Technische Universität Braunschweig

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Fundamentals of Mobile Radio Communications

Exercise 3: Teletraffic Engineering

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May 19, 2025

1 Basic Terms

1.1 How is the offered traffic A defined?

The offered traffic is the traffic carried when no call attempts are rejected due to lack of capacity, i.e. when the number of servers is unlimited. It is the average number of call attempts per mean holding time, but can also be defined as the traffic volume Y per time unit t:

$$A = \frac{Y}{t}$$

The unit of A is the pseudo-unit Erlang (Erl).

1.2 How is the "busy hour" defined?

The busy hour (BH) are those continuous 60 minutes (usually at an resolution of 15 minutes) in which the highest traffic in the network occurs. In that hour, one observes the number of busy hour call attempts λ_{BHCA} and their respective average hold time T_m. With these values, the offered traffic during the BH (A_{BH}) can be calculated as:

$$A_{\mathrm{BH}} = \lambda_{\mathrm{BHCA}} \cdot T_m$$

2 Traffic Analysis and Calculations

Figure 1 shows the calls conducted by 10 subscribers over the timespan from 6:00 AM to 6:00 PM. One orange box implies a conducted call of 15 min, subsequent boxes mean a longer call of multiples of 15 min.

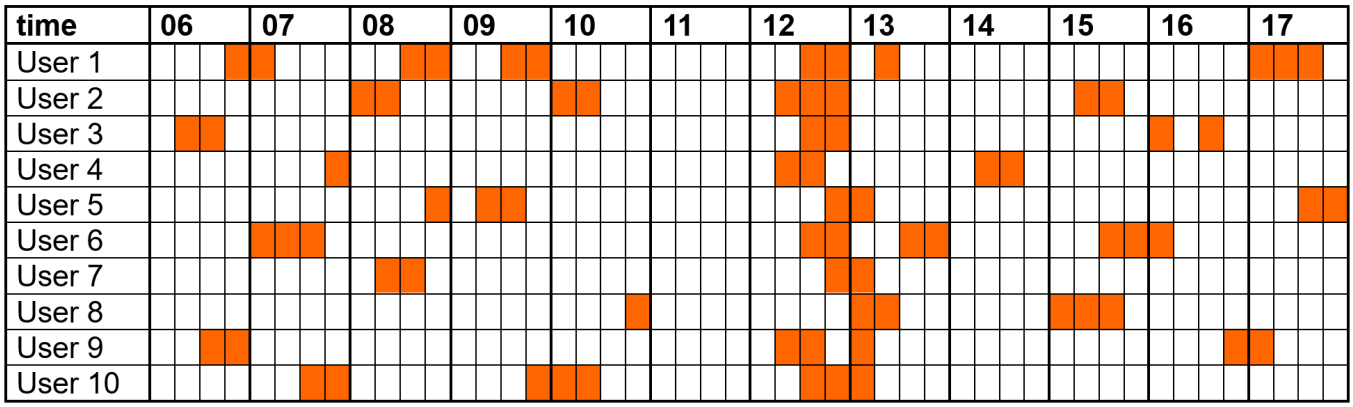

Figure 1: Connection times of 10 users

2.1 Calculate the average holding time T_m (which can be assumed to be constant throughout the day) and the busy hour call attempts λ_{BHCA}.

2.2 What is the maximum offered traffic by user 9 during the busy hour and the total offered traffic during the busy hour?

2.3 How many lines would be needed to fully serve all subscribers if calls always would happen exactly according to the schedule shown (fig. 1)?

2.4 However, since call arrival times are statistically distributed and do not always follow the schedule given in the table, blockages may occur despite the number of lines selected in task 2.3. What is the blocking probability for a very large number of subscribers with a constant offered traffic from 2.2?

2.5 How many lines are needed if a blocking probability of only 10% or 1% is allowed? Use Table 1 for your approximation.

n	$A_{\max}$/Erl for $B = 1\%$	$A_{\max}$/Erl for $B = 2\%$	$A_{\max}$/Erl for $B = 5\%$	$A_{\max}$/Erl for $B = 10\%$
2	0.15	0.22	0.38	0.6
4	0.87	1.09	1.52	2.05
6	1.91	2.28	2.96	3.76
8	3.13	3.63	4.54	5.60
10	4.46	5.08	6.22	7.51
14	7.35	8.20	9.73	11.5
22	13.7	14.9	17.1	19.7
30	20.3	21.9	24.8	28.1
36	25.5	27.3	30.7	34.5

Table 1: Maximum allowed offered traffic $A_{\max}$ for fixed number of lines n and blocking probability B

3 Traffic Considerations in GSM

In real mobile radio systems such as GSM, an average offered traffic of 20 mErl and an average hold time of 120 s for voice telephony can be assumed as a rough guide for each user. Considering these values, conduct the following calculations.

3.1 Calculate the number of busy hour call attempts for a single user.

3.2 What is the total offered traffic and the call rate of a district of 4,500 inhabitants for one of the three operators if about 50% of the inhabitants have a mobile phone, assuming a equal spread of subscribers among the operators?

3.3 The mobile subscribers are expected to have a maximum blocking probability of 2 %. How many frequency channels would a GSM omni-cell need to fully cover the area considered in 3.2? What is the situation for a 3-sector cell, assuming an even distribution of the population?

3.4 What is the maximum cluster size that can be selected for the omni-cell if the total bandwidth is $B_t = 22.4$ MHz and the bandwidth of a frequency channel is $B_c = 200$ kHz?