Part 2. Introduction to Operational Regimes

Example from exam (Spring, 2006)

Consider 3 examples of ACD reports from an Israeli Telecom call center:

Report 1

Time	Arrivals	Average Service Time (sec)	Offered Load	Number of Agents	Fraction Abandoning (%)	Average Wait (sec)	Served Immediately (%)
22:00	476	160.1	42.3	34.3	21.8	104.4	0.8
22:30	**416**	**196.5**	**45.4**	**28.9**	**38.7**	**163.2**	**0.4**
23:00	346	194.0	37.3	24.8	41.0	171.1	0.9

Report 2

Time	Arrivals	Average Service Time (sec)	Offered Load	Number of Agents	Fraction Abandoning (%)	Average Wait (sec)	Served Immediately (%)
13:30	859	70.9	33.8	53.6	0.0	0.0	100.0
14:00	**768**	**75.1**	**32.0**	**57.3**	**0.0**	**0.0**	**100.0**
14:30	700	80.2	31.2	52.8	0.0	0.0	100.0
15:00	596	84.5	28.0	39.0	0.0	1.6	88.1

Report 3

Time	Arrivals	Average Service Time (sec)	Offered Load	Number of Agents	Fraction Abandoning (%)	Average Wait (sec)	Served Immediately (%)
13:00	176	202.2	19.8	18.8	5.7	30.6	23.5
13:30	**175**	**207.1**	**20.1**	**20.1**	**3.5**	**17.1**	**54.2**
14:00	169	196.3	18.4	20.9	1.8	5.4	74.7

Question 1. Explain how the Offered Load has been calculated.

Solution: $R = \frac{\lambda \cdot E(S)}{1800}$, where $E(S)$ is the average service times, 1800 – number of seconds in half-hour interval.

Question 2. Explain how non-integer number of agents could arise.

Solution: Number of agents changed during half-hour interval.

Question 3. Write an operational regime that corresponds to each report.

Solution:

Report 1: ED

Report 2: QD

Report 3: QED

Question 4. For each report, write the most relevant staffing rule that establishes the characterizing relation between the offered load R and the number of agents n. Calculate parameter values (QoS grades) for the second line of each report.

Solution:

Report 1: ED. $n = R - \gamma R,\ \gamma > 0$.

For the second line $\gamma = 1 - n/R = 0.363$.

Report 2: QD. $n = R + \delta R,\ \delta > 0$.

For the second line $\delta = n/R - 1 = 0.791$.

Report 3: QED. $n = R + \beta\sqrt{R},\quad -\infty < \beta < \infty$.

For the second line $\beta = (n - R)/\sqrt{R} = 0$.

Question 5. For all intervals, presented in the reports, assume that the nine-fold increase of the arrival rate and the number of agents took place. For the second line of each report, estimate how the average wait will change in this case.

Solution:

Report 1: Average wait will remain 163 seconds.

Report 2: Average wait will remain zero.

Report 3: A three-fold decrease of average wait will take place (to 5.7 seconds).

Question 6. (This question is not related directly to the previous ones.)

Assume that in a telephone call center the arrival rate is 100 calls per minute, the average service time is equal to 1 minute and the average patience is equal to 4 minutes. There are 105 agents answering calls. Using the graph below, estimate the fraction of customers that are served without delay.

Solution: The system is operating in the QED regime. The offered load R=100.

The QoS grade $\beta = \frac{105-100}{\sqrt{100}} = 0.5$.

The ratio $\mu/\theta = 4$. According to the graph, the delay probability is 0.4. Hence, 60% of customers are served without delay.