UNIT-II

INTERFERENCE

Types of Interferences:- There are 2 types:

1. Co-channel interference
2. Adjacent-channel interference

Co-channel interference (CCI):-

→ Cells using the same set of frequencies, are called as Co-channel cells.

• Interference problem occurs due to the co-channel cells termed as co-channel interference.

→ CCI is a crosstalk from 2 different radio transmitters using the same frequency.

→ CCI arises due to frequency reuse.

→ Besides the desired signal from the cell, co-channel signals arrive at receiver from undesired transmitters located far away in some other cells lead to a deterioration in the receiver performance.

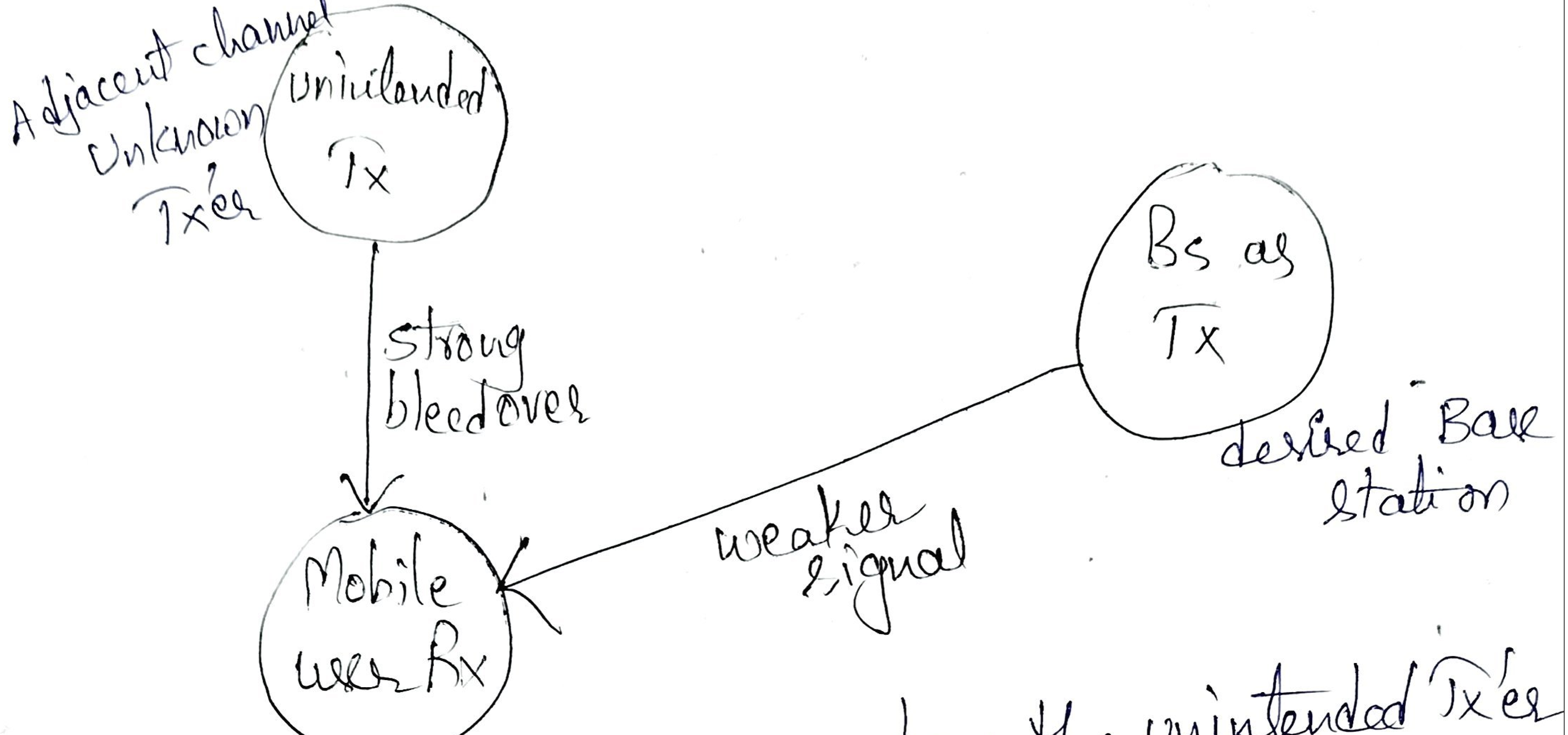
Adjacent-channel interference (ACI):-

→ It is also known as inter-channel interference caused by extraneous power from a signal in an adjacent channel.

→ It is also caused by : inadequate filtering
improper tuning in FM systems
poor frequency control etc.

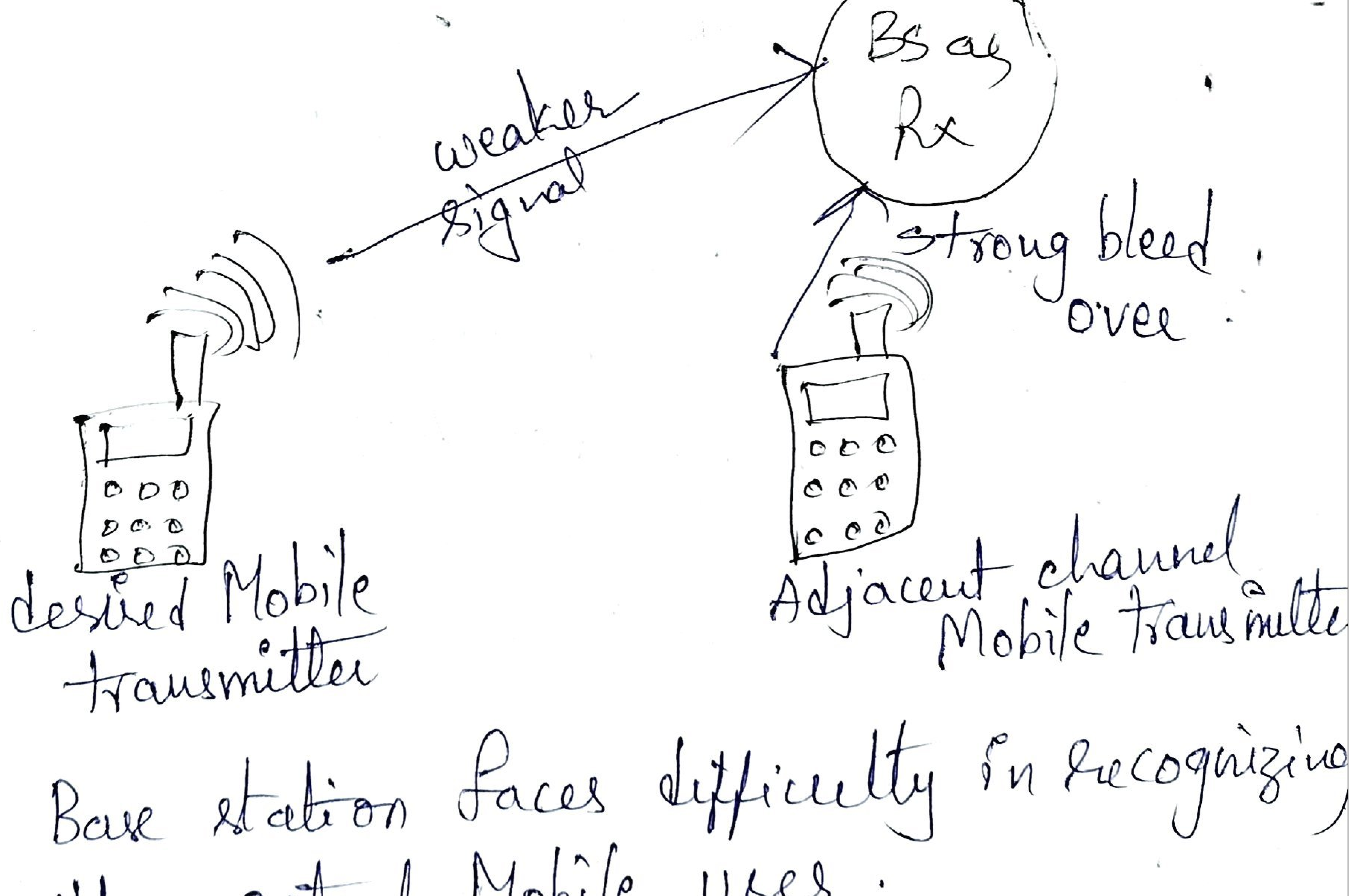
Near-Far effect:-

Case ①:- Bleed over:- This is something which should sta[y] in one domain crosses over into another domain.



here, Mobile user receiver captures the unintended Tx'er signal, instead of desired base station.

Case ②:-



here, Base station faces difficulty in recognizing the actual Mobile user.

Introduction to Co-channel Interference:-

→ The frequency-reuse increase efficiency, but results in co-channel interference.

- when customer demand increases, no. of channels has to increase ⇒ system capacity has to increase.

→ The received voice quality affected by both:

- Grade of coverage
- Amount of CCI

→ For detection of serious CCI in a cellular system, 2 tests are suggested:

Test 1:- Find the co-channel interference area from a mobile receiver

→ CCI occurs in one channel will occur equally in all the other channels in a given area.

- Thus, select one channel and transmit on that channel at all co-channel sites at night while the mobile Rxer is traveling in one of the co-channel cells.

→ During this test, detect for any changes by a field-strength recorder in the MU and compare the data with the condition of no co-channel sites being Tx'ed.

- This test must be repeated as the mobile unit travels in every co-channel cell.

- To facilitate this test, we can install a channel scanning receiver in one car.

(i) (f_1) - 1st channel records - signal level - no-cochannel condition.

(ii) f_2 - 2nd channel records - Interference level - 6 cochannel condition is maximum

iii) f_3 — 3rd channel receives f_3 — noise level (not in use).

∴ We can obtain (In decibels)

① $\frac{C}{I} = C - I$ = result obtained from f_1 − result obtained from f_2.

② $\frac{C}{N} = C - N$ = result obtained from f_2 − result obtained from f_3.

4 conditions used to compare the results:

① if $\frac{C}{I} > 18\,dB$ (throughout most of the cells) ⇒ system is properly designed.

② if $\frac{C}{I} < 18\,dB$ and $\frac{C}{N} > 18\,dB$ (in some areas) ⇒ There is CCI

③ if both $\frac{C}{N}$ & $\frac{C}{I} < 18\,dB$ and $\frac{C}{N} \simeq \frac{C}{I}$ (in given area) ⇒ coverage problem

④ if both $\frac{C}{N}$ & $\frac{C}{I} < 18\,dB$ and $\frac{C}{N} > \frac{C}{I}$ (in given area) ⇒ CCI & coverage problem

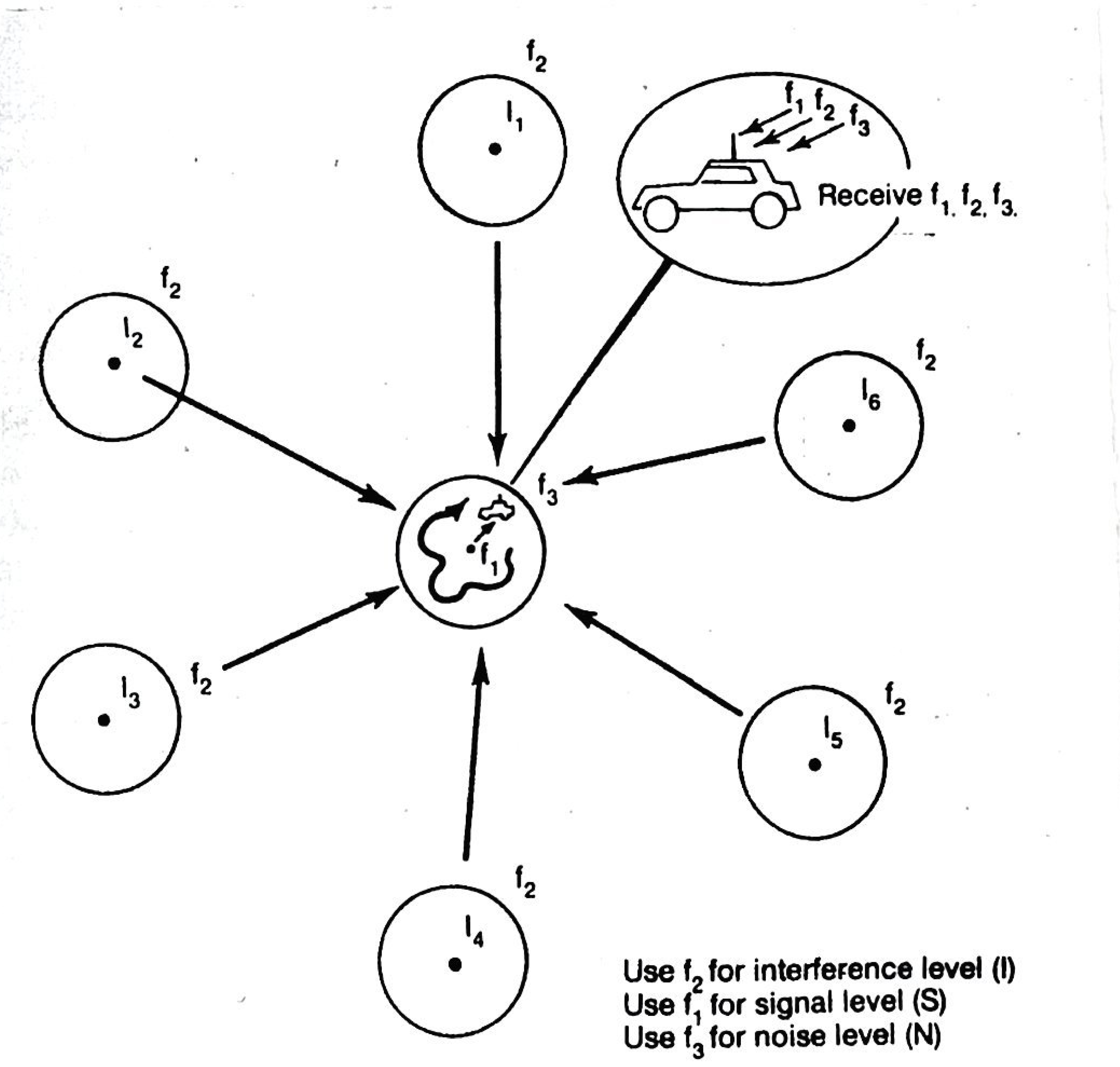


Figure 6.1 Test 1: cochannel interference at the mobile unit.

Test 2 : Find the co-channel interference area which affects a cell site :- (3)

Test (1) drawbacks :- (1) reciprocity theorem cannot applied for CCI

∴ Test 1 result will not apply to test 2 result condition

(2) It is difficult to use 7 cars simultaneously, with each car traveling in each co-channel cell for this test.

Test 2 :-

→ An alternative approach (Test 2) must be performed to record the signal strength at every cochannel cell site while a mobile unit is travelling either in its own cell (or) in one of the co-channel cells as shown below :

procedure (Test 2) :-

→ Find areas in an interfering cell in which the top 10% level of signal Tx'ed from mobile unit in those areas is received at the desired site (J^{th} cell).

• This top 10% level can be distributed in different areas in a cell.

∴ Average value of top 10% level signal strength is used as I-level from that particular interfering cells.

→ The mobile unit also travels in different (6) interfering cells, I-levels are obtained.

∴ Average of bottom 10% level of signal strength is tx'ed from Mobile unit in desired (J^{th}) cell, received at desired cell site as a C-level.

∴ The $\frac{C}{I}$ received at a desired cell (say J^{th} cell) is :

$$\boxed{\frac{C_J}{I} = \frac{C_J}{\sum_{\substack{i=1 \\ i \neq J}}^{6} I_i}}$$

<u>Note:</u> This test can be carried out repeatedly for any given cell. We then compare $\boxed{\frac{C_J}{I} \text{ and } \frac{C_J}{N_J}}$ and determine CCI condition, which is same as test 1.

- where, N_J – noise level in J^{th} cell (Assume $I_J = 0$)

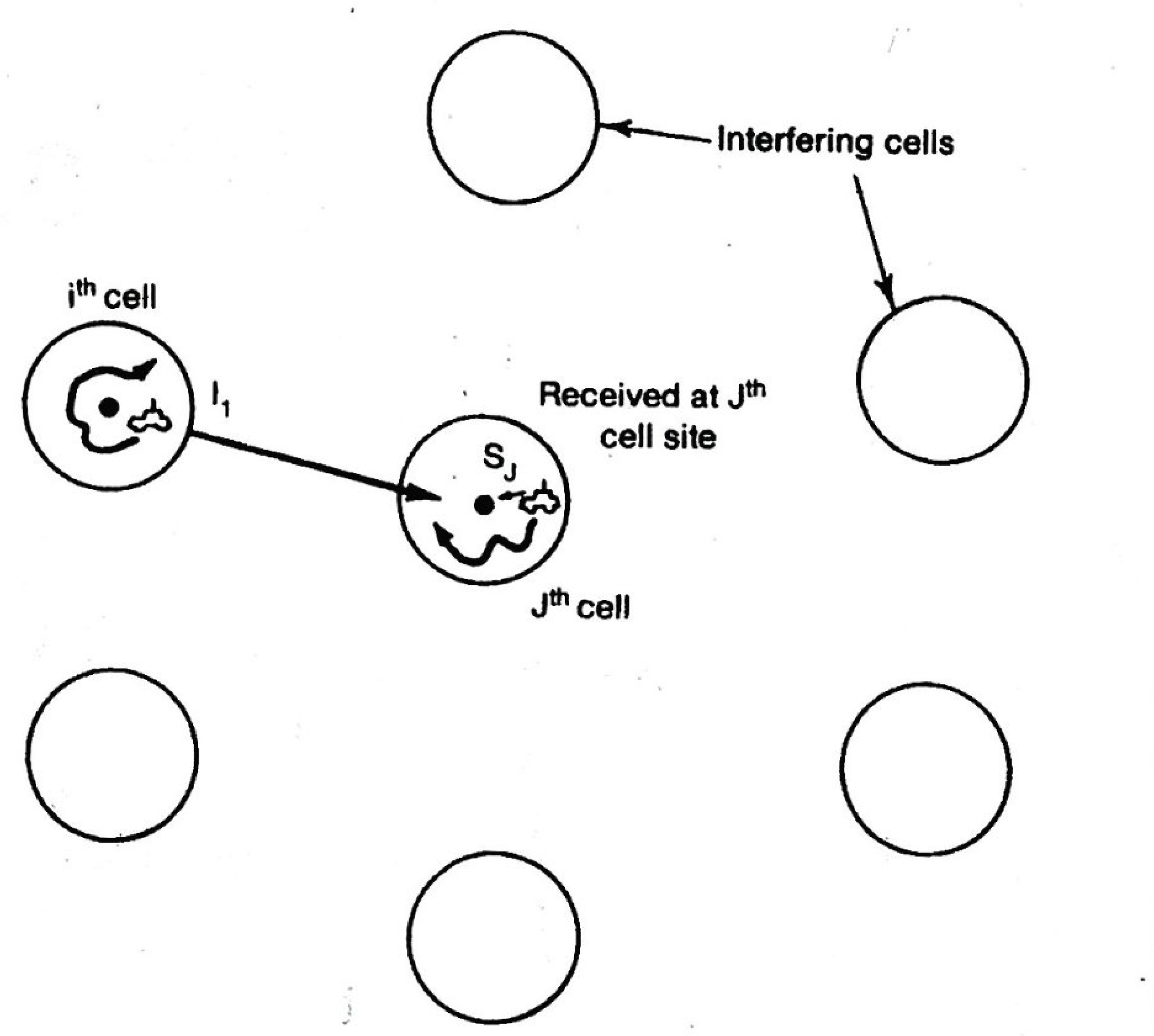


Figure 6.2 Test 2: cochannel interference at the cell site.

Real Time Cochannel Interference Measurement at Mobile Radio Transceivers:

→ When the carriers are angularly modulated by the voice signal and the RF frequency difference between them is much higher than the fading frequency, Measurement of signal carrier to interference ratio $\left(\frac{C}{I}\right)$ states that:

(i) Signal is $e_1 = S(t)\sin(\omega t + \phi_1)$

(ii) Interference is $e_2 = I(t)\sin(\omega t + \phi_2)$

∴ Received signal is

$$e(t) = e_1(t) + e_2(t) = R\sin(\omega t + \psi)$$

where $R = \sqrt{\left(S(t)\cos\phi_1 + I(t)\cos\phi_2\right)^2 + \left(S(t)\sin\phi_1 + I(t)\sin\phi_2\right)^2}$

and $\psi = \tan^{-1}\left[\dfrac{S(t)\sin\phi_1 + I(t)\sin\phi_2}{S(t)\cos\phi_1 + I(t)\cos\phi_2}\right]$

→ The envelope (R) can be simplified and R^2 become

$$R^2 = S^2(t) + I^2(t) + 2S(t)I(t)\cos(\phi_1 - \phi_2)$$

• Following Kozono and Sakamoto's analysis:

(i) $S^2(t) + I^2(t)$ fluctuates close to fading freq $-\frac{V}{\lambda}$.

(ii) $2S(t)I(t)\cos(\phi_1 - \phi_2)$ fluctuates to a frequency close to $\frac{d}{dt}(\phi_1 - \phi_2) >>$ fading frequency.

∴ The two parts of squared envelope can be separated as

$$x = s^2(t) + I^2(t)$$
$$y = 2\,s(t)\,I(t)\cos(\phi_1 - \phi_2)$$

· Assume $s(t), I(t), \phi_1, \phi_2$ — independent random variable

Then, the average processes on x and y are

$$\overline{x} = \overline{s^2(t)} + \overline{I^2(t)}$$
$$\overline{y^2} = 4\,\overline{s^2(t)}\,\overline{I^2(t)}\,(1/2) = 2\,\overline{s^2(t)}\,\overline{I^2(t)}$$

∴ Signal to interference ratio (Γ) becomes

$$\Gamma = \frac{\overline{s^2(t)}}{\overline{I^2(t)}} = k + \sqrt{k^2 - 1}$$

where $k = \frac{\overline{x}^2}{\overline{y^2}} - 1$

→ The computation of (Γ) can be accomplished by means of envelope detector, A/D converter & Microcomputer

→ The sampling delay time (Δt) should be small enough to satisfy : $s(t) \simeq s(t+\Delta t)$; $I(t) \simeq I(t+\Delta t)$

and $E\left[\cos(\phi_1(t) - \phi_2(t))\cos[\phi_1(t+\Delta t) - \phi_2(t+\Delta t)]\right] \simeq 0$

→ The delay time (Δt) determining to meet above requirement is difficult. — drawback of this measurement technique.

∴ Real time CCI measurement is difficult to achieve in practice

Z.

Co-channel Interference Reduction Factor :-

→ CCI is a function of a parameter q defined as $\frac{D}{R}$.
where q – CCI reduction factor.
- when q – increases, CCI – decreases.

→ Further, D is a function of K_I and C/I,
i.e $D = f\left(K_I, \frac{C}{I}\right)$

where K_I – no. of co-channel interfering cells in first tier

C/I – received carrier-to-interference ratio at desired mobile receiver.

$$\frac{C}{I} = \frac{C}{\sum_{K=1}^{K_I} I_K}$$

→ In a fully equipped hexagonal-shaped cellular system there are always 6 co-channel interfering cell. (i.e $K_I = 6$).

→ CCI can be experienced both at cell site and at Mobile units in center cell.

- According to both the reciprocity theorem and the statistical summation of radio propagation,

$\frac{C}{I}$ at mobile units due to 6 interfering sites	=	$\frac{C}{I}$ received at center cell site due to interfering mobile units in 6 cells.

→ Assume, local noise is much less than the interference level and can be neglected. $\frac{C}{I}$ can be expressed as

$$\frac{C}{I} = \frac{R^{-\gamma}}{\sum_{K=1}^{K_I} D_K^{-\gamma}}$$

where γ – propagation path-loss slope, determined by the actual terrain environment.
(γ = 2 to 5 for different mediums)

ex:- $\gamma = 2$ for freespace
$\gamma = 4$ for mobile radio medium.

→ Also, CCI from the second tier (6 interfering cells) & higher tiers are negligible. (since they cause weaker interference than first tier).

$$\therefore \frac{C}{I} = \frac{1}{\sum_{K=1}^{K_I} \left(\frac{D_K}{R}\right)^{-\gamma}} = \frac{1}{\sum_{K=1}^{K_I} q_K^{-\gamma}} \quad \left(\text{where } q_K = \frac{D_K}{R}\right)$$

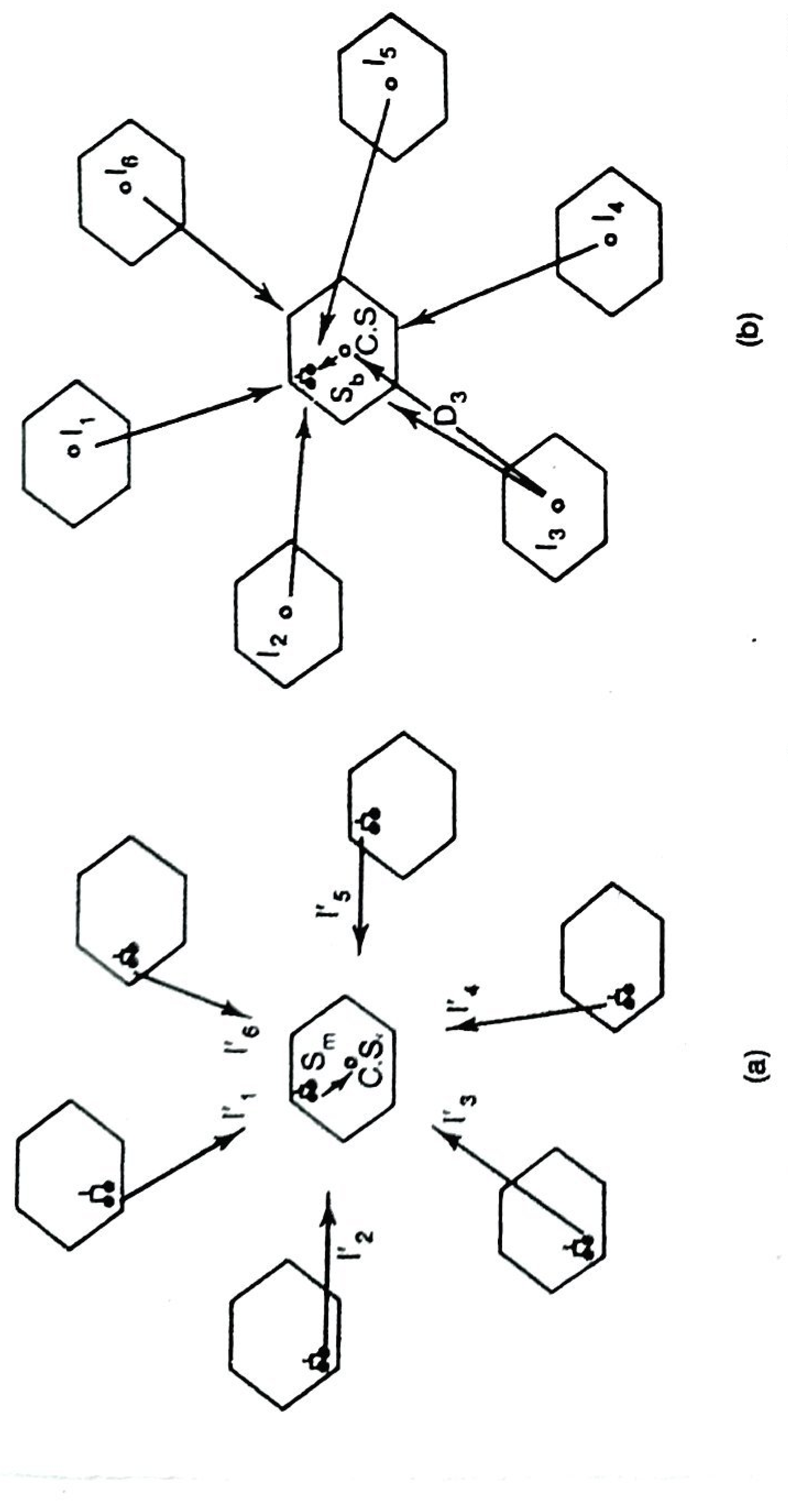


Figure 2.5 Cochannel interference from six interferers. (*a*) Receiving at the cell site; (*b*) receiving at the mobile unit.

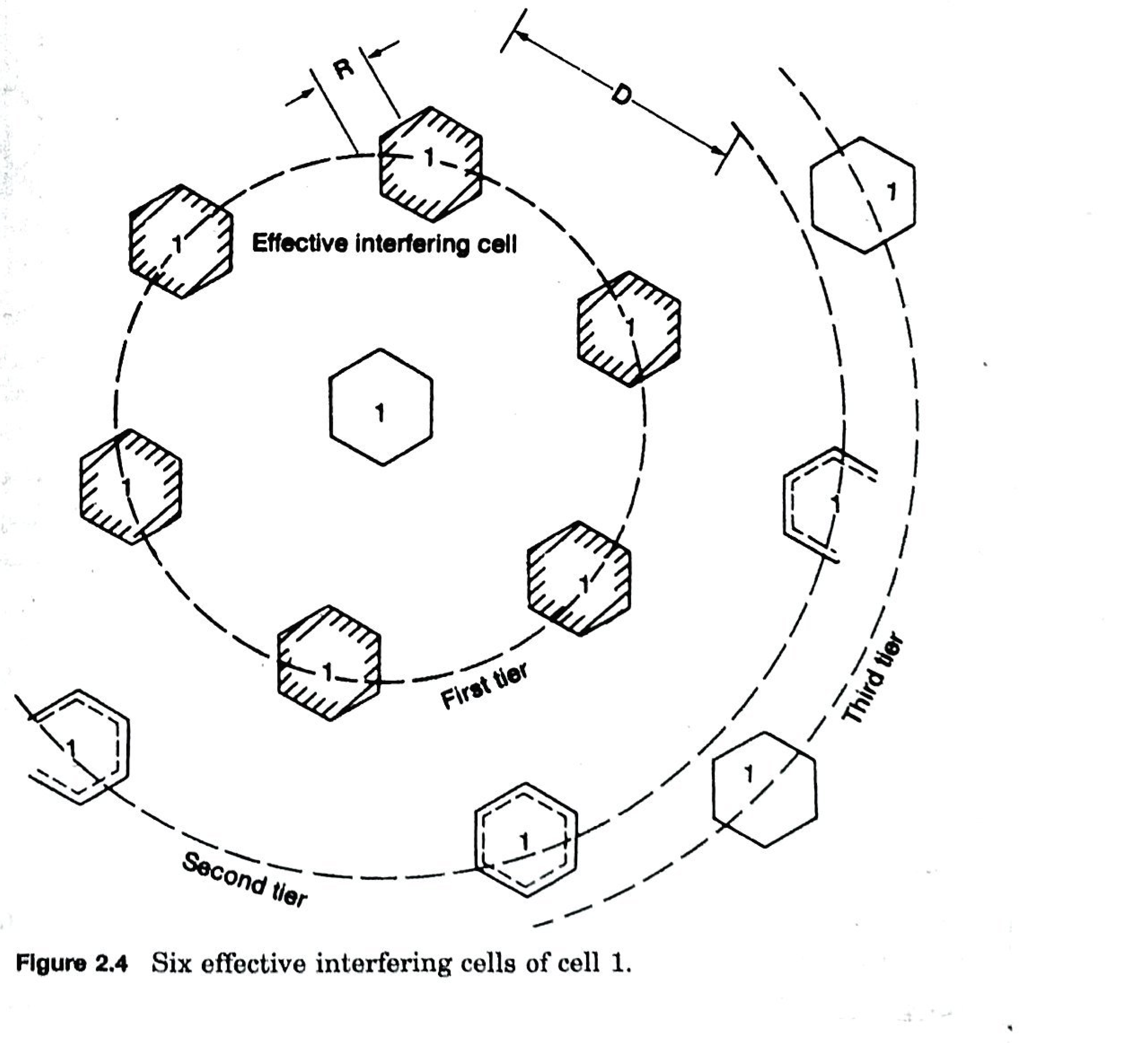


Figure 2.4 Six effective interfering cells of cell 1.

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Desired C/I from a normal case in a omni-directional Antenna system:-

→ There are 2 cases to be considered :

(i) Signal & CCI received by mobile unit

(ii) Signal & CCI received by cell site.

Both cases are shown below:

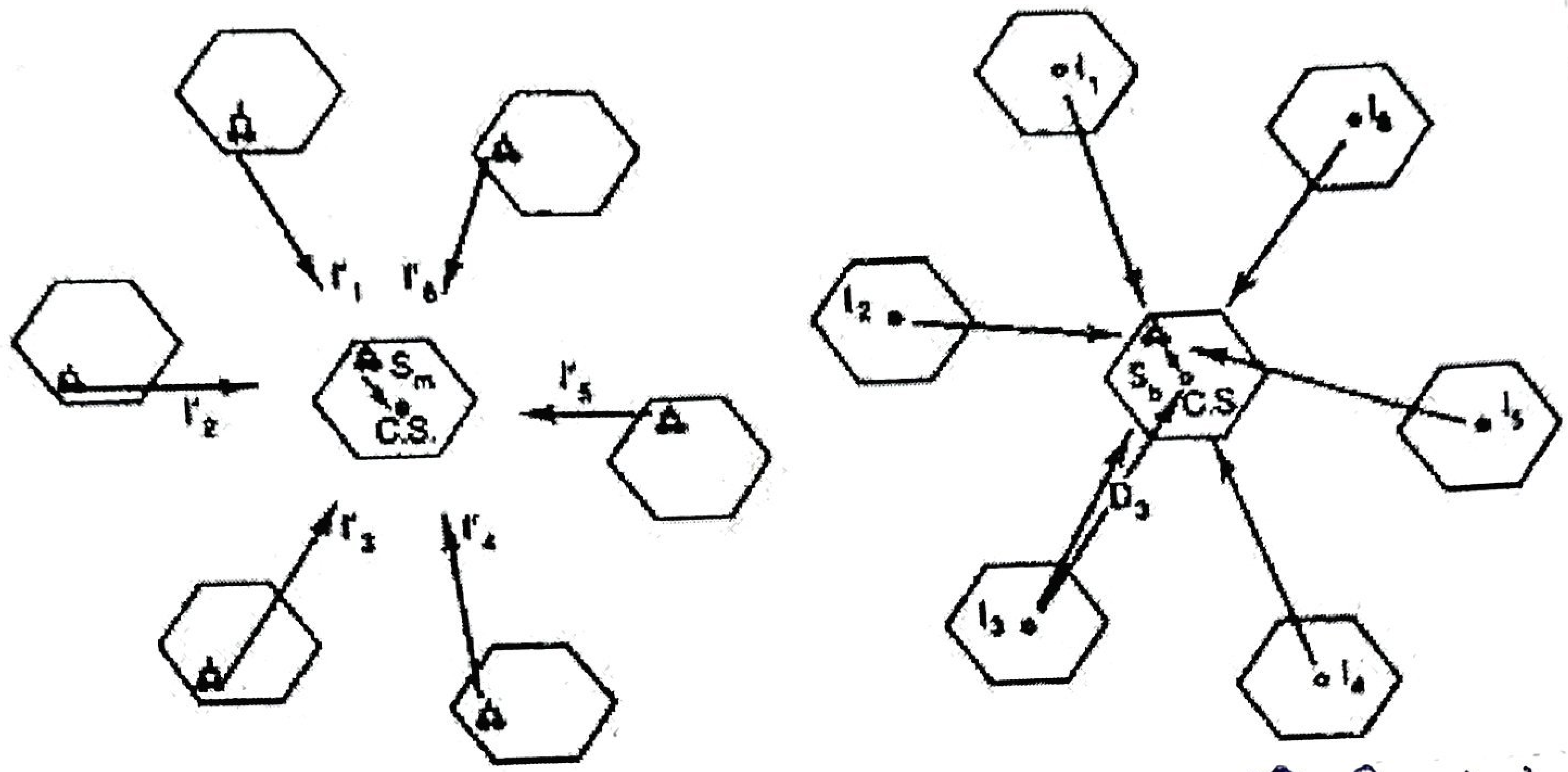

fig: CCI from 6 Interferers (a): receiving at cell site (b) Receiving at mobile uni

Balanced system:- The received $\frac{C}{I}$ ratios at both mobile unit & cell site are same, the system is called balanced system

∴ choose any one of two cases to analyze the system requirement: (since results from one case are same for others)

- Assume $D = D_K$ and $q = q_K$, Also assume D_K same for simplicity, then.

$$\frac{C}{I} = \frac{R^{-\gamma}}{6D^{-\gamma}} = \frac{q^{+\gamma}}{6}$$

$$\Rightarrow q^{\gamma} = 6\frac{C}{I} \Rightarrow q = \left(6\frac{C}{I}\right)^{1/\gamma}$$; γ - pathloss slope.

Let $\gamma = 4$ (for mobile radio enviroment), then

$$q = \frac{D}{R} = (6 \times 63.1)^{1/4} = 4.41.$$

- computer simulation described the value of $q = 4.6 \simeq 4.41$.

$\therefore$ $q = 4.6$ yields $K = 7$ (since $q = \sqrt{3K}$).

Note:- Total coverage/covered area achieved by increasing the transmitted power at each cell, does not affect $q = 4.41$ value. (since q is not a function of transmitted power).

Design of an Omni-directional Antenna system in the worst case:- (or) Design of Antenna System:-

→ The worst case is at the location where the mobile unit would receive the weakest signal from its own cell site & strong interferences from all interfering cell sites.

→ In worst case the mobile unit is at the cell boundary (R) as shown in fig:

• The distances from all 6 co-channel interfering sites are also shown in figure:

2 distances : D−R
2 distances : D
2 distances : D+R.

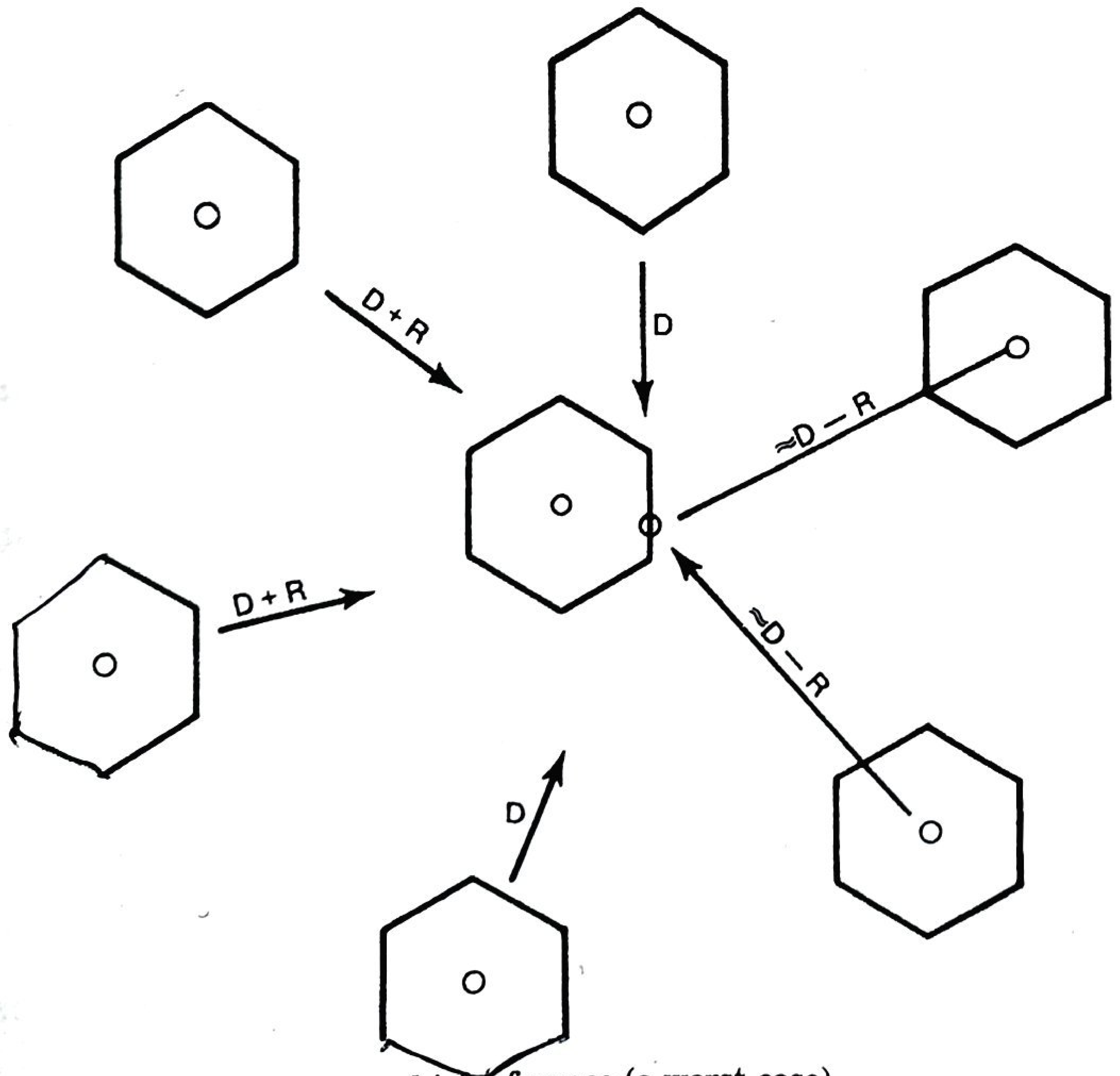

Figure 6.3 Cochannel interference (a worst case).

→ From the mobile radio propagation rule of 40 dB/dec we obtain: (7)

$$C \propto R^{-4}.$$
$$I \propto D^{-4}.$$

$$\therefore \frac{C}{I} = \frac{R^{-4}}{2(D-R)^{-4} + 2D^{-4} + 2(D+R)^{-4}}$$

$$= \frac{1}{2(q-1)^{-4} + 2q^{-4} + 2(q+1)^{-4}} \quad \text{(1)}$$ (since $q = \frac{D}{R}$)

where $q = 4.6$ (normal case value).

- Substituting $q = 4.6$ in Eq (1), we get $\frac{C}{I} = 54 = 17\,dB$
i.e $\boxed{\frac{C}{I} < 18\,dB}$

→ To be conservative, use the shortest distance D−R for all 6 interferers as a worst case:

$$\frac{C}{I} = \frac{R^{-4}}{6(D-R)^{-4}} = \frac{1}{6(q-1)^{-4}} = 28 = 14.47\,dB$$

Note:- In reality, $\frac{C}{I}$ value is always worse than 17 dB & could be 14 dB and lower, due to

- imperfect site locations
- rolling nature of terrain configuration.

- Such instance easily occur in a heavy traffic situati[on]
- ∴ system must be designed around the C/I of the worst case.
- In such case, $q = 4.6$ is insufficient.

→ Therefore, in an omnidirectional-cell system K = 9 & K = 12 would be a correct choice.

→ Then the values of q are:

$$q = \begin{cases} \frac{D}{R} = \sqrt{3K} = 4.6 & K = 7 \\ 5.2 & K = 9 \\ 6 & K = 12. \end{cases}$$

substituting these values in Eqn ①, we obtain

$$\frac{C}{I} = 84.5 = 19.25 \text{ dB} \quad \text{for } K = 9$$

$$= 179.33 = 22.54 \text{ dB} \quad \text{for } K = 12.$$

∴ $K = 9$ & $K = 12$ cell patterns, shown in fig: are used when the traffic is light.

- Each cell covers an adequate area with adequate numbers of channels to handle the traffic.

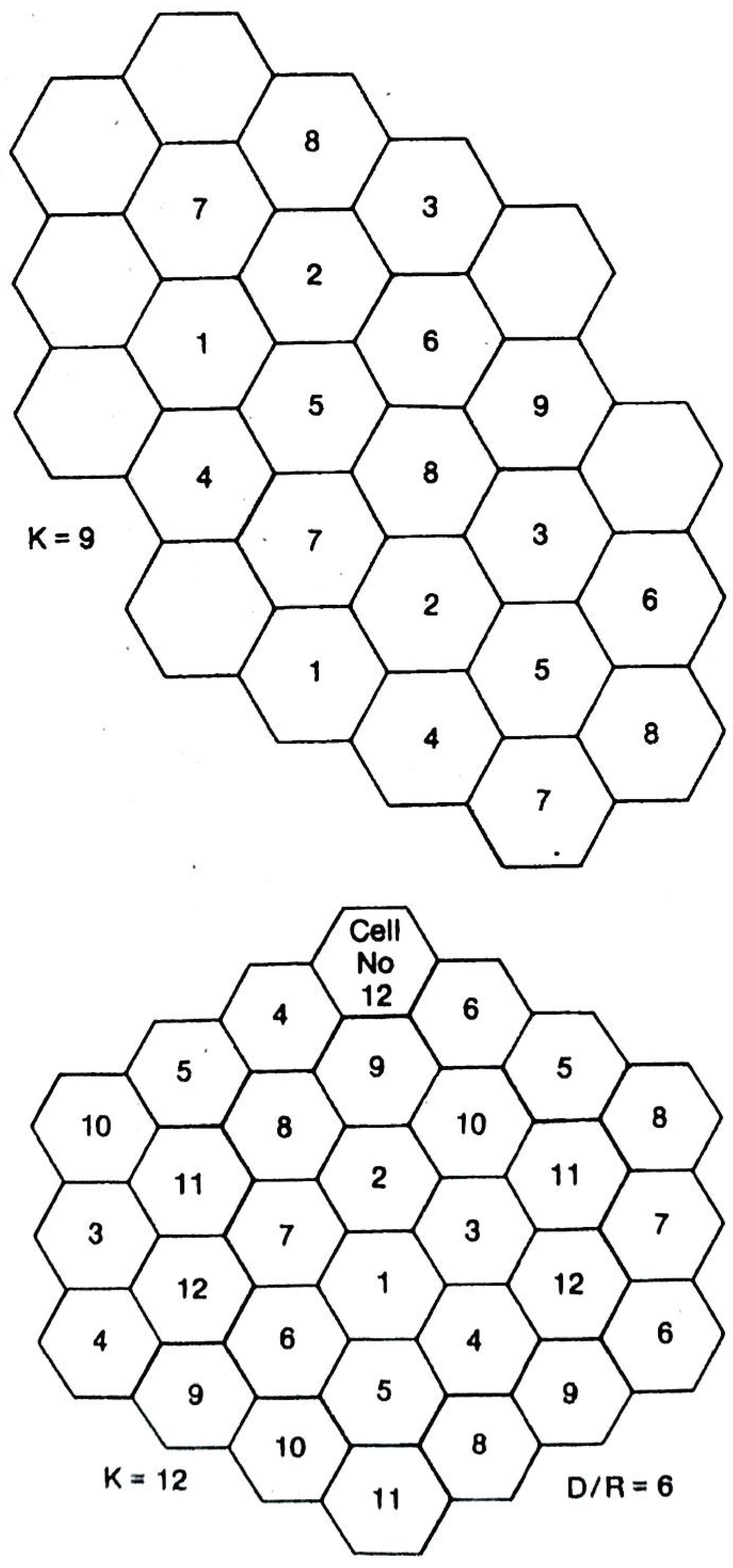

Figure 6.4 Interference with frequency-reuse patterns $K = 9$ and $K = 12$.

Design of an Directional Antenna System:-

→ when the call traffic begins to increase, we need to use the frequency spectrum efficiently & avoid increasing the number of cells K in a 7-cell frequency reuse pattern

→ when K increases, the no. of frequency channels assign in a cell must become smaller (assume total allocated channel divided by K) and efficiency of applying the frequency-reuse scheme decreases.

→ Let K=7, introduce a directional antenna arrangement
- CCI can be reduced by using directional antennas
- Each cell is divided into 3 & 6 sectors and uses 3 & 6 directional antennas at a base station.
- Each sector is assigned a set of frequencies (channels
- The interference between 2 co-channel cells decreases as shown in below figure.

Directional antennas in K=7 cell patterns:-

3-sector case:-

→ To illustrate the worst case situation, 2 co-channel cells are shown in fig(a):

- The MU at position E will experience greater interference in the lower shaded cell sector than in the upper shaded cell-sector site.
- This is because the mobile receiver receives the weakest signal from its own cell but fairly strong

Interference from the interfering cell.

→ Because of the use of directional antennas, the number of principal interferers is reduced from 6 to 2.

→ The worst case of C/I occurs when the mobile unit is at position E, at which point the distance between the mobile unit & the two interfering antennas is roughly $D + (R/2)$.

$$\therefore \frac{C}{I}(\text{worst case}) = \frac{R^{-4}}{(D+0.7R)^{-4} + D^{-4}} = \frac{1}{(q+0.7)^{-4} + q^{-4}}$$

Let $q = 4.6$ then $\frac{C}{I}(\text{worst case}) = 24.5\,dB$
$= 285$

i.e $\frac{C}{I} >> 18\,dB$.

⇒ Thus, $\frac{S}{I}$ – improved, CCI – reduces (due to directional antenna sectors).

Note:- In reality, $\frac{C}{I}$ (24.5 dB) could be 6 dB weaker in a heavy traffic area as a result of

- irregular terrain contour
- imperfect site locations.

∴ The remaining 18.5 dB (24.5 dB – 6 dB) is still adequate.

Six-Sector Case:-

→ divide a cell into 6 sectors by using 6, 60^0 beam directional antennas as shown in fig (b).

- In this case, only one instance of interference can occur in each sector as shown in fig.

$$\therefore \frac{C}{I} = \frac{R^{-4}}{(D+0.7R)^{-4}} = \frac{1}{(q+0.7)^{-4}}$$

Let $q = 4.6$ then $\frac{C}{I} = 794 = 29$ dB

- In reality, 29 dB − 6 dB = 23 dB is still more than adequate.

→ when heavy traffic occurs, 60^0 sector configuration can be used to reduce CCI.

Directional antenna in K=4 cell pattern:-

3-sector case:- To obtain $\frac{C}{I}$, use same procedure as K=7 cell pattern system.

- The 120^0 directional antennas used in sectors reduced interferers to 2 as in K=7 systems as shown:

→ For K=4, $q = \sqrt{3K} = 3.46$. then

$$\frac{C}{I}(\text{worst case}) = \frac{1}{(q+0.7)^{-4} + q^{-4}} = 97 = 20\text{dB}$$

→ In reality, 20dB − 6 dB = 14dB is unacceptable.

6-sector case: There is only one interferer at a distance of D+R shown in fig: with q=3.46 then,

$$\frac{C}{I}(\text{worst case}) = \frac{R^{-4}}{(D+R)^{-4}} = \frac{1}{(q+1)^{-4}} = 397.5 = 27\,dB.$$

→ In reality, 27dB − 6dB = 21dB is adequate.

• Under heavy traffic conditions, there is still a great deal of concern over using a K=4 cell pattern in 60° sector

Comparing K=7 & K=4 systems:

1. when traffic increases, a 3-sector system should be implemented. (i.e 3, 120° directional antennas).
2. In certain hot spots, 60° sectors can be used locally to increase the channel utilization.
3. If a given area covered by both K=7 & K=4 cell patterns & both patterns have 6-sector configuration, then K=7 system has a total of 42 sectors but K=4 system has a total of only 26 sectors.
4. 60° sectors with K=4 require fewer cell sites than 120° sectors with K=7 — advantage of 60° sectors
5. Two disadvantages of 60° sectors are that:
   (i) They require more antennas to be mounted.
   (ii) They often require more frequent handoffs because of increased chance that MU's will travel across sectors of the cell.

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(6) In small cells, interference could become uncontrollable; Thus, $K=4$ pattern with 60° sectors needs to be considered.

(7) In small cells, a better alternative scheme is to use a $K=7$ pattern with 120° sectors.

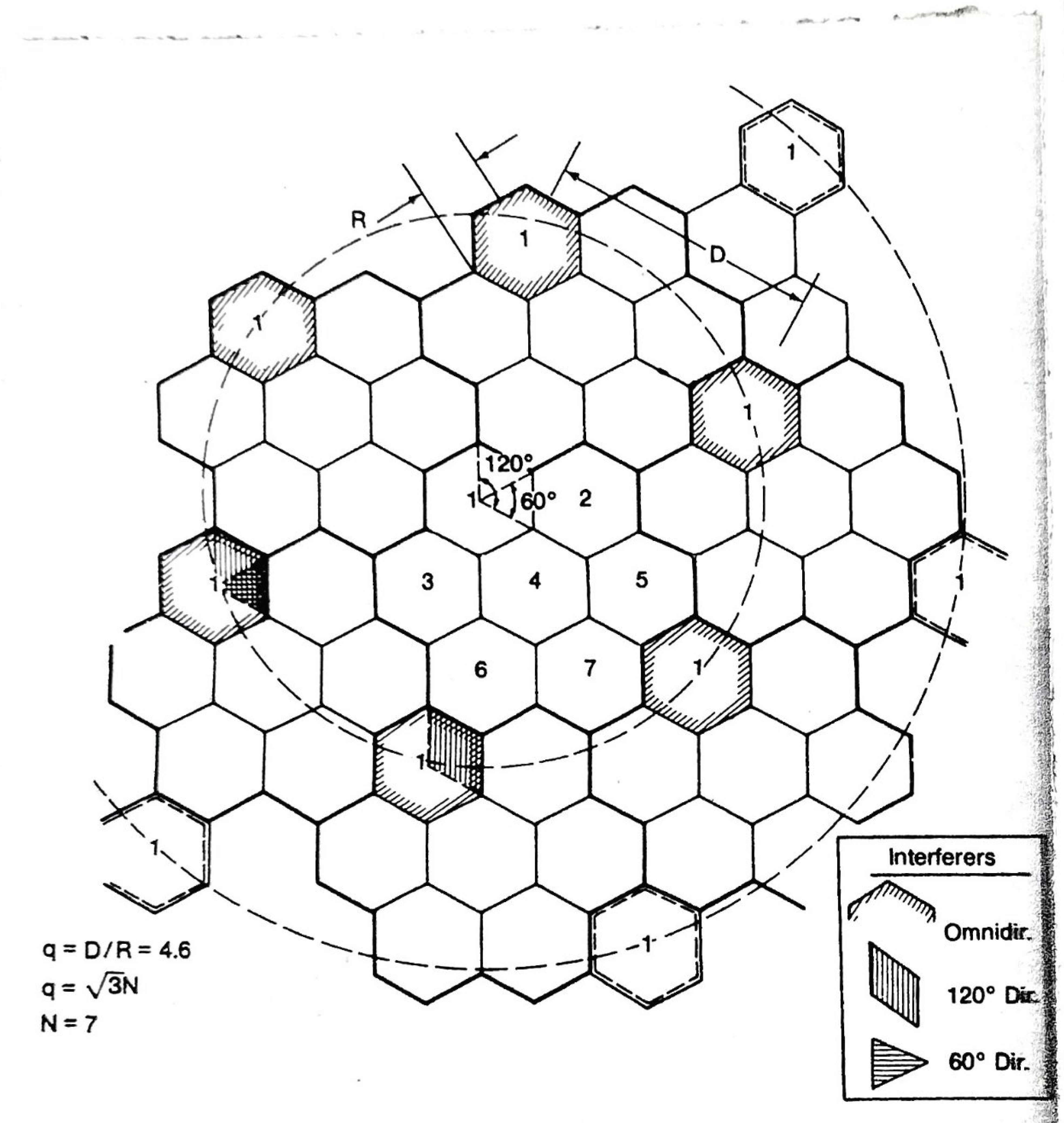

Figure 6.5 Interfering cells shown in a seven-cell system (two-tiers).

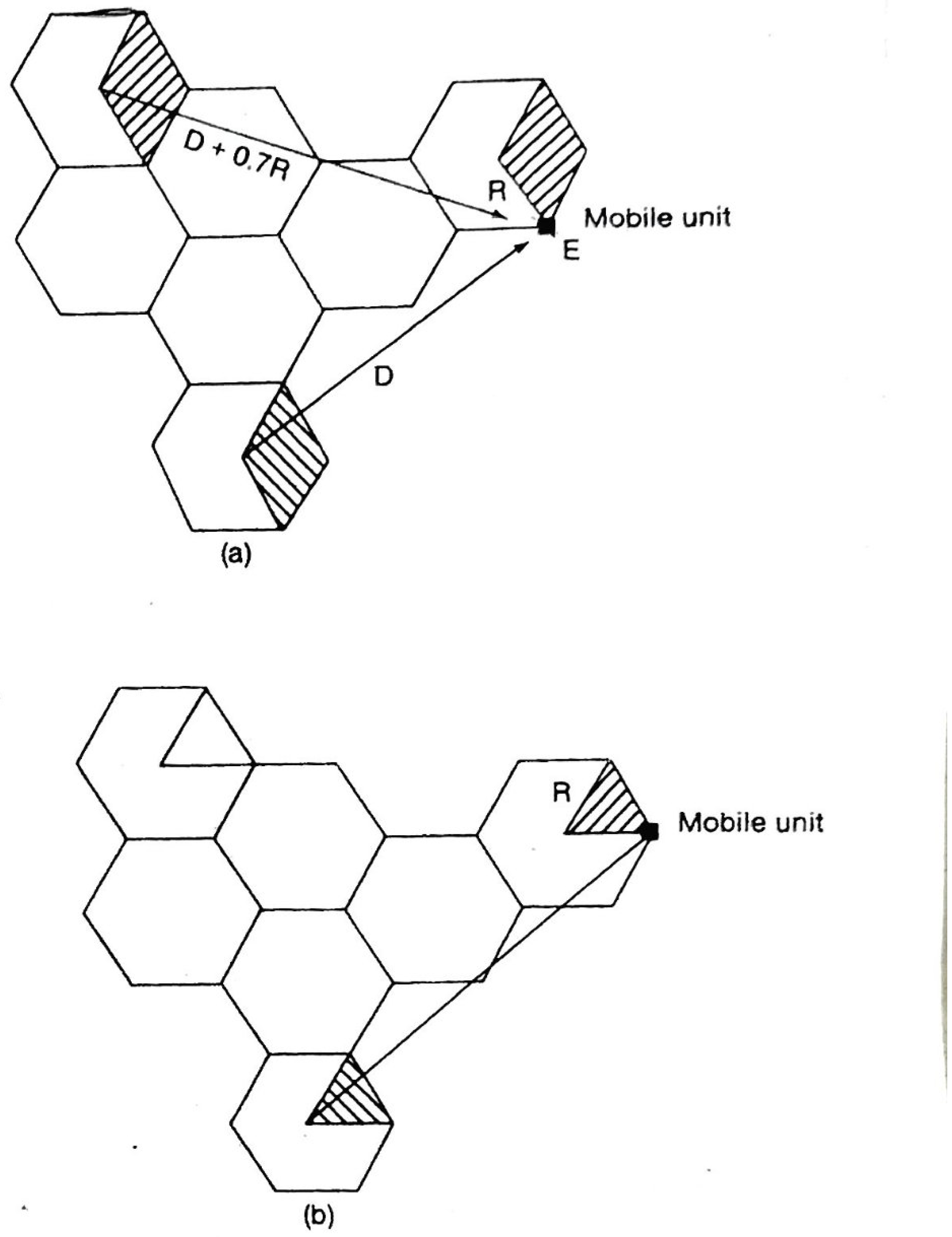

Figure 6.6 Determination of carrier-to-interference ratio C/I in a directional antenna system. (*a*) Worst case in a 120° directional antenna system ($N = 7$); (*b*) worst case in a 60° directional antenna system ($N = 7$).

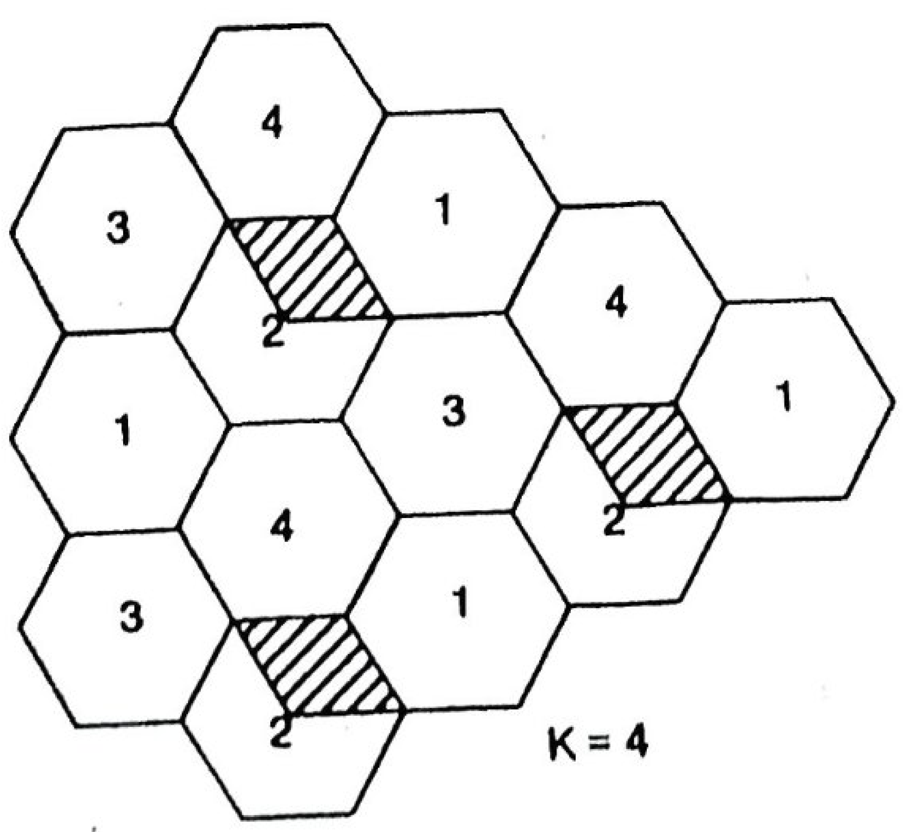

Figure 6.7 Interference with frequency-reuse pattern $K = 4$.

Antenna Parameters & their effects :-

→ The effect of antenna parameters on the cell interfaces are described below :

① The base station antenna height must be decided just to covers the horizon distance allotted for the cell because service area having hills, mountains, valley regions. etc.

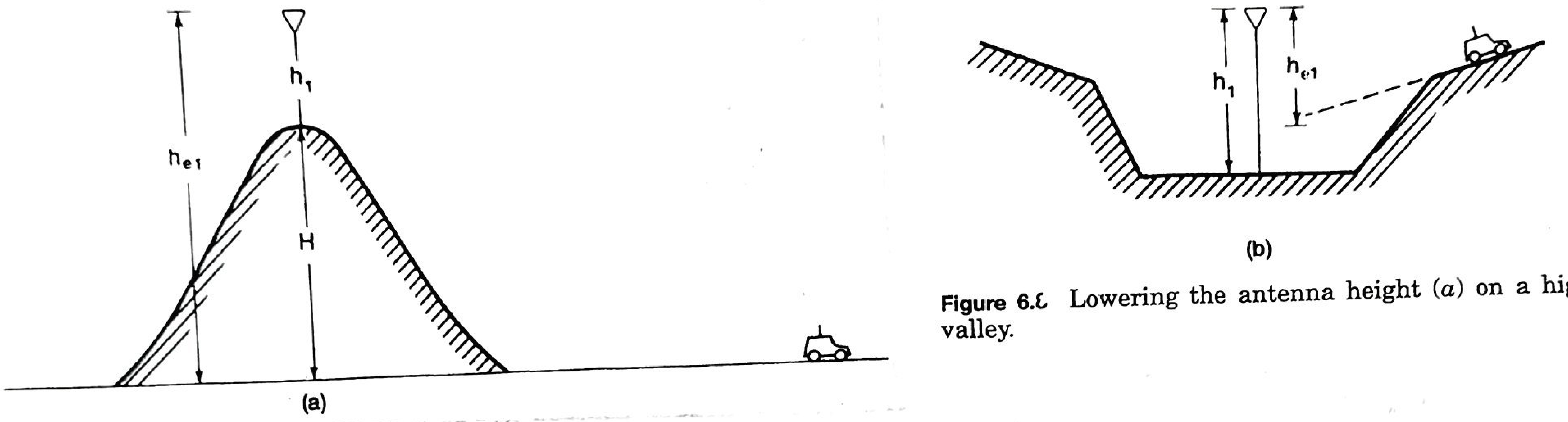

Figure 6.8 Lowering the antenna height (*a*) on a high hill and (*b*) in a valley.

② Co-channel interference can be reduced by means of a tilted antenna pattern. The pattern shown below is umbrella pattern in elevation.

• In this pattern, radiation near to antenna is higher compare to long distances. Then, result in reduction of CCI under normal condition.

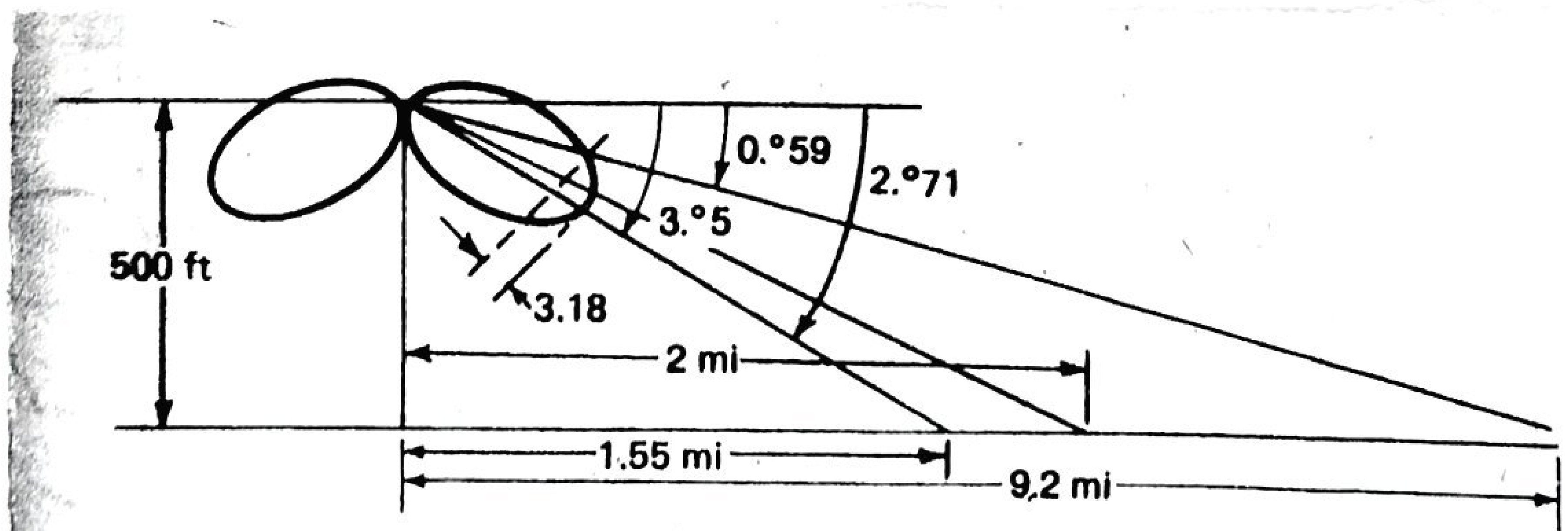

Figure 6.14 Coverage with the tilted-beam pattern.

③ Using directional antennas :-

→ To reduce CCI

→ Concentrate radiation in the desired direction & avoid unwanted directions.

→ Better co-channel rejection, switching them according to the movement of the mobile unit is complex affair

- This problem is overcomed by smart antennas can be put into applications.
- smart antennas work on the principle of adaptive arrays.
- This adaptive arrays have many elements, produces the required bandwidth for system.

④ Both mobile unit, base stations make use of transmitters to send information to each others by wireless. This means power radiation in air, controlled by MTSO,

→ when mobile unit approach to base station, the power radiated by mobile unit is reduced.

- Then chance of interfering with other co-channel base stations can be reduced by lowering power level.

→ when power received from the mobile unit is quite strong at base station, the MTSO must reduce the cell radiated power to mobile unit and also send control signal to reduced mobile unit radiated power.

Diversity Receiver:

→ Diversity Receivers are used to improve reception of RF signals

- It utilizes two separate independent antenna systems.
- The receiver looks at signal coming from each antenna, determines which one is stronger, then switches to that stronger signal.
- The receiver is constantly comparing to see which antenna is providing better signal, and can quickly switch from one to the other as signal strength changes

→ Use a selective combiner to combine 2 correlated signals as shown in fig: which shows a family of curves representing this selective combination.

- Each curve has an associated correlation coefficient (ρ). When using the diversity scheme, the optimum result is obtained when $\rho = 0$.

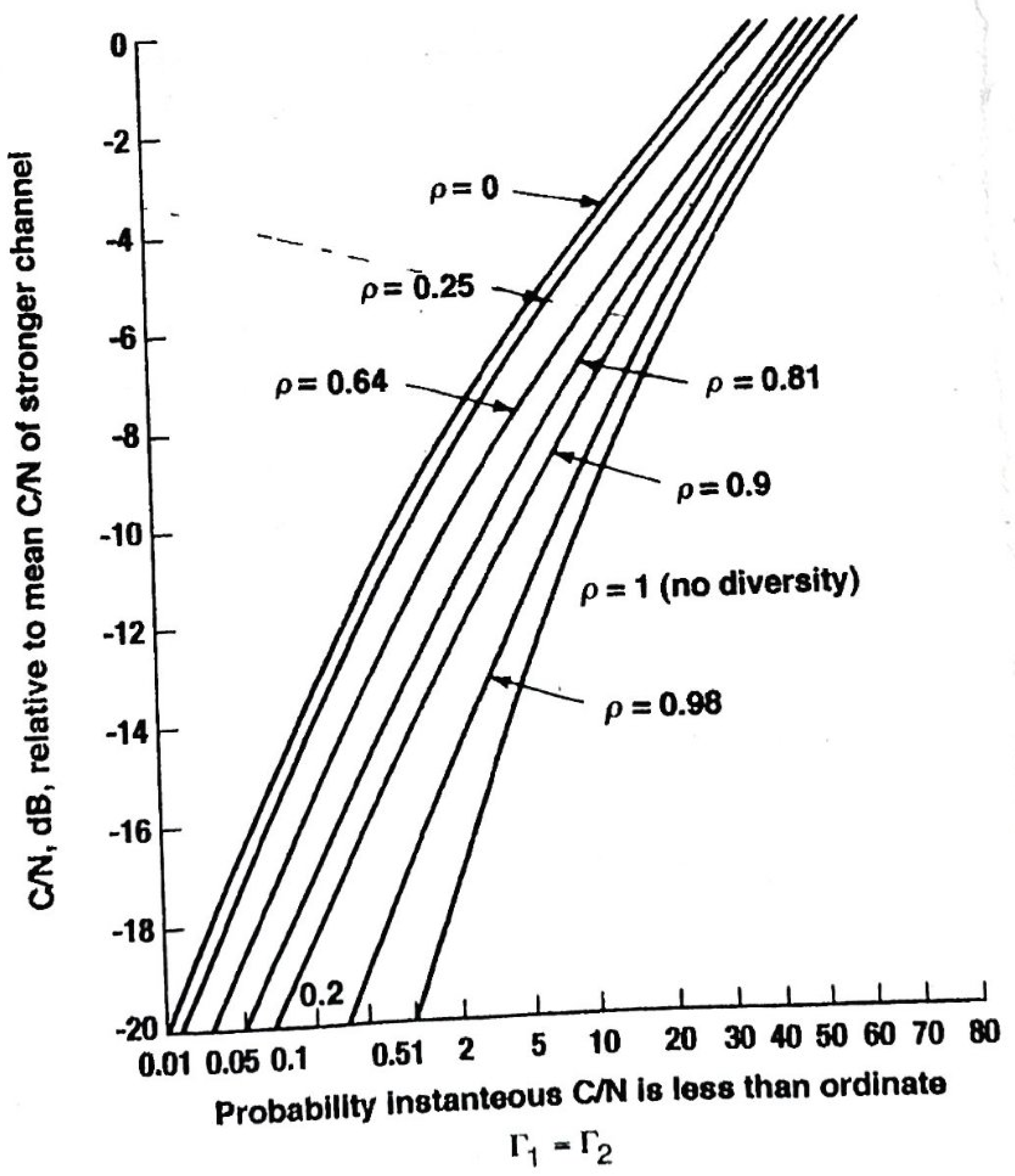

Figure 6.17 Selective combining of two correlated signals.

→ At the mobile unit, use $\rho = 0$, which implies that two roof-mounted antennas of the mobile unit are 0.5λ (or) more apart, verified by the measured data.

estimate the advantage of using diversity:-

- Assume, a threshold level of 10dB below the avg. power level.
- Compare the percent of signal below threshold level both with and without a diversity scheme.

At the Mobile unit :-

→ The comparison is between curves $\rho = 0$ and $\rho = 1$.

- If diversity scheme is used, power can be reduced by 10 dB for the same performance as in non-diversity scheme without reducing power.
- With 10 dB less power transmitted at the cell site, CCI can be drastically reduced.

At the cell site:-

→ The comparison is between curves of $\rho = 0.7$ & $\rho = 1$.

- The mobile transmitter (for a cell site diversity receiver) could undergo a 7-dB reduction in power & attain the same performance as a non-diversity receiver at the cell site.
- Thus, interference from the mobile transmitters to the cell-site receivers can be drastically reduced.

Non-Cochannel Interference — Different Types:-

1. Adjacent-channel interference.
2. Near-End-Far-End Interference
3. Cross Talk
4. Interference between systems.
5. UHF TV interference
6. Long distance interference
7. Use of parasitic elements
8. Diversity Receiver
9. channel Combiner

1. Adjacent-channel Interference:- It can be eliminated on the basis of the channel assignment, filter characteristics and the reduction of near-end-far-end interference.

→ It includes:
1. Next-channel (channel next to operating channel)
2. Neighboring-channel interference (channel away from the operating channel).

Next-channel interference:-

→ It arrive at MU from other cell sites, if system is not designed properly.

→ MU initiating a call on a control channel in a cell may cause interference with next control channel at another cell site.

→ The filter with a sharp falloff slope can help to reduce all ACI, including the next-channel interfere

Neighboring-channel Interference:-

→ The channels which are several channels away from the next channel will cause interference with the desired signal.

- A fixed set of serving channels is assigned to each cell site.
- If all channels are simultaneously transmitted at one cell site antenna, a sufficient amount of band isolation between channels is required for a multi-channel combiner to reduce inter-modulation products.

(2) Near-End-Far-End Interference:-

i) In one cell:- The close-in mobile unit has a strong signal which causes ACI.

- In this situation, near-end-far-end interference can occur only at the reception point in the cell site as shown in fig(a).

ii) In Two cells:-

- The frequency channels of both cells of the two systems must be coordinated in the neighborhood of 2-system frequency bands, as shown in fig(b).

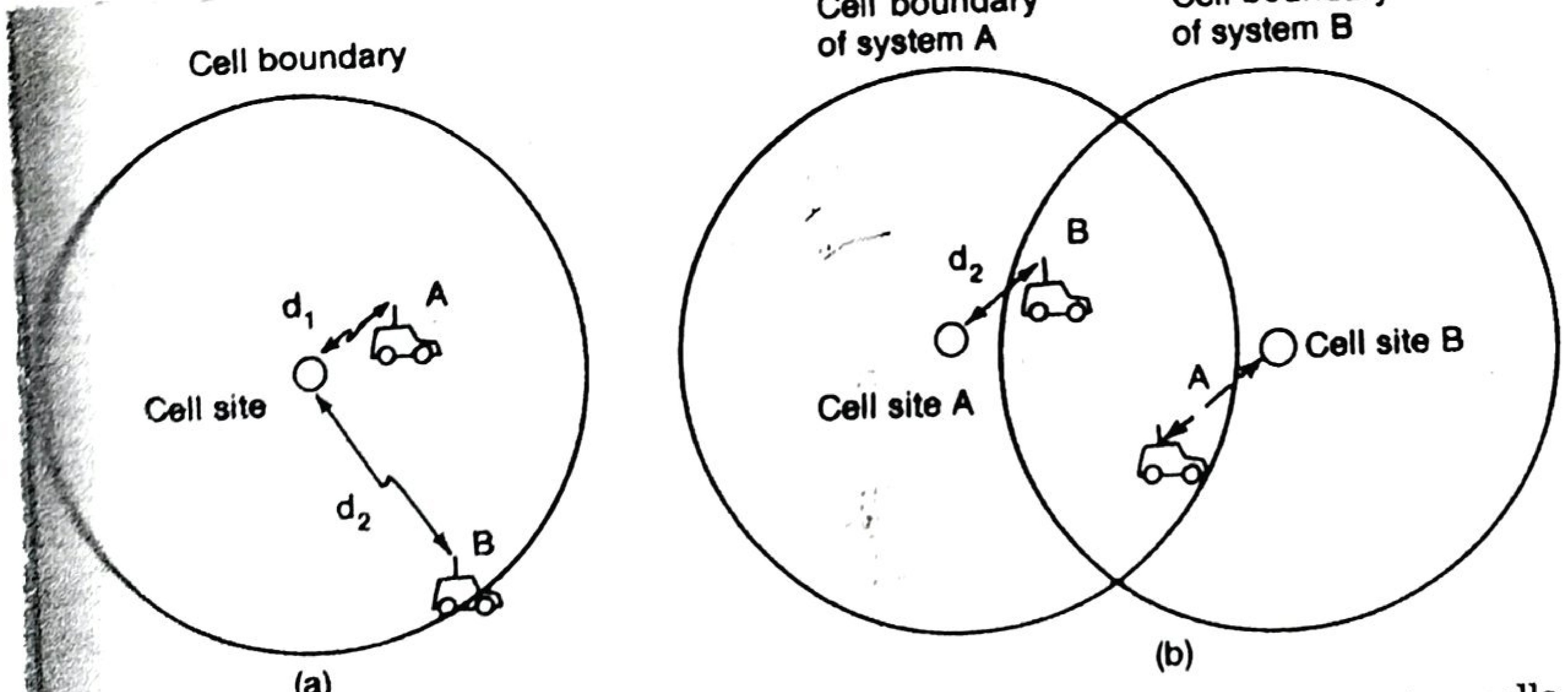

Figure 7.5 Near-end–far-end (ratio) interference. (a) In one cell; (b) in two-system cells.

(3) Cross Talk:-

Near-end Mobile Unit:-

→ cross talk can occur when one mobile unit (unit A) is very close to the cell site & other (unit B) is far from cell site.

- Both units are calling to their land-line parties as shown in fig:

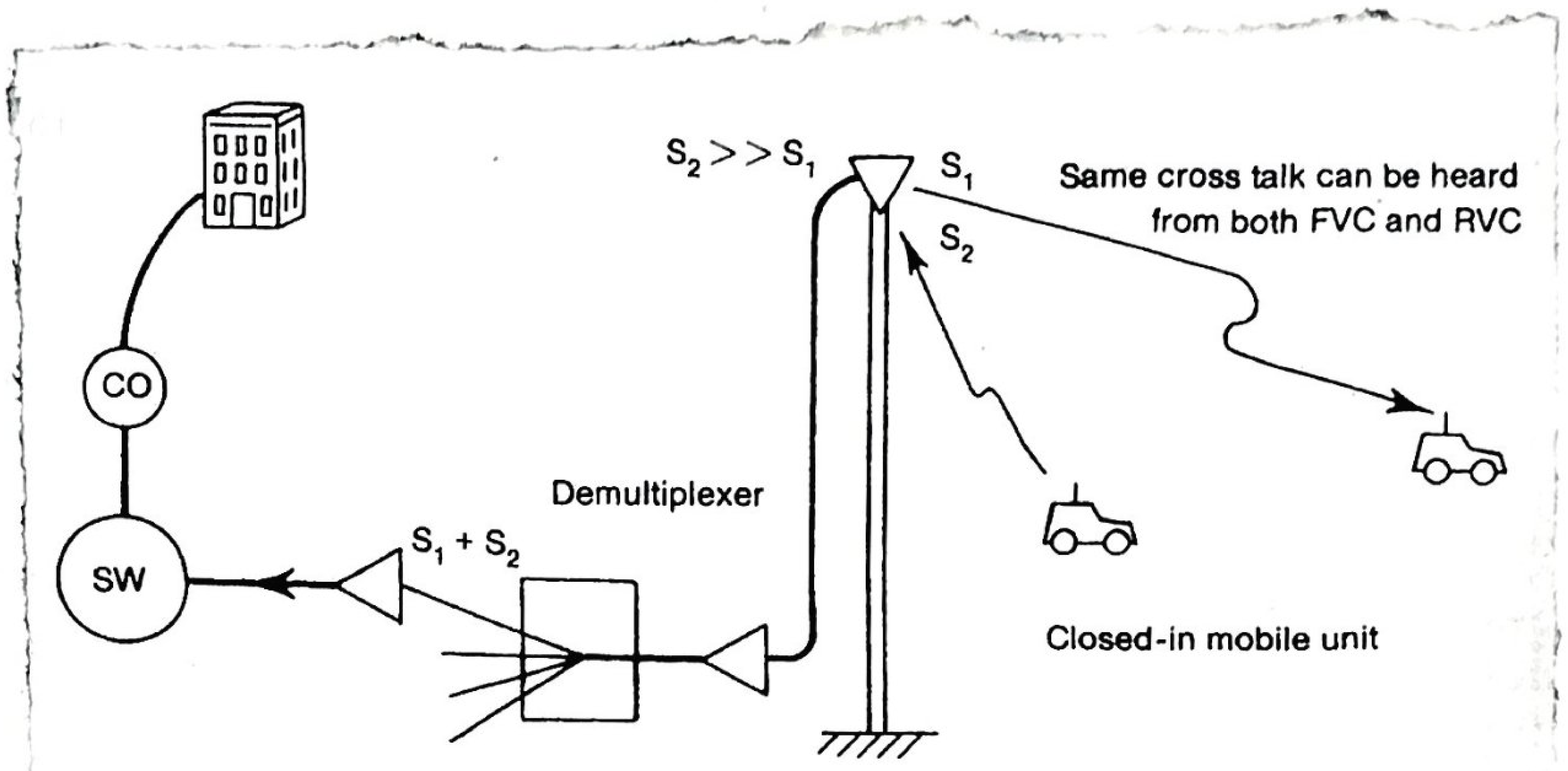

Figure 7.10 Cross-talk phenomenon.

→ The near-end mobile unit has a strong signal such that the demultiplexer cannot have an isolation of > 30dB.

- Then the strong signal can generate strong cross talk while the received signal from MU(B) is 30dB weaker than signal (A).

close-in mobile units:-

→ when a MU is very close to cell site and if reception at the cell site is > −55 dBm, the channel preamplifier at the cell site can become saturated & produce IM as a result of the non linear portion of the amplification.

Co-channel cross talk:-

(i) q should as large as possible to compensate for the cost of site construction & limited channels at each cell site. An adequate system design reduces co-channel cross talk.

Telephone-line cross talk:

→ Sometimes cross talk can result from cable imbalance (or) switching error at the central office and be conveyed to the customer through telephone line.

→ Minimizing this cross talk should be given the same priority as reducing the no. of call drops.

(4) Interference between Systems:

In one city: Assume 2 systems operating in one city. If MU (A) of system is closer to a cell site of system (B) while a call is being initiated through system (A), ACI & IM can be produced if the transmitted frequency of MU (A) close to the covered band of the received preamplifier at cell site B, as shown below:

Fig: Intersystem Interference

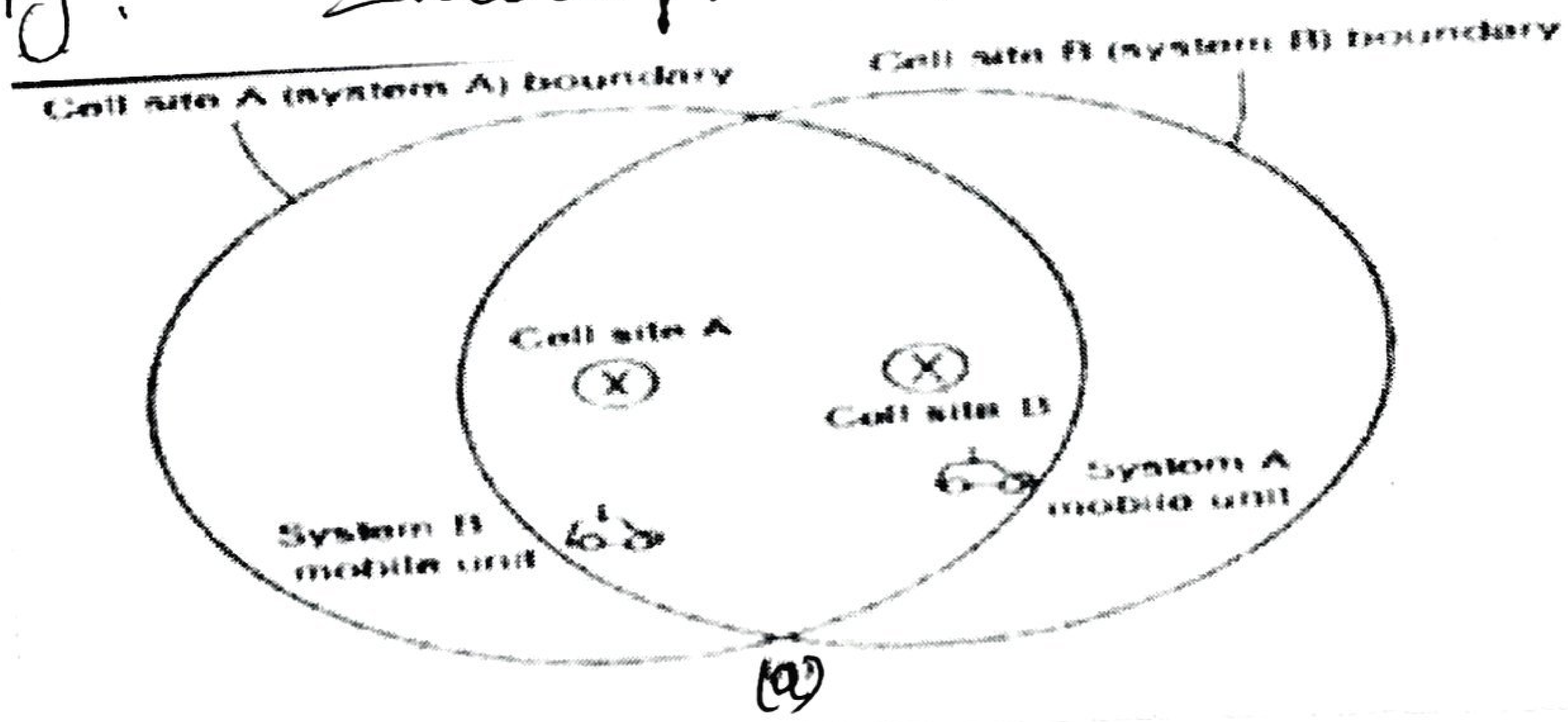

fig (a): System (A) cell sites in system (B) cell coverage.

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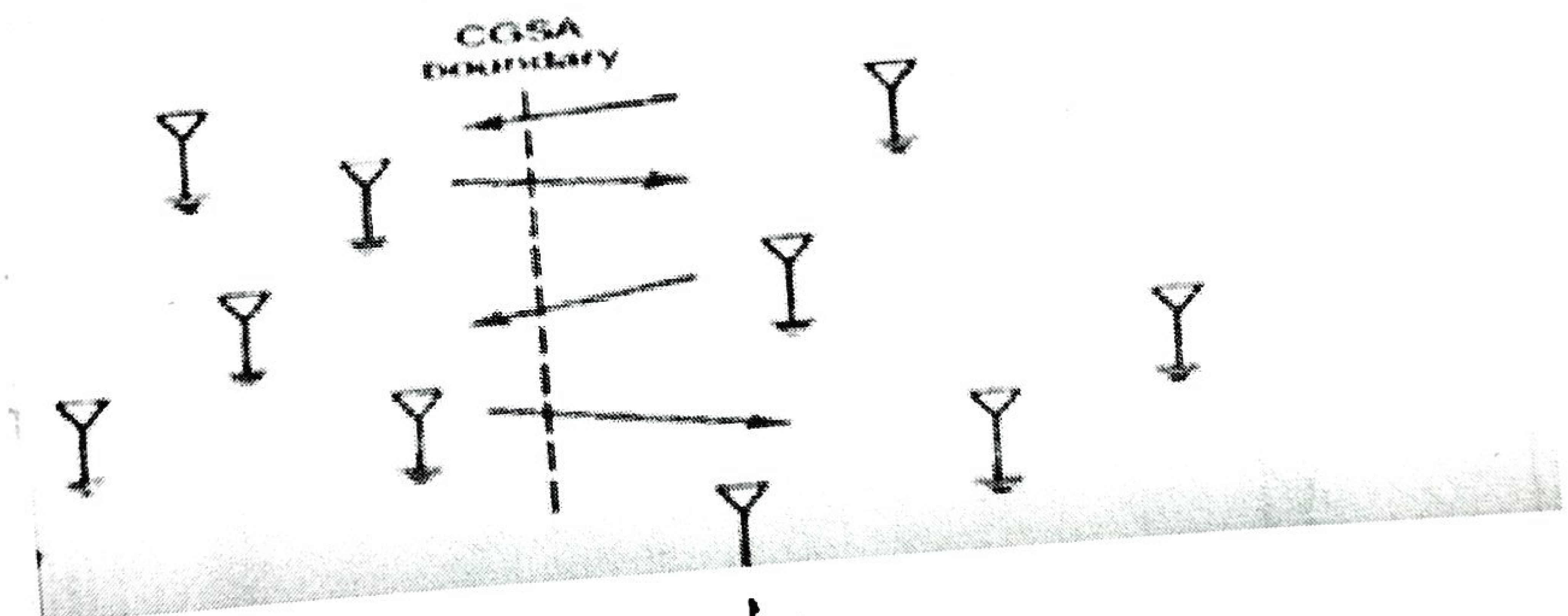
In adjacent cities:-

→ 2 systems operating at the same frequency band and in two adjacent cities (or) areas may interfere with each other if they do not coordinate their frequency channels use.

- Most cases of interference are due to cell sites at high altitudes (see fig(b)).
- In any start-up system, a high-altitude cell site is always attractive to the designer.
- Such a system can cover a larger area & in turn fewer cell sites are needed.
- However, if the neighboring city also uses the same system block, then the result is strong interference.



(b)

fig(b): Interference between 2 cellular geographic service area (CGSA) systems.

(5) UHF TV Interference:-

→ 2 types of interference can occur between UHF television and 850 MHz cellular mobile phones.

(i) Interference to UHF TV receivers from cellular mobile transmitters.

(ii) Interference of cellular mobile Receivers by UHF TV transmitters.

→ Because of the wide frequency separation between cellular phone systems and the media broadcast services (TV & radio) and the significantly high power levels used by the UHF TV broadcast transmitters, the likelihood of interference from cellular phone transmissions affecting broadcasting is very small.

→ There is a slight probability that when the cellsite transmission is 90MHz above that of a TV channel, it can interfere with the image response frequency of typical home TV receivers.

→ Interference b/w TV & cellular mobile channels is illustrated in fig:

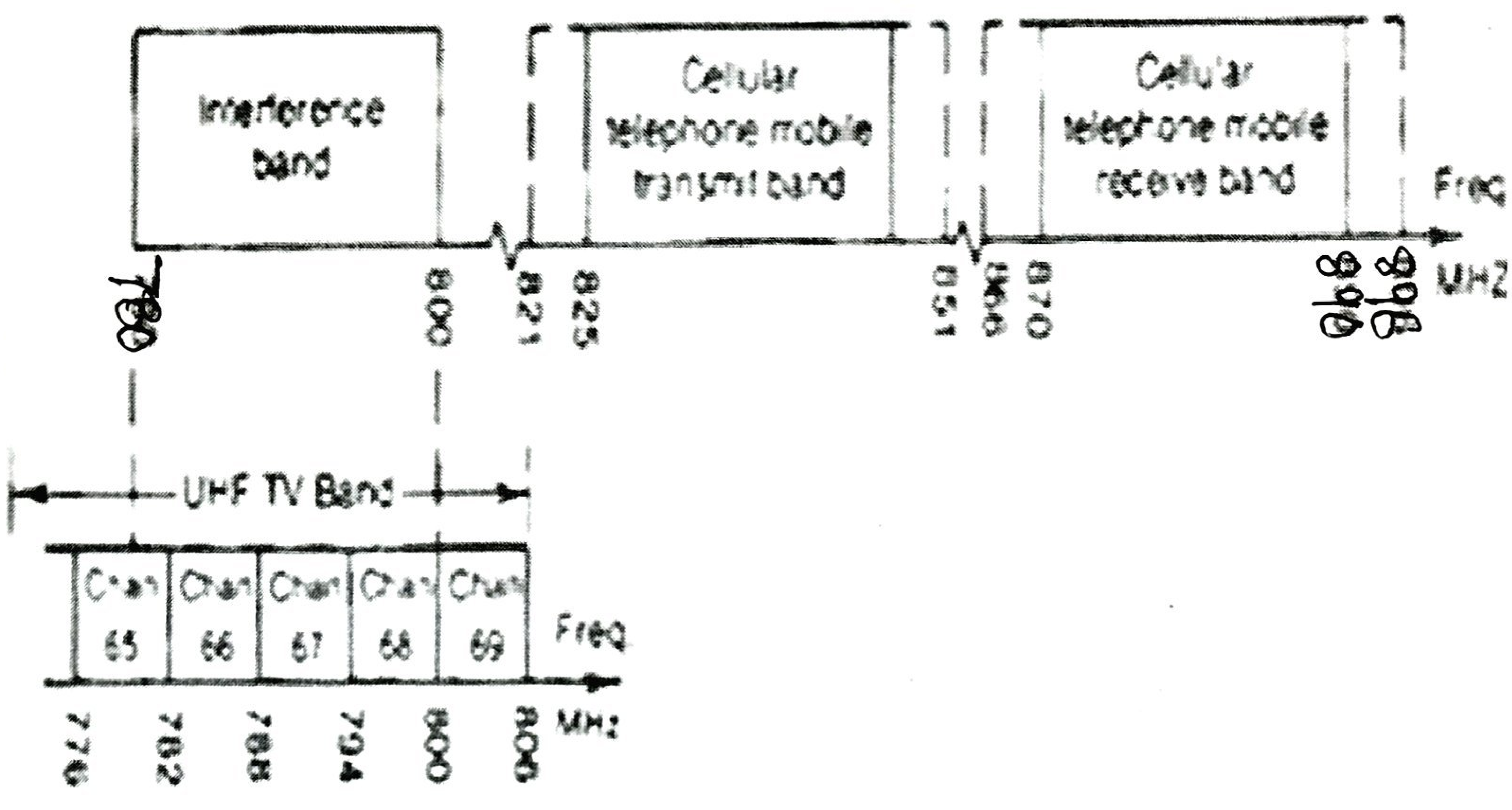


FIGURE 10.20 Cellular telephone frequency plan.

6 Long-Distance Interference :-

Overwater path :- A 41-mi overwater path operating at 1.5 GHz in Massachusetts Bay.

a Low ducts (< 50 ft thick) :- steady signal well above normal level is received.

b High ducts (≥100 ft thick) :- a high signal level on average is received but with deep fading.

Overland path :-

→ Tropospheric scattering over a land path is not as consistent as that over water and can be varied from time to time.

- Usually, tropospheric propagation is more pronounced in the morning. The distance can be about 200 mi.

7 Use of Parasitic Elements :-

→ Interference at the cell site can sometimes be reduced by using parasitic elements, creating a desired pattern in a certain direction.

- Currents appearing in several parasitic antennas are caused by radiation from a nearby drive antenna.
- A driven antenna and a single parasite can be combined in several ways.

(8) Diversity Receiver :-

→ The diversity scheme applied at the receiving end of the antenna is an effective technique for reducing interference because any measures taken at the receiving end to improve signal performance will not cause additional interference.

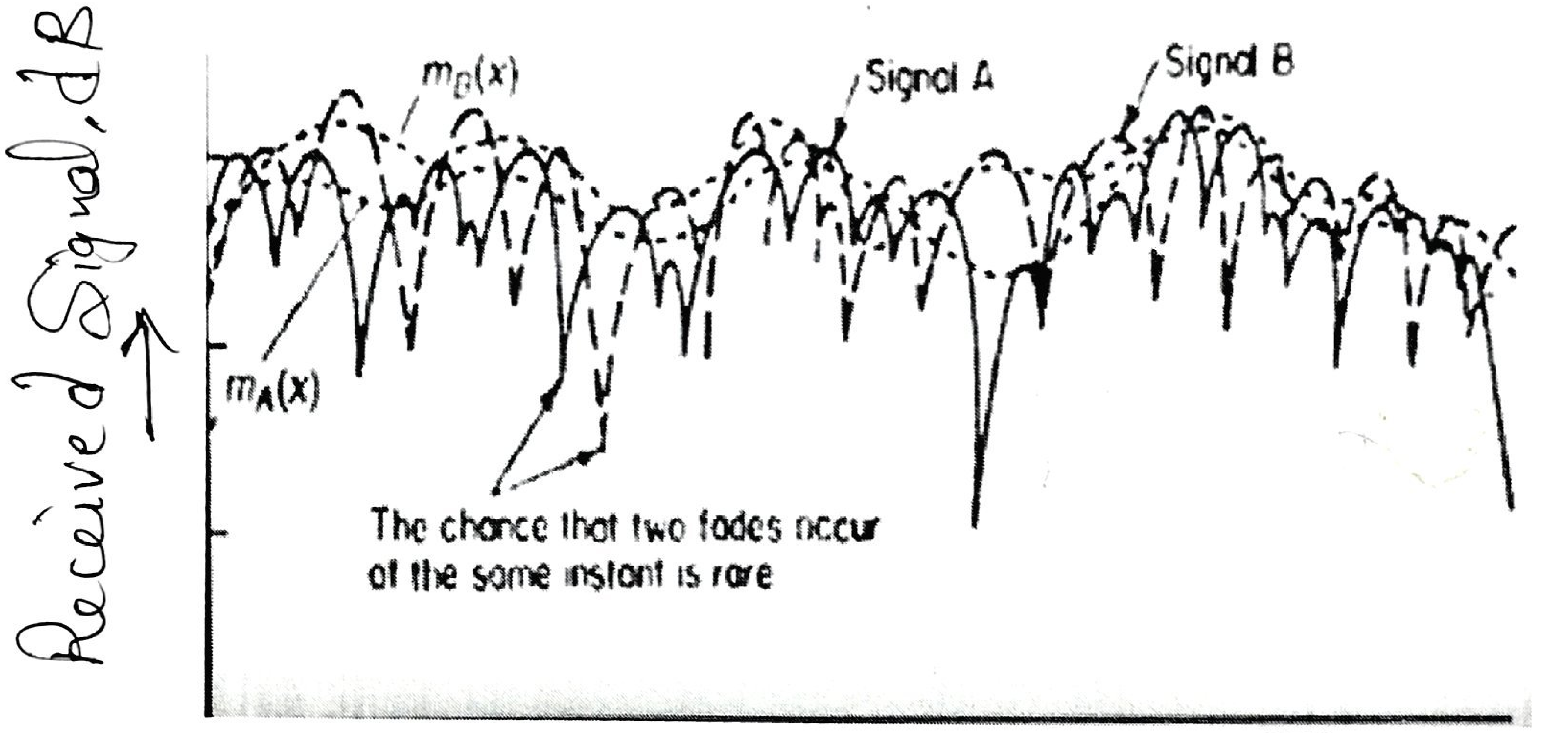


fig : Uncorrelated fading signals.

(9) channel Combiner :-

→ It is installed at each cell site, then all Tx'ed channels can be combined with minimum insertion loss & maximum isolation of signal between channels.

→ We can eliminate the channel combiner by letting each channel feed to its own antenna.

→ Then a 16-channel site will have 16 antennas for operation.

• It is an economical & a physical constraint.