Enhance Capacity of CDMA Network

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Introduction

- first used during World War II by English allies to foil German .
- CDMA development started in early 1989 after the NA- TDMA standard .
- CDMA Consistently provides better capacity for voice and data communication than other commercial mobile technologies .

FDMA

- Each user is assigned a channel for the entire duration of the user's conversation.
- Other users can access the channel after the first user's conversation has ended.

TDMA

- multiple users can make use of the band assigned to the communication at different moments of time .

Problem statement

- The capacity of network always is limited.

Objective

- To increase the capacity of CDMA network by using several enhancing technologies such as smart antenna and adaptive sectorization.

The purpose of communication system is to transmit message from an information source to a one or more destination

Four basic components in a communication system:-

- Information source.
- Transmitter.
- Channel.
- Receiver.

Information Source

- Information can take either:-.
  - Analoge -speech -music.
  - Digital - computer data.

- Analoge information can converted into digital forms for the purpose of transmission.

Transmitter

- Role of transmitter :-

  Convert a given message into an appropriate form that is suitable for transmission.

-Modulation allows the message signal to occupy an allocated frequency spectrum.

Channel

-Physical medium through which the signal from the transmitter is transmitted to the receiver.

-Two basic type of channels :-

1. Wireless –normally the atmosphere.
2. Weird – various forms such as :-
   a. Twisted pairs.
   b. Coaxial cables.

Receiver

-Job of receiver

At the destnation the original useful message has to recovered .

-The message recovery can not be perfect .

-Quality of reception described by :-

SNR in the case (Analoge source).

E_b/N_o in the case (Digital transmission).

Fundamental Limitations

-Technological problems :-

1. Hardware problems.
2. Economic factors.
3. Fedral regulations.

-Physical limitations :-

1. Bandwidth.
2. Noise.

Modulation

-Two wave form :-

- Modulating signal (message).
- Carrier wave.

-Continuous - wave modulating:-

1. AM.
2. FM.
3. DM.

-Pluse modulation.

Coding

-Transforms a digital message into new sequence of symbols.

-Decoding converts encoded sequence back to original message with a few errors caused by transmission contamination.

Multiplexing

-Multiplexing describe how several users can share a medium with minimum or no interference.

-There are three basic multiplexing techniques:-

1.FDM.

2.TDM.

3.CDM.

FDM

Frequency Division Multiplexing

-Describe schemes to subdivide the frequency dimension into several non-overlapping frequency bands.

-Sender using a certain frequency band .

-Guard spaces are needed to avoid frequency band over lapping.

-FDM used for radio station within the same region.

-A fixed assignment of a frequency to a sender limits the number of senders.

TDM
Time Division Multiplexing

-All senders use the same frequency but at different points in time.

-Synchronization between different senders is important.

CDM
Code Division Multiplexing

-First used in military applications but now used in many civil wireless transmission.

-All channels use the same frequency at the same time for transmission.

-Give good protection against interference.

CDMA
Coded Division Multiple Access

-CDMA provides better capacity.
-CDMA is military first used in the war II.

PN Sequence

-User signal is multiplied by pseudo-random sequence.

-Sequence must be known by receiver and transmitter to make synchronization and despreading.

Near far problem

-Near far problem can be neglected by reducing the transmission power of mobiles by using power control.

Power Control

-Used in CDMA because of three reasons:-

1.Near-far-problem.

2. saving of the power in the mobile.

3.The capacity of CDMA is interference limited.

Advantage of CDMA

-Out standing voice and call quality.
-Improved security.
-Fewer Dropped calls.
-Reduced noise and interference.
-Longer Battery life.
-Greater capacity.

Disadvantages of CDMA

-Wide bandwidth.
-Near-far-problem.
-Soft hand over.
-Fast power control.

-The system capacity would be improved by a factor of Z for a Z-sector system because the interference is effectively reduced by the same factor .

-Interference consists of :-

1. Intracell interference .
2. Intercell interference .

Adaptive sectorization

-Adaptive sectorization allows sector beamwidth to be approximately 30, 60, 90, 120, 150, 180, or 210 degrees .

-Switched beams can adjust the sector size to include either fully or partially an area of high user density .

-Adaptive sectorization is a method proposed to increase the system capacity in CDMA cellular systems.

-there is a capacity loss if a large number of sectors are used .

voice activity detection

Voice activity detection enhancing system capacity by reducing co-channel interference .

Forward Link

-The forward link of the CDMA system modelled uses orthogonal Walsh codes to separate the users .

-The transmitted signals from all the users are combined together, then passed through a radio channel model .

-The receiver uses the same Walsh code that was used by the transmitter to demodulate the signal .

System Simulation

-The number of users the system can support is evaluated using a computer simulation .

-The simulation software was written in visual basic employing random number generators to represent call arrivals .

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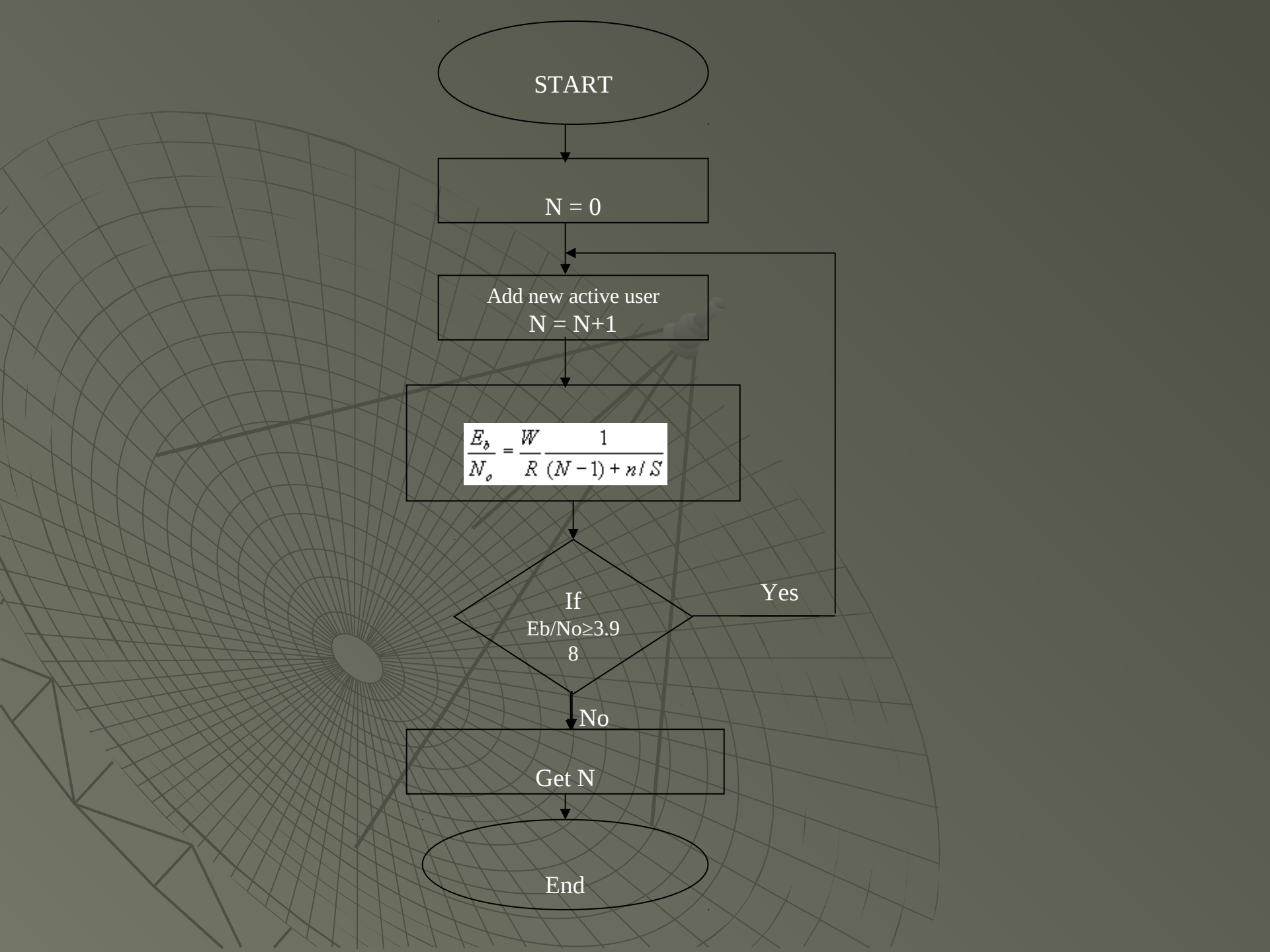
simulation parameters

G is the antenna sectorization,	2.55
d is the voice duty cycle	0.4
E_b/N_o th	6dB
W is the total transmission bandwidth,	1.25 MHz
R is the base band bit rate,	19.5 kHz
n/S is the ratio of received thermal noise to user signal power	0 (Assume no thermal noise)


START
N = 0
Add new active user
N = N+1
$\frac{E_b}{N_o} = \frac{W}{R}\frac{1}{(N-1)+n/S}$
If
Eb/No≥3.98
Yes
No
Get N
End

Capacity of a single CDMA cell

-For a the CDMA link that has no voice detection activity and no cell sectorization then cell capacity can be calculated using visual basic program as follow .

E_b/N_o(dB	Expected Bit Error Rate (BER)	Max. No. Users for single cell (no voice detection, no cell sectorization)	Spectral Efficiency (bits/Hz)
6	0.023007	17.1	0.267
8	0.006004	11.1	0.173
10	0.000783	7.4	0.116
12	3.43E-05	5.0	0.078
14	2.7E-07	3.54	0.055

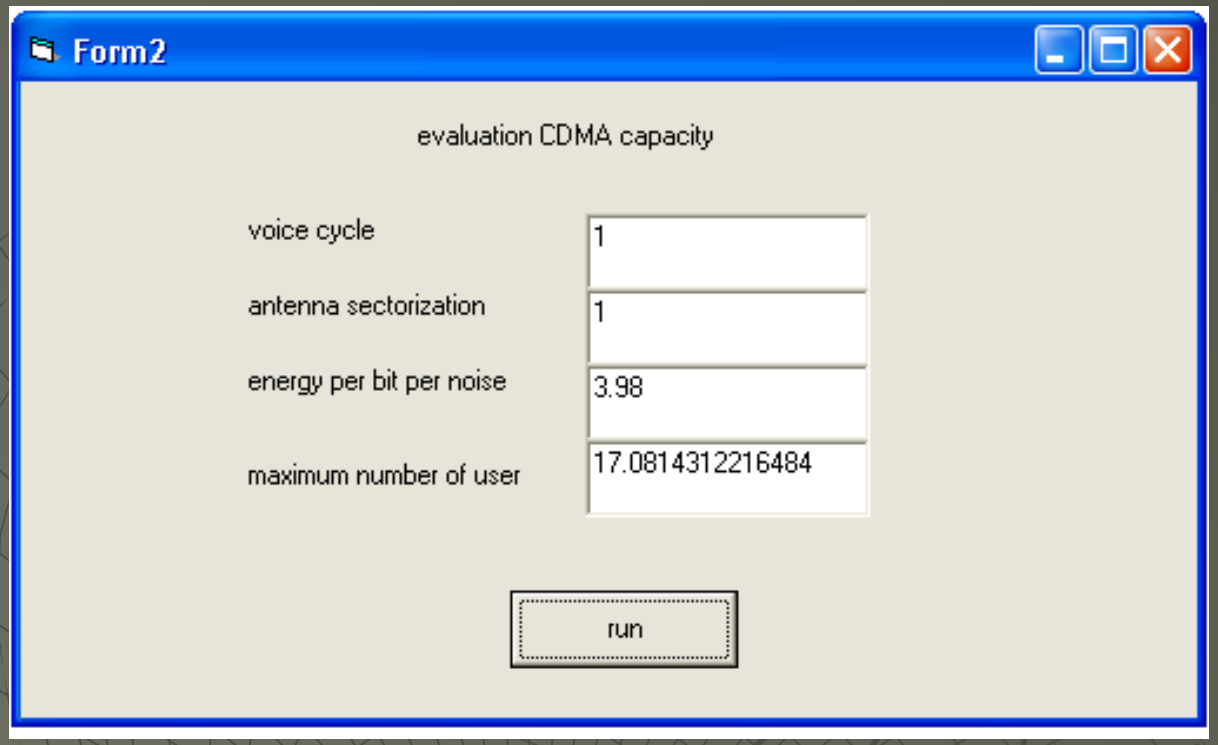
-Capacity of CDMA can be improved by using voice detection to reduce the duty cycle of each user, and by using cell sectorization .

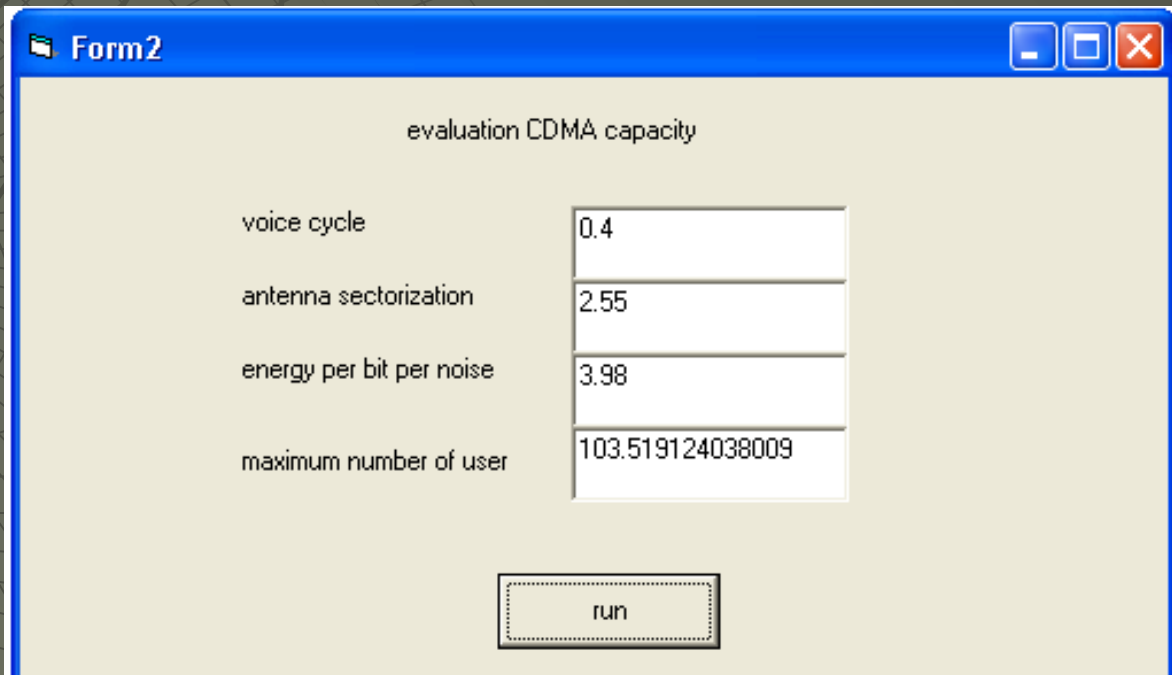
-Voice activity detection can only be used for voice communications .

-Assume that the cell is split three ways then the ideal cell sectorization factor will be 3. However, sidelobes of the antennas used will always reduce this, there reducing the factor to about 2.55

-Appling both voice duty cycle detection and cell sectorization the effective capacity is increased as follow :-

Eb/No(dB)	Expected Bit Error Rate (BER)	Max. No. Users for single cell (voice detection, cell sectorization)	Spectral Efficiency (bits/Hz)
6	0.023007	103.6	1.62
8	0.006004	65.7	1.03
10	0.000783	41.8	0.65
12	3.43E-05	26.5	0.41
14	2.7E-07	17.2	0.27


Form2
evaluation CDMA capacity
voice cycle
1
antenna sectorization
1
energy per bit per noise
3.98
maximum number of user
17.0814312216484
run


Form2
evaluation CDMA capacity
voice cycle
0.4
antenna sectorization
2.55
energy per bit per noise
3.98
maximum number of user
103.519124038009
run

Capacity of CDMA with Multiple Cells

-Using cell sectorization and voice activity detection allows the capacity to be increased by up to 6.4 time.

Eb/No(dB)	Expected Bit Error Rate (BER)	Max. No. Users for single cell (no voice detection, no cell sectorization)	Max. No. Users for single cell (voice detection, cell sectorization)
6	0.023007	11.1	67.3
8	0.006004	7.2	42.7
10	0.000783	4.8	27.2
12	3.43E-05	3.3	17.2

Conclusions

-Adaptive sectorization can be used to improve the capacity of a CDMA cellular system when a cell or a sector contains an area of congested traffic .

-Voice activity detection enhancing system capacity by reducing co-channel interference and power consumption in portable digital devices ..