

Homework 3 submission

ECET 512 — Wireless Systems



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1 Submitted files

For this assignment, besides this report, the following archives were created:

1.1 SRC Folder

- + "*main.py*": This **script** extends the simulation done in homework 2 to demonstrate inter-cellular handoff between two basestations, and random path movement of 20 users withing a single cell cluster. To calculate our basestation power, new functions are introduces in the form of *bspower* and *bspowershadow*.

1.2 DOC Folder

- + "*BSPower.gif*" An illustration showing a mobile station move between two base stations in a cellular handoff.
- + "*RecievedPowervsTime.png*" A graph of the mobile stations received power from both base stations at each second of travel. Also indicated the handoff power and interval.
- + "*RandomUserCellMvmt.gif*" Animation of 20 mobile users with random starting and ending locations moving through single cellular cluster.
- + "*UsersPerCell.png*" A graph which shows the number of users in each cell at each time step. Cells which do not have users are omitted.

2 Inter-Cell Handoff Simulation

Below is the simulation and analysis of intercellular hand off as a mobile station move diagonally between two stations. You can see from the graph, that the shadowing effects on the propagation model could cause signal to be dropped early, so that is something to be accounted for as the user approaches minimum usable signal power.

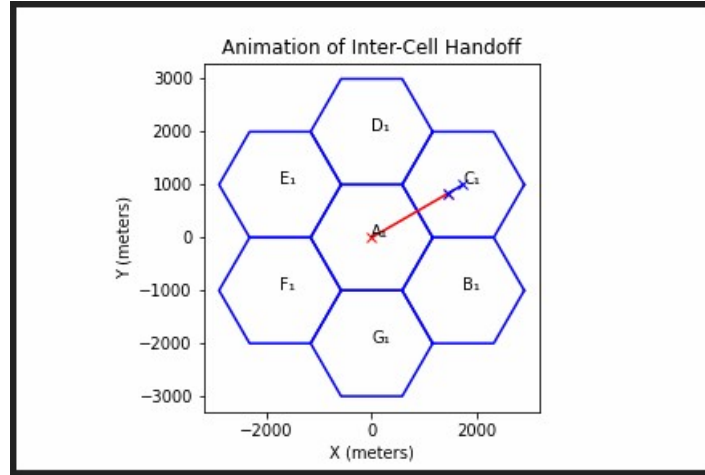


Figure 1: Screenshot of the Inter-Cellular movement animation

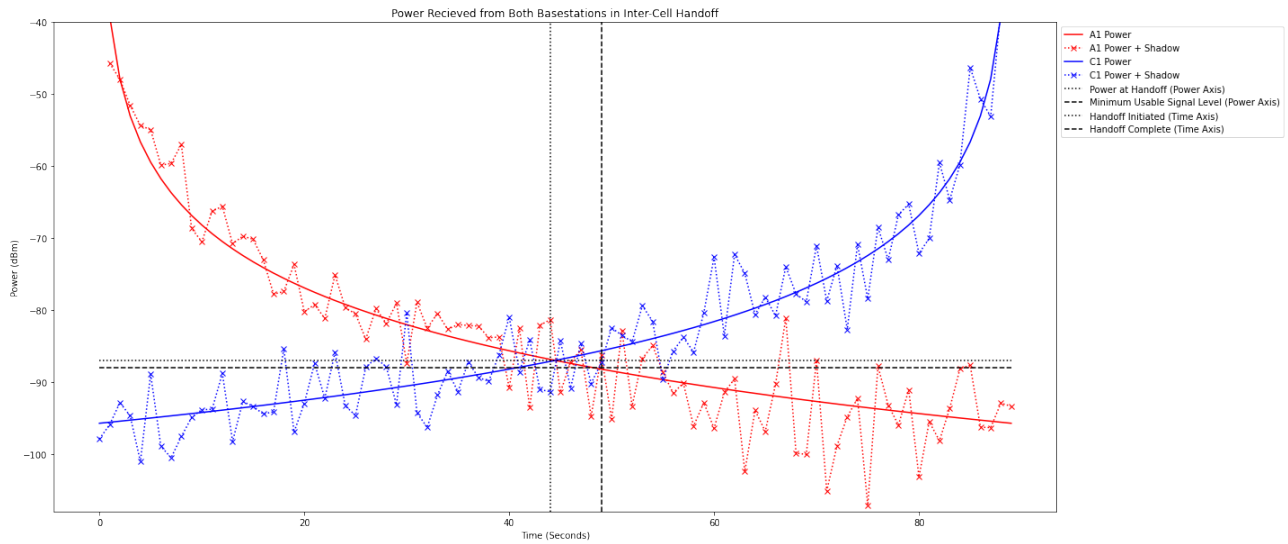


Figure 2: Recieved Power vs. Time for Power emitted from Basestations.

3 Multi User Pathway Propagation

Demonstration of the multi user pathway propagation. We can see from the graph, that there exists points in the movement where certain cells are free for use, and trunking would allow the users to be handed off to different resources. This is where call blocking comes in, because as users are handed off to different cells, when resources are not available, the call may be dropped.

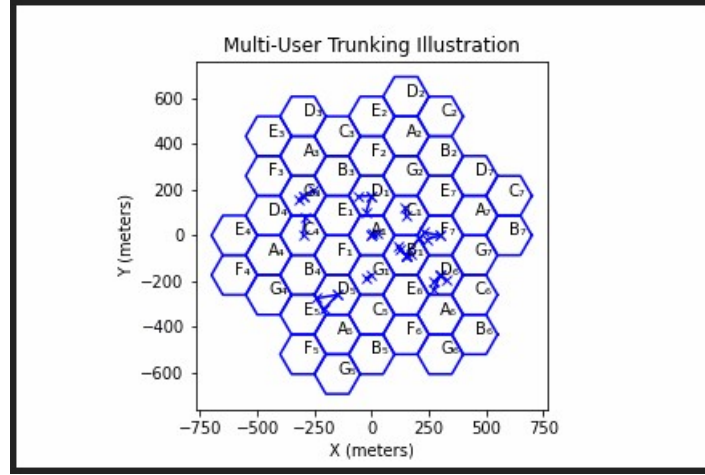
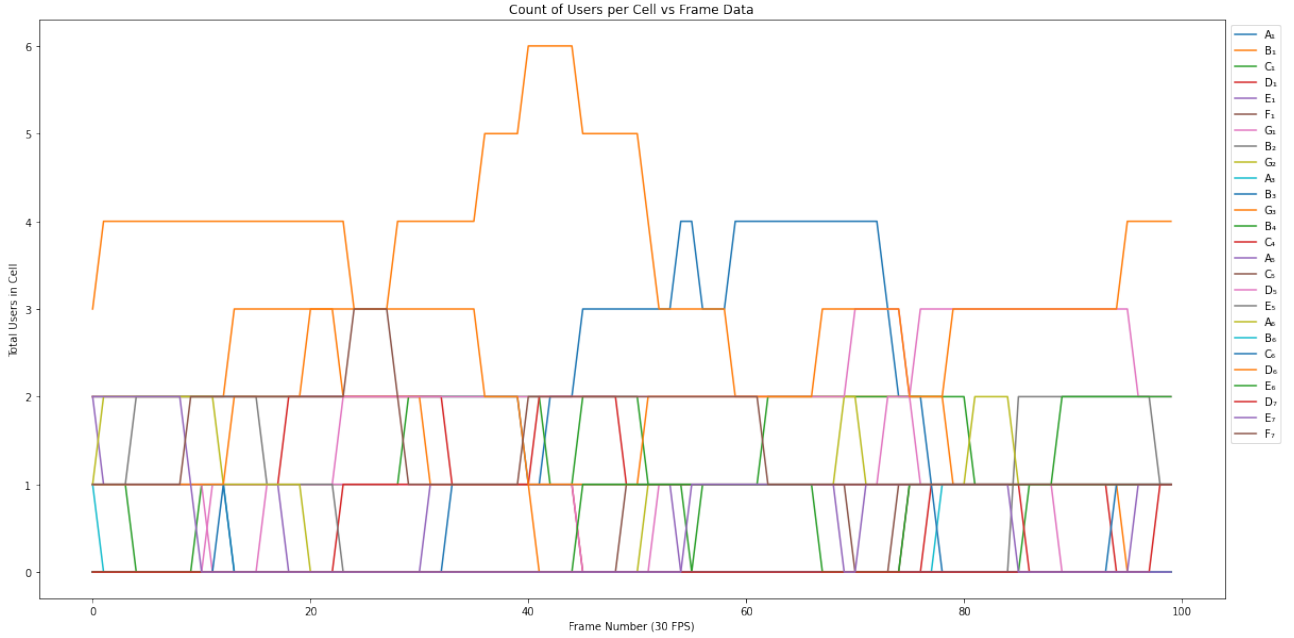


Figure 3: Screenshot of multiple users propagating through the first tier channels.



4 Python code

```
def bs_power(d):
    return 0 - 10*2.9*np.log10(d)

def bs_power_shadow(d):
    k = np.random.normal(0, 4, 1)
    return 0 - 10*2.9*np.log10(d) + k

Apower = list(map(bs_power, Adistances))
Apowershadow = list(map(bs_power_shadow, Adistances))
Cpower = list(map(bs_power, Cdistances))
Cpowershadow = list(map(bs_power_shadow, Cdistances))
fig = plt.figure(figsize=(20, 10))

plt.plot(Apower, color = 'red', label='A1 Power')
plt.plot(Apowershadow, marker = 'x', linestyle = ':', color = 'red', label='A1 Power + Shadow')
plt.plot(Cpower, color = 'blue', label='C1 Power')
plt.plot(Cpowershadow, marker = 'x', linestyle = ':', color = 'blue', label='C1 Power + Shadow')

a = np.array(Apower)

# plot handoff power and min power
plt.plot(np.full(shape=len(Apower), fill_value=Apower[np.argmax(a<-88)-4], dtype=np.int), linestyle = ':', color = 'black', label = 'Power at Handoff (Power Axis)')
plt.plot(np.full(shape=len(Apower), fill_value=-88, dtype=np.int), linestyle = '--', color = 'black', label = 'Minimum Usable Signal Level (Power Axis)')

# plot handoff interval time
plt.axvline(np.argmax(a<-88)-5, linestyle = ':', color = 'black', label='Handoff Initiated (Time Axis)')
plt.axvline(np.argmax(a<-88), linestyle = '--', color = 'black', label='Handoff Complete (Time Axis)')

plt.title('Power Recieved from Both Basestations in Inter-Cell Handoff')
plt.xlabel('Time (Seconds)')
plt.ylabel('Power (dBm)')

plt.ylim(-108,-40)

plt.legend(bbox_to_anchor=(1,1))
plt.show()

ni = 1
nj = 2
N = ni**2 + ni*nj + nj**2
center = [0,0]
radius = 100
labels = ['A', 'B', 'C', 'D', 'E', 'F', 'G']
```

Figure 5: Snippet of main.py.