Cairo University

Faculty of Engineering

Fourth Year Electronics and Communication

Fall Semester 2024

Wireless Communication Systems (ELC-4012)

(Submitted to Dr. Hazim Tawfik)

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	Presentation	Report
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Introduction:

Objective is to verify erlang-B formula, calculate blocking probability, and simulate Damps system that serves both Amps and Damps users with equal probabilities for a certain cell having eight Damps channels. Each of these Damps channels can support analog or digital subscribers with different cases will be discussed. Calls is assumed to follow poisson distribution with mean value of 930 calls per hour with an average hold time of 77 seconds. When both Amps and Damps calls are generated in the system, it's assumed to be equally probable.

1. All calls belong to Amps only or Damps only:

1.1. Amps only:

- $E = \lambda * average\ hold\ time = \frac{930}{3600} * 77 = 19.8916$
- C=Total number of channels=8.
- Blocking probability= $P_b = \frac{\frac{E^C}{C!}}{\sum_{i=0}^{C} \frac{E^i}{i!}} = \frac{\frac{E^8}{8!}}{\sum_{i=0}^{8} \frac{E^i}{i!}} * 100 = 62.513\%$

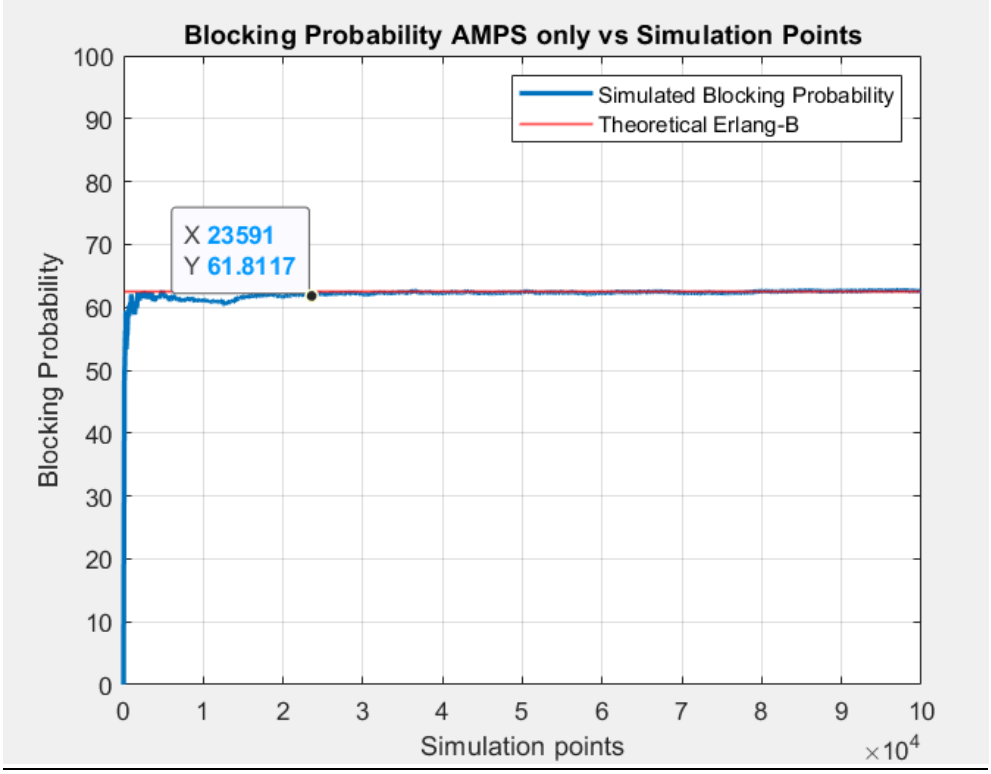

FIGURE 1: APMS ONLY BLOCKING PROBABILITY

- Since the Amps channel can serve only one user, so blocking probability is considered to be high as number of users can be served simultaneously is only 8 users.

1.2. Damps only:

- $E = \lambda * average\ hold\ time = \frac{930}{3600} * 77 = 19.8916$
- C=Total number of channels=8*3.
- Blocking probability= $P_b = \frac{\frac{E^c}{c!}}{\sum_{i=0}^{c} \frac{E^i}{i!}} = \frac{\frac{E^{24}}{24!}}{\sum_{i=0}^{24} \frac{E^i}{i!}} * 100 = 6.417\%$
- For a damps only system of 8 channels each can serve 3 users, the probability of blocking calls is considered to be low due to system large capacity.
- Due to the nonlinear relation between blocking probability, number of total channels and number of erlangs, the decrease in blocking probability isn't linear.

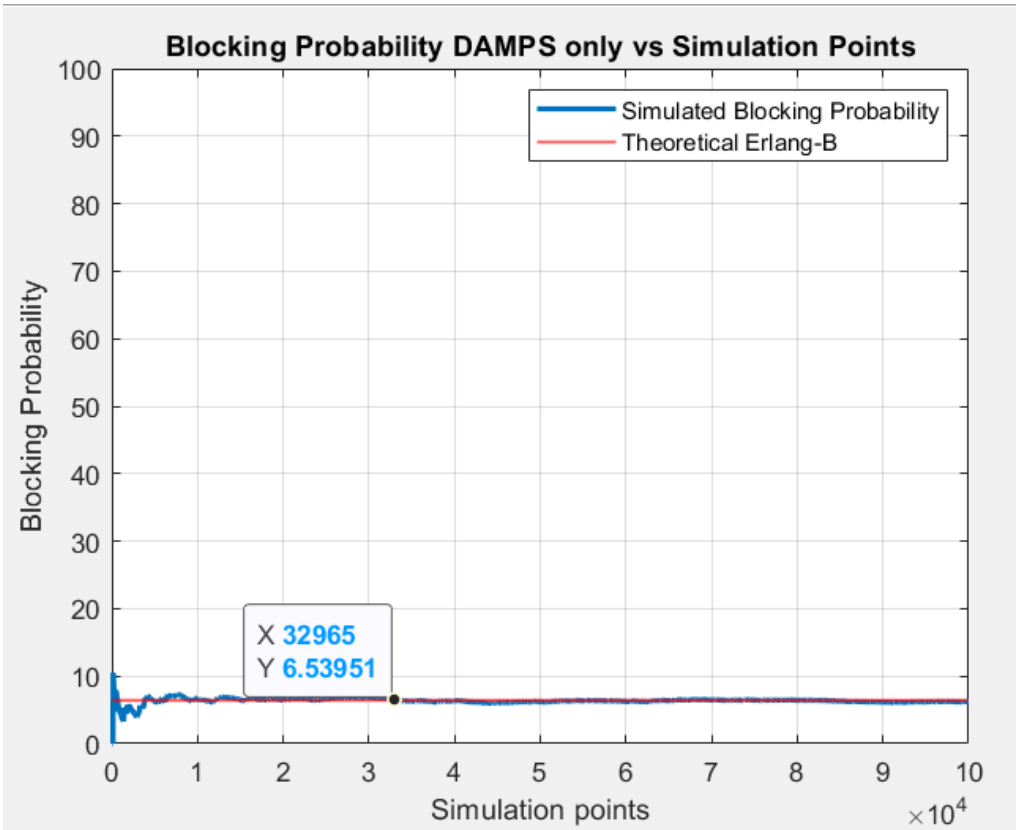

FIGURE 2: DAMPS ONLY BLOCKING PROBABILITY

2. **Calls belong to Amps or Damps with equal probability(3users):**
    - Amps blocking probability $\approx 63.56\%$
    - Damps blocking probability $\approx 8.639\%$
    - Total blocking probability $\approx 36.43\%$
    - We notice that total blocking probability is approximately average between amps and damps.
    - Amps blocking probability is higher than amps only case, also damps blocking probability is higher than damps only case. This is due to sharing channels between both amps and damps subscribers and if an amps call received for example it will occupy 3 times higher than the case of damps only.
    - Total blocking probability is much lower than amps only case, this is due to having equal probability of damps or amps call arrival, if it's damps it will occupy only 1/3 the channel which means overall higher capacity.

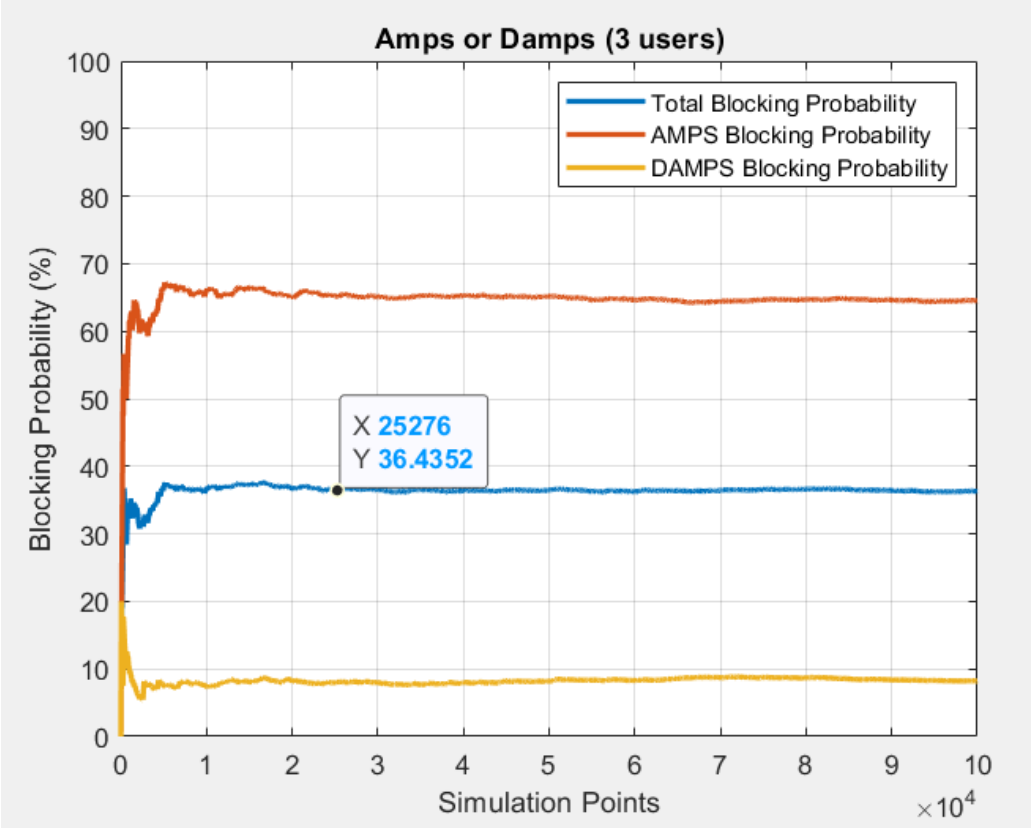

FIGURE 1 AMPS-DAMPS BLOCKING PROBABILITY (3USERS)

3. **Calls belong to Amps or Damps with equal probability(6users):**
    - Amps blocking probability $\approx 51.35\%$
    - Damps blocking probability $\approx 2.64\%$
    - Total blocking probability $\approx 27.8\%$
    - Due to doubling the capacity of a channel that serves Damps call as it can serve 6 users simultaneously instead of 3, the three blocking probabilities is reduced as the channel can serve double number of damps users so probability that Amps call arrive and gets served increases as well.
    - Damps blocking probability decrease significantly and the rationale is having double capacity for channels serving Damps users.

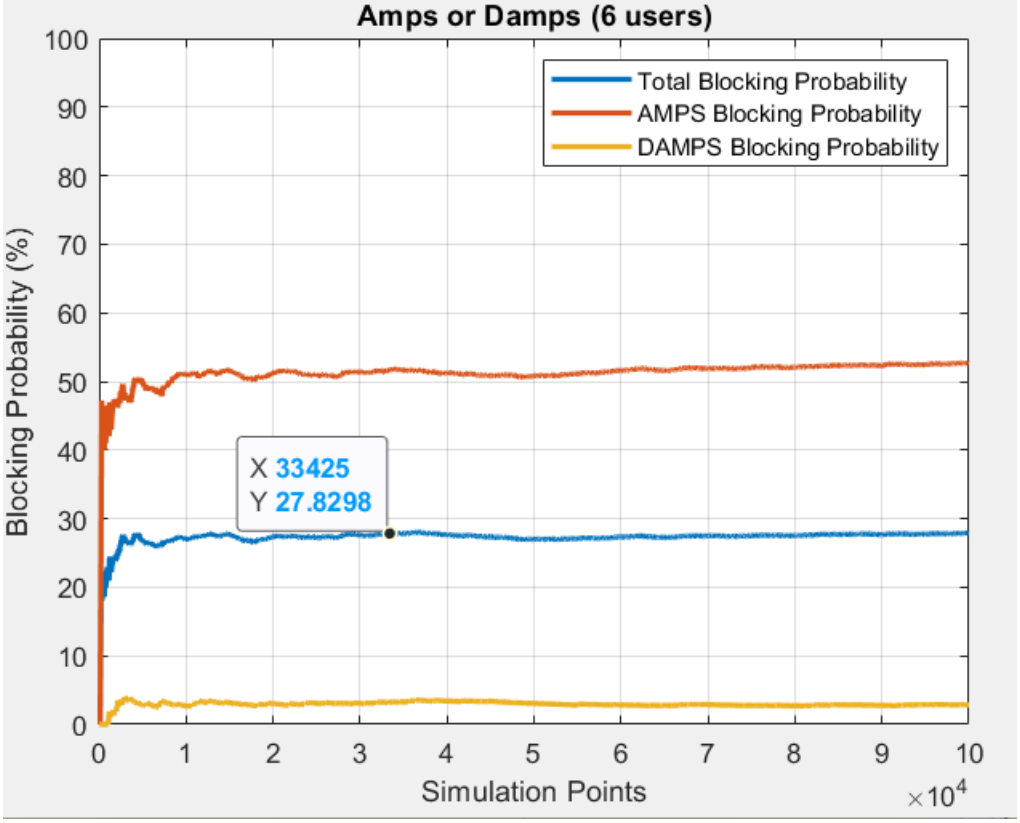

FIGURE 4: AMPS-DAMPS BLOCKING PROBABILITY (6USERS)

4. **Number of simulation points needed:**
    - Amps only≈23591
    - Damps only≈32965
    - Amps and Damps (3 users) ≈25276
    - Amps and Damps (6 users) ≈33425

- Note that number of simulation points represents the number of seconds the system will be monitored, according to system complexity and the number of available channels in the system the number of simulation points will change. We will see the number of simulation points needed to reach as near results to theoretical and expected results.
- When the number of channels increase the number of simulation points needed to get accurate results and as realistic as possible increases too.
- For Amps only the least number of simulation points was required to achieve a good result, that's due low capacity of 8 channels only.
- For damps only higher number of simulation points was required to achieve good settling point due to higher number of available channels.
- Comparing 3 users dynamic with 6 users dynamic we see that 6 users needs more simulation points due to increased capacity of channels serving Damps users.

5. Scenarios of channel assignment:

5.1. Fixed amps only -others shared

Number of fixed Amps only channels	**Number of shared channels**	P_b **amps %**	P_b **damps %**	**Total** P_b **%**
0	8	52.3439	2.979	27.775
1	7	52.0215	11.96	31.99
2	6	50.72	20.669	35.812
3	5	46.199	33.32	39.83
4	4	45.72	42.11	43.9
5	3	42.699	51.89	47.4
6	2	41.46	60.81	51.10
7	1	38.6	72.5	55.7
8	0	34.59	100	67.23

- Probability of blocking increase when number of amps only channels increase, this is due to less capacity of amps only fixed channels.

5.2. Fixed damps only – others shared

Number of fixed Damps only channels	Number of shared channels	P_b amps %	P_b damps %	Total P_b %
0	8	51.83	2.51193	26.91
1	7	52.73	2.8	27.89
2	6	53.881	3.02	28.54
3	5	73.15	0.3646	36.46
4	4	98.77	0	49.46
5	3	100	0	49.7
6	2	100	0	49.6
7	1	100	0	49.94
8	0	100	0	50.4

- For low simulation points, Amps channels didn't have 100 percent blocking probability, but for higher simulation points it reached 100, that's due to sharing channels with damps for channels which isn't assigned as fixed damps.
- Blocking probability of damps is considered really low(reached approximately zero in last 5 entries), and that's due to having number of channels conserved to serve damps only, while others are shared. Also for the shared channels if a channel serves 1 damps user will occupy only 1/6 of it's capacity but this channel will not be able to serve amps until expiry of hold times of all damps users within it.

5.3. Fixed amps only and damps only

Number of fixed Amps only channels	Number of fixed Damps only channels	P_b amps %	P_b damps %	Total P_b %
0	8	100	0	50
1	7	90.35	0	45.16
2	6	81.82	0	41.88
3	5	73.68	0	36.6
4	4	64.5	0	32.15
5	3	57.2	0.845	29.02
6	2	48.52	11.96	30.19

7	1L	41.37	50.29	45.78
8	0	33.01	100	66.47

- Fixed amps and damps solutions offered some fairness between amps and damps users due to having each channel assigned to serve only certain subscribers, yet is limits degrees of freedom.
- High blocking probability for amps users when fixed number of assigned to damps is slightly higher due to the low capacity of the amps channels.
- Lowest scenario regarding blocking probability is for fixed amps =5 channels while fixed damps=3 channels.
- This is considered the lowest scenario due to having totally number of amps subscribers can be served=5 while number of amps subscribers can be served=9.So this is the most case offering good probability of blocking even though amps has high probability of blocking.

5.4. Observation and analysis:

- Dynamic channel assignment without fixing the number of channels that serves only one subscriber type is offering the best probability of blocking, as it offers fairness between amps and damps users.
- Generally, in networks design this approach is called on-demand channel assignment which is usually used and preferred in many real life network applications.

6. Erlang-C results:

- Amps blocking probability $\approx 44.89\%$
- Damps blocking probability $\approx 2.03\%$
- Total blocking probability $\approx 23.45\%$
- Due to using Erlang-C, both amps and total blocking probabilities is reduced.
- The impact isn't really significant due to the small queue capacity as only 3 users can be queued, also low queue length which figures the number of second in our case which the call will be held in queue before it's

expiration equals 9 seconds which is really small with respect to average call hold time (77 seconds).

- The result may not be rewarding if we consider memory and system complexity due to queuing feature.

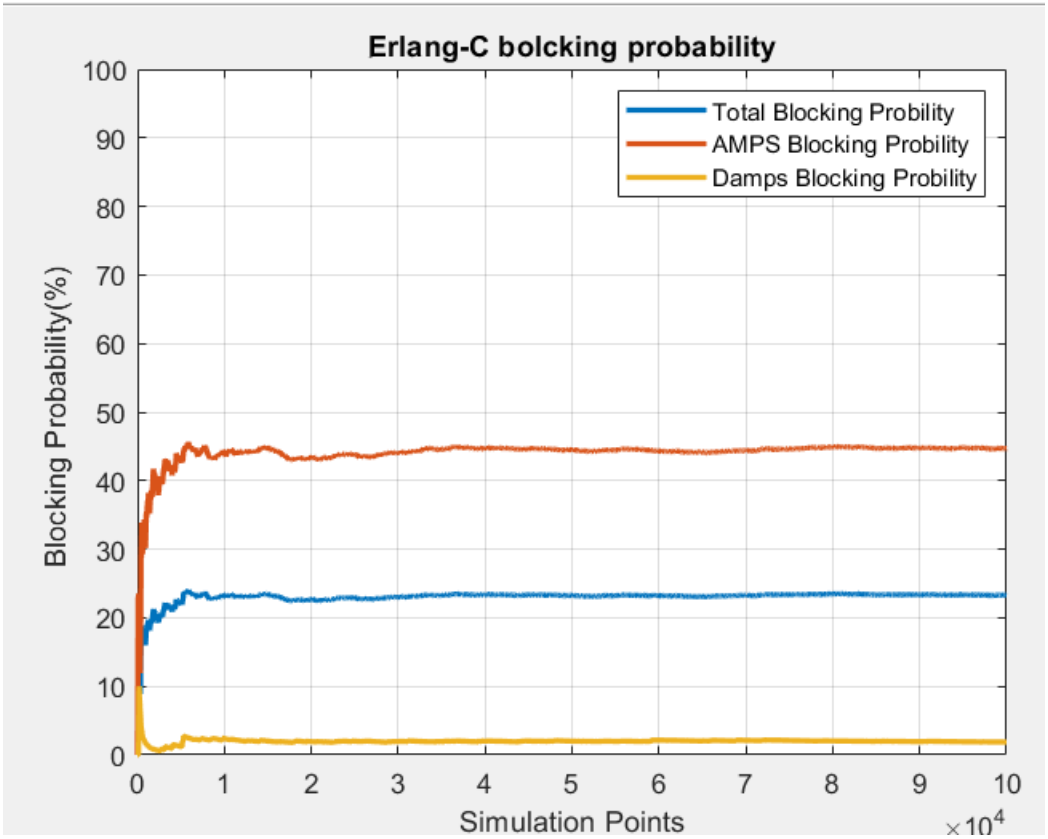

FIGURE 5: ERLANG-C BLOCKING PROBABILITY

7. Conclusion:

To wrap up,this report analyzed the performance of wireless communication systems under various scenarios involving AMPS and DAMPS channel configurations. Through simulations and calculations, we validated the Erlang-B formula and assessed blocking probabilities in different conditions, such as AMPS-only, DAMPS-only, and mixed scenarios with equal probabilities for both systems. The results demonstrated the nonlinear relationship between blocking probability, the number of available channels, and the system's total capacity.