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4.

(a) A newly built city near a reclamation land requires a new wireless telecommunication service to be provided for the next 5 years. The mobile operator starts by designing a hexagonal cellular mobile network to provide these telecommunication services.

The distance between the centers of two adjacent hexagonal cells is 1.3 km. Determine the cell radius R, the number of cells N_c in a cluster, and the distance D between the centers of the reference cell and its first-tier co-channel cell. You many assume from any particular reference cell, the first-tier co-channel cell is at coordinates (0, 2) using the hexagonal lattice coordinate system.

Answer 4 (a) $\sqrt{3}R = 1.3$ km $\therefore R \approx 0.75$ km

The cell Radius is approximately 0.75 km

$D = 2 \times 1.3 = 2.6$ km

The re-use distance D is 2.6 km

$N_c = i^2 + j^2 + ij = 4$

The number of cells in a cluster is 4

(b) Suppose 3-sectored antennas are used at each base station. The total number of channels $C_v = 540$. The parameters used for this design are:

Coverage area 400 km^2;
Projected population of 5 million.
Market penetration rate = 20%
Holding time of a call H = 65 seconds
Busy hour call arrival rate per user λ=1.5 calls/hour

State and justify any necessary assumptions. Find the blocking probability P_B and the trunking gain T_g.

Answer: 1b) The number of channels for each cell: $\frac{540}{4} = 135$

The numbers of channels for each sector: $\frac{135}{3} = 45$

The traffic for each user: $A_u = \lambda \cdot h = 1.5 \times 65/3600 \approx 0.027$ Erlang

The Size of a cell $S = \frac{3\sqrt{3}}{2}R^2 \approx 1.46\ km^2$

The number of users for a cell is $\frac{1.46}{400} \times 5 \times 10^6 = 18250$

The number of users for a sector is $\frac{18250}{3} \approx 6083$

The traffic in a sector is around: $A_s = n \cdot A_u \cdot R_p \approx 32.85$ Erlang

Assume the queuing model is 'blocked call clear'

Looking up the Erlang B Table, $P_B = 1\%$

$T_g = \frac{6083 \times 20\%}{45} \approx 27.04$

The trunking gain of the system is $T_g = 27.04$

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4 (c) All routing protocols in Ad Hoc Networks need to perform two basic functions. List and explain these two basic functions. In addition, describe how these routing protocols uses the knowledge of the instantaneous connectivity of the network. List two types of topology-based protocols approaches for the Ad Hoc Network and explain on their functionality.

Answer: (c) The function of routing protocols are routing and forwarding.
Routing is find an optimum route from source to destination.
Forwarding is to let the nodes know which ports should they forward the packet to.

The two basic functions of routing protocols in Ad Hoc Networks are:
1. Route Discovery: Finding an available path between source and destination.
2. Route Maintenance: Keeping the path active and recovering from failure.

These protocols are knowledge of instantaneous connectivity to dynamically adapt to changes in network topology. They rely on neighbor discovery, link status monitoring, and timely updates to ensure routes remain valid.

Two types of topology-based protocols:
Proactive protocols (DSDV): Maintain routes to all nodes at all times; low delay but high overhead.
Reactive protocols (AODV, DSR): Create routes only when needed; lower overhead but higher initial latency