

# Intelligent Cell concept

- The rate of increasing the mobile phone in a year 100% hence it is necessary to increase the capacity of cellular system
- There are many technique to increase the capacity of cellular system like splitting, sectorizing, microcell etc they are not intelligent because they suffer from:
  1. Interference is difficult to control
  2. Handoff do not have the enough time to complete so call drop.

## INTELLIGENT CELLS

- Capacity can be increased by reducing cell sizes (Cell Splitting). As cell size reduces , control of interference among the cells becomes difficult. There may not be enough time for the hand-off to get completed. The call may get dropped. Intelligent cell solves these problems.
- Intelligent cell is that cell which is able to intelligently monitor the position of the MU and find a way to deliver the confined power to that MU. This cell is called POWER DELIVERY INTELLIGENT CELL.
- Intelligent cell is also that cell in which the signals co-exist comfortably and permanently with the interference. This type of cell is called PROCESSING GAIN INTELLIGENT CELL.
- Intelligent Cells can be large cells (Macro cells) or small cells( mini cell or micro cell ) .These increase capacity and improve performance of voice and data transmission.
- .

# Power delivery intelligent cell

- In conventional microcell or macro-cell when mobile unit enter the enter the cell or sector ,the cell site cover the power to entire cell.
- In intelligent microcell or macro-cell , when mobile unit enter the enter the cell or sector ,the cell cover only the local area which follows the mobile unit.

# The Philosophy of implementing

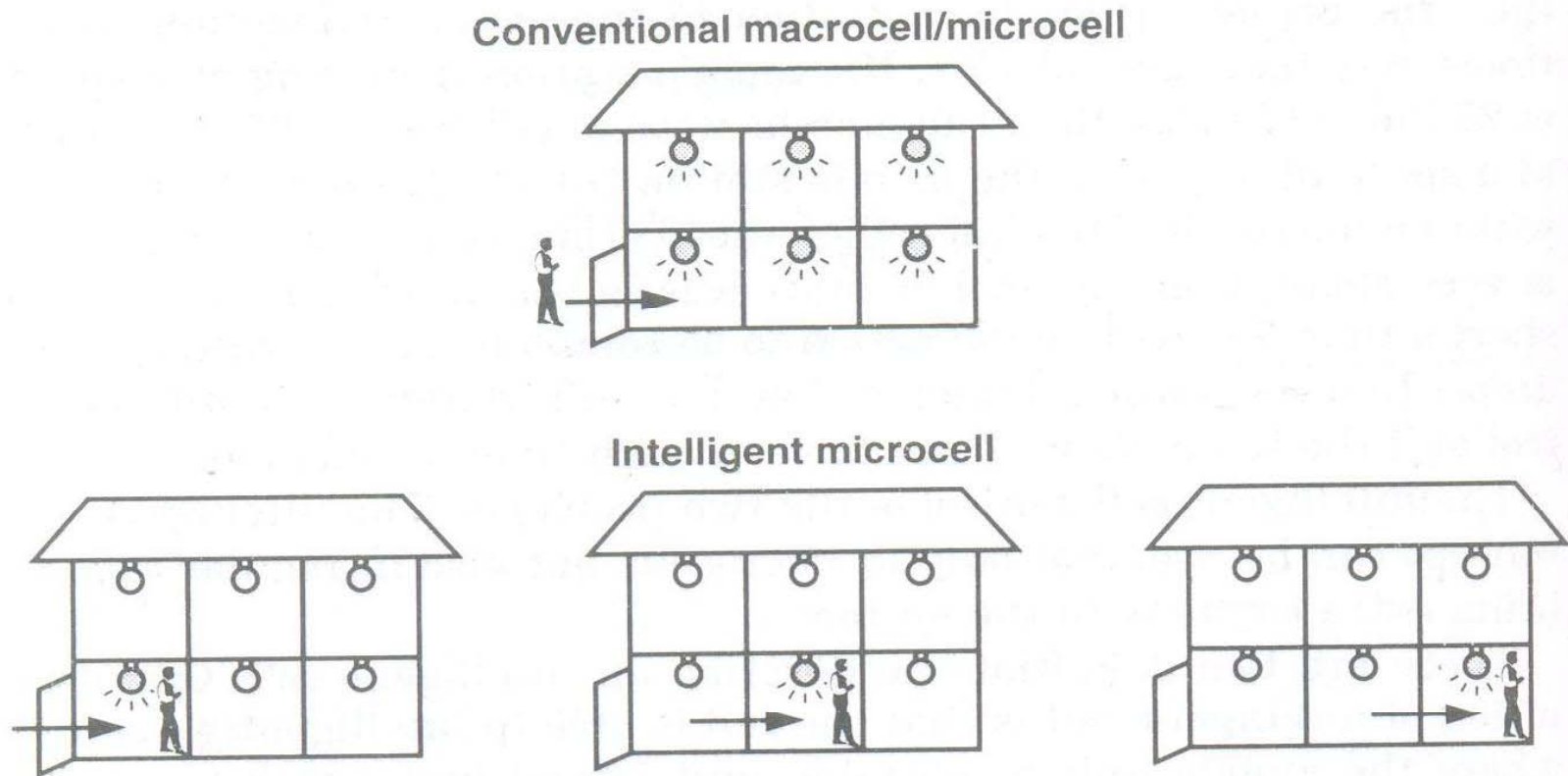


Figure 16.1 Microcell philosophy: energy follows the mobile analogy, light follows the person.

# The Philosophy of implementing

- To make the system intelligent there are two conditions:
  1. The cell operator has know where the mobile unit is located so different resolution methods are used to locate the mobile unit.
  2. The cell operator has to be able to deliver the power to the mobile unit .if the power transmitted from cell site to mobile unit can be confirmed in a small area co- channel interference reduces and system capacity increase.

# Radio Capacity

- Radio capacity(for omni cell):  $m = \frac{M}{K}$   
no of channel/cell
- Radio capacity(for Sector cell):  $m = \frac{M}{(K * S)}$  no of  
channel/cell
- Cell Reuse Factor:  $K = \frac{1}{3} \left(\frac{D}{R}\right)^2$
- Carrier to interference ratio:  $\frac{C}{I} = \frac{D/R^2}{6}$
- Radio capacity of omni cell is :  $m = \frac{M}{\sqrt{\frac{2}{3} \left(\frac{C}{I}\right)}}$

M- total no of channel, s-no of sector, k- cell reuse factor, m-radio capacity

D=co channel cell separation, R= cell radius

# Power Delivery in intelligent cell

- 1. Zone –divided cell: there are three types of zone divided in to cell
  1. Sectorial cells
  2. Intelligent Microcell
  3. Reuse of Sectorial beams with directional antenna.
- 2. Processing gain of intelligent cells
  - Implementation of cell concept may be include using multiple zone, multiple antenna beam,

# Sectorial Cell

- Power deliver to the intelligent cell Sectorial cell
  1. They are used to reduced the interference.
  2. Used in non flat geographical areas.

There are two types of Sectorial cells

1. 7-cell/3-sector reuse system ( $K=7, S=3$ )
2. 4-cell /6- sector reuse system( $K=4, S=6$ )

Each sector has dedicated channel , radio capacity of these two system are

$$m_1 = M/7 * 3 = N/21 \text{ Channel/sector}$$

$$m_2 = M/9 * 8 = N/24 \text{ Channel/sector}$$

M- total no of channel, s-no of sector- cell reuse factor, m-radio capacity



# Sectorial Cell

- Co channel interference

$$\frac{C}{I} = \frac{R^{-4}}{D + 0.7R^{-4} + D^{-4}} = 285 \text{ or } 24 \text{ dB (for } K=7, S=3)$$

$$\frac{C}{I} = \frac{R^{-6}}{(D + R)^{-6}} = 395 \text{ or } 26 \text{ dB (for } K=4, S=6)$$

# Intelligent Microcell

- Divided the cell into many zones
- The cell operator knows which zone the mobile unit is in and delivers the radio signal to that zone.
- When the mobile unit assign a frequency channel is always associate with a call in a cell.
- The cell operator simply turn on the new zone site while the mobile unit is entering & turn off the old zone site when it leaves with the assign frequency channel to the mobile unit unchanged.

# Intelligent Microcell

- Assume the desired mobile unit in a zone Q of the center cell .
- There are three interfering zone marked A & B
- One in each interfering cell where the six interfering mobile could be
- The voice quality should be maintained at the stated requirement of  $C/I \geq 18\text{dB}$

# Intelligent Microcell

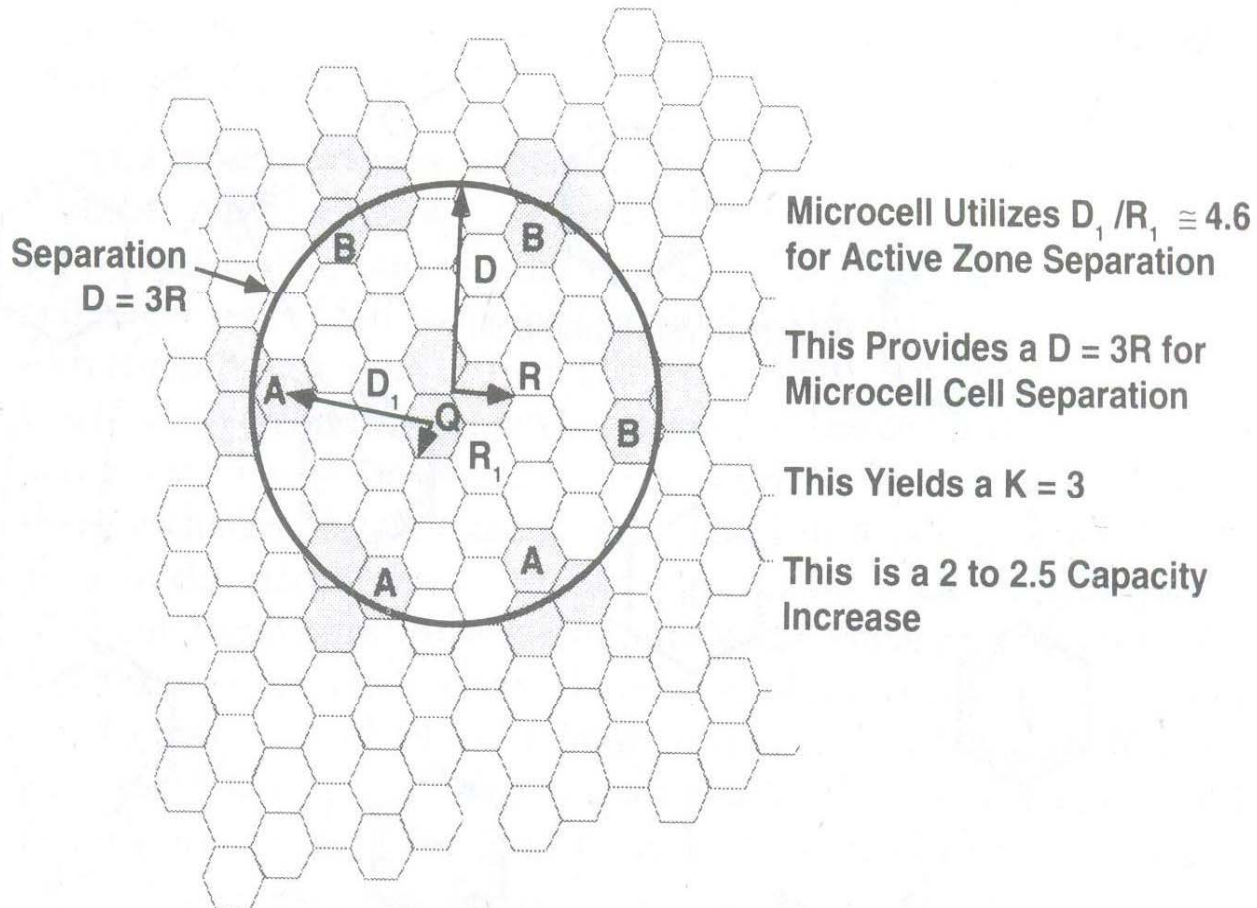


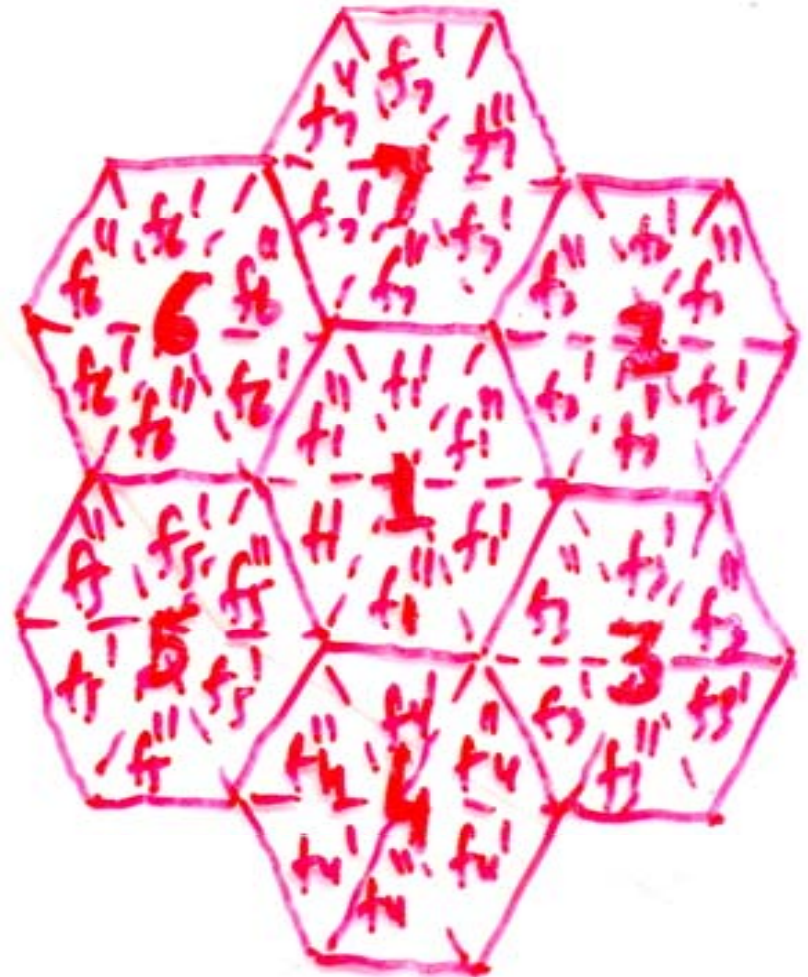
Figure 16.3 Intelligent microcell capacity application.

# Reuse of Sectorial beam with directional antennas

- Applying the same intelligent cell concept we used the antenna beam to confine the energy in to individual mu. In the cell unit.
- At the cell side if directional antenna are used to corner of 360 in that cell & if whole set of channel assigned is to the cells is divided to the subset which are alternating from sector to sector using each subset in a cell as shown in fig

# Reuse of Sectorial beam with directional antennas

- In this arrangement , we can increase the capacity by 3 times . If N sector beam are reused alternately , the capacity is increased by  $N/2$  times the AMPS capacity .This reuse of Sectorial beam scheme can be used in a small cell system or a large flat-terrain cell system with much less reduction on trucking efficiency



# Adaptive Antenna Array

- The antenna pattern can be formed by tracking the mobile unit & nulling the interference.
- If the same frequency channel can be used by  $N$  mobile cell, the capacity is  $Nx$
- The cell reuse configuration may be reduced from  $k=7$  to a smaller  $k$  depending on the magnitude of  $N$ . if  $N$  is large, the  $N$  antenna beams operating the same frequency to serve  $N$  user within the cell can be treated as they are from omni directional antenna.



# Adaptive Antenna pattern

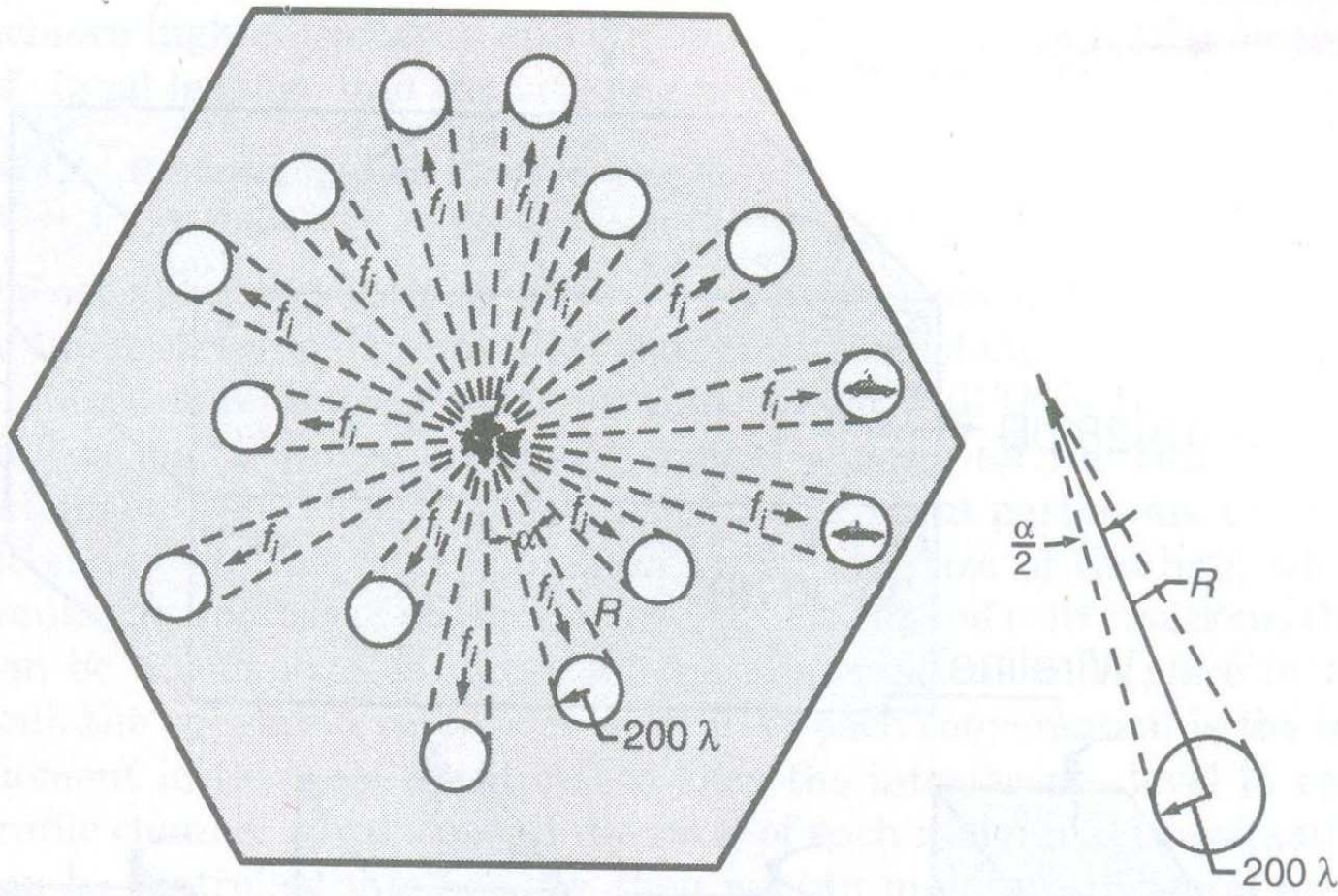


Figure 16.6 Intelligent cell with adaptive antenna-array beams.



# Adaptive Antenna pattern

- This pattern provides a good mean of generating multiple co channel mobile calls on the reverse links
- The identical antenna pattern for transmitting & receiving at the cell site , the cells are conducted on forward links as well.
- The beam angle  $\alpha$  received at the cell site is a function of distance R
- $\alpha = 2 \cdot 200\lambda/R$

## Philosophy of Designing in-Building Communication

- Signal should not be forced into the building with high power.
- Rather, it should be led into the bldg and distributed on to each floor.
- Methods of leading cellular signal into the Building :
  - (a) OPTICAL LINK up convert all cellular signals into optical frequency at the base end and transmit over the optical fiber cable. When the optical signal reaches the building, down-convert it back to the cellular signals and serve the building users.
  - (b) MICROWAVE LINK up convert all cellular signals into microwave frequency at the base end and transmit over the radio link. When the microwave signal reaches the building, down-convert it back to the cellular signals and serve the building users.
  - (c) CABLE LINK down convert all cellular signals into 200 M Hz UHF signals at the base end and transmit over cable with low path loss. When 200 M Hz UHF signal reaches the building, up-convert it back to the cellular signals and serve the building users

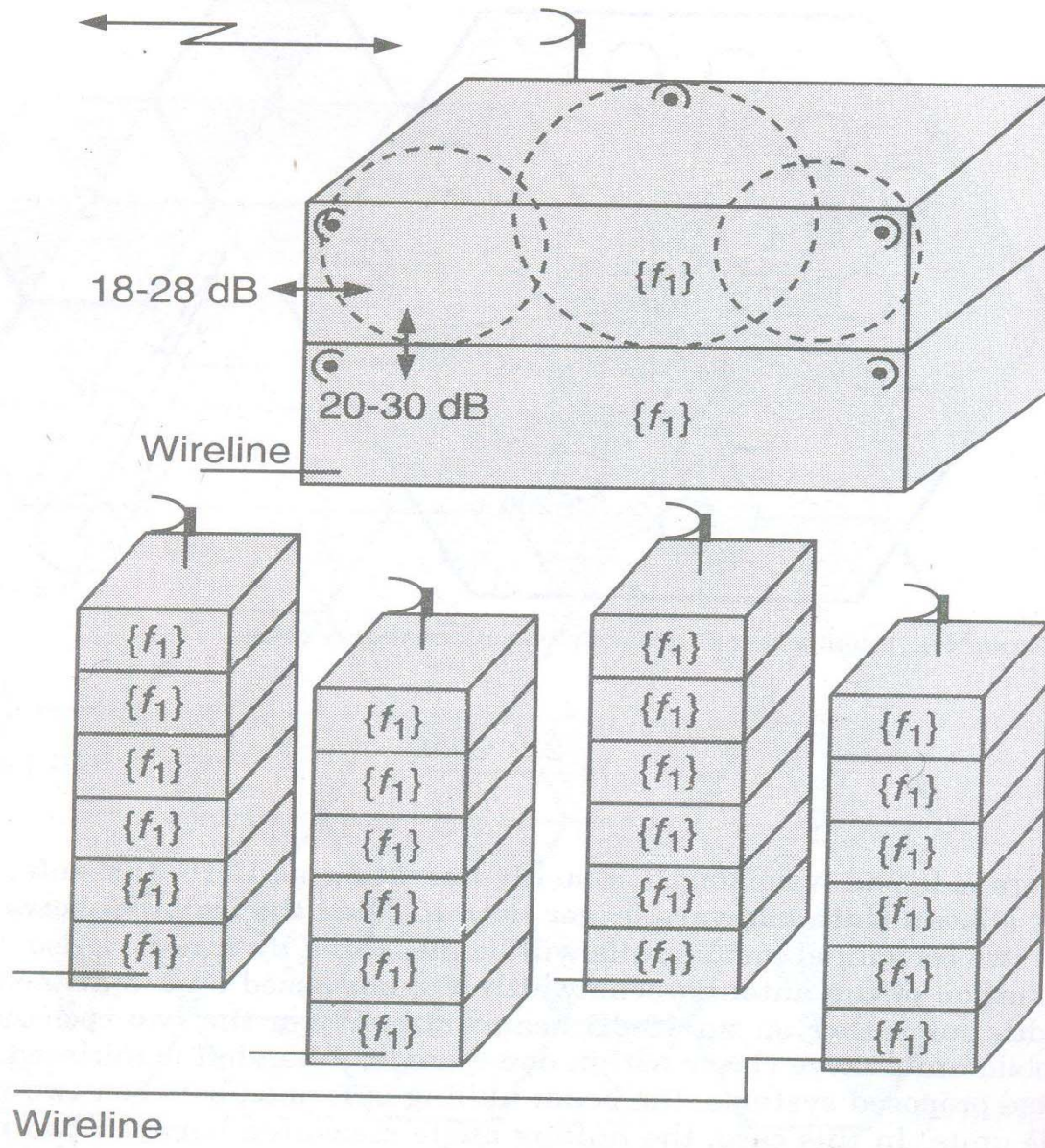


Figure 16.7 Concept of in-building communication.

# Processing gain of intelligent cells

- The big hall like a big radio channel serving all the traffic in an intelligent cell.
- The processing gain like the size of a hall, which limits the no of persons ,no of conversations take place in a hall
- If level of each individual conversation can be controlled intelligently ,we maintain total interference level & add more conversation.
- Implementation of cell concept may be include using multiple zone, multiple antenna beam

# Intelligent Microcell Applications

1. Delivering power to extended cells converters are used to upconvert 800 M Hz signal at BS and Tx to an extended cell thru air. It is then downconverted to 800 M Hz when it reaches the cell where only a converter is installed.
2. Increasing capacity As the power can be delivered and received intelligently at the MU, the capacity increases.
- 3 Coverage At places where regular cell sites can not be installed, there these invisible zone sites can be used to provide coverage especially in urban areas(covering the winding roads and coverage under the greens).
4. Reducing interference An intelligent microcell reduces its unnecessary radiated power and the interference it generates.
5. In- building communication The intelligent cell can increase radio capacity many times.

# Application of Intelligent Microcell in in-Building Communication

- Tx power for in-Building communication should be 20 dB stronger than for outside building communication.
- There is weak reception at lower floor compared to strong reception at higher floor. It poses problem for the running system to serve both ground mobile and in-Building communication simultaneously.
- A ch entering a multifloor building can serve only one user who is located on one floor. So in-Building comm needs enormous channels which are NA
- In-Building Natural Environment.
- (a) Building Penetration Bldg penetration depends on geographical area, 22-28 dB in Tokyo (more earth quake prone area), 13-17 dB in Chicago. Bldg construction (RCC) matters a lot. Steel mesh frame offers more loss.
- (b) Building Height Effect Signal strength is always higher at top floor. Floor gain height is about 2.7 dB/floor (independent of building construction )
- (c) Building Floor Isolation The signal isolation between floors in a multi-floor building is about 20 dB. Within a floor of 50m by 50m the Propagation loss due to interior walls depending on wall materials is about 20 dB between the strong and weak areas.



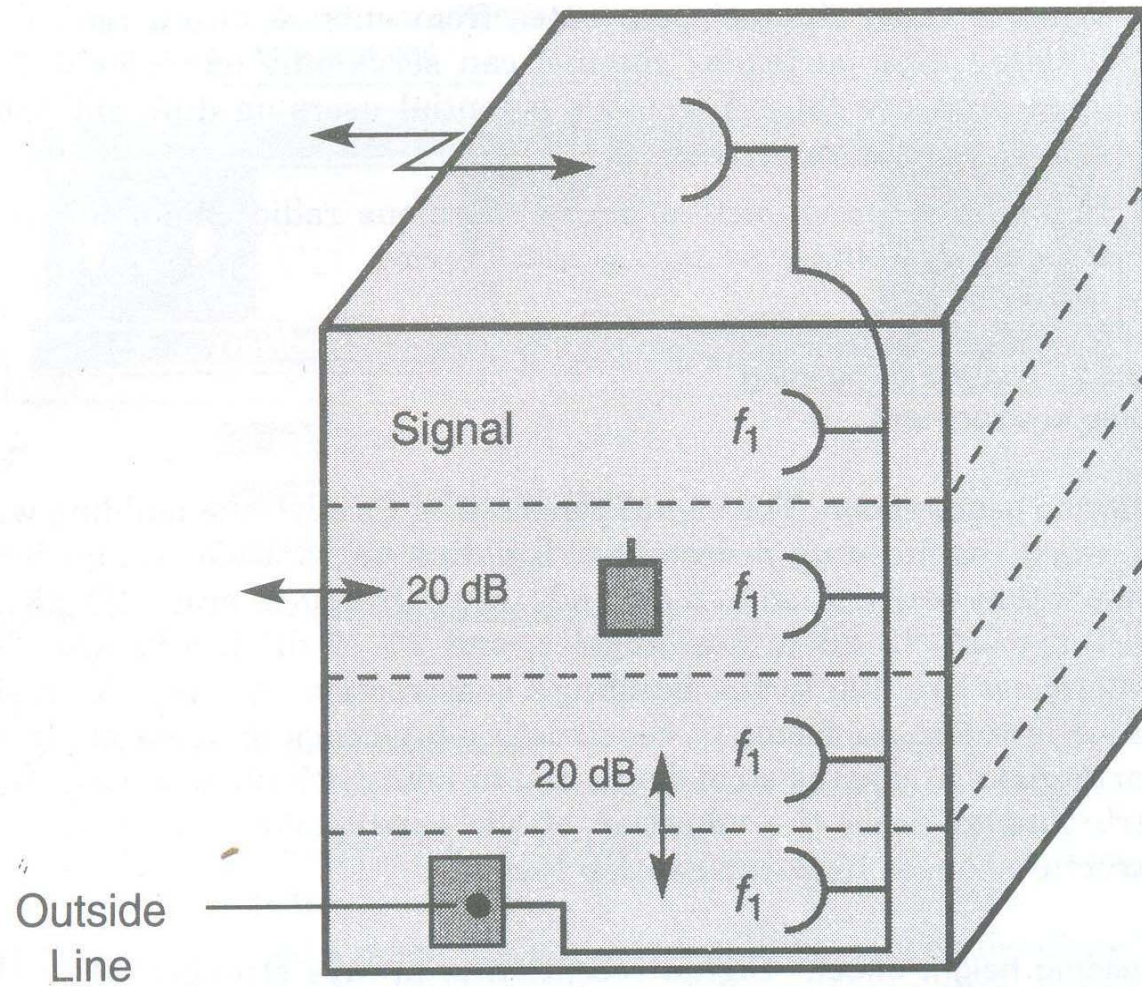


Figure 16.20 Signal within a building.

## ADVANTAGES OF IMPLEMENTING INTELLIGENT CELL

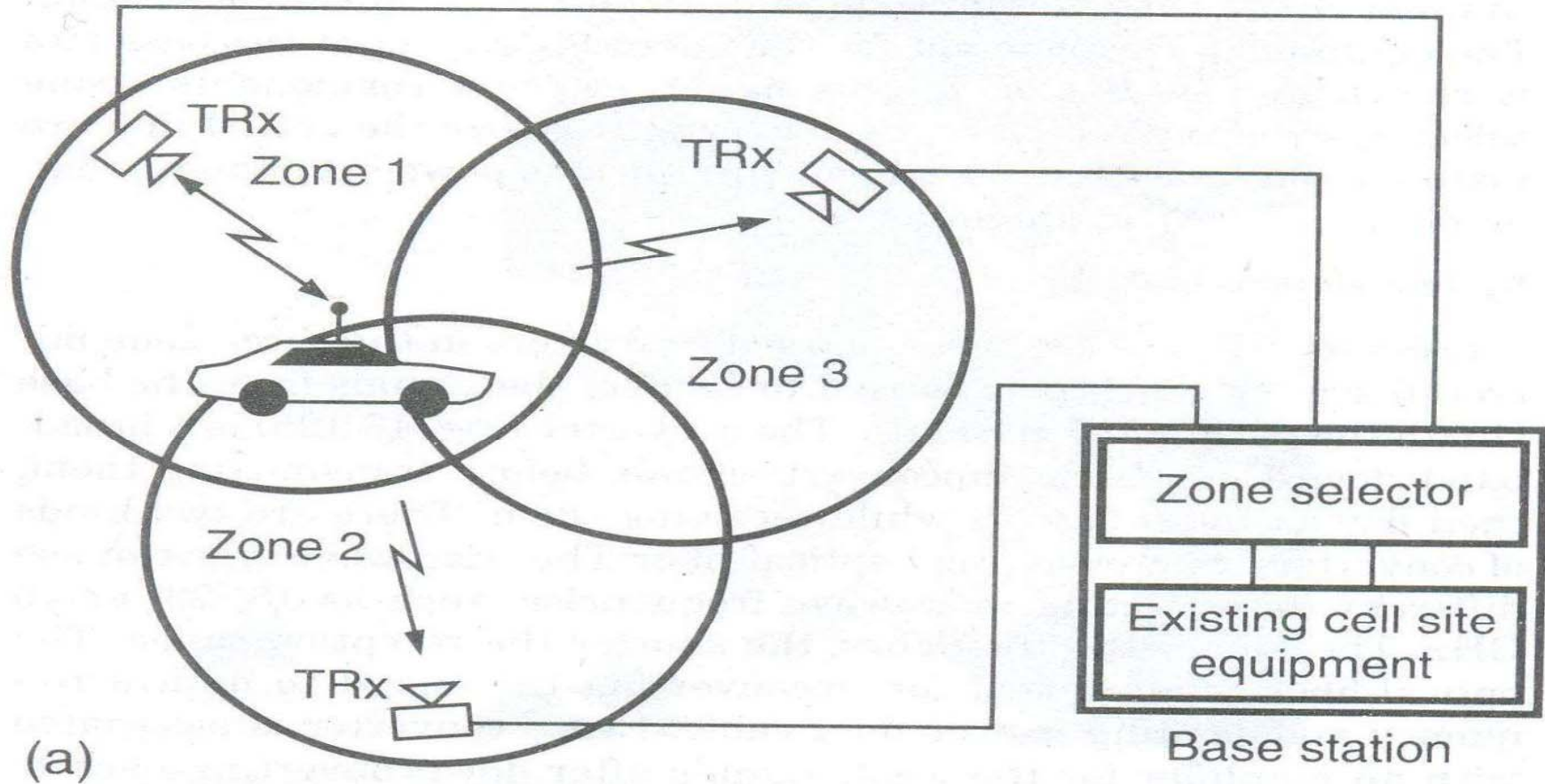
1. More Zones Possible Any no of zones can be included in microcell. More zones in a microcell can further reduce power and lower the interference.
2. Location of Antennas The antennas face inwards from the edges of the cell rather than outward further reducing interference.
3. Suitable for PCS Intelligent microcell is well suited for PCS terminals.
4. Hand-offs With a 3 –zone microcell, no hand off is needed. By reducing hand-offs no of calls dropped reduces.
5. Implementable on any system Intelligent cell approach can be implemented on any existing cellular system.
6. Mobilbility of Zone Site Zone site can be moved from one location to another in almost no time. (to take an antenna and converter down the utility pole and put them up on another utility pole is easy).
7. Redundancy of Connections A fiber cable network can provide redundancy of connections. If fiber cable is broken at one end, the signal can still be delivered via the network thru the other end to the MU.



## ADVANTAGES OF IMPLEMENTING INTELLIGENT CELL(CONTD)

8. No Modifications Required : No need to modify the existing cellular subscriber units for the intelligent microcell system.
9. Better Reception : Better voice quality than an analog cellular system.
10. Higher Capacity: It can enhance capacity by as much as 2.33 times the capacity of the analog system.

# Structure of Microcell



**Figure 16.12** The structure of the microcell system. (a) The basic microcell concept; (b) modifying the equipment arrangement for the microcell system.

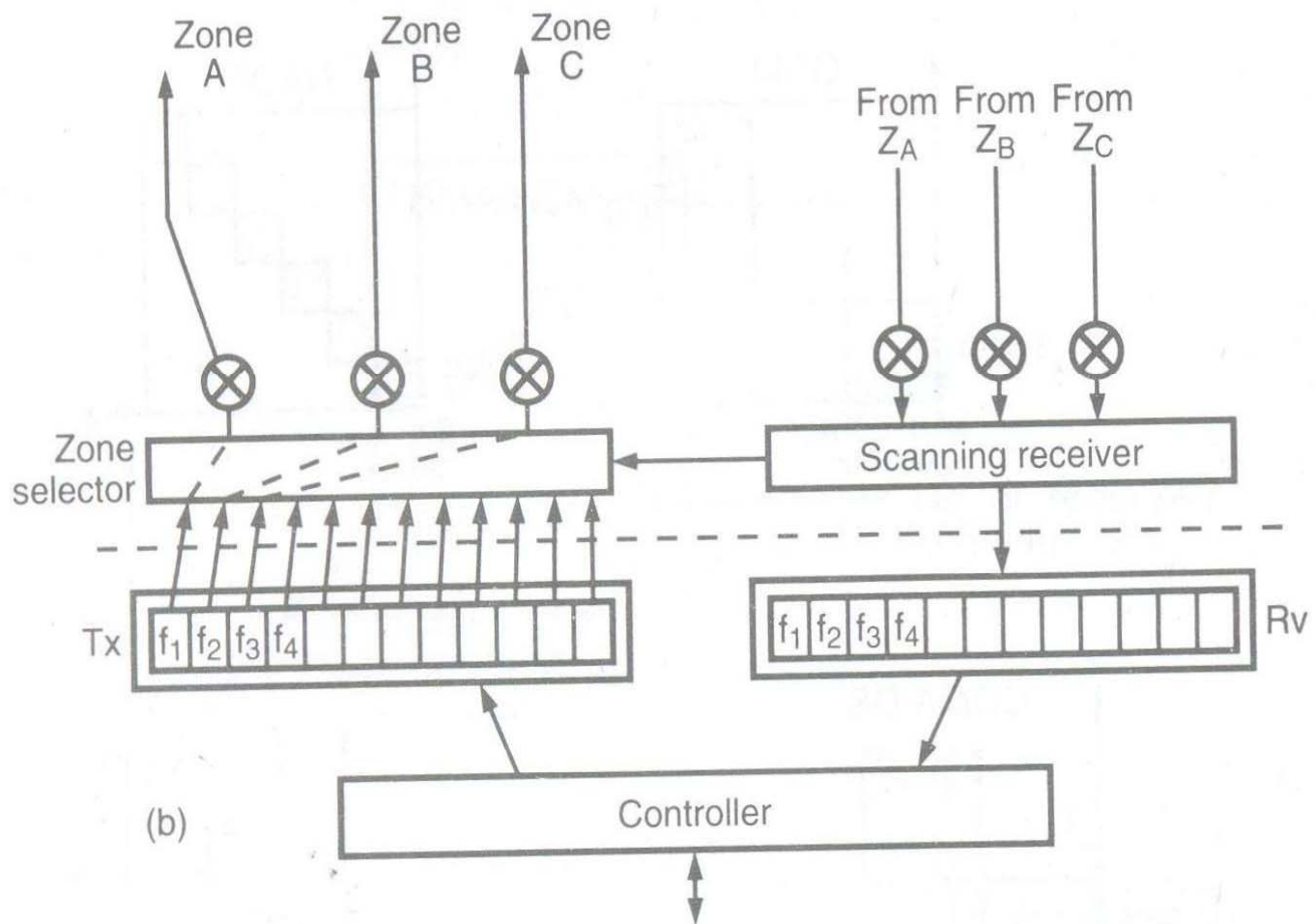


Figure 16.12 (Continued)

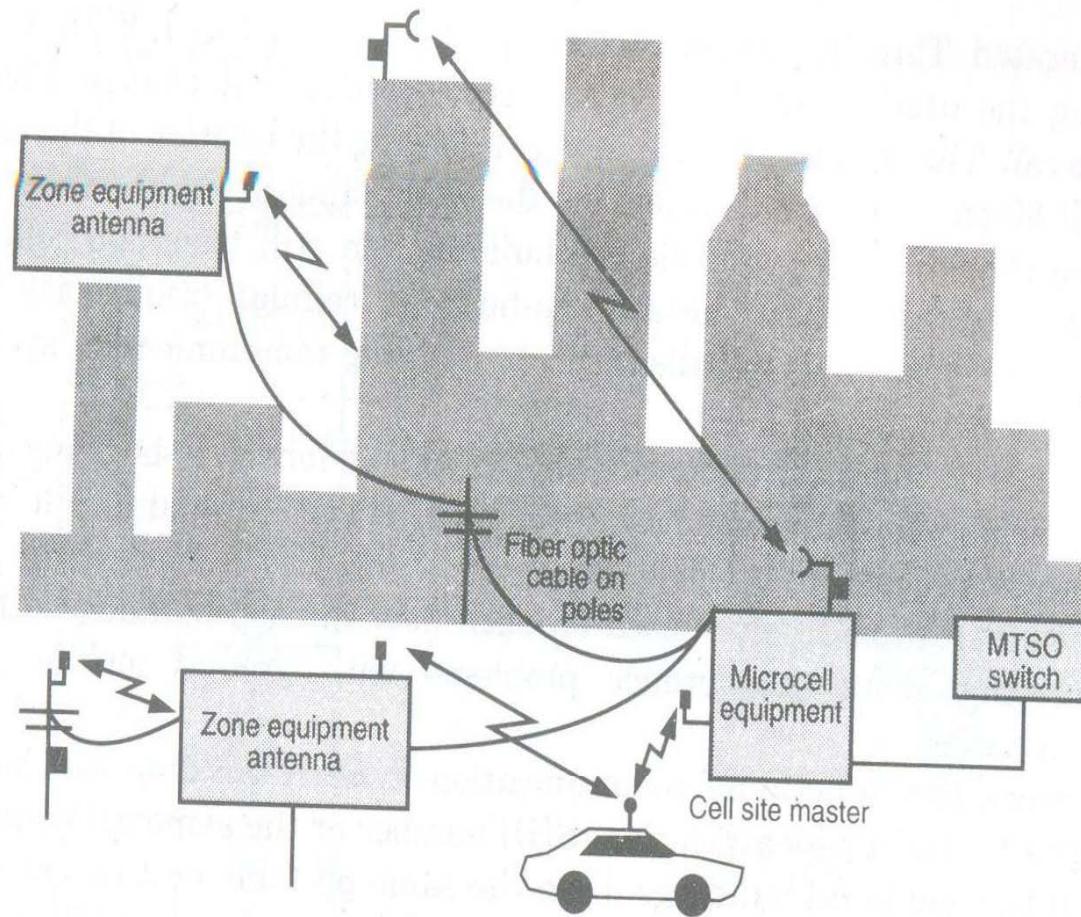


Figure 16.21 Microcell installation concept.