

# **ENTS 656**

# **INTRODUCTION TO CELLULAR COMMUNICATION NETWORKS**

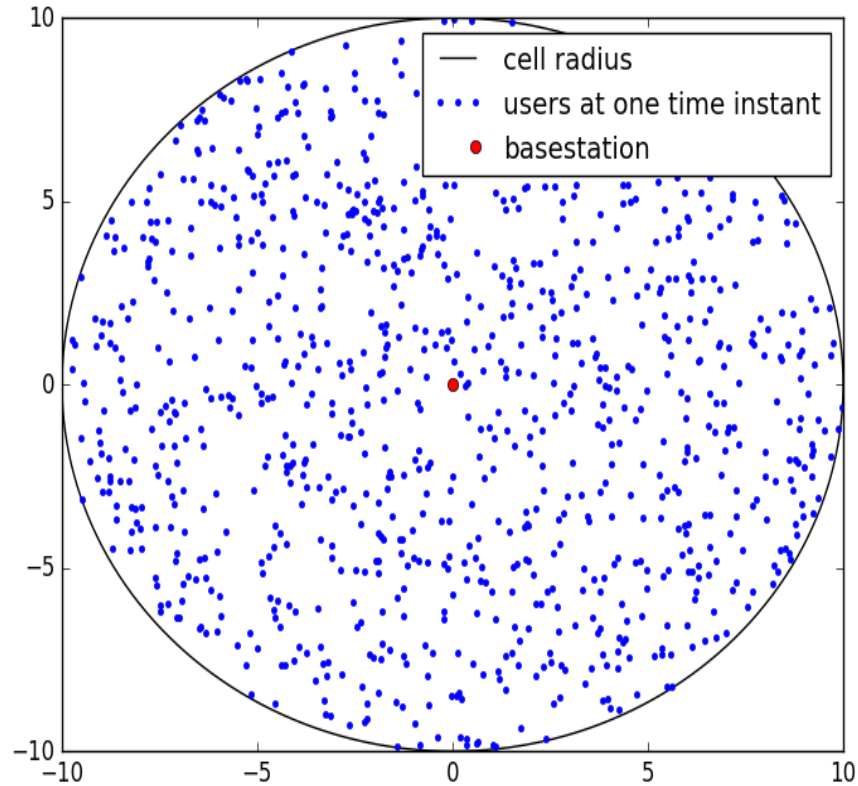
## **PROJECT REPORT**

Admission Control Simulator on a single cell in a CDMA  
mobile network

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## **Project Introduction**

This project is a simulator application in Python that will simulate the effects of admission control on a single cell in a mobile cellular network as described below:



There is a single Base Station at the center which serves a radius of 10 km. The users can appear anywhere within the 10 km radius and will make calls at random during the simulation. Once they are connected to the base station, their call/session will occupy a traffic channel until it ends (either because the call ends properly or because it drops).

The goal of this project is to track different statistics for the system and monitor the effect of changing certain parameters.

Additionally, to improve the service, Admission Control is introduced in the system which make it easier to model the interference effects of additional users.

This report gives the results generated by the simulator program and consists of two main cases:

1. **Case I:** Without using Admission Control
2. **Case II:** Using Admission Control

The following statistics are to be reported every 2 mins and finally at the end of the simulation time of 2 hours:

- Number of call attempts not counting retries
- Number of call attempts including retries
- Number of dropped calls
- Number of blocked calls due to signal strength
- Number of blocked calls due to channel capacity
- Number of successfully completed calls
- Number of calls in progress at any given time
- Number of failed calls (blocks + drops)
- Current cell radius (distance between the basestation and the most distant connected user)

### **Key Results:**

#### **Case I:** Without using Admission Control

1. When Admission control is not used, following is the Final Report for a total of **1000 users** in the system:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :11773
Number of call attempts including retries         :17508
Number of dropped calls                          :7064
Number of blocked calls due to signal strength    :1728
Number of blocked calls due to channel capacity   :0
Number of successfully completed calls           :2953
Number of calls in progress at any given time    :28
Number of failed calls (blocks + drops)          :8792
Current Cell Radius                             :9229.29 meters

>>>
```

---

**[Fig 1.] 1000 Users, without Admission Control**

2. When Admission control is not used, following is the Final Report for a total of **10000 users** in the system:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :118923
Number of call attempts including retries         :176652
Number of dropped calls                          :91219
Number of blocked calls due to signal strength    :17170
Number of blocked calls due to channel capacity   :5825
Number of successfully completed calls            :4660
Number of calls in progress at any given time     :49
Number of failed calls (blocks + drops)          :114214
Current Cell Radius                             :9750.06 meters

>>>
```

---

**[Fig 2.] 10000 Users, without Admission Control**

## **Case II:** Using Admission Control

1. When Admission control is used, following is the Final Report for a total of **1000 users** in the system:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :11747
Number of call attempts including retries         :26586
Number of dropped calls                          :2214
Number of blocked calls due to signal strength    :6680
Number of blocked calls due to channel capacity   :0
Number of successfully completed calls            :2828
Number of calls in progress at any given time     :25
Number of failed calls (blocks + drops)          :8894
Current Cell Radius                             :5322.11 meters

>>>
```

---

**[Fig 3.] 1000 Users, with Admission Control**

2. When Admission control is used, following is the Final Report for a total of **10000 users** in the system:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :119526
Number of call attempts including retries         :269228
Number of dropped calls                          :48857
Number of blocked calls due to signal strength    :67259
Number of blocked calls due to channel capacity   :0
Number of successfully completed calls           :3377
Number of calls in progress at any given time    :33
Number of failed calls (blocks + drops)          :116116
Current Cell Radius                             :7001.06 meters

>>>
```

---

[Fig 4.] 10000 Users, with Admission Control

### Answers to the Questions

**Q1: What is the ratio of the number of dropped calls to the number of completed calls? What is the main reason for call failure? Are blocks for channel capacity?**

**Ans:**

As per Fig 1, The ratio of the number of dropped calls to the number of completed calls is the following:

$$7064/2953 = \underline{2.39}$$

The main reason for call failure in this case was the high number of dropped packets due to insufficient SINR. Due to the high level of interference from many users at or near the edges of the cell, the SINR of user reduces and thus the failed SINR tests result in packets being dropped during active calls.

The blocks are not for channel capacity but are for inadequate RSL of users i.e. due to signal strength. The blocks due to channel capacity will not be present in the system since the number of channels available stay adequate due to high drops in active calls.

**Q2: Change the values of  $C_d$  and  $C_i$  to 20 and 15 respectively. What happens to your statistics? What is the ratio of dropped calls to completed calls now? How has the number of blocked calls changed? What is the effect on the cell radius?**

**Ans:**

After changing the values of  $C_d$  and  $C_i$  to 20 and 15 respectively, i.e. after implementing Admission Control, the statistics are shown in Fig 3.

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :11747
Number of call attempts including retries         :26586
Number of dropped calls                          :2214
Number of blocked calls due to signal strength    :6680
Number of blocked calls due to channel capacity   :0
Number of successfully completed calls           :2828
Number of calls in progress at any given time    :25
Number of failed calls (blocks + drops)          :8894
Current Cell Radius                             :5322.11 meters

>>>
```

---

As we can see, The ratio of the number of dropped calls to the number of completed calls is the following now:

$$\mathbf{2214/2828 = 0.78}$$

Thus, the ratio has improved significantly from the previous case where admission control wasn't used.

The number of blocked calls due to signal strength has increased considerably from **1728 to 6680**. This is because of the reduction in EIRP of pilot when channel usage crosses threshold. When the threshold is crossed, the signal strength reduction causes users at the edges of the cell to be blocked due to low signal strength, and thereby the overall interference level goes down due to this.

The Cell Radius has changed from **9229.29 meters (9.2 km)** to **5322.11 meters (5.32 km)**. This is due to the shrinking of the cell due to admission control. The dropped users will usually come from the edges of the cell so the cell will appear to shrink and thus the distance of the farthest user will be reduced, thus reducing the effective cell radius.

**Q3: Increase the number of users to 10000 and rerun your simulation, first with no admission control (i.e.  $C_a$  and  $C_i$  set to 57 and 0 respectively) and then with the  $C_a$  and  $C_i$  values from Q2. What happens to the blocks due to channel capacity? How do they change when the  $C_a$  and  $C_i$  values change?**

**Ans:**

When the number of users is increased to 10000 users, these are the statistics

Without Admission control:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :118923
Number of call attempts including retries         :176652
Number of dropped calls                          :91219
Number of blocked calls due to signal strength   :17170
Number of blocked calls due to channel capacity  :5825
Number of successfully completed calls           :4660
Number of calls in progress at any given time    :49
Number of failed calls (blocks + drops)          :114214
Current Cell Radius                             :9750.06 meters
```

>>>

---

With Admission control:

```
*****
-----FINAL REPORT-----
*****
Number of call attempts not counting retries      :119526
Number of call attempts including retries         :269228
Number of dropped calls                          :48857
Number of blocked calls due to signal strength   :67259
Number of blocked calls due to channel capacity  :0
Number of successfully completed calls           :3377
Number of calls in progress at any given time    :33
Number of failed calls (blocks + drops)          :116116
Current Cell Radius                             :7001.06 meters
```

>>>

---

Firstly, when Admission control was not used, the blocks due to channel capacity were increased to **significantly high value of 5825**. This is because of such a high user count since 10000 users will be far more than what the maximum number of channels could provide for a reasonable GOS.

When Admission control was implemented, the blocks due to channel capacity were **reduced to zero**. This happened because, the channel capacity was managed efficiently by admission control by dropping off users from the edges and thus the number of channels were made sufficient by limiting the number of users demanding those channels.