Mobile Comms Cheatsheet

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1 Mobile Generations

1G Analogue with FDMA. No encryption.

2G Digital with CDMA or FDMA/TDMA. Encryption with text messaging, roaming and better spectral efficiency.

3G Digital with CDMA, faster data rates to support Internet applications. Better security.

2 Traffic Modelling

Real Traffic Tracing Represents valid sample of traffic for a system. May not be fully representative of all network operating conditions.

Empirical Distribution Derived from real traffic trace. Can be used for long-term simulations without repetition. May not cover all network operating conditions.

Theoretical Distribution Allows simulating extreme network operating conditions. Reduced data storage requirements. May not be possible to find a suitable fit for the given network.

Circuit-switched telephony can be modelled as a continuous, bidirectional and balanced Poisson distribution with negative exponential distribution between calls. Quality of service should accommodate less than 100ms of delay, with BER of 10^{-6} for landline and 10^{-3} for mobile.

Web traffic can be modelled as a non-continuous, bidrectional and unbalanced negative exponential distribution with number of packets dictributed with Pareto or geometric distribution. Quality of service gives no limit on delay with BER of at least 10^{-6}. Packet retransmission will occur if below this BER.

3 Multiple Access Schemes

FDMA Frequency Division Multiple Access, users transmit at different frequencies. Supports continuous transmission, suited for voice telephony. Inflexible capacity and requires nonlinear amplifiers.

TDMA Time Division Multiple Access, users transmit at same frequecny at different time slots. Capacity can be flexibly assigned, suited for burst communication like packet-switched applications. Requires synchronization to prevent overlapping.

CDMA Code Division Multiple Access, users transmit at same frequency with different spreading codes. No limit on capacity and anti-jamming. Requires accurate code synchronization.

4 Free Space Path Loss

$$P_r = \frac{P_t G_t G_r}{((4\pi d)/\lambda)^2}$$

5 Lee's Formula

$$\text{CIR} = \frac{1}{6/\text{sectors}(\sqrt{3K})^{-\gamma}}$$

Pseudo-worst case where all cells are active but co-channel users are at the centre of the cell.

6 Cellular Planning

$$K = m^2 + n^2 + mn$$

Cells are never hexagonal in practise as the availability of certain locations differs, shadowing of obstacles in high-density environments, and variable density of users of the system.

6.1 Large Scale Channel Loss

$$\text{Loss} = K + 10\gamma \log_{10} d + \eta$$

Steps:

1. Calculate γ from loss equation as gradient / 10
2. Determine standard deviation for shadowing loss
3. Calculate $\frac{\sigma}{\gamma}$
4. Use graph given to convert cell area to cell perimeter
5. Specify percentage of perimeter that can have loss greater than maximum tolerable loss
6. Use Q-function to determine tolerable mean loss at perimeter
7. Calculate cell radius based on tolerable mean loss by solving loss equation for d

7 Erlang-B

$$P(\text{blocking}) = \frac{E^K/K!}{\sum_{c=0}^{K} \frac{E^c}{c!}}$$

, where $E = \frac{\text{avg. call time}}{\text{avg. time btwn calls}} \times \text{no. of users}$, $K = \text{no. of channels available}$