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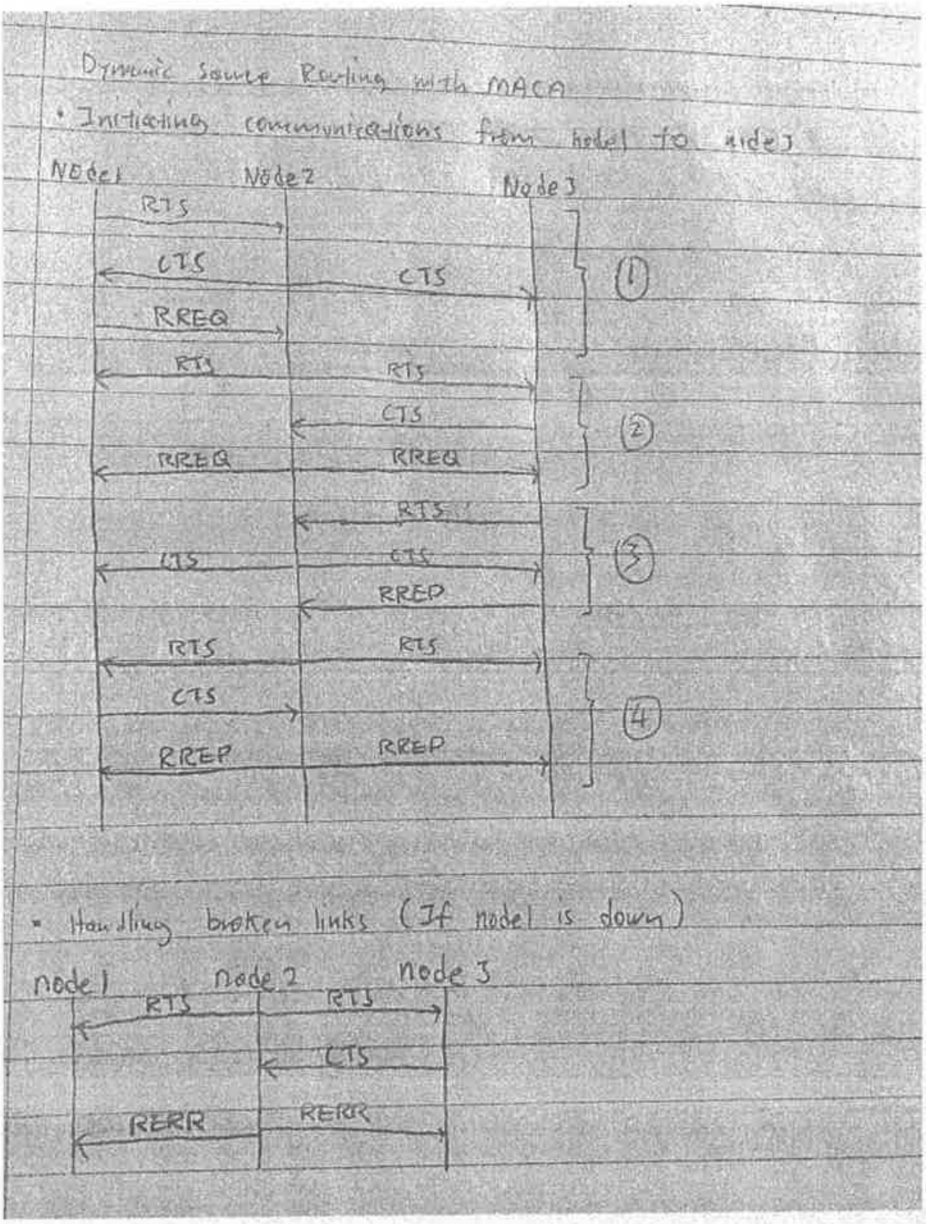
1. (a)



1) Node 1 send RREQ to node 2
2) Node 2 pass RREQ to node 3
3) Node 3 send RREP to node 2
4) Node 2 send RREP to node 1

Note: Packet data also passed in the same manner between node 1 and node 3

4

(b)

$Let\ m_1 = 1, m_2 = 3, T = \ time\ period$

$Pr(0\ channel\ occupied) = \ e^{-T} + e^{-3T}$
$Pr(1\ channel\ occupied) = \ Te^{-T} + 3Te^{-3T}$
$Pr(2\ channel\ occupied) = \frac{T^2}{2}e^{-T} + \frac{9T^2}{2}e^{-3T}$
$Pr(3\ channel\ occupied) = \frac{T^3}{6}e^{-T} + \frac{9T^3}{2}e^{-3T}$
$Pr(4\ channel\ occupied) = \frac{T^4}{24}e^{-T} + \frac{27T^4}{8}e^{-3T}$
$Pr(5\ channel\ occupied) = \frac{T^5}{120}e^{-T} + \frac{81T^5}{40}e^{-3T}$

Average number of occupied channels:

$$C_{avg} = \frac{1}{6}\sum_{i=0}^{5} \Pr(i\ channel\ \ occupied)$$

2. (a)(i)

$Let\ P_T = Transmit\ Power, P_R = Received\ \ Power$
$P_{TA} = 10dB = 10W, P_{TB} = 15dB = 31.62W$
$Capture\ Ratio = 2$

$$P_{RA} = \frac{P_{TA}}{(1+D)^2} = \frac{10W}{(1+3)^2} = 0.625W$$

$For\ A\ \ to\ capture, ratio\ of\ P_{RA}\ :\ P_{RB} \geq 2$

$$\therefore P_{RB} = 0.3125 = \frac{P_{TB}}{(1+D)^2}$$

$$0.3125 = \frac{31.62}{(1+D)^2}$$

$D = 9km$

$$\therefore \Pr(A\ \ captures\ base\ station) = \frac{\pi(10^2 - 9^2)}{\pi(10^2)} = 0.19$$

(a)(ii)

$For\ B\ \ to\ capture, ratio\ of\ P_{RB}\ :\ P_{RA} \geq 2$

$$\therefore P_{RB} = 1.25 = \frac{31.62}{(1+D)^2}$$

$D = 4km$

$$\therefore \Pr(B\ \ captures\ base\ station) = \frac{\pi(4^2)}{\pi(10^2)} = 0.16$$

(a)(iii)

$\Pr(No\ users\ \ capture\ base\ station) = 1 - 0.16 - 0.19\ = 0.65$

(b)(i)

$$\Pr(successful\ in\ 6\ tries)$$
$$= 0.3 + (0.7 \cdot 0.3) + (0.7^2 \cdot 0.3) + (0.7^3 \cdot 0.3) + (0.7^4 \cdot 0.3) + (0.7^5 \cdot 0.3)$$
$$= 0.882351$$

(b)(ii)

$$Average\ Delay$$
$$= \frac{1}{6}[0 + (10 \cdot 0.7 \cdot 0.3) + (20 \cdot 0.7^2 \cdot 0.3) + (40 \cdot 0.7^3 \cdot 0.3) + (80 \cdot 0.7^4 \cdot 0.3) + (160 \cdot 0.7^5 \cdot 0.3)]$$
$$= 3.83096\ delays\ in\ timeslots$$

(c)

- Mobility
  - Wired networks do not have mobile hosts
- No centralized administration
  - Wired networks can easily view state of network
- Bandwidth constraints
  - Costly to maintain topology information in wireless routing
- Time varying link capacity and error rate
  - Wired networks have constant link capacity and error rate because there are no mobile nodes in the network
- Resource constraints
  - Mobile nodes have limited battery and processing power

3. (a)(i)

$$SIR = 10\log\left(\frac{(\sqrt{3(7)})^2}{6}\right) = 5.44dB$$

(a)(ii)

$$SIR = 10\log\left(\frac{(\sqrt{3(7)})^2}{2}\right) = 10.21dB$$

(a)(iii)

$N_1 = 7, N_2 = 3, n = 2$

Derive R_2:

$SIR_1 = SIR_2$

$$\left(\frac{D_1}{R_1}\right)^2 = \left(\frac{D_2}{R_2}\right)^2$$

$D_1 = \sqrt{3N_1}R_1, D_2 = \sqrt{3N_2}R_1$

$$\therefore \frac{\sqrt{3N_1}R_1}{R_1} = \frac{\sqrt{3N_2}R_1}{R_2}$$

$$\sqrt{3N_1} = \sqrt{3N_2}\frac{R_1}{R_2}$$

$$R_2 = \sqrt{\frac{N_2}{N_1}}R_1$$

Derive total area A_{Total}:

$$A_2 = \frac{3}{2}\sqrt{3}(R_2)^2$$

$$A_2 = \frac{3}{2}\sqrt{3}\left(\frac{N_2}{N_1}(R_1)^2\right)$$

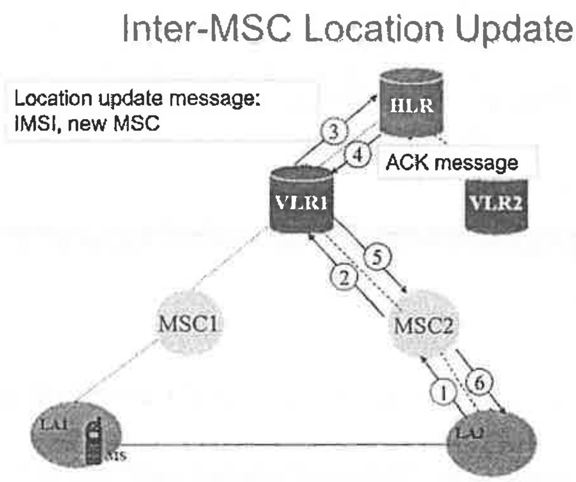
$$A_2 = \frac{N_2}{N_1}A_1 = \frac{3}{7}A_1$$

$$A_{Total} = \frac{4N_1}{7}A_1 + \frac{3N_2}{7}A_2 = \frac{37}{7}A_1$$

$Original\ system = 7 \cdot 37 = 259\ users\ (259\ users\ spread\ across\ 7A_1)$

$$Expanded\ system = \frac{259}{A_{Total}} = 49\ users/cell$$

(b)



1. Location update(TMSI, old LAI)
2. Location update(MSC, TMSI, old LAI, new LAI)
3. Location update(IMSI, new MSC)

4 to 6. ACK

4. (a)

$RSS = 10\log\left(\frac{P_R}{1mW}\right)$

$RSS\ A = -45\ dBm$

$RSS\ B = -49\ dBm$

$n = 2$

$At\ point\ C, solve\ for\ P_{TA}\ and\ P_{TB}:$

$P_{RA} = 10^{-4.5} \cdot 10^{-3}$

$\therefore P_{RA} = 10^{-7.5}$

$P_{RB} = 10^{-4.9} \cdot 10^{-3}$

$\therefore P_{RB} = 10^{-7.9}$

$P_R = \frac{P_T}{D^n}$

$P_{TA} = 100^2 \cdot 10^{-7.5}$

$P_{TB} = 200^2 \cdot 10^{-7.9}$

$At\ point\ D:$

$P_{RA} = \frac{P_{TA}}{150^2} = -48.52\ dBm$

$P_{RB} = \frac{P_{TB}}{150^2} = -46.5\ dBm$

Algorithms	Base Station
RSS	B
RSS + Threshold	A
RSS + Hysteresis	B
RSS + Threshold + Hysteresis	A

(b)

1. IP Multicasting
2. Hierarchical foreign agents

(c)(i)

FA4 to FA5:
Home address IP = 156.12.64.3
Home Agent IP = 179.42.66.1
Care-of-address IP = 180.40.23.1

FA5 to FA6:
Home address IP = 156.12.64.3
Home Agent IP = 178.20.18.1
Care-of-address IP = 179.50.40.1

(c)(ii)

1. CH sends packet to home network
2. HA intercepts packet, forward to FA1 via tunneling
3. FA1 decapsulate packet and re-encapsulate packet before sending it to FA2
4. FA2 decapsulate packet and re-encapsulate packet before sending it to FA4
5. FA4 decapsulate packet and forwards it to MH