

# **Dynamic Channel Assignment Techniques**

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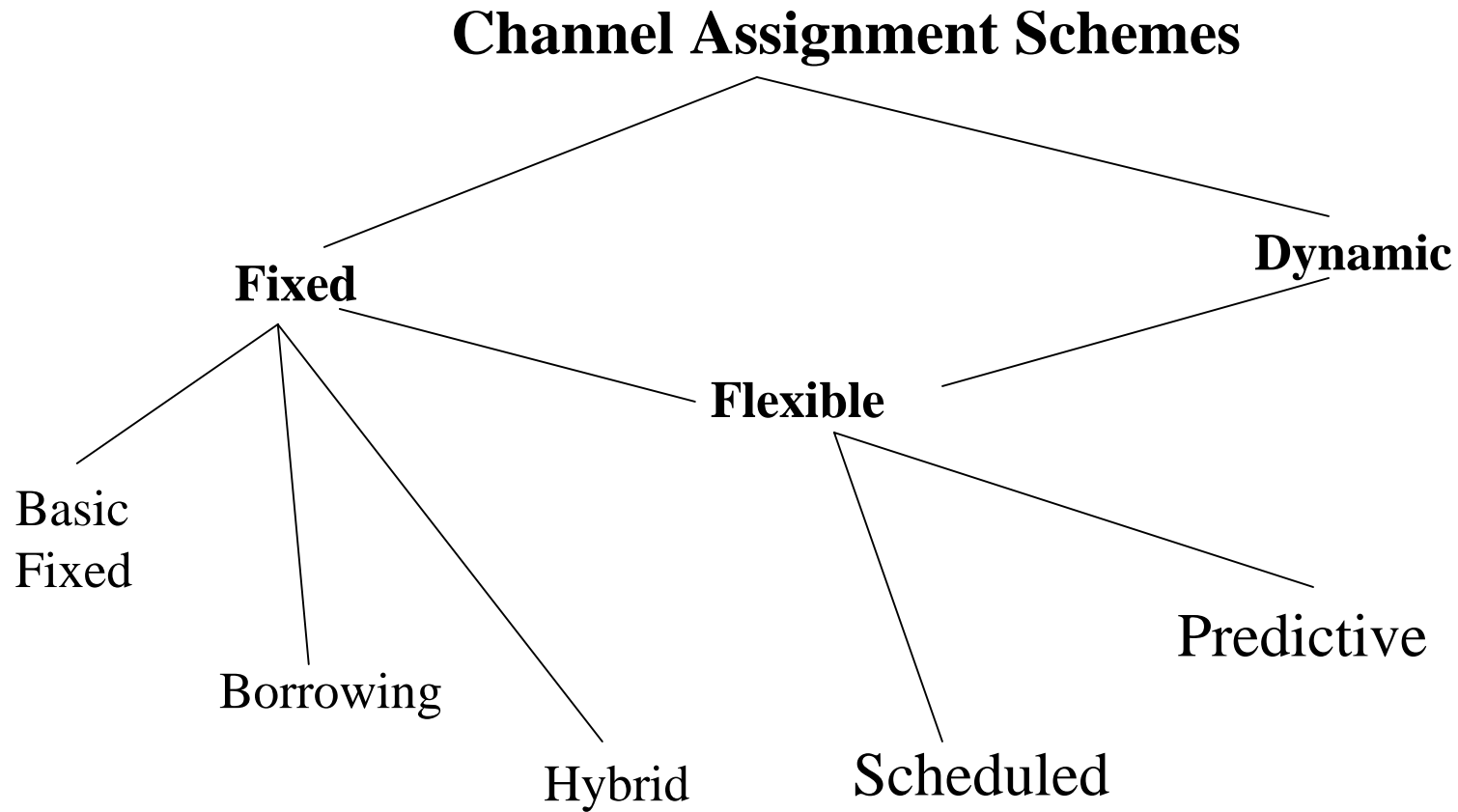
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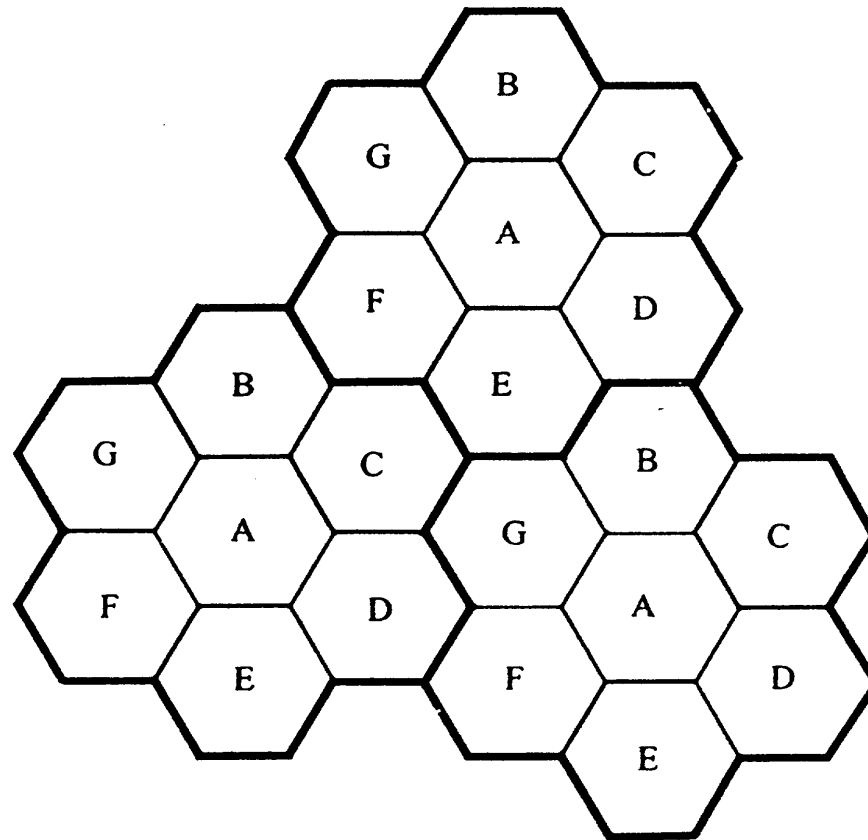
# Channel Allocation Algorithm

- A method for allocating channels to users while maintaining an acceptable quality of service (QoS).
- Three basic types of CAA:
  - (1) Fixed (FCA)
  - (2) Dynamic (DCA)
  - (3) Flexible

# Channel Assignment Schemes



# Fixed Channel Assignment (FCA) (1)



7-cell reuse clusters  
395 traffic channels

With FCA  
56 channels/cell

Figure 1.1 A Example

# Fixed Channel Assignment (FCA) (2)

- Three FCA schemes:

## (1) Basic Fixed

A new call or handoff arrival that finds all channels busy in a cell will be blocked even though there may be some idle channels in the adjacent cells that could service the call.

## (2) Borrowing

a MS can be allocated a channel from a neighboring cell. It should not degrade the link quality of other calls, but introduces excessive cochannel interference.

# Fixed Channel Assignment (FCA) (3)

## (3) Hybrid

Channels assigned to a cell are divided into two groups: the channels in one group are owned by the cell, while the channels in the other group may be borrowed. The ratio of the number of owned-to-borrowable channels can be dynamically varied to compensate for traffic changes.

## Fixed Channel Assignment (FCA) (2)

FCA is suitable for:

- Macrocellular systems with stationary and homogeneous traffic
- A predictable propagation environment

Doesn't suit for

- Conditions of nonstationary and nonhomogeneous traffic

# Dynamic Channel Assignment (DCA) (1)

## **What is DCA scheme?**

- Overcomes the main drawback of FCA strategies — no or little adaptability to temporal and spatial variations of traffic—by assigning channels in a dynamic way
- Has no exclusive relationship between cells and channels.
- Every channel can be used in any cell as long as the cochannel reuse distance and the interference constraints are fulfilled (i.e. not violate the cochannel reuse constraint).
- The channels are used in the cells only for the duration of the call.

## **DCA is partially suitable for:**

- Microcellular systems (highly erratic)
- Conditions of light nonstationary traffic.

## Dynamic Channel Assignment (DCA) (2)

- Three types of DCA schemes:
  - (1) Centralized DCA schemes
    - require centralized control with system-wide channel information
  - (2) Fully decentralized DCA schemes
    - require no network planning or communication among BSs
  - (3) Decentralized DCA schemes
    - require limited communication among local clusters of BSs

# Centralized DCA (1)

- Require system-wide information and control for making channel assignments.
- Provide the best performance.

However

- require anormous amount of computation
- communication among BSs
- impractical

# Centralized DCA (1)

Two types of schemes:

- **Maximum Packing (MP)**

A call is blocked only if there is no global rearrangement of calls to channels that will accommodate the call.

- **MAXMIN**

A MS is assigned a channel that maximizes the minimum C/I that any MS will experience in the system at the time of assignment.

# Decentralized DCA (1)

- **First Available (FA)**
  - acquires the first available channel found in the search
- **Nearest Neighbour (NN)— the best**
  - acquires the channel that is being used by the nearest BS at distance  $D_N$  or greater
- **Nearest Neighbour+1 (NN+1)**
  - acquires the channel that is in use at the nearest BS at distance  $D_{N+1}$  or greater
- **Mean Square (MSQ)**
  - assigns the available channel that minimizes the mean square of the distances among all BSs using the same channel

# Decentralized DCA (2)

- **Dynamic Resource Acquisition (DRA)**

A channel is selected based on a reward/cost function calculated by DRA.

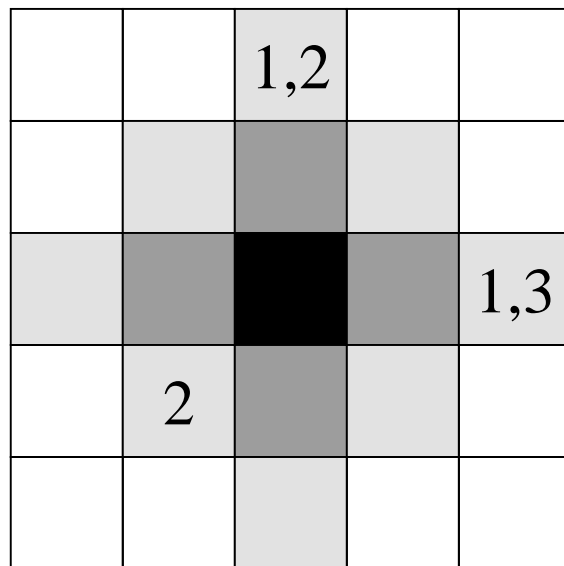
**Reward function:**

The reward associated with a channel release is the number of cells in the interference neighborhood of the BS that could acquire the channel after it is released. When a channel is released, the busy channel giving the largest reward is selected.

**Cost function:**

The cost associated with a channel acquisition is the number of cells in the interference neighborhood of the BS that would be deprived from using the acquired channel. When a channel is acquired, the available channel having the smallest cost is selected.

# Dynamic Resource Acquisition



Reward/Cost Function

Channel 1: 2

Channel 2: 1

Channel 3: Absolute

- Given Cell
- Interference Neighborhood
- DRA Neighborhood

Figure: Illustrates the reward/cost functions associated with three carriers.  
The numbers within each cell indicate active channels.

# Fully Decentralized DCA

- **Channel Segregation (CS)**

— develop favourite channels through a process that is based on the criteria of eliminating unnecessary interference.

- **Channel Segregation with Variable Threshold**

— uses prioritized orderings with a variable interference threshold.

If interference level > threshold    threshold ↓

if interference level < threshold    threshold ↑

- **Minimum Interference (MI) Schemes**

- **Aggressive and Timid DCA Strategies**

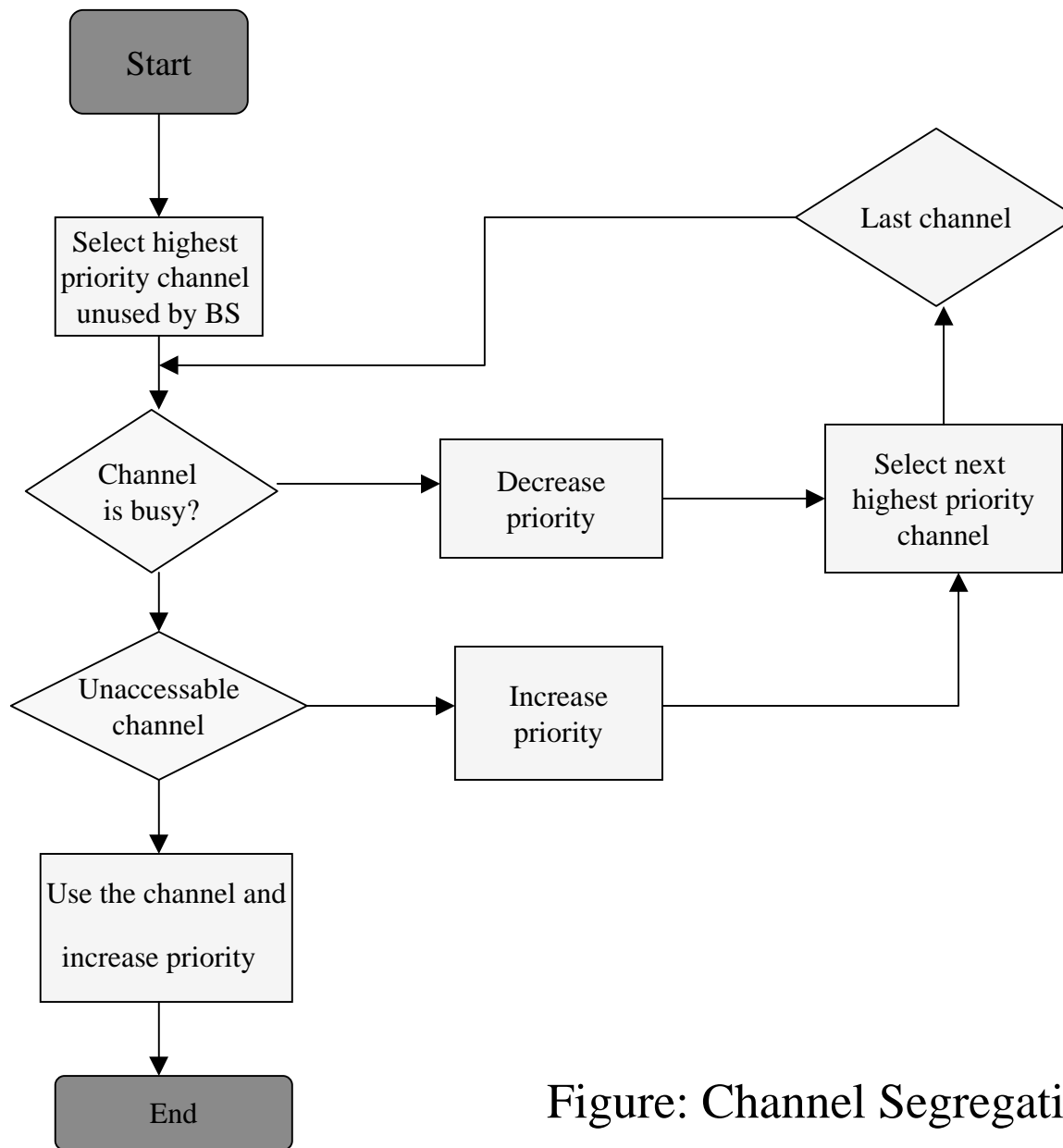


Figure: Channel Segregation (CS) algorithm

# Channel Segregation with variable threshold

- Hannbe et al. Propose a particular threshold:

$$T(k) = \begin{cases} T_0 + 15 + S, K = 1, 2, \dots, N_1 \\ T_0 + 10 + S, K = 9, 10, \dots, N_2 \\ T_0 + 5 + S, K = 17, 18, \dots, N_3 \end{cases}$$

Where  $N_3 = 72$ , is the total number of channels in the system,  $T(k)$  is the threshold,  $\tau_0$  is the minimum required C/I, and  $S$  is a constant margin.

# Minimum Interference (MI) Schemes

- The BS measures the interference level on all channels that is not using. The MS is then assigned the channel with the minimum interference.
- **Several types of MI schemes:**
  - Random Minimum Interference (RMI)
  - RMI with Reassignment (RMIR)
  - Sequential Minimum Interference (SMI)
- \* They differ in the order in which MSs are assigned channels

# Aggressive and Timid DCA Strategies (1)

- **Timid**

A MS acquires a channel only if the channel is free of interference.

- **Aggressive**

A MS can acquire a channel even if it is not free of interference

\*A linear array of cells could selforganize its placement of a single channel to saturate the array from random starting arrangements.

An array is saturated when no additional cells can use a channel without violating the cochannel reuse constraint.

# Aggressive and Timid DCA Strategies (2)

## Saturation density

- uses to measure of the performance of the algorithm
- definition: the ratio of the number of cells using a particular channel to the number of cells in the array.

The maximum and minimum saturation densities are:

- For linear cells  $\begin{cases} C_{\max} = 1/(R+1) \\ C_{\min} = 1/(2R+1) \end{cases}$
- For hexagonal planar cells

$$C_{\max} = \begin{cases} \frac{4}{3(R+1)^2}, & R \text{ even} \\ \frac{4}{1+3(R+1)^2}, & R \text{ odd} \end{cases}$$

$$C_{\min} = \frac{1}{1+3R(R+1)}$$

# Hybrid FCA/DCA Schemes

- DCA

light non-stationary, non-homogeneous traffic

- FCA

conditions of uniformly heavy traffic

- hybrid FCA/DCA

to provide a compromise between FCA/DCA

# Dynamic Channel Reassignment (DCR)

## What is DCR?

- Each cell is assigned number of fixed channels, while the remaining channels are available for DCA.
- Fixed channels are used first to accommodate call requests, calls that can't be serviced by the fixed channel are offered to the dynamiced assigned channels.
- The dynamic channel is selected based on using of the schemes such as FA, NN, NN+1 etc.

# Reference

- Gordon L.Stuber, “Principles of Mobile Communication (Second Edition)”, Kluwer Academic Publishers, 2001.
- Lauro Ortigoza-Guerrero, A.Hamid Aghvami, “Resource Allocation in Hierarchical Cellular Systems”, Artech House publishers, 1999