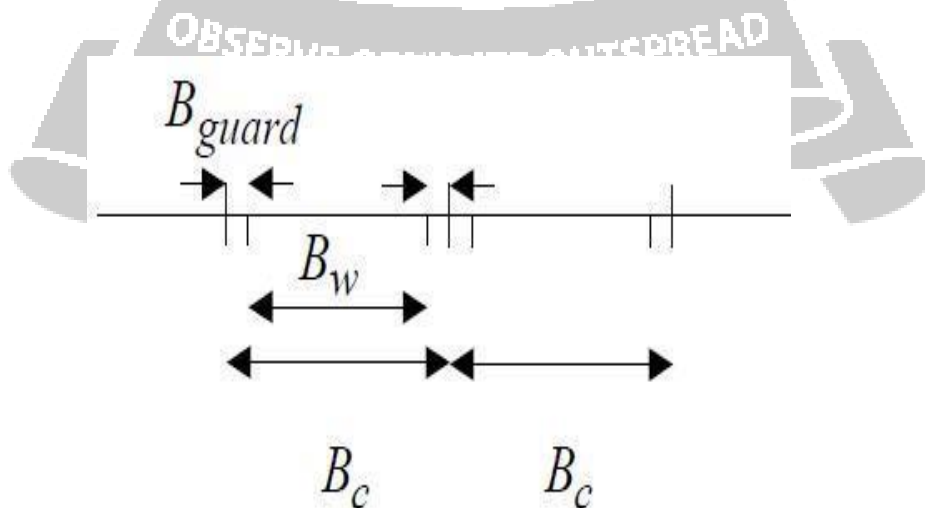
- FDMA is usually implemented in narrowband systems.

Figure 5.5.2 Frequency Spectrum

Continuous transmission: the channels, once assigned, are used on a non-time-sharing basis. This means that both subscriber and BS can use their corresponding allotted channels continuously and simultaneously.

Narrow bandwidth: Analog cellular systems use 25-30 kHz. Digital FDMA systems can make use of low bit rate speech coding techniques to reduce the channel band even more.

If FDMA channels are not in use, then they sit idle and cannot be used by other users to increase capacity.

Low ISI: Symbol time is large compared to delay spread. No equalizer is required(Delay spread is generally less than a few μs – flat fading).

Low overhead : Carry overhead messages for control, synchronization purposes. Asthe allotted channels can be used continuously, fewer bits need to be dedicated compared to TDMA channels.

Simple hardware at mobile unit and BS : (1) no digital processing needed tocombat ISI (2) ease of framing and synchronization.

Use of duplexer since both the transmitter and receiver operate at the same time. This results in an increase in the cost of mobile and BSs.

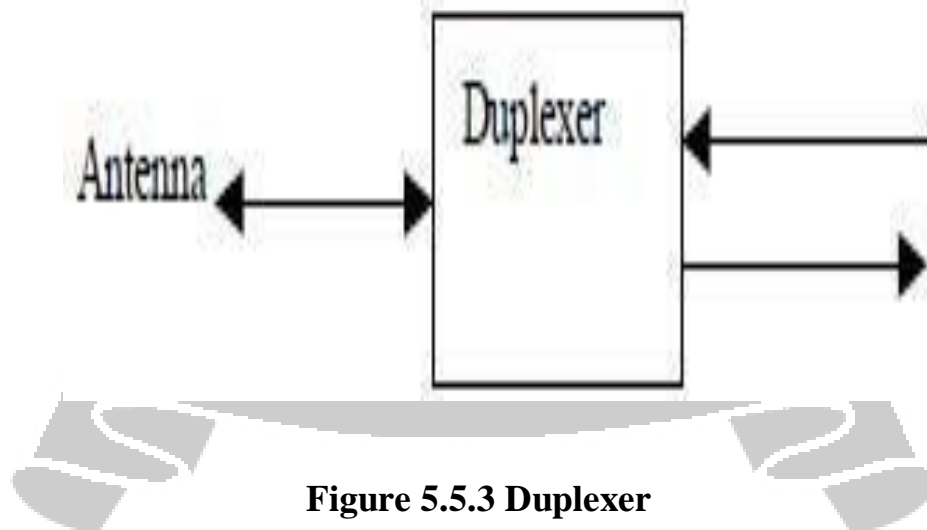FDMA required tight RF filtering to minimize adjacent channelinterference.

Figure 5.5.3 Duplexer

TIME DIVISION MULTIPLE ACCESS

- 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 transmitor receive.
- Unlike FDMA, only digital data and digital modulation must be used.
- 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
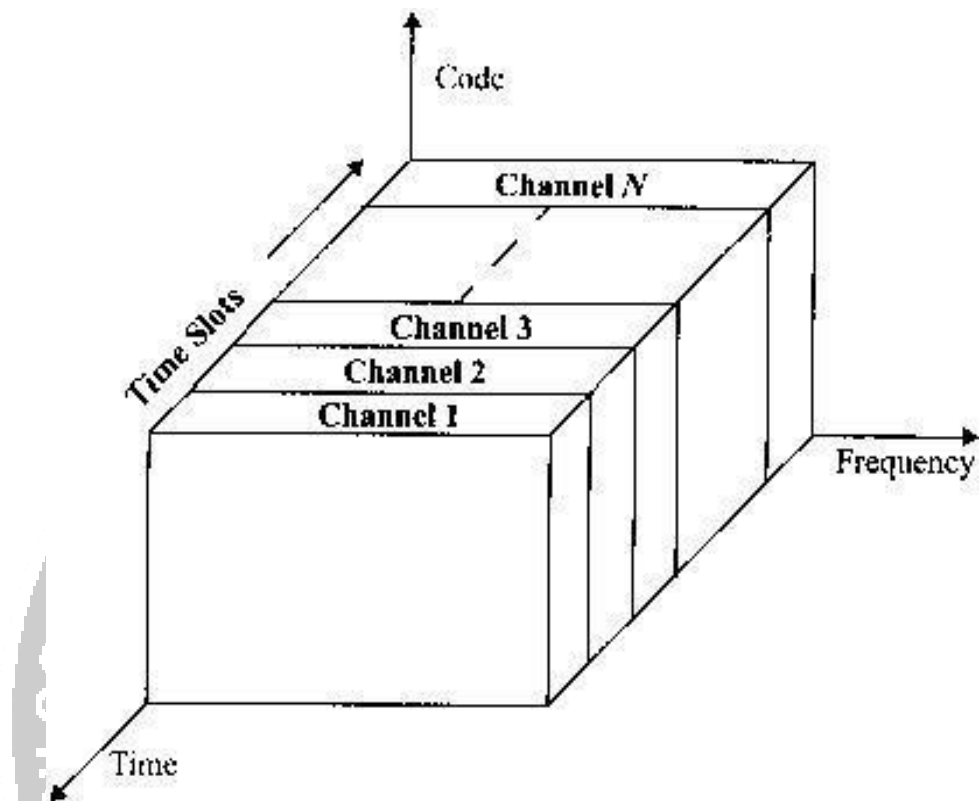
comprisea frame.

Figure 5.5.4 TDMA Channel

- Multiple channels per carrier or RF channels.
- Burst transmission since channels are used on a timesharing basis. Transmitter canbe turned off during idle periods.
- 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. Adaptiveequalizer required.

FEATURES

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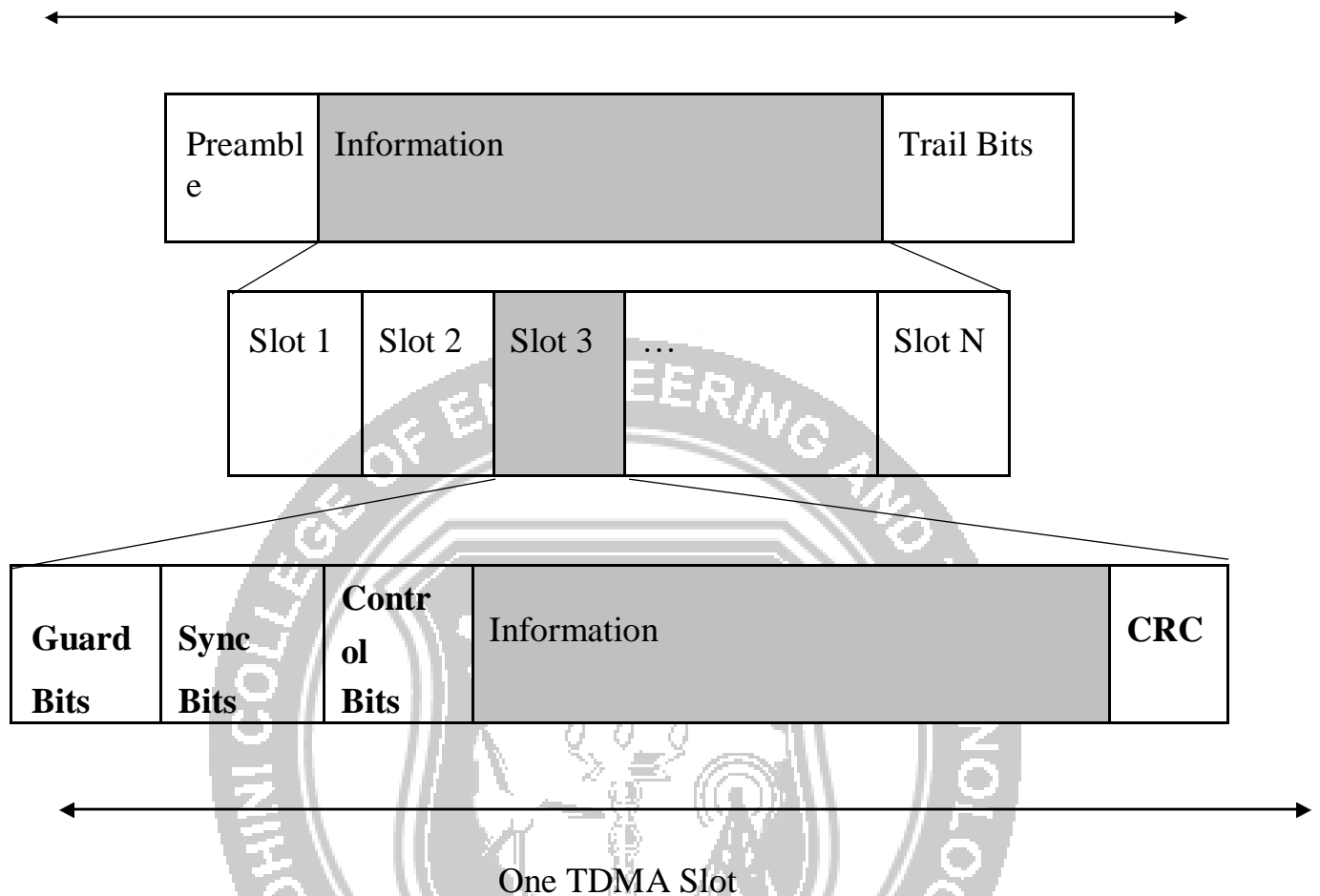
TDMA Frame

One TDMA Frame

Preamble	Information	Trail Bits

Slot 1	Slot 2	Slot 3	…	Slot N

Guard Bits	Sync Bits	Control Bits	Information	CRC

One TDMA Slot

Figure 5.5.5 TDMA Frame

A Frame repeats in time

CODE DIVISION MULTIPLE ACCESS (CDMA)

- In CDMA, the narrowband message signal is *multiplied* by a very large bandwidthsignal called spreading signal (code) before modulation and transmission over the air. This is called spreading.

- CDMA is also called DSSS (Direct Sequence Spread Spectrum). DSSS is a moregeneral term.
- Message consists of symbols
- Has symbol period and hence, symbol rate
- Spreading signal (code) consists of chips
- Has Chip period and and hence, chip rate
- Spreading signal use a pseudo-noise (PN) sequence (a pseudo-randomsequence)
- PN sequence is called a codeword

- Each user has its own cordword
- Codewords are orthogonal. (low autocorrelation)
- Chip rate is order of magnitude larger than the symbol rate.
- The receiver correlator distinguishes the senders signal by examining the wideband signal with the same time-synchronized spreading code
- The sent signal is recovered by despreading process at the receiver.

CDMA ADVANTAGES

- Low power spectral density.
- Signal is spread over a larger frequency band
- Other systems suffer less from the transmitter
- Interference limited operation
- All frequency spectrum is used
- Privacy
- The codeword is known only between the sender and receiver. Hence other userscan not decode the messages that are in transit
- Reduction of multipath affects by using a larger spectrum