TD INF567

Cellular Access

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1 Timing advance

We want to increase the GSM cell size by using 2 slots instead of 1 for a communication. Recall that a GSM time-slot duration is 577 μs. The access burst is sent at a data rate of 270.8 kbps and is 88 bits long. The base station transmits its clock top on a broadcast channel, this signal is receive after some delay at the mobile station. We assume the receive to transmit switch delay is negligible. The mobile station then transmits its access burst to the base station.

Question 1 *Calculate the maximum distance between the base station and the mobile station in order that the access burst does not overlap with the next time-slot. Same question if time-slot duration is doubled.*

2 Call blocking

We want to dimension a GSM base station using Fig. 1. One TRX includes 7 slots for traffic and 1 slot for signaling. Calls lasts in average 4 min and there are 300 calls per hour. We assume that call arrivals are Poisson and service duration follows and exponential law. The operator requires a maximum blocking probability of 5%.

Question 2 *What is the peak traffic on a TRX in Erlangs ?*

Question 3 *What is the traffic generated by the users in Erlangs?*

Question 4 *If we don't care about possible blocking, how many TRX would be required in average for this traffic? How many TRX should be deployed to meet the blocking probability constraint?*

We assume that every call starts with a signalling phase that lasts 3 seconds and follows an exponential law.

Question 5 *How many slots do we need if we want a blocking probability less than 1% on the signalling phase? Is the number of TRX found at the previous question sufficient to ensure the required quality of service?*

Abaque Erlang B

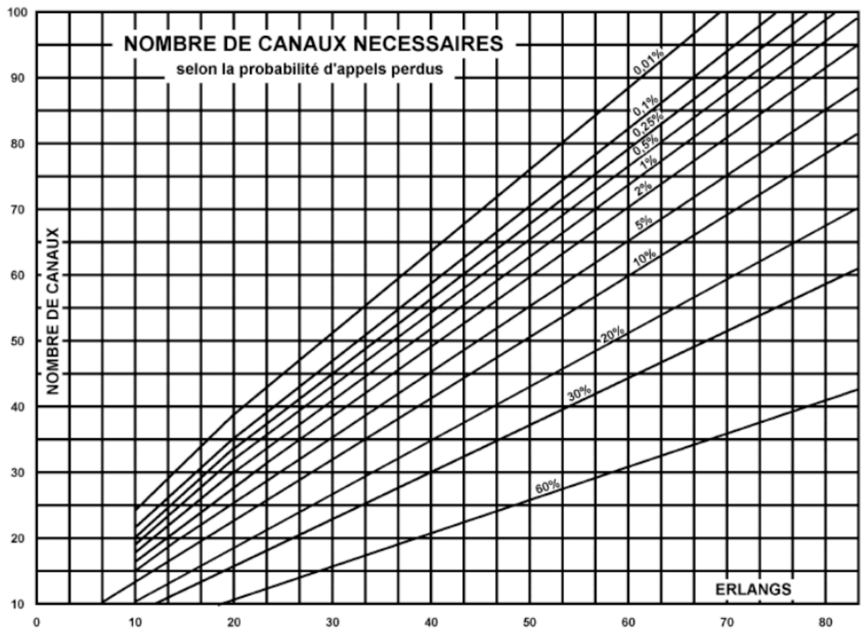

Figure 1: Erlang B.

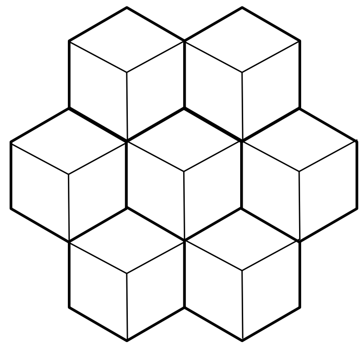

Figure 2: Sectorization (US).

3 Channel reuse

Let us consider a GSM hexagonal cellular network for which we want to ensure a minimum SIR of 9 dB on traffic channels and 13.6 dB on broadcast channels (BCCH). We neglect the effect of shadowing.

Question 6 *Which reuse factor do you propose for traffic channels if the path-loss exponent is* $\alpha = 2$ *? if the path-loss exponent is* $\alpha = 3.5$ *? Same questions for broadcast channels. Give the corresponding* i *and* j *values.*

We now assume $\alpha = 3.5$ (typical for urban areas). Assume now that the operator has acquired a spectrum of 6 MHz. Recall that a GSM duplex channels is 2×200 kHz wide.

Question 7 *How many carrier frequencies should be deployed per cell in this network ?*

Question 8 *Assuming that 2 slots are dedicated to broadcast channels and dedicated signalling channels, deduce the number of voice channels available per cell. How many Erlangs can be supported per MHz per cell if we require a maximum blocking probability of 2 % ?*

We now assume that cell are sectorized, i.e., every hexagon is split into 3 cells served by directional antennas (120°), as shown in Figure 2. We select the smallest reuse factors fulfilling the SIR requirements, which are also multiple of 3.

Question 9 *Is it possible for the operator to adopt sectorization with this strategy?*

Question 10 *We will now show that the reuse factors can be reduced when cells are sectorized. How many cells from the first ring now interfere with the cell of interest (from Figure 2) ? Based on this result, recompute the reuse factors for traffic and broadcast channels and deduce the new Erlang capacity.*

4 GSM Channels

Recall from the lecture that: every slot lasts 577 μs; in every slot, $2 * 57$ bits can be transmitted; TCH and associated SACCH transmissions use the 26-multiframe structure; BCCH, SDCCH and associated SACCH transmissions use the 51-multiframe structure. See the lecture for the number of slots used by every channel in its multiframe.

Question 11 *Compute the data rate at physical layer of TCH, SDCCH, SACCH associated to TCH, SACCH associated to SDCCH, and BCCH channels in GSM (without taking into account channel coding).*

Question 12 *Voice codec GSM Full Rate produces frame at a data rate of 13 kbps. Deduce from the previous question the channel coding rate.*