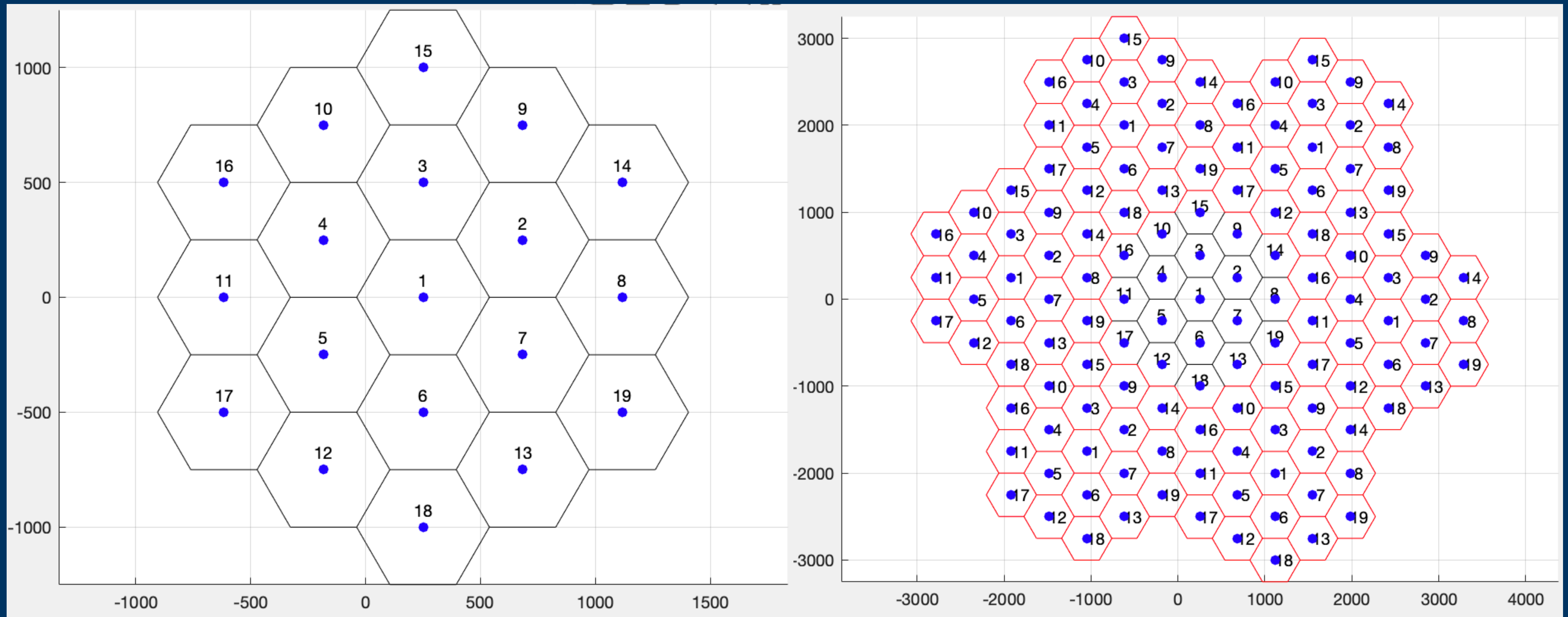


Introduction to Wireless and Mobile Network HW3

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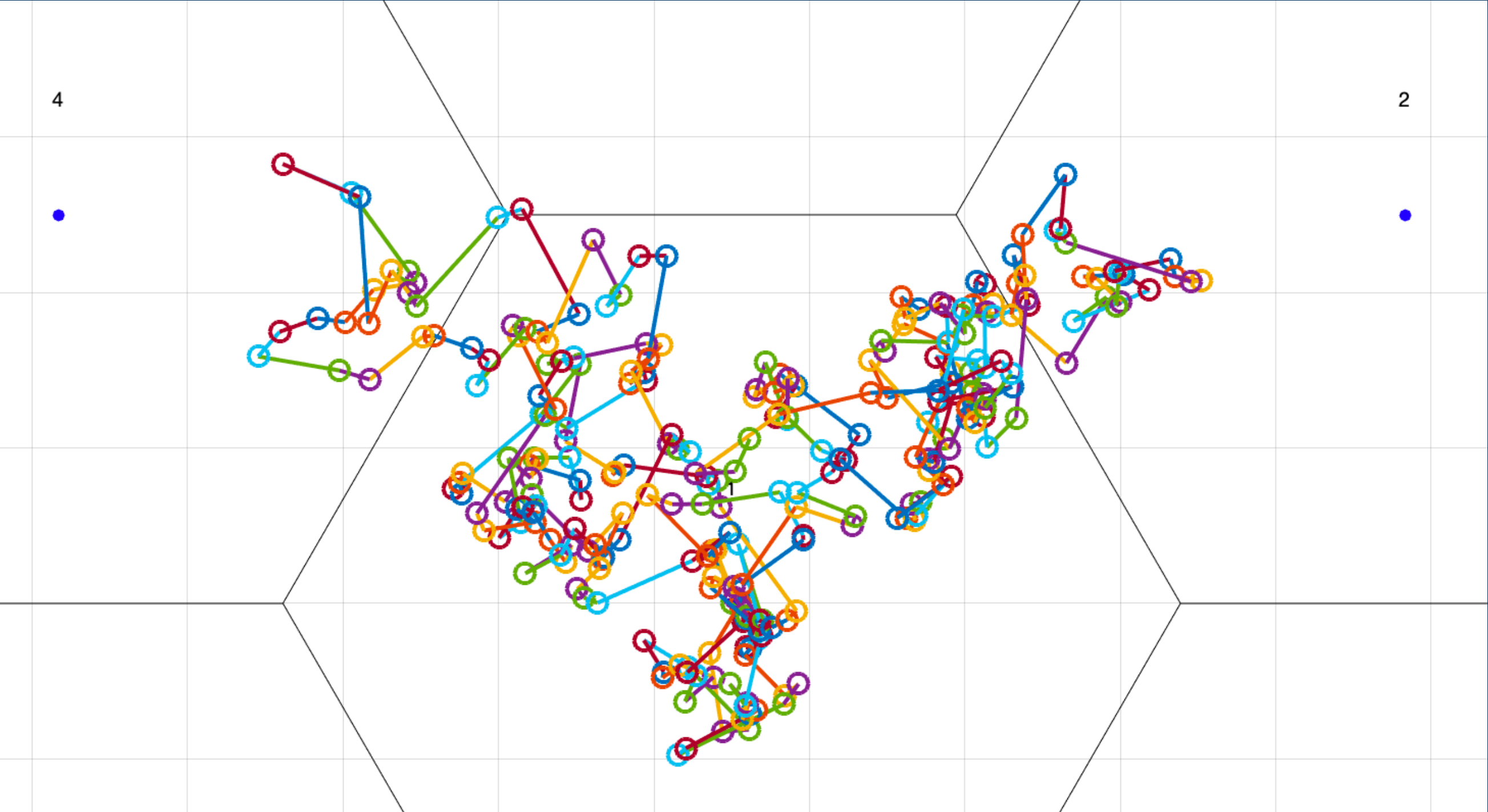
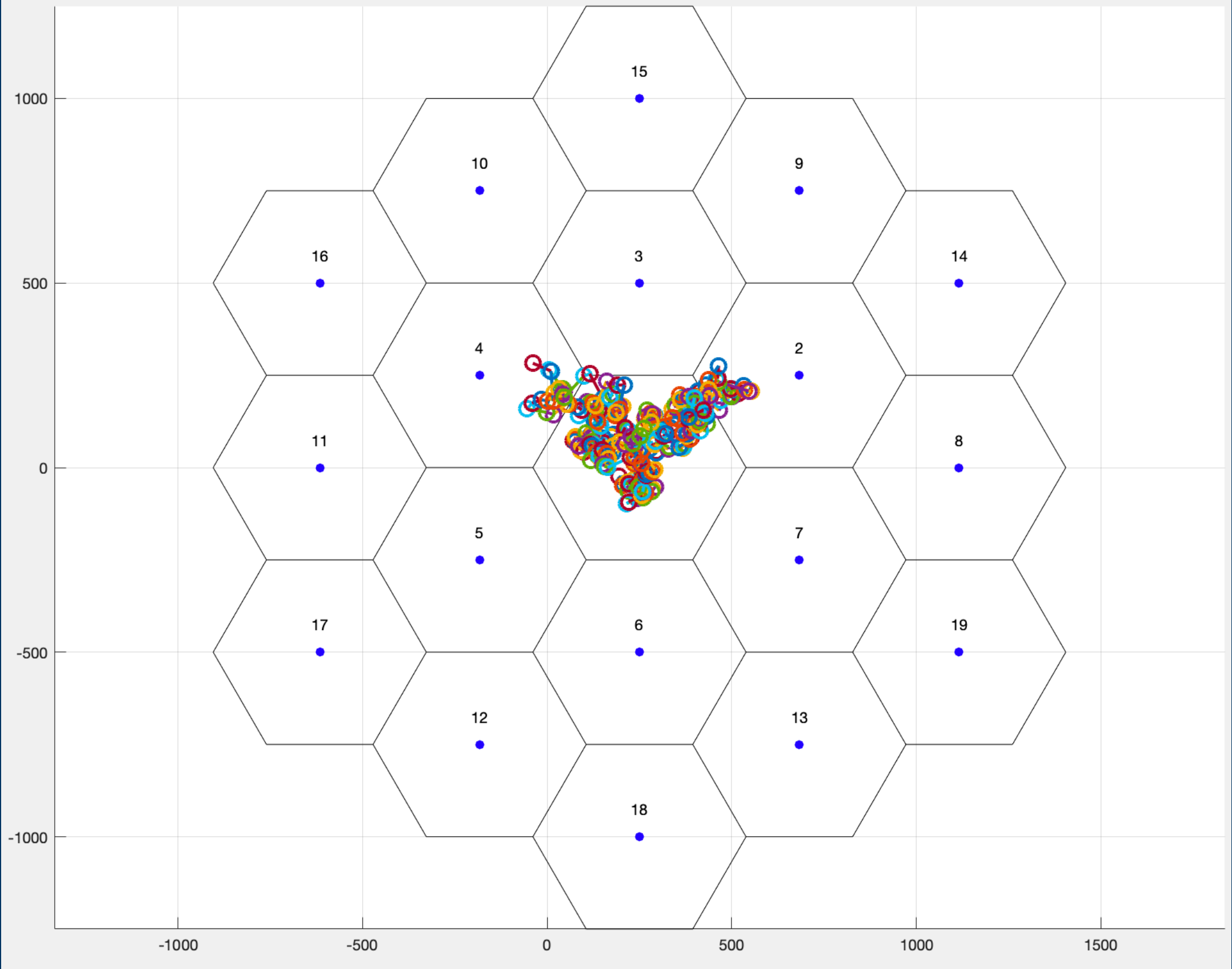
1. The arrangement of the cells



The basic arrangement of 19 cells

The extended version of 7 times more cells

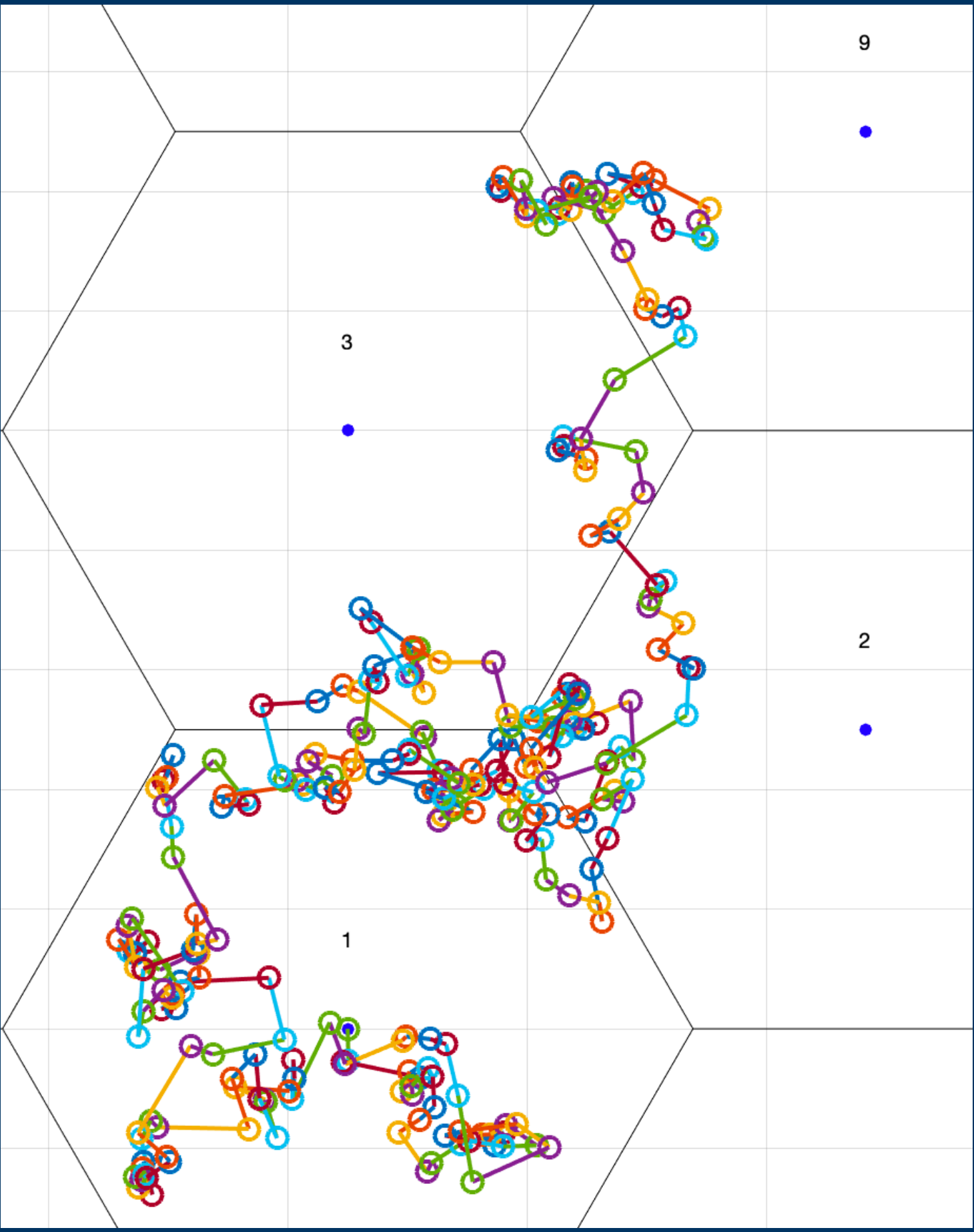
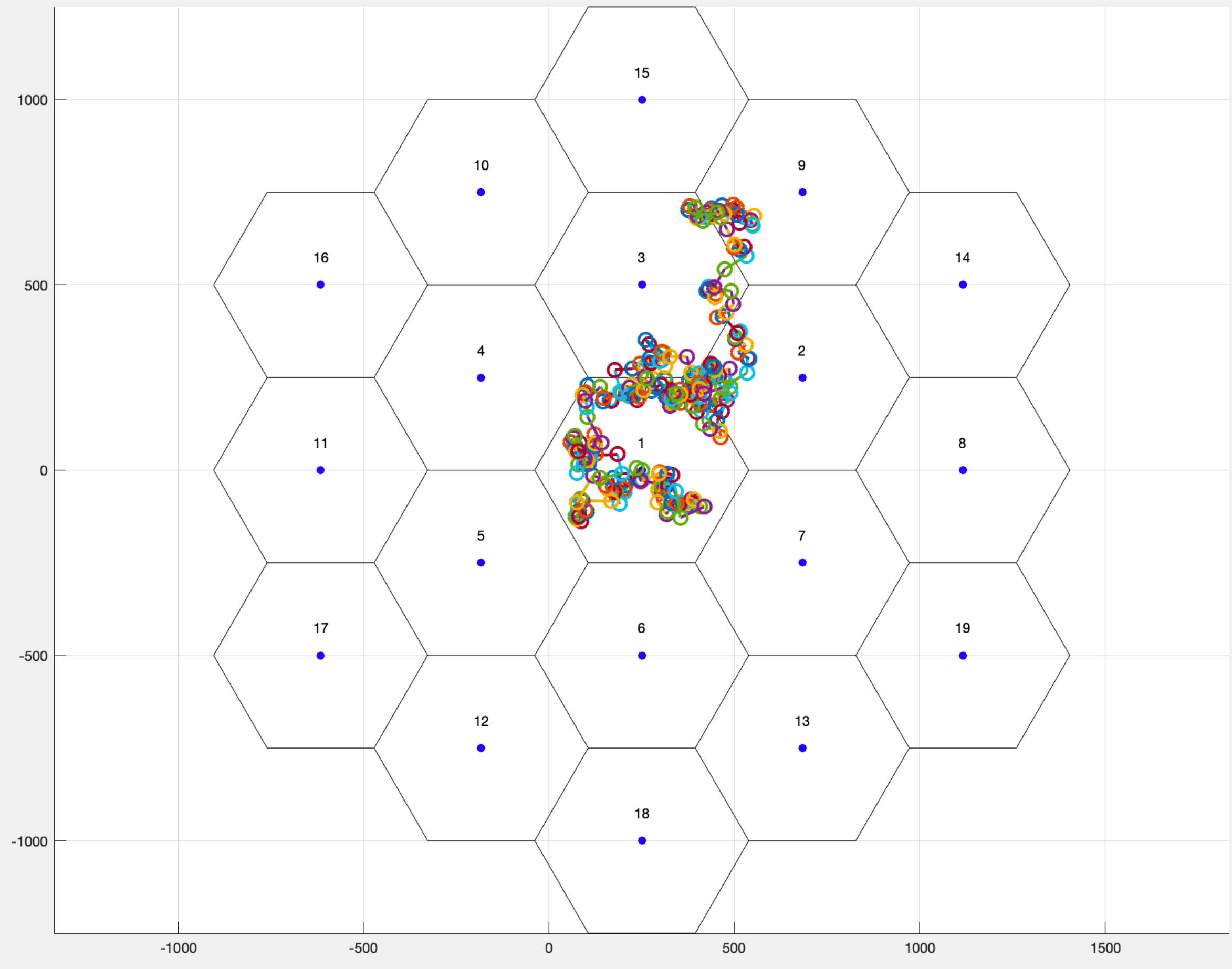
2. The 1st simulation



Time	Src_Cell	Dest_Cell
312.6433	1.0000	4.0000
380.1807	4.0000	3.0000
384.9767	3.0000	1.0000
710.0622	1.0000	2.0000
717.3652	2.0000	1.0000
721.4113	1.0000	2.0000
793.4778	2.0000	1.0000

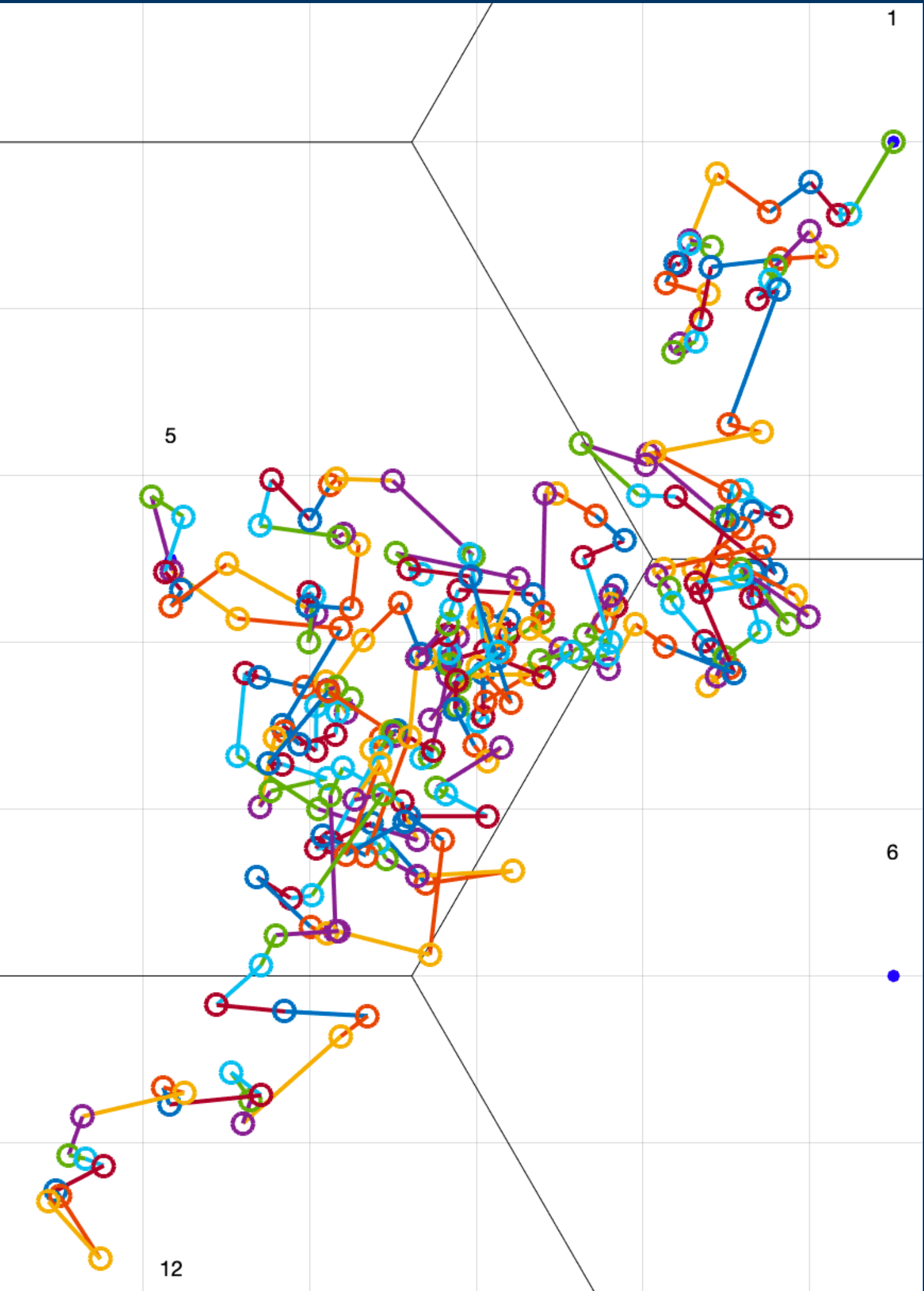
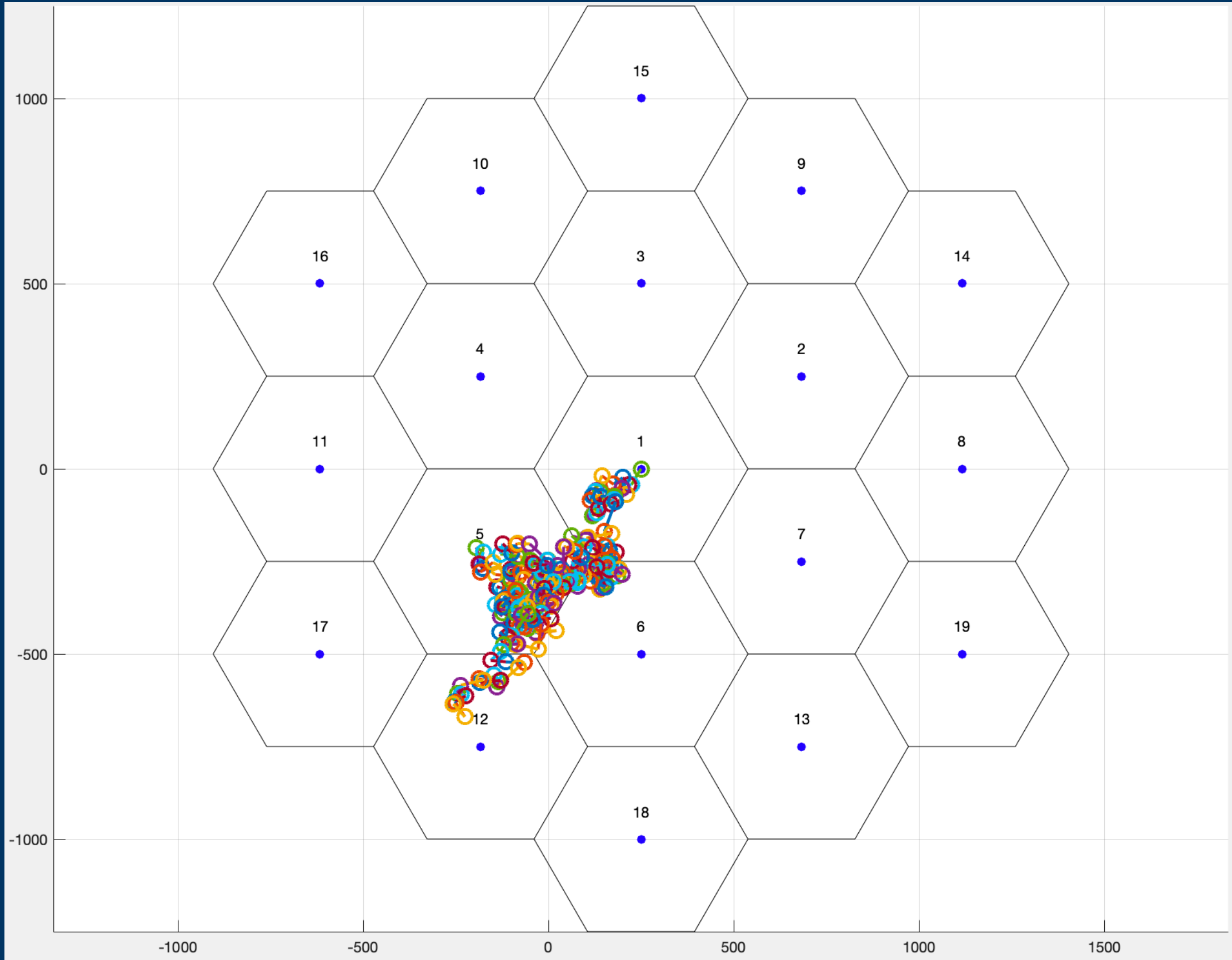
Total handoff count: 7

2. The 2nd simulation



Time	Src_Cell	Dest_Cell
352.5863	1.0000	3.0000
367.5838	3.0000	1.0000
438.3294	1.0000	2.0000
459.0621	2.0000	1.0000
461.8545	1.0000	2.0000
484.5939	2.0000	1.0000
576.3584	1.0000	3.0000
578.3531	3.0000	1.0000
581.2054	1.0000	3.0000
629.4889	3.0000	2.0000
649.3699	2.0000	3.0000
654.8828	3.0000	2.0000
695.3145	2.0000	1.0000
708.4804	1.0000	2.0000
744.2191	2.0000	3.0000
786.6502	3.0000	9.0000
809.2461	9.0000	3.0000
812.9416	3.0000	9.0000
822.5475	9.0000	3.0000
827.2452	3.0000	9.0000
873.4732	9.0000	3.0000

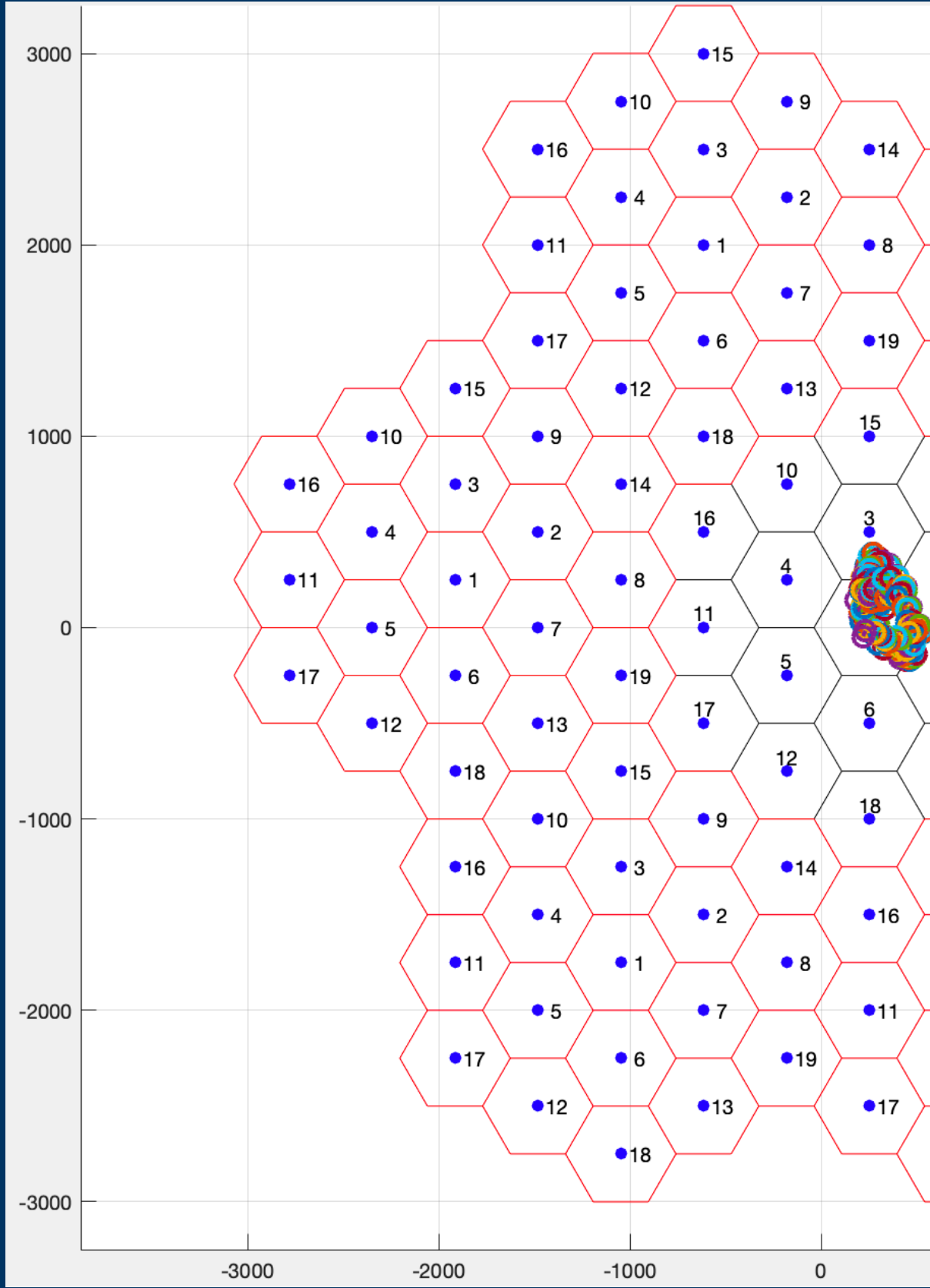
2. The 3rd simulation



Time	Src_Cell	Dest_Cell
115.5168	1.0000	6.0000
132.9612	6.0000	1.0000
146.9007	1.0000	5.0000
150.8101	5.0000	1.0000
158.1710	1.0000	6.0000
162.6887	6.0000	1.0000
166.6780	1.0000	6.0000
205.1793	6.0000	1.0000
209.1487	1.0000	6.0000
245.5209	6.0000	5.0000
250.5765	5.0000	6.0000
255.6259	6.0000	5.0000
275.7014	5.0000	6.0000
278.8034	6.0000	5.0000
609.5018	5.0000	6.0000
614.6524	6.0000	5.0000
764.1827	5.0000	6.0000
769.5289	6.0000	5.0000
828.7618	5.0000	12.0000

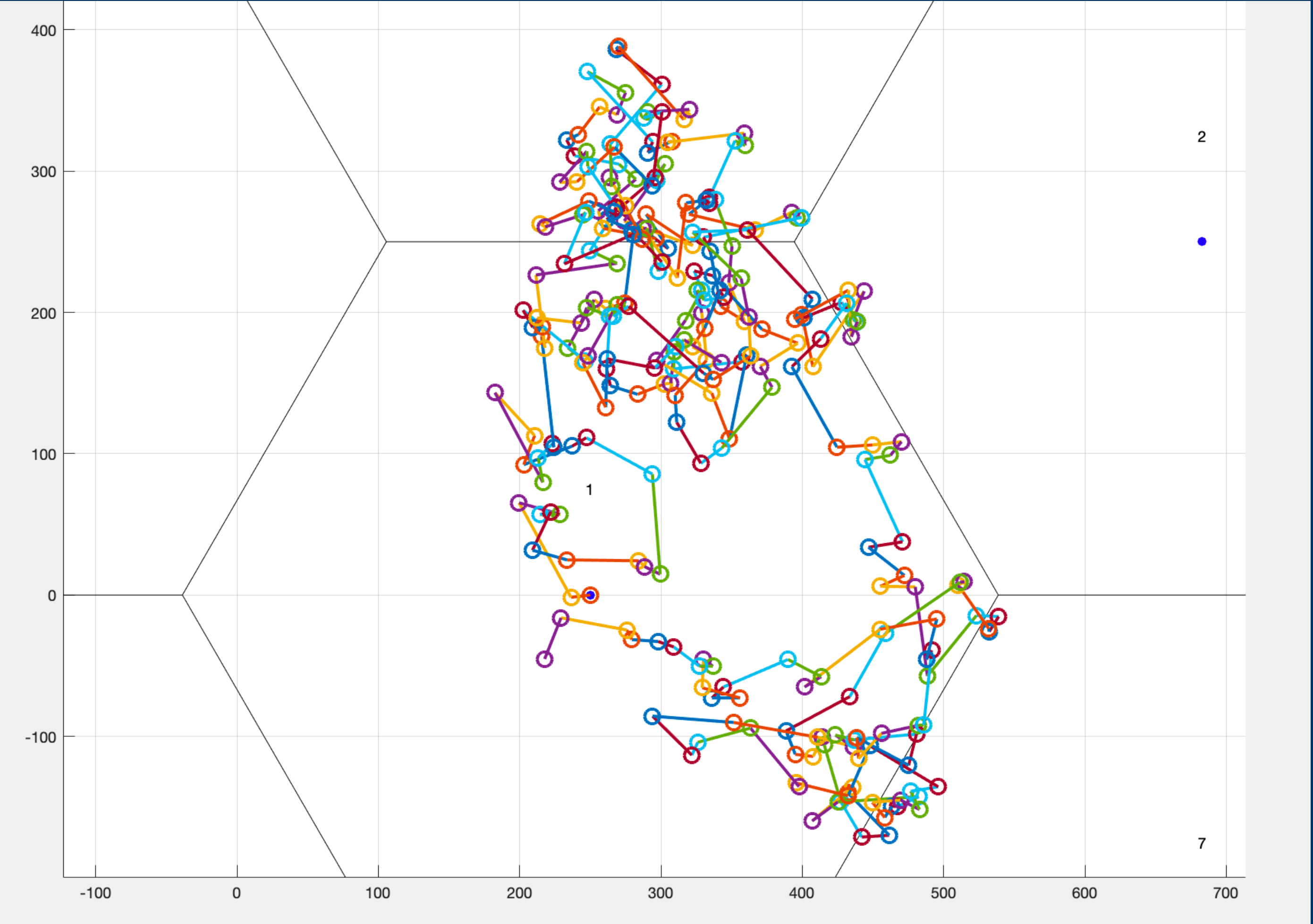
Total handoff count: 19

2. The 4th simulation

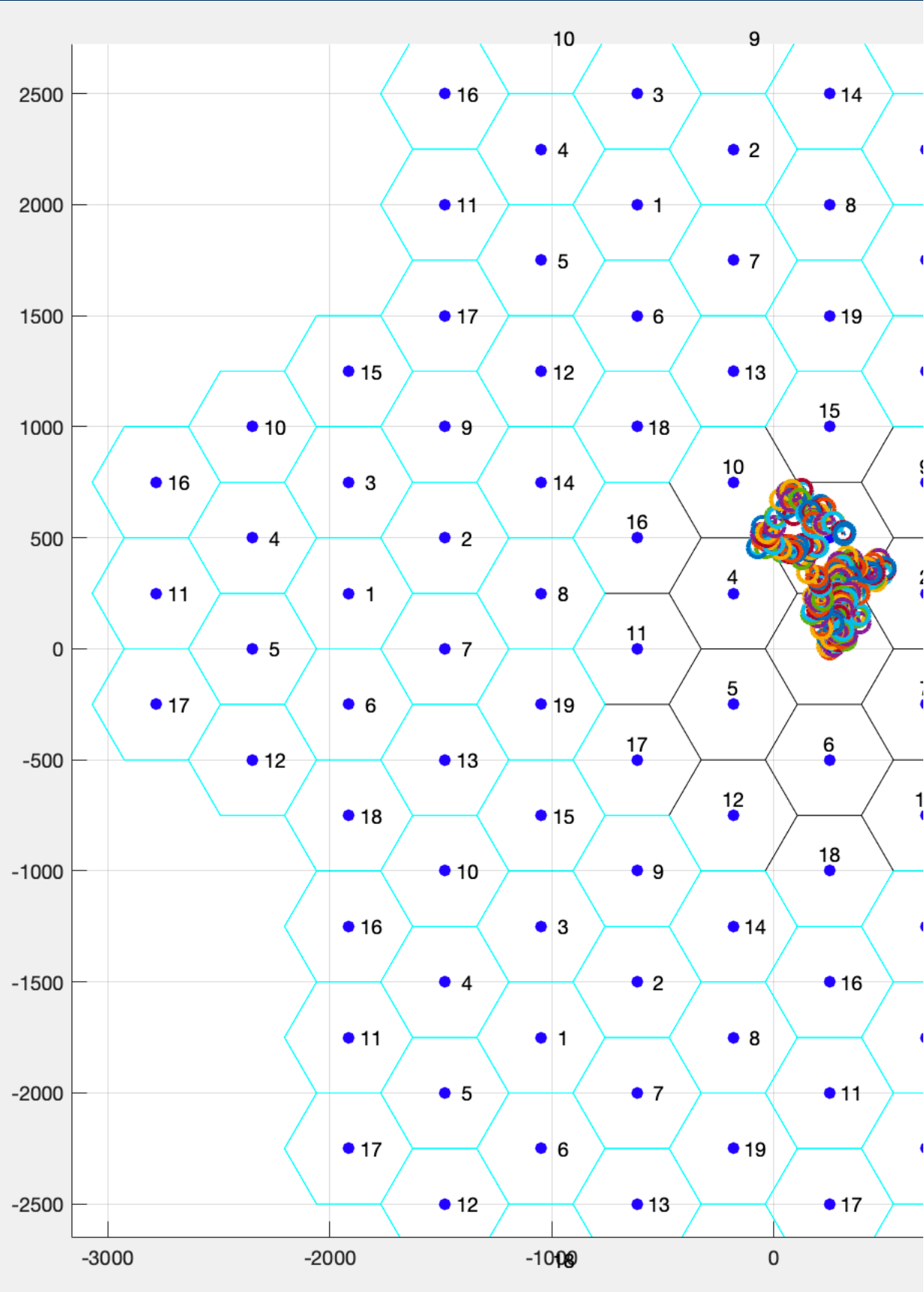


Time	Src_Cell	Dest_Cell
91.3190	1.0000	3.0000
94.5377	3.0000	1.0000
98.7178	1.0000	3.0000
102.6134	3.0000	1.0000
106.2942	1.0000	3.0000
221.4862	3.0000	1.0000
234.4637	1.0000	3.0000
249.5117	3.0000	1.0000
252.7500	1.0000	3.0000
257.5597	3.0000	1.0000
263.9519	1.0000	3.0000
358.8914	3.0000	1.0000
362.0876	1.0000	3.0000
365.8625	3.0000	1.0000
557.7918	1.0000	3.0000
568.3812	3.0000	1.0000
578.4866	1.0000	2.0000
591.5313	2.0000	1.0000
597.3180	1.0000	2.0000
608.8457	2.0000	1.0000
666.1397	1.0000	7.0000
672.3384	7.0000	1.0000
710.4048	1.0000	7.0000
719.6348	7.0000	1.0000
732.6553	1.0000	7.0000
745.2767	7.0000	1.0000
747.0738	1.0000	7.0000
762.0495	7.0000	1.0000
818.9627	1.0000	7.0000
822.3222	7.0000	1.0000
837.5087	1.0000	7.0000
841.9159	7.0000	1.0000

Total handoff count: 32

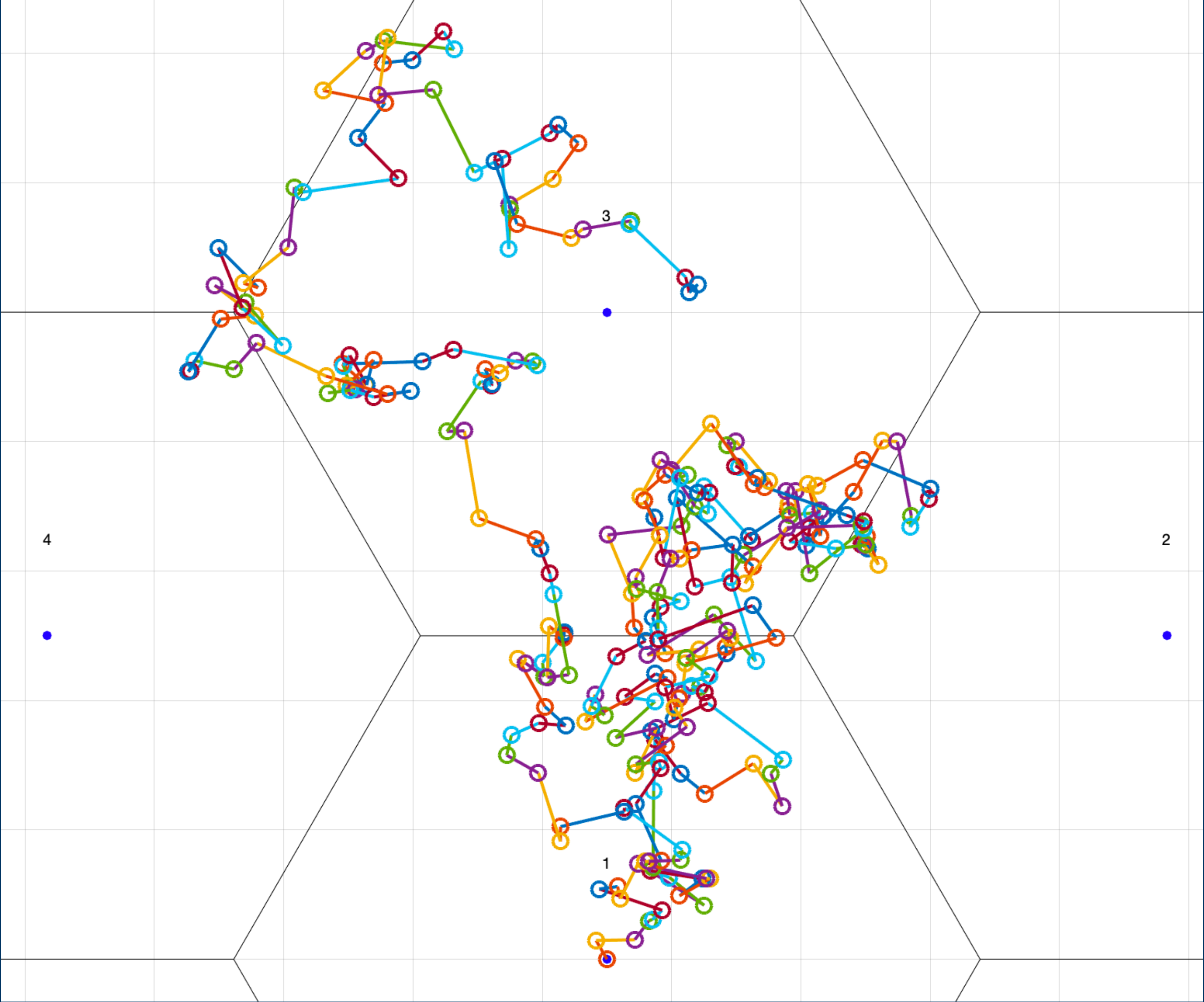


2. The 5th simulation



Time	Src_Cell	Dest_Cell
147.8161	1.0000	3.0000
208.5163	3.0000	2.0000
218.0856	2.0000	3.0000
232.8247	3.0000	2.0000
248.8225	2.0000	3.0000
300.7376	3.0000	2.0000
312.6076	2.0000	3.0000
412.6585	3.0000	1.0000
424.3157	1.0000	3.0000
428.4425	3.0000	1.0000
432.6564	1.0000	3.0000
454.5810	3.0000	1.0000
458.7325	1.0000	3.0000
462.6387	3.0000	1.0000
489.4641	1.0000	3.0000
491.5567	3.0000	1.0000
589.6850	1.0000	3.0000
594.7163	3.0000	1.0000
597.5231	1.0000	3.0000
600.9443	3.0000	1.0000
607.9312	1.0000	3.0000
727.1202	3.0000	4.0000
741.6931	4.0000	3.0000
744.7431	3.0000	10.0000
748.6384	10.0000	3.0000
763.1485	3.0000	10.0000
767.7128	10.0000	3.0000
771.2584	3.0000	10.0000
773.8914	10.0000	3.0000
777.5288	3.0000	10.0000
787.4598	10.0000	3.0000
798.7922	3.0000	10.0000
810.1389	10.0000	3.0000
827.3963	3.0000	10.0000
830.3172	10.0000	3.0000

Total handoff count: 35



2. Summary

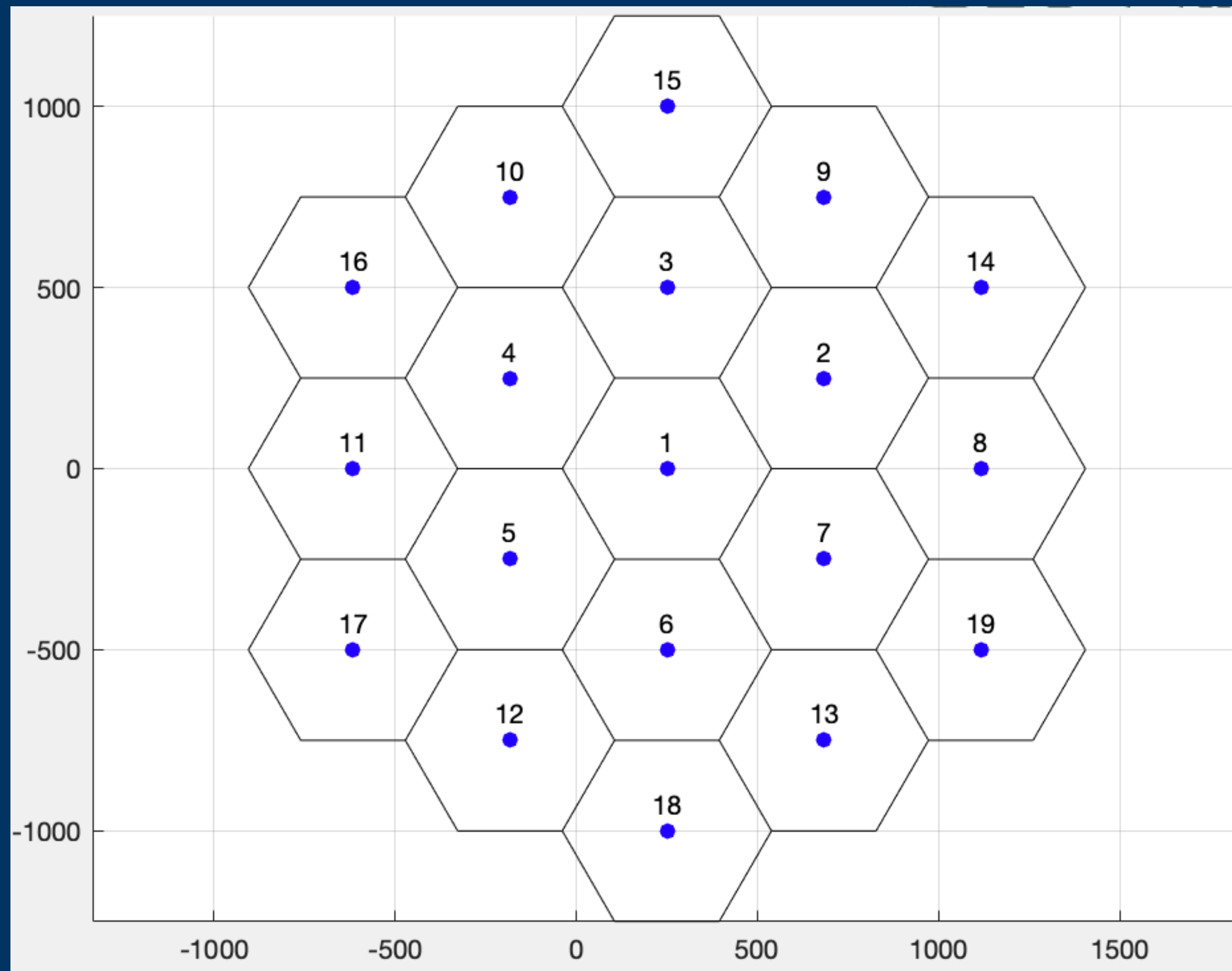
My criteria is coordination-based in this HW.

Handoff records are all including in the figure of every example.

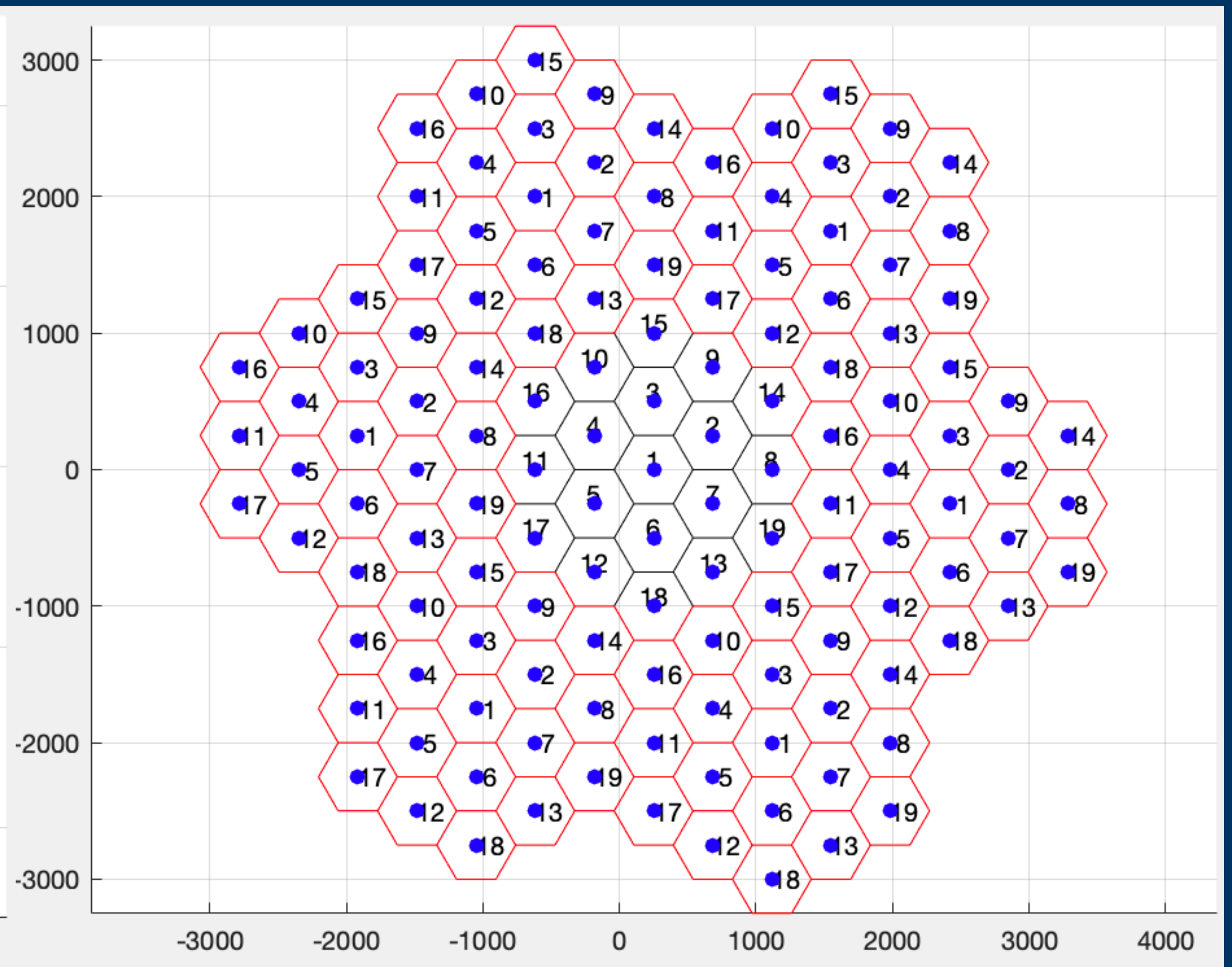
At first, I found that the device only moved around the neighbor cells and I thought it was weird. As a result, I draw the trajectory of the mobile device and found that it's quite valid since the maximum displacement would be only 90m.

I think that in this 900s case, the basic 19 cells arrangement wouldn't be worse than the 19*7 version. So my first 3 simulations are basic version, while the last two are extended version.

B-1. The arrangement of the cells



The basic arrangement of 19 cells



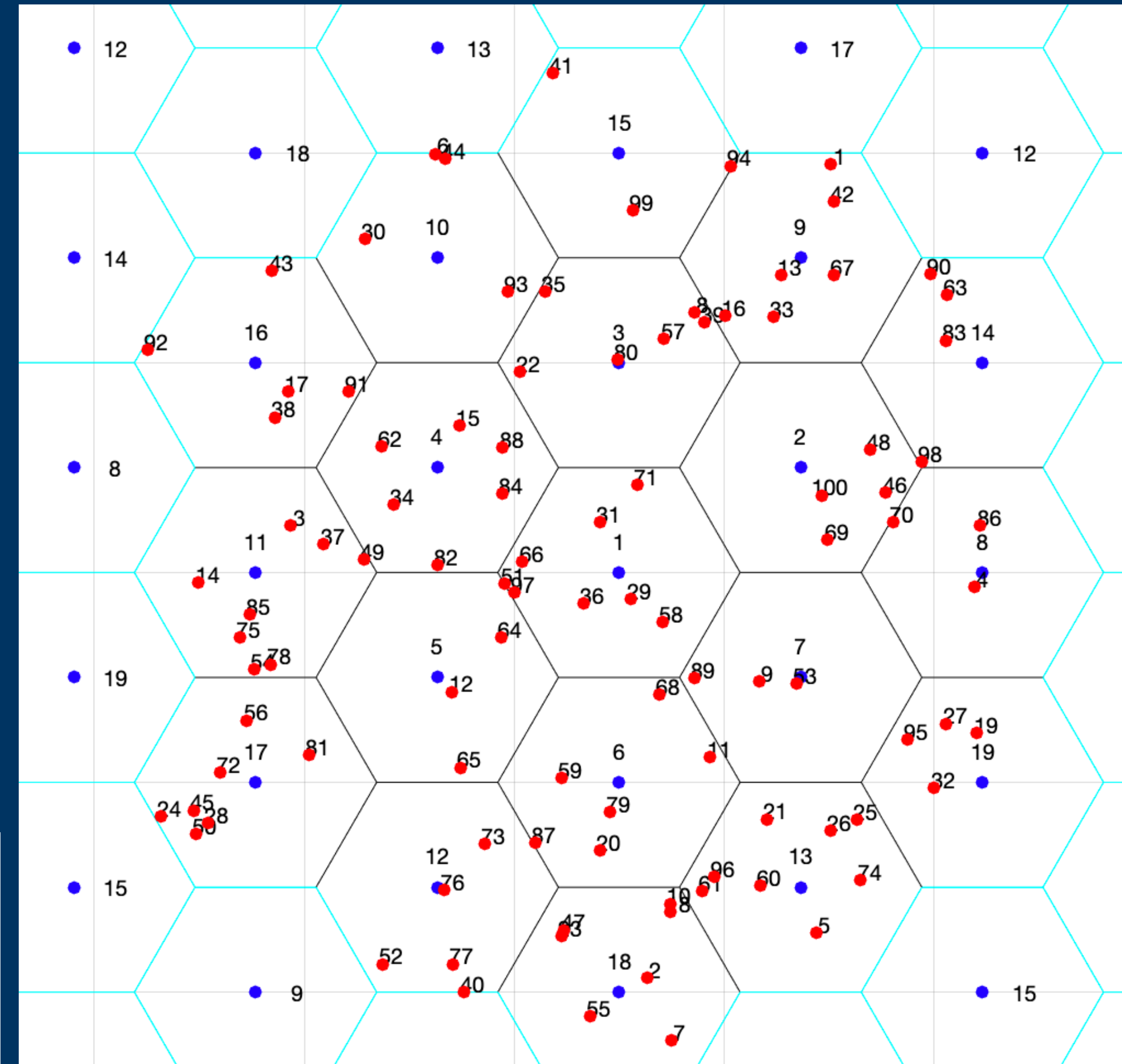
The extended version of 7 times more cells

B-2. The arrangement of the devices

Randomly distribute the 100 mobile devices in the first 19 cell cluster

I make the label of all the devices to make sure that there are really 100 devices.

```
while size(all_points,1)<all_devices % do 100 times
    x = 1200 * (2*rand()-1);
    y = 1200 * (2*rand()-1);
    for i = 1:19
        if inpolygon(x,y,all_x(i)+radius*cosd(0:60:360),all_y(i)+radius*sind(0:60:360))
            all_points = [all_points; x y];
            text(x+20, y+20, num2str(size(all_points,1)), 'HorizontalAlignment', 'center', 'VerticalAlignment', 'middle');
        end
    end
end
```



B-3. The HO simulation of 100 devices

The format would be like the figure on the right side.

The bonus is based on the SINR.

There are 1409 times of HO this time.

```
1385) Time: 882.4363, Source_Cell: 1, Dest_Cell: 5
1386) Time: 882.4363, Source_Cell: 17, Dest_Cell: 5
1387) Time: 885.8007, Source_Cell: 17, Dest_Cell: 12
1388) Time: 885.8007, Source_Cell: 5, Dest_Cell: 6
1389) Time: 885.8007, Source_Cell: 7, Dest_Cell: 2
1390) Time: 885.8007, Source_Cell: 1, Dest_Cell: 4
1391) Time: 885.8007, Source_Cell: 3, Dest_Cell: 1
1392) Time: 885.8007, Source_Cell: 16, Dest_Cell: 11
1393) Time: 891.5683, Source_Cell: 13, Dest_Cell: 1
1394) Time: 891.5683, Source_Cell: 2, Dest_Cell: 14
1395) Time: 891.5683, Source_Cell: 11, Dest_Cell: 5
1396) Time: 891.5683, Source_Cell: 2, Dest_Cell: 7
1397) Time: 891.5683, Source_Cell: 1, Dest_Cell: 8
1398) Time: 894.4771, Source_Cell: 6, Dest_Cell: 5
1399) Time: 894.4771, Source_Cell: 17, Dest_Cell: 5
1400) Time: 896.8962, Source_Cell: 1, Dest_Cell: 13
1401) Time: 896.8962, Source_Cell: 5, Dest_Cell: 11
1402) Time: 896.8962, Source_Cell: 15, Dest_Cell: 10
1403) Time: 896.8962, Source_Cell: 5, Dest_Cell: 17
1404) Time: 899.8938, Source_Cell: 8, Dest_Cell: 7
1405) Time: 899.8938, Source_Cell: 11, Dest_Cell: 16
1406) Time: 899.8938, Source_Cell: 16, Dest_Cell: 11
1407) Time: 899.8938, Source_Cell: 14, Dest_Cell: 2
1408) Time: 899.8938, Source_Cell: 10, Dest_Cell: 4
1409) Time: 899.8938, Source_Cell: 17, Dest_Cell: 5
Number of Handoff: 1409
```

B-3. The HO simulation of 100 devices

The way that I decide the HO occurs:

```
% to remember all the distances in a 100x133 matrix,
dx = repmat(all_points(:,1), 1, 133) - repmat(all_x', 100, 1);
dy = repmat(all_points(:,2), 1, 133) - repmat(all_y', 100, 1);
distance = sqrt(dx.^2 + dy.^2);

gd = ((h_b*h_m)^2)./distance.^2;
Pr_W = gd.*p_m_W*gt_W*gr_W;

[rows, cols] = size(Pr_W); % Determine the size of the pr_W matrix

% Create a matrix with same size as pr_W, but with zeros along the diagonal
Pr_W_no_diagonal = Pr_W;
for i = 1:min(rows, cols)
    Pr_W_no_diagonal(i,i) = 0;
end

% Compute the sum of each row except for the diagonal element
Interference = sum(Pr_W_no_diagonal, 2);
SINR = Pr_W./(Interference+N);
SINR_dB = to_dB(SINR);
```

```
while current_t < total_t
    direction = [];
    velocity = [];
    travel_t = [];
    delta_x = [];
    delta_y = [];

    travel_t = [travel_t; min_t + rand * (max_t - min_t)];

    for i = 1:100
        direction = [direction; rand() * 2 * pi];
        velocity = [velocity; min_v + rand * (max_v - min_v)];

        delta_x(i,1) = velocity(i,1) * cos(direction(i,1)) * travel_t;
        delta_y(i,1) = velocity(i,1) * sin(direction(i,1)) * travel_t;
    end

    current_location = current_location + [delta_x delta_y];

    for i = 1:100
        for j = 1:133
            dx = current_location(i, 1) - all_x(j);
            dy = current_location(i, 2) - all_y(j);
            distance(i, j) = sqrt(dx^2 + dy^2);
        end
    end
end
```


B-3. The HO simulation of 100 devices

The way that I decide the HO occurs:

```
gd = ((h_b*h_m)^2) ./ distance.^2;
Pr_W = gd.*p_m_W*gt_W*gr_W;

mask = ones(size(Pr_W));
mask(:,j) = 0;
Interference = sum(Pr_W .* mask, 2);

SINR = Pr_W ./ (Interference+N);
SINR_dB = to_dB(SINR);

for i = 1:100
    new_cell(i,:) = check(SINR_dB(i,:));

    if new_cell(i,:) ~= current_cell(i,:)
        ho_amount = ho_amount+1;
        ho_events = [ho_events; current_t, current_cell(i,:), new_cell(i,:)];
        disp([num2str(ho_amount), ') ', 'Time: ', num2str(current_t), ', Source_Cell: '
        current_cell(i,:) = new_cell(i,:);
    end
end
current_t = current_t + travel_t;
```

The functions I used:

```
function cell_id_out = check(vec)
    [~, maxIdx] = max(vec);
    mapping = mod(maxIdx-1, 19) + 1;
    mapping(mapping == 19) = 1;
    cell_id_out = mapping;
end
```

```
function result_dB = to_dB(value)
    result_dB = 10 * log10(value);
end
```

```
function result_value = to_value(db)
    result_value = 10^(db/10);
end
```

Reference

<https://chat.openai.com/chat>