

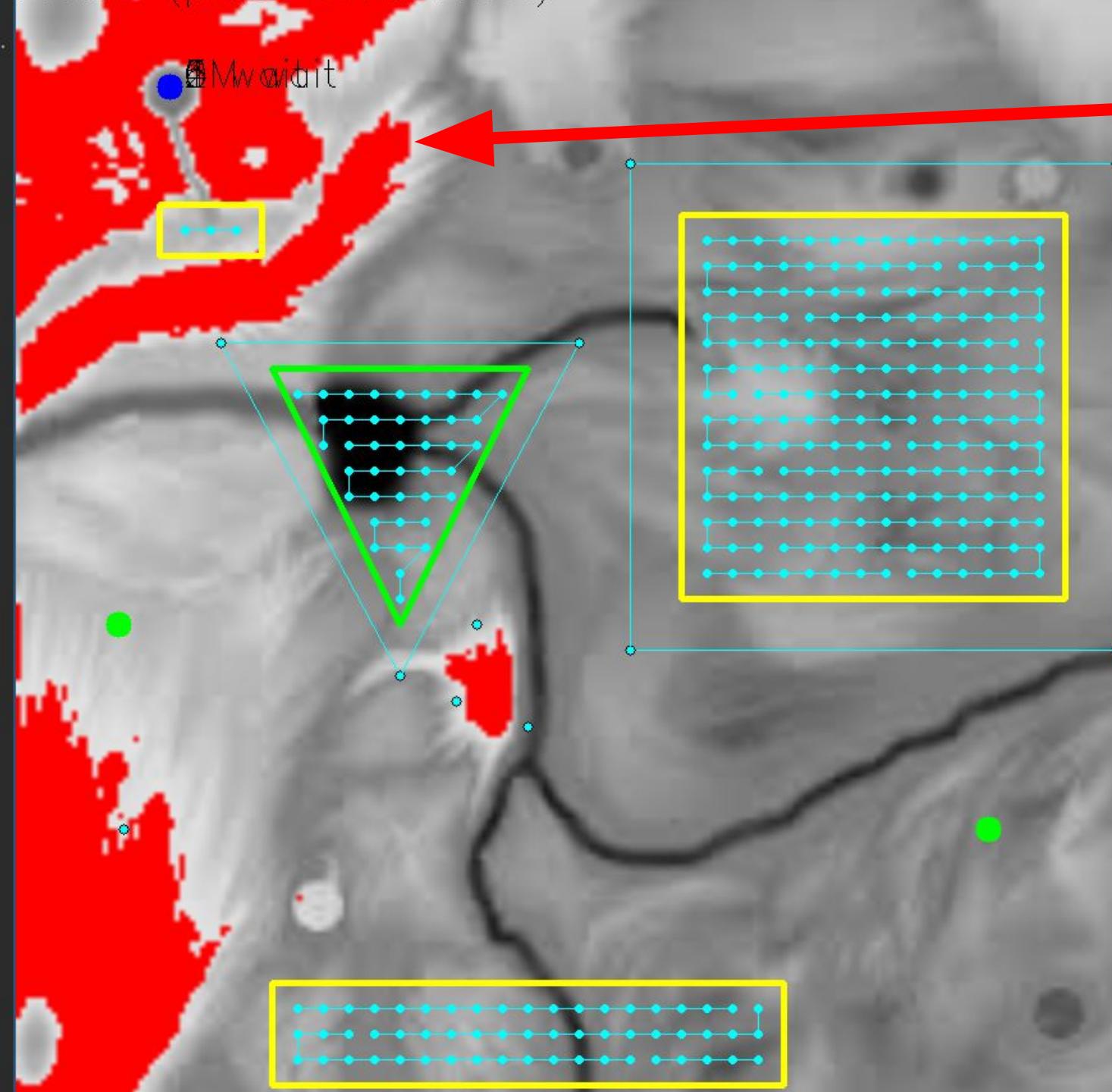
X-MAS  
HACK

# Drone Swarm симулятор & планировщик

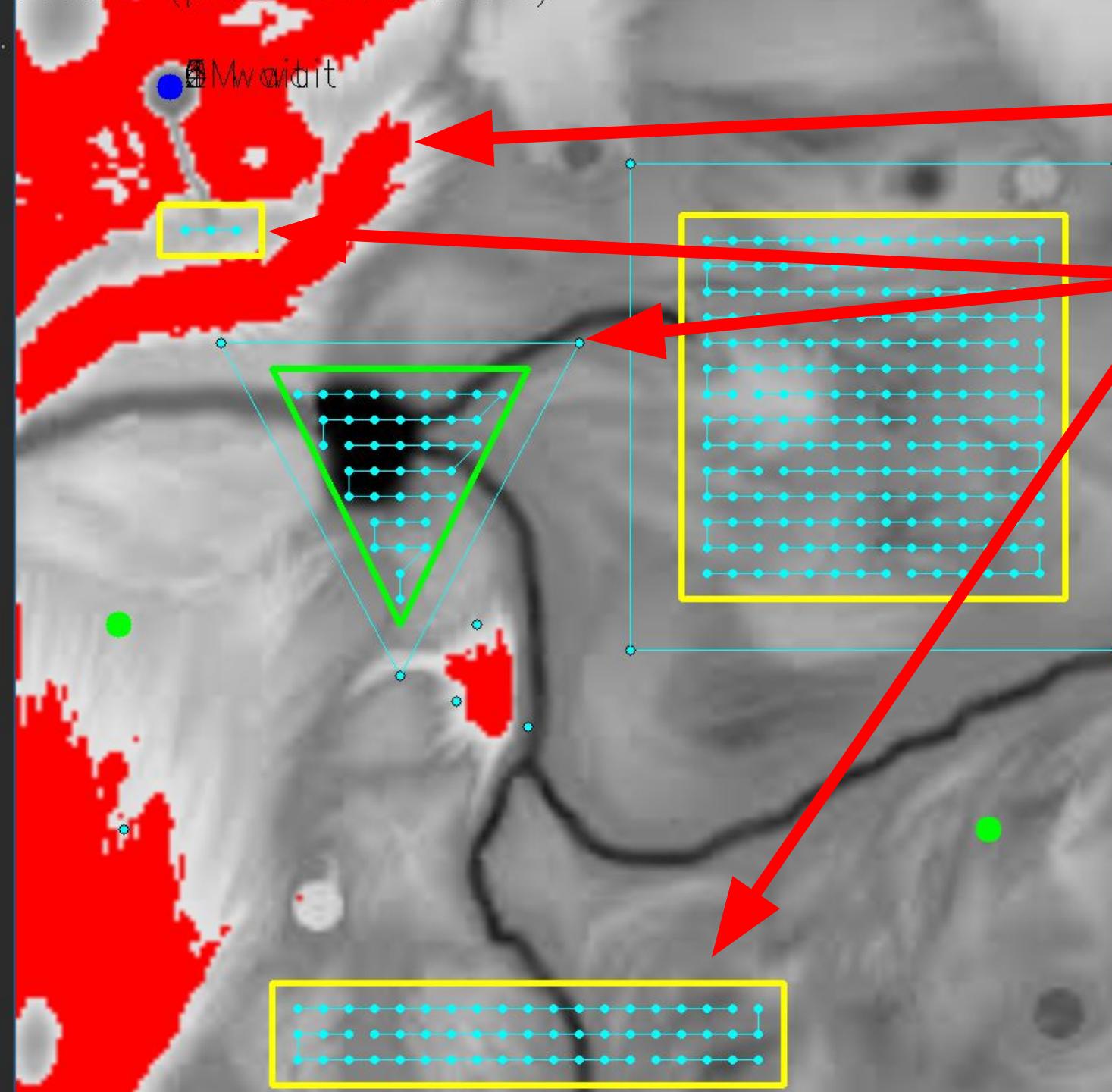
Команда “Может по ржать?”

- Борис Симиютин [simiyutin.boris@yandex.ru](mailto:simiyutin.boris@yandex.ru)
- Николай Полярный [PolarNick239@gmail.com](mailto:PolarNick239@gmail.com)

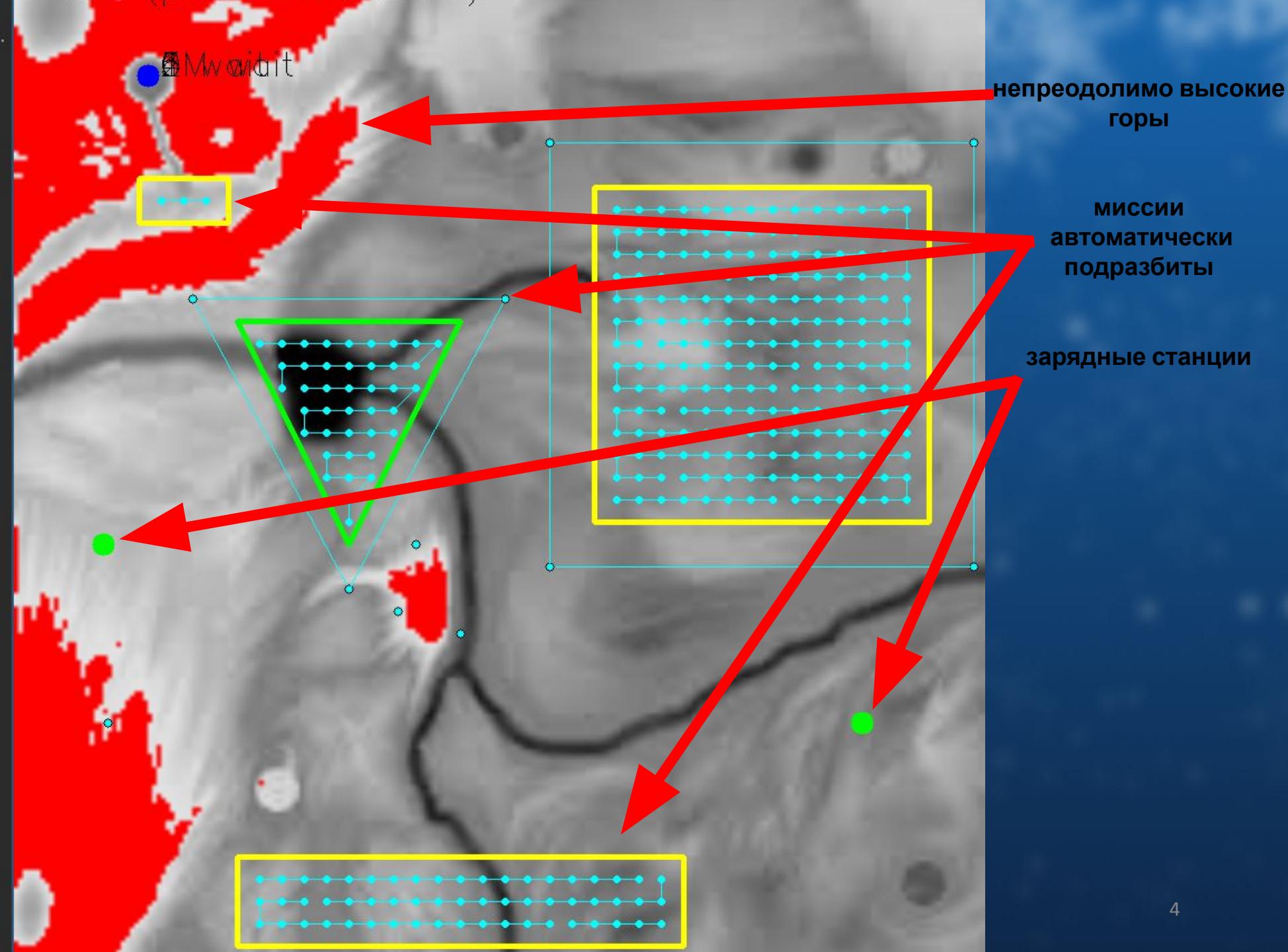
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation
```



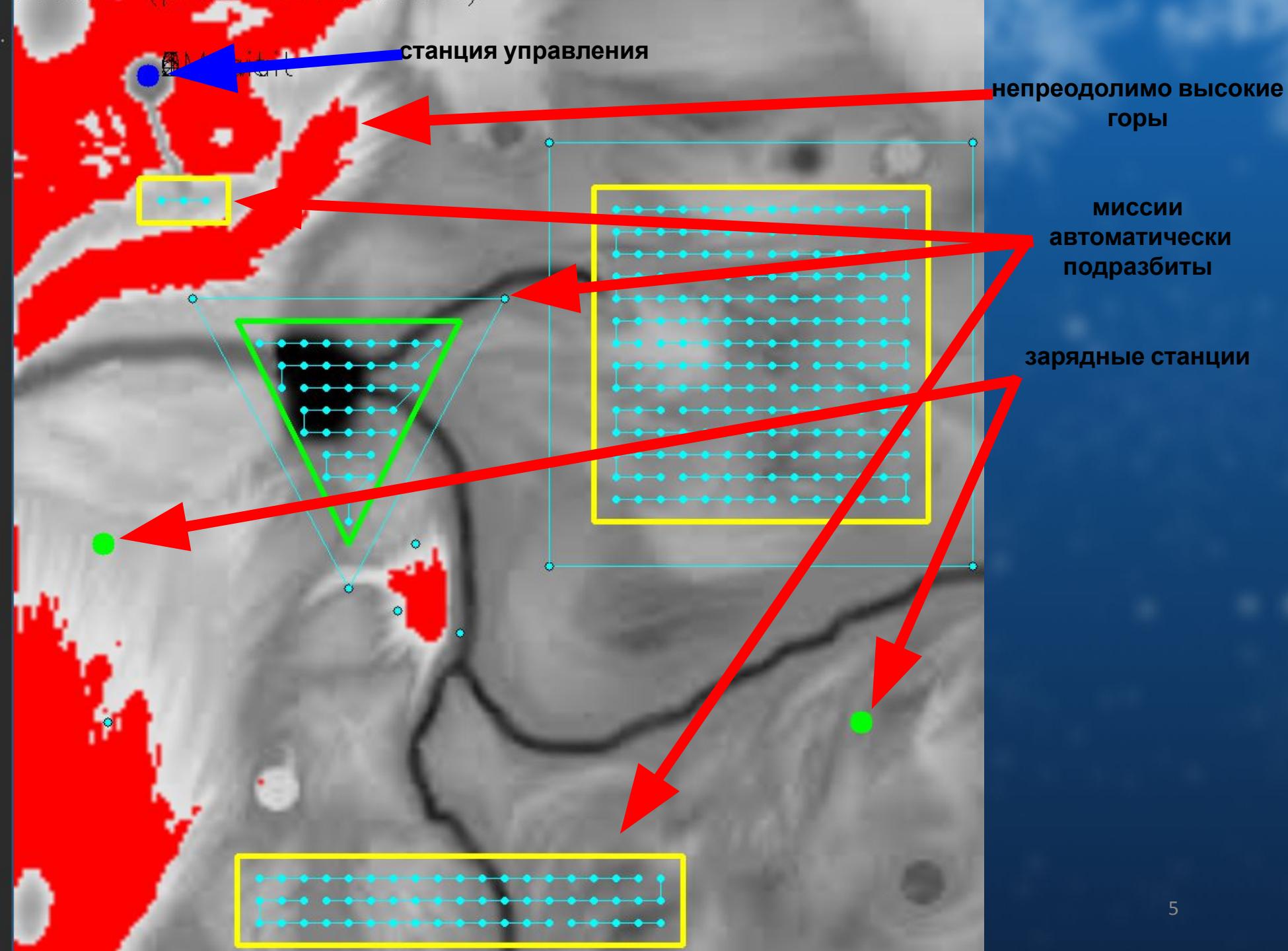
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation
```



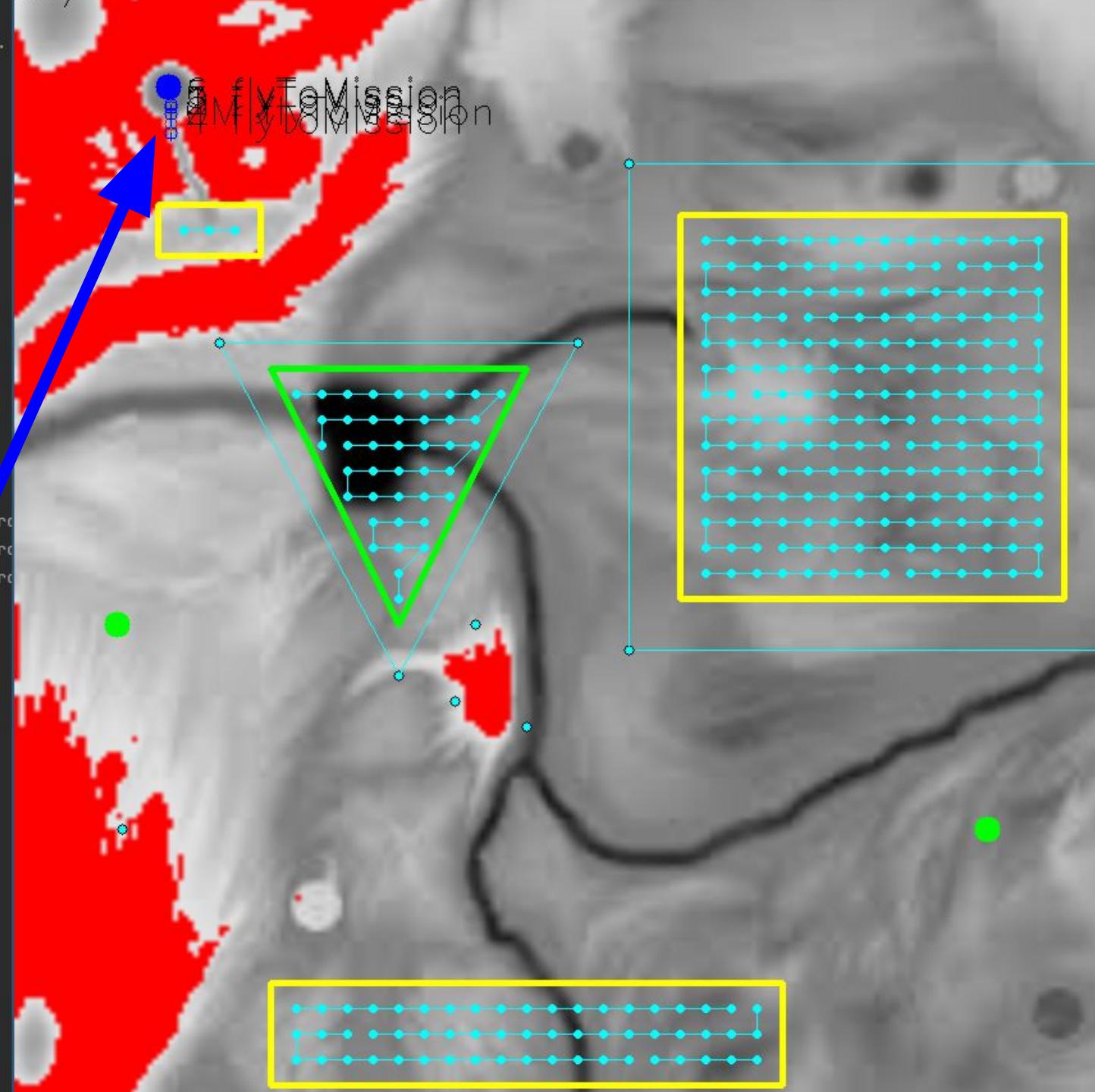
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation
```



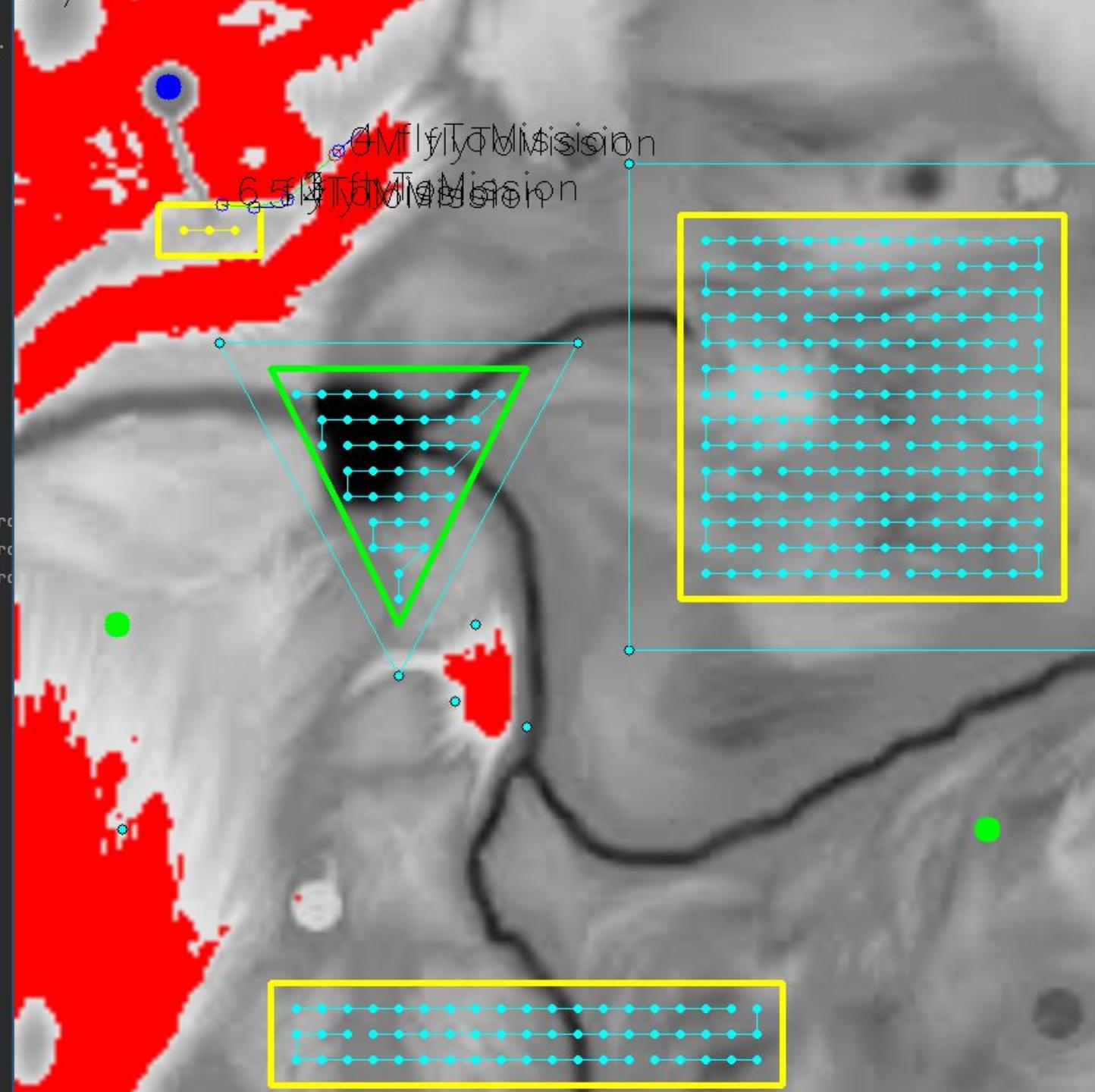
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation
```



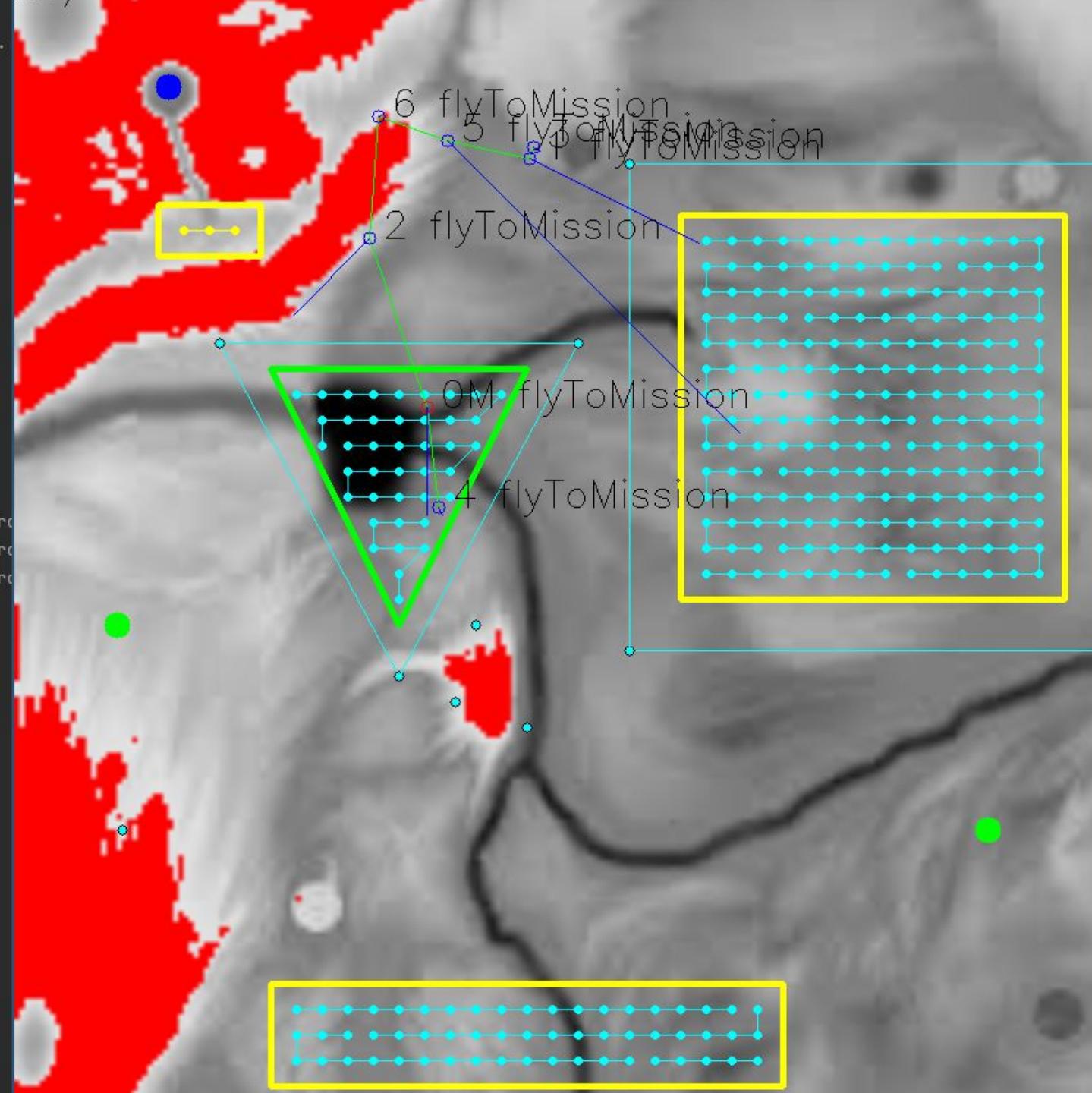
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation  
  
Drone 4: new mission 17  
Drone 0: new mission 3  
Drone 6: new mission 23  
Drone 1: new mission 5  
Drone 5: new mission 16  
Drone 2: new mission 4  
Drone 3: new mission 22  
  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5
```



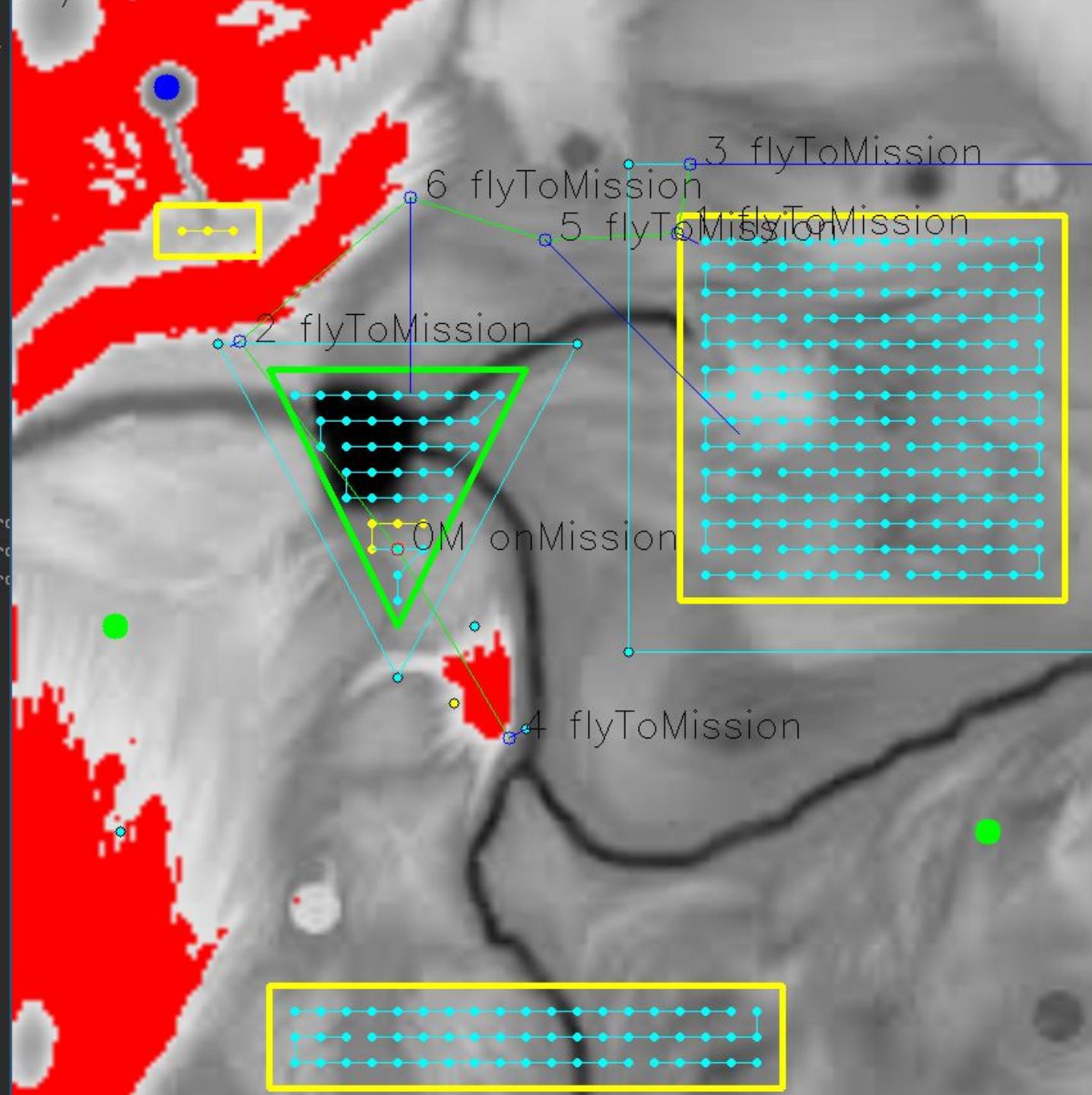
```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation  
  
-----  
Drone 4: new mission 17  
Drone 0: new mission 3  
Drone 6: new mission 23  
Drone 1: new mission 5  
Drone 5: new mission 16  
Drone 2: new mission 4  
Drone 3: new mission 22  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: new mission 24
```



```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
-----  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation  
  
-----  
Drone 4: new mission 17  
Drone 0: new mission 3  
Drone 6: new mission 23  
Drone 1: new mission 5  
Drone 5: new mission 16  
Drone 2: new mission 4  
Drone 3: new mission 22  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: new mission 24
```

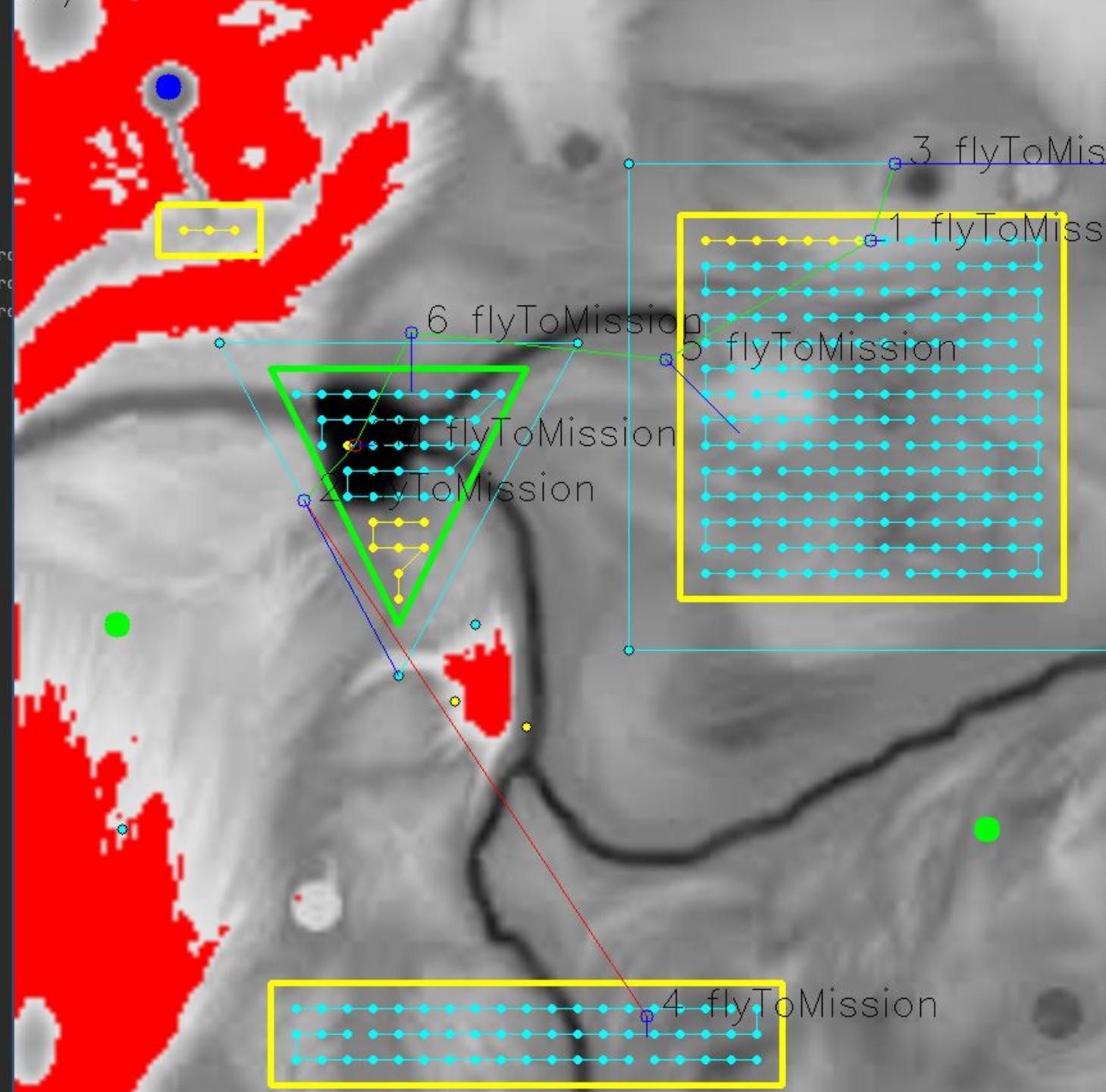


```
DEM loaded: 225x225 pixels, 22500x22500 m  
building 50625 vertices graph w.r.t. DEM...  
graph prepared!  
1+2 stations loaded  
1+6 drones loaded  
  
Welcome to Drones Swarm Simulator!  
Controls:  
SPACE - pause/unpause  
+/- - speedup/slowdown simulation  
  
Drone 4: new mission 17  
Drone 0: new mission 3  
Drone 6: new mission 23  
Drone 1: new mission 5  
Drone 5: new mission 16  
Drone 2: new mission 4  
Drone 3: new mission 22  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 5: PAUSE! Collision avoidance with Drone 5  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: new mission 24  
Drone 0: executing mission 3...  
Drone 3: executing mission 22...  
Drone 0: executing mission 3...  
Drone 4: executing mission 24...  
Drone 4: new mission 25  
Drone 0: executing mission 3...  
Drone 0: executing mission 3...
```

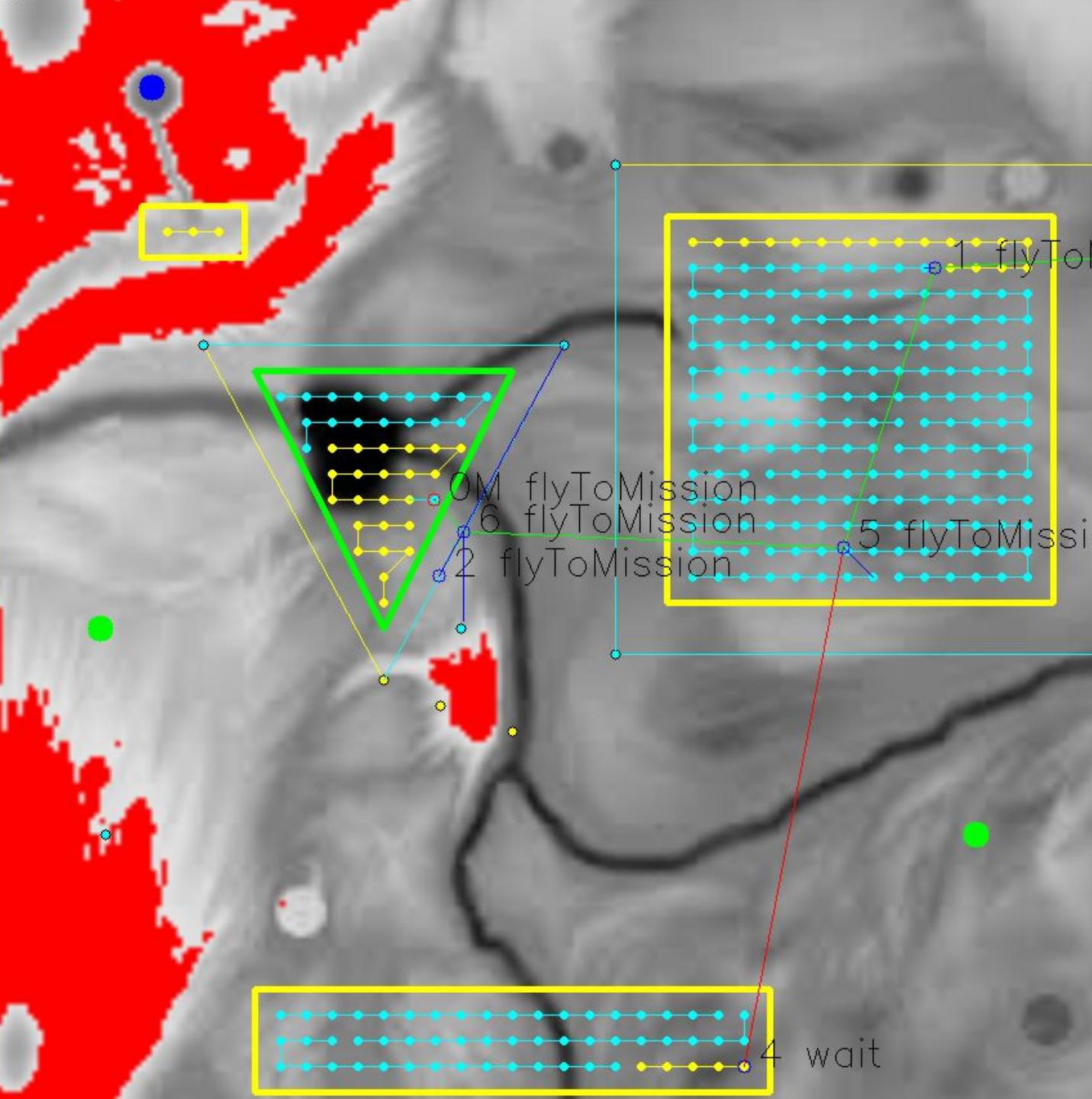


+/- - speedup/slowdown simulation

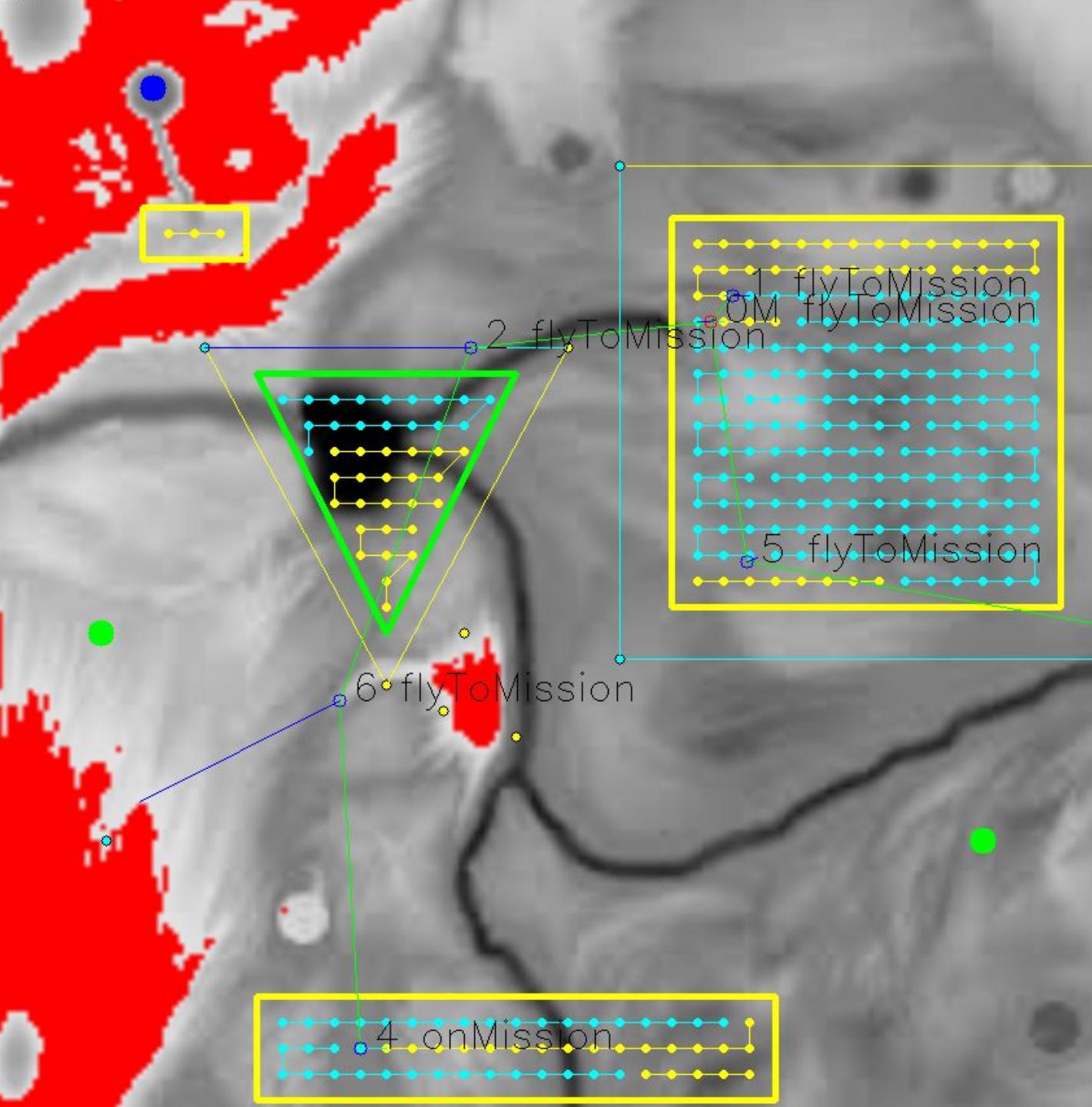
Drone 4: new mission 17  
Drone 0: new mission 3  
Drone 6: new mission 23  
Drone 1: new mission 5  
Drone 5: new mission 16  
Drone 2: new mission 4  
Drone 3: new mission 22  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 5: PAUSE! Collision avoidance with Drone 4  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: executing mission 17...  
Drone 4: new mission 24  
Drone 0: executing mission 3...  
Drone 3: executing mission 22...  
Drone 0: executing mission 3...  
Drone 4: executing mission 24...  
Drone 4: new mission 25  
Drone 0: executing mission 3...  
Drone 0: executing mission 3...  
Drone 0: executing mission 3...  
Drone 4: executing mission 25...  
Drone 4: new mission 21  
Drone 0: executing mission 3...  
Drone 2: executing mission 4...  
Drone 1: executing mission 5...  
Drone 0: executing mission 3...  
Drone 1: executing mission 5...  
Drone 0: executing mission 3...  
Drone 0: new mission 2  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...



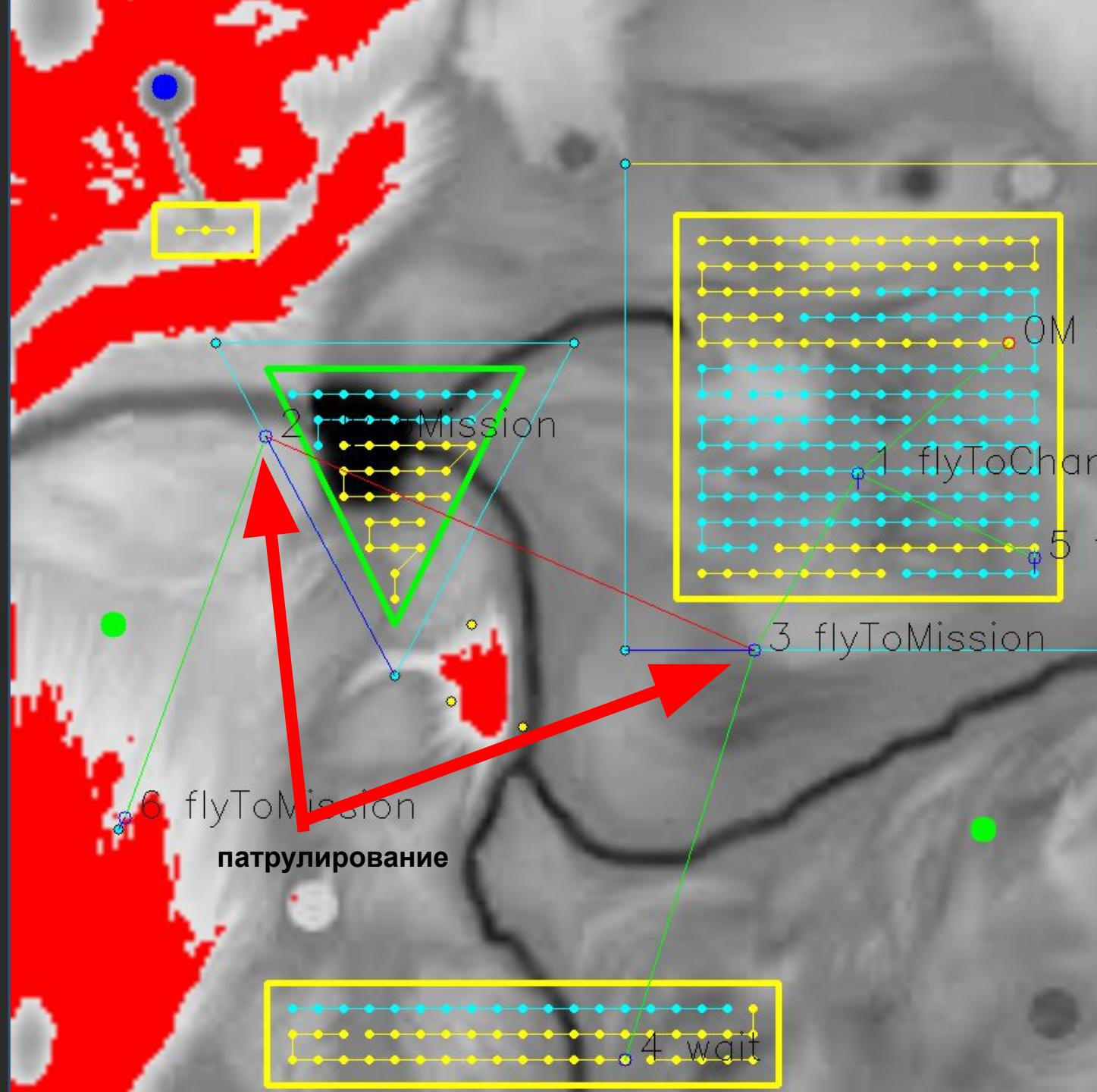
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 4: executing mission 21...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 4: executing mission 21...  
Drone 0: executing mission 2...  
Drone 4: executing mission 21...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 4: executing mission 21...  
Drone 0: executing mission 2...  
Drone 4: executing mission 21...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 3: executing mission 22...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 1: executing mission 5...  
Drone 0: executing mission 2...  
Drone 1: new mission 6



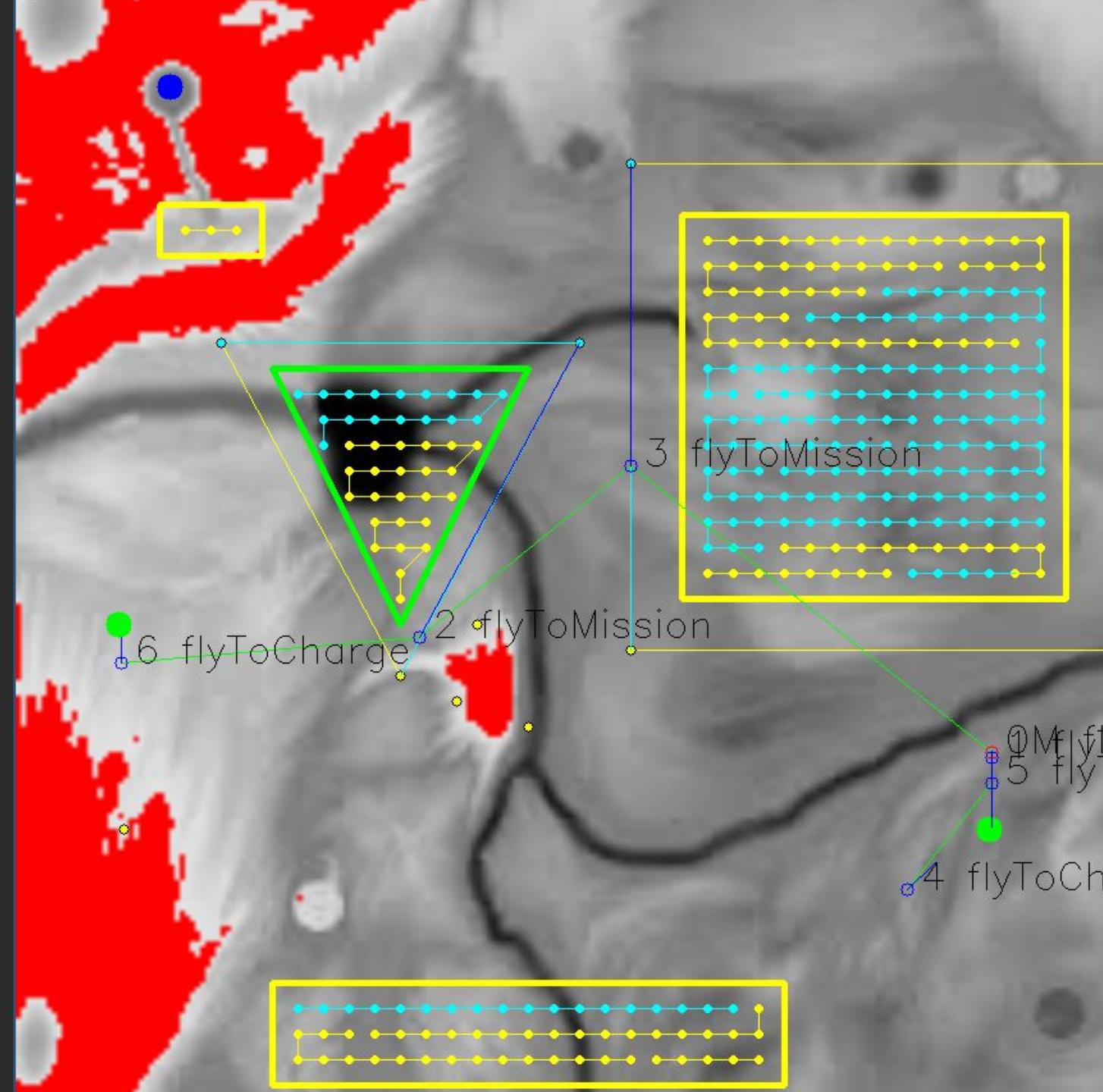
```
drone 0: executing mission 2...
Drone 1: new mission 6
Drone 0: executing mission 2...
Drone 0: new mission 8
Drone 1: executing mission 6...
Drone 4: new mission 19
Drone 1: executing mission 6...
Drone 5: executing mission 16...
Drone 4: executing mission 19...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
Drone 4: executing mission 19...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 6: executing mission 23...
Drone 6: new mission 26
Drone 5: executing mission 16...
Drone 4: executing mission 19...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
Drone 1: executing mission 6...
Drone 2: executing mission 4...
Drone 4: executing mission 19...
Drone 1: executing mission 6...
Drone 4: executing mission 19...
Drone 5: executing mission 16...
```



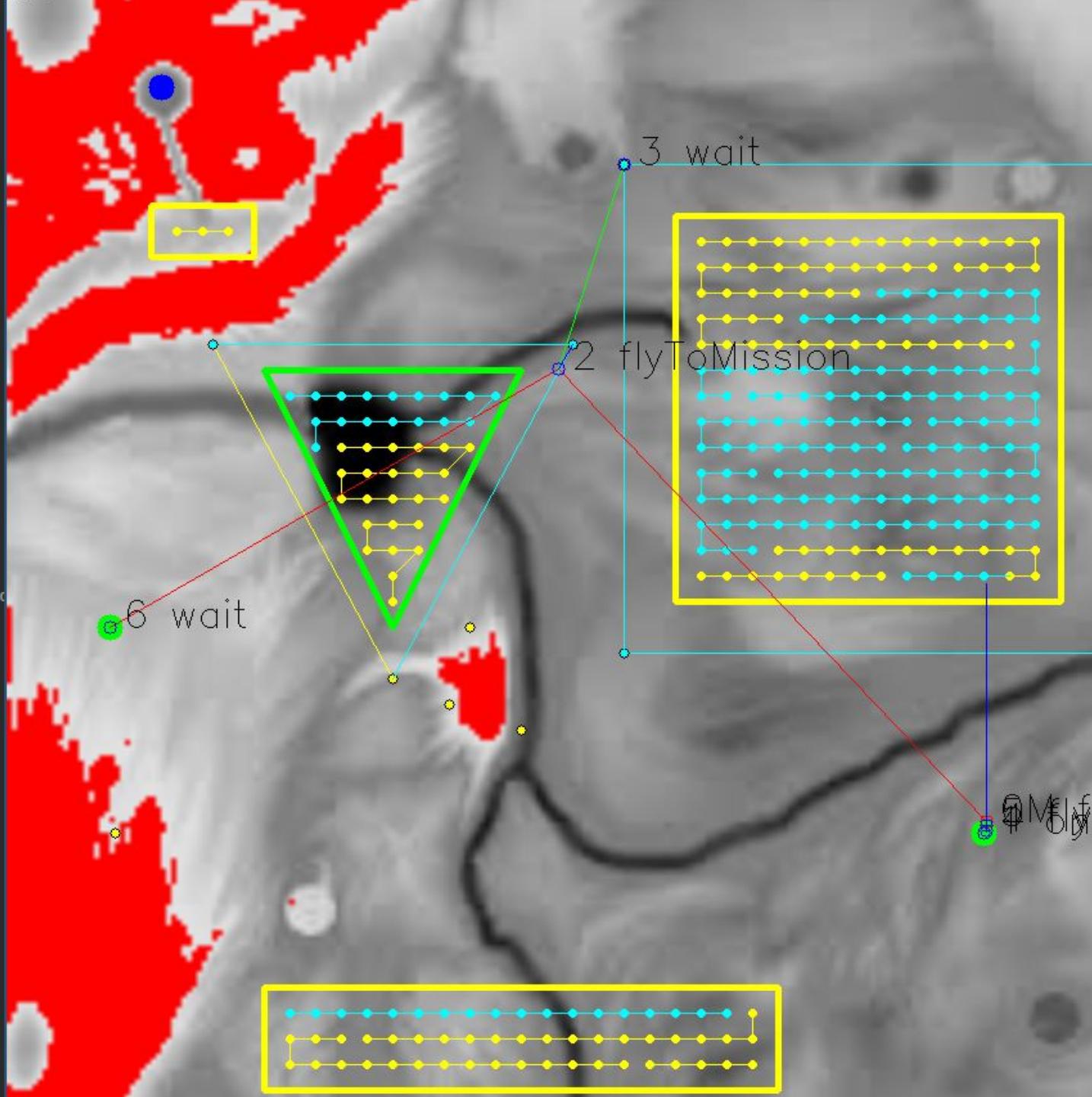
```
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 0: executing mission 8...
Drone 1: executing mission 6...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 1: executing mission 6...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 0: executing mission 8...
Drone 1: low battery, flying to station 2
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 2: executing mission 4...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 2: new mission 4
Drone 0: executing mission 8...
Drone 2: executing mission 4...
Drone 4: executing mission 20...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 5: executing mission 15...
```



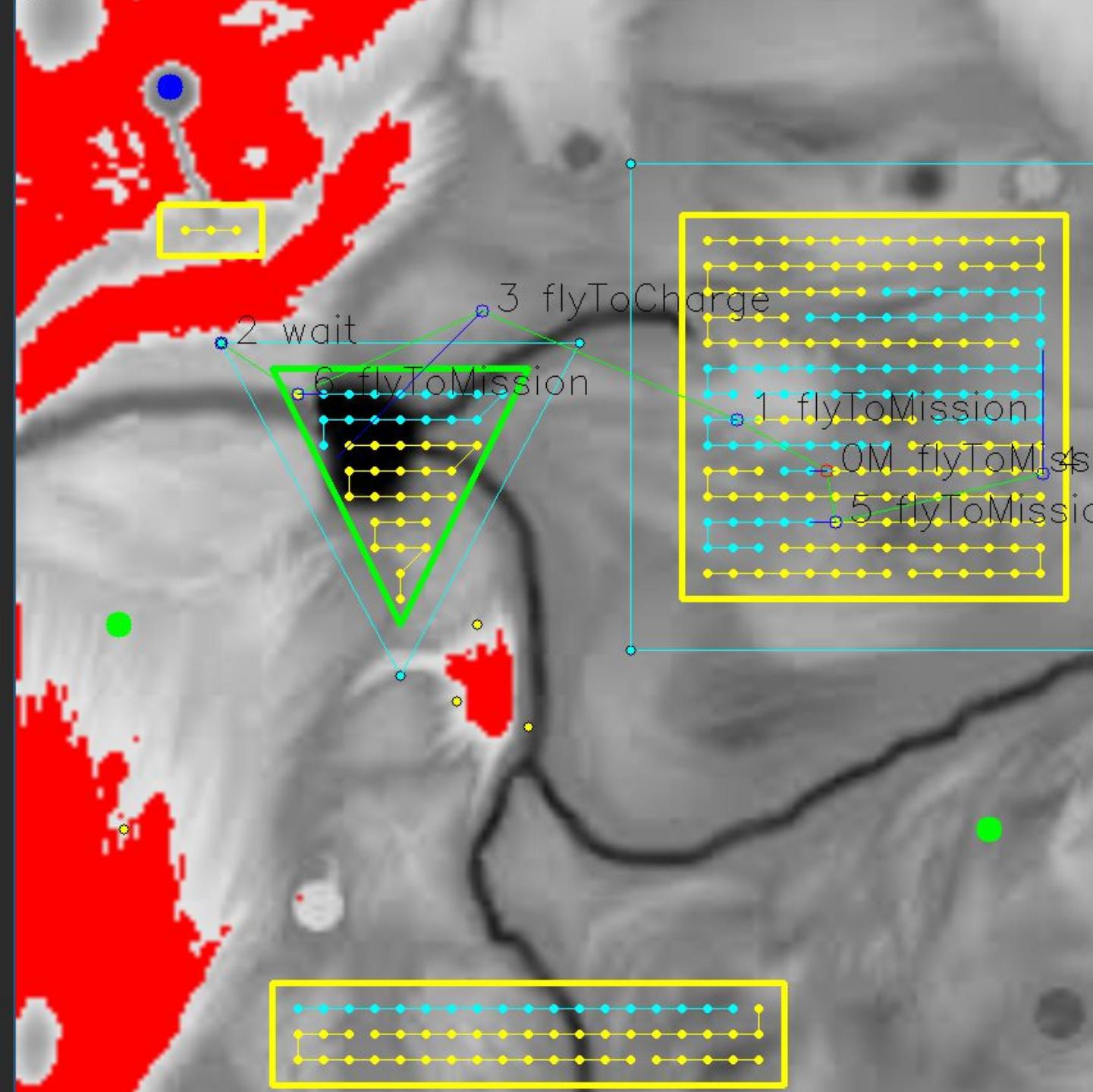
```
drone 1: executing mission 6...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 0: executing mission 8...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 1: low battery, flying to station 2
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 2: executing mission 4...
Drone 4: executing mission 20...
Drone 5: executing mission 15...
Drone 2: new mission 4
Drone 0: executing mission 8...
Drone 2: executing mission 4...
Drone 4: executing mission 20...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 5: executing mission 15...
Drone 5: executing mission 15...
Drone 0: low battery, flying to station 2
Drone 5: executing mission 15...
Drone 6: executing mission 26...
Drone 5: executing mission 15...
Drone 5: low battery, flying to station 2
Drone 6: low battery, flying to station 3
Drone 4: low battery, flying to station 2
Drone 3: executing mission 22...
```



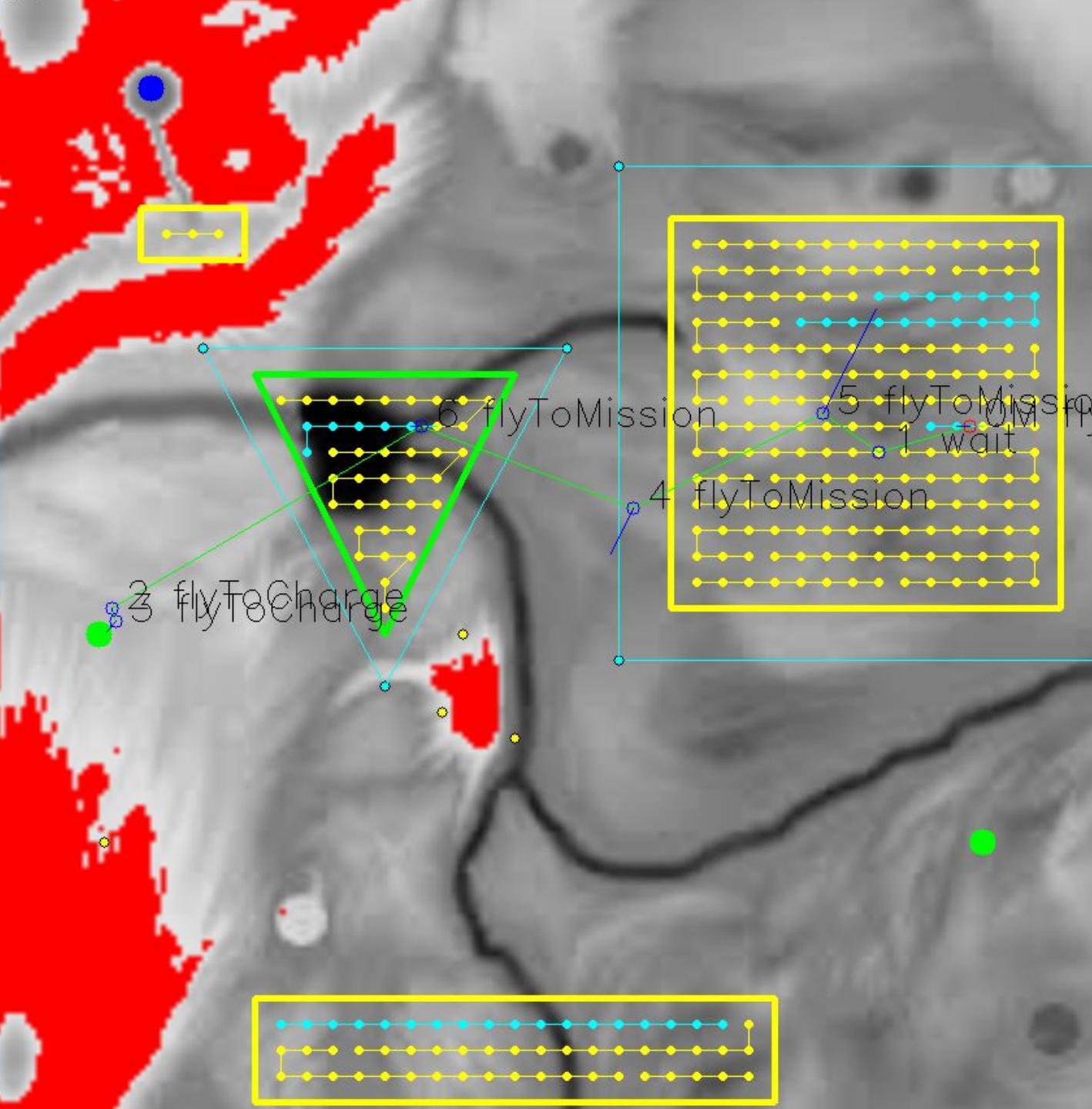
```
drone 5: executing mission 15...
Drone 2: new mission 4
Drone 0: executing mission 8...
Drone 2: executing mission 4...
Drone 4: executing mission 20...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 4: executing mission 20...
Drone 0: executing mission 8...
Drone 5: executing mission 15...
Drone 5: executing mission 15...
Drone 0: low battery, flying to station 2
Drone 5: executing mission 15...
Drone 6: executing mission 26...
Drone 5: executing mission 15...
Drone 5: low battery, flying to station 2
Drone 6: low battery, flying to station 3
Drone 4: low battery, flying to station 2
Drone 3: executing mission 22...
Drone 2: executing mission 4...
Drone 0: PAUSE! Collision avoidance with Drone 5
Drone 5: on charge...
Drone 0: on charge...
Drone 6: on charge...
Drone 0: Agro payload updated to 1000!
Drone 4: on charge...
Drone 1: on charge...
Drone 5: charge finished
Drone 5: charged! waiting...
Drone 5: new mission 14
Drone 0: charge finished
Drone 0: charged! waiting...
Drone 6: charge finished
Drone 6: charged! waiting...
Drone 0: new mission 12
Drone 4: charge finished
Drone 4: charged! waiting...
Drone 4: new mission 15
```



```
drone 4: executing mission 13...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 2: executing mission 4...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 3: low battery, flying to station 3
Drone 1: executing mission 11...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 0: executing mission 12...
Drone 1: executing mission 11...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 1: executing mission 11...
Drone 5: executing mission 14...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 1: executing mission 11...
Drone 4: executing mission 13...
Drone 0: executing mission 12...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 1: executing mission 11...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 4: executing mission 13...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 5: executing mission 14...
Drone 0: executing mission 12...
Drone 4: executing mission 13...
Drone 1: executing mission 11...
```



Drone 2: low battery, flying to station 3  
Drone 0: executing mission 10...  
Drone 1: executing mission 11...  
Drone 4: executing mission 9...  
Drone 5: executing mission 14...  
Drone 0: executing mission 10...  
Drone 4: executing mission 9...  
Drone 6: executing mission 1...  
Drone 1: executing mission 11...  
Drone 4: executing mission 9...  
Drone 0: executing mission 10...  
Drone 5: executing mission 14...  
Drone 4: executing mission 9...  
Drone 1: executing mission 11...  
Drone 6: executing mission 1...  
Drone 0: executing mission 10...  
Drone 4: executing mission 9...  
Drone 5: executing mission 14...  
Drone 4: executing mission 9...  
Drone 5: new mission 7  
Drone 0: executing mission 10...  
Drone 1: executing mission 11...  
Drone 4: executing mission 9...  
Drone 6: executing mission 1...  
Drone 4: executing mission 9...  
Drone 0: executing mission 10...  
Drone 4: executing mission 9...  
Drone 0: executing mission 10...  
Drone 4: executing mission 9...  
Drone 6: executing mission 1...  
Drone 0: executing mission 10...  
Drone 4: executing mission 9...  
Drone 4: executing mission 9...  
Drone 4: new mission 18  
Drone 0: executing mission 10...  
Drone 6: executing mission 1...  
Drone 0: executing mission 10...  
Drone 0: executing mission 10...  
Drone 6: executing mission 1...  
Drone 0: executing mission 10...



# Что реализовано

- 1) Прокладка маршрутов с учетом DEM (карты высот)
- 2) Дрон избегает столкновений (с другими дронами)

# Что реализовано

- 1) Прокладка маршрутов с учетом DEM (карты высот)
- 2) Дрон избегает столкновений (с другими дронами)
- 3) Дроны могут добавляться/исчезать
- 4) Миссии распределяются модификацией Венгерского алгоритма
- 5) Учитывается связность по радиосигналу

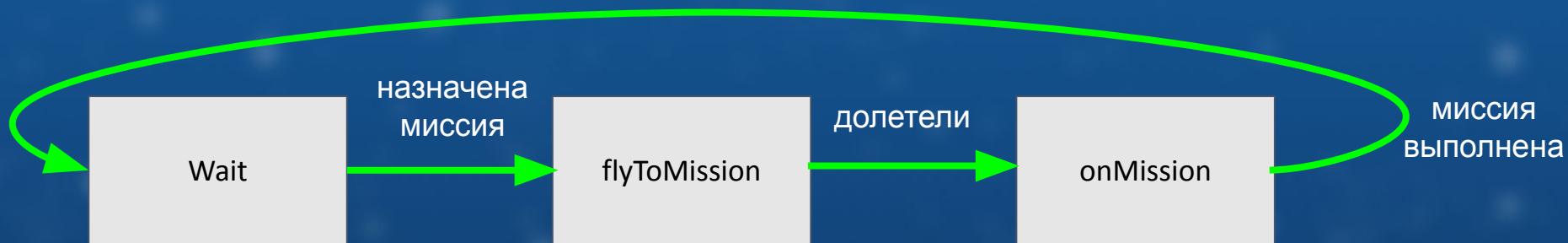
# Что реализовано

- 1) Прокладка маршрутов с учетом DEM (карты высот)
- 2) Дрон избегает столкновений (с другими дронами)
- 3) Дроны могут добавляться/исчезать
- 4) Миссии распределяются модификацией Венгерского алгоритма
- 5) Учитывается связность по радиосигналу
- 6) Дрон отправляется к зарядной станции в момент когда это последний шанс успеть до нее долететь
- 7) Из зарядных станций выбирается ближайшая
- 8) Визуализатор для отладки (произвольная скорость симуляции)

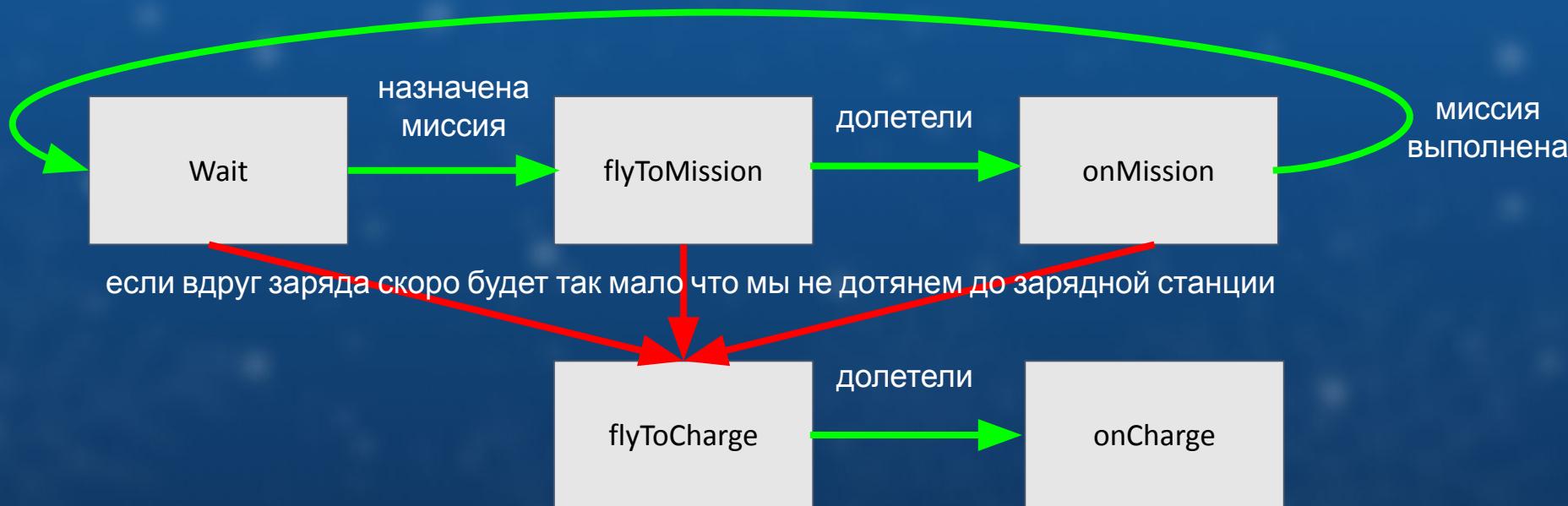
# Что реализовано

- 1) Прокладка маршрутов с учетом DEM (карты высот)
- 2) Дрон избегает столкновений (с другими дронами)
- 3) Дроны могут добавляться/исчезать
- 4) Миссии распределяются модификацией Венгерского алгоритма
- 5) Учитывается связность по радиосигналу
- 6) Дрон отправляется к зарядной станции в момент когда это последний шанс успеть до нее долететь
- 7) Из зарядных станций выбирается ближайшая
- 8) Визуализатор для отладки (произвольная скорость симуляции)
- 9) Вся информация - параметрическая - используется **json** (о каждом дроне/миссии/полезной нагрузке)

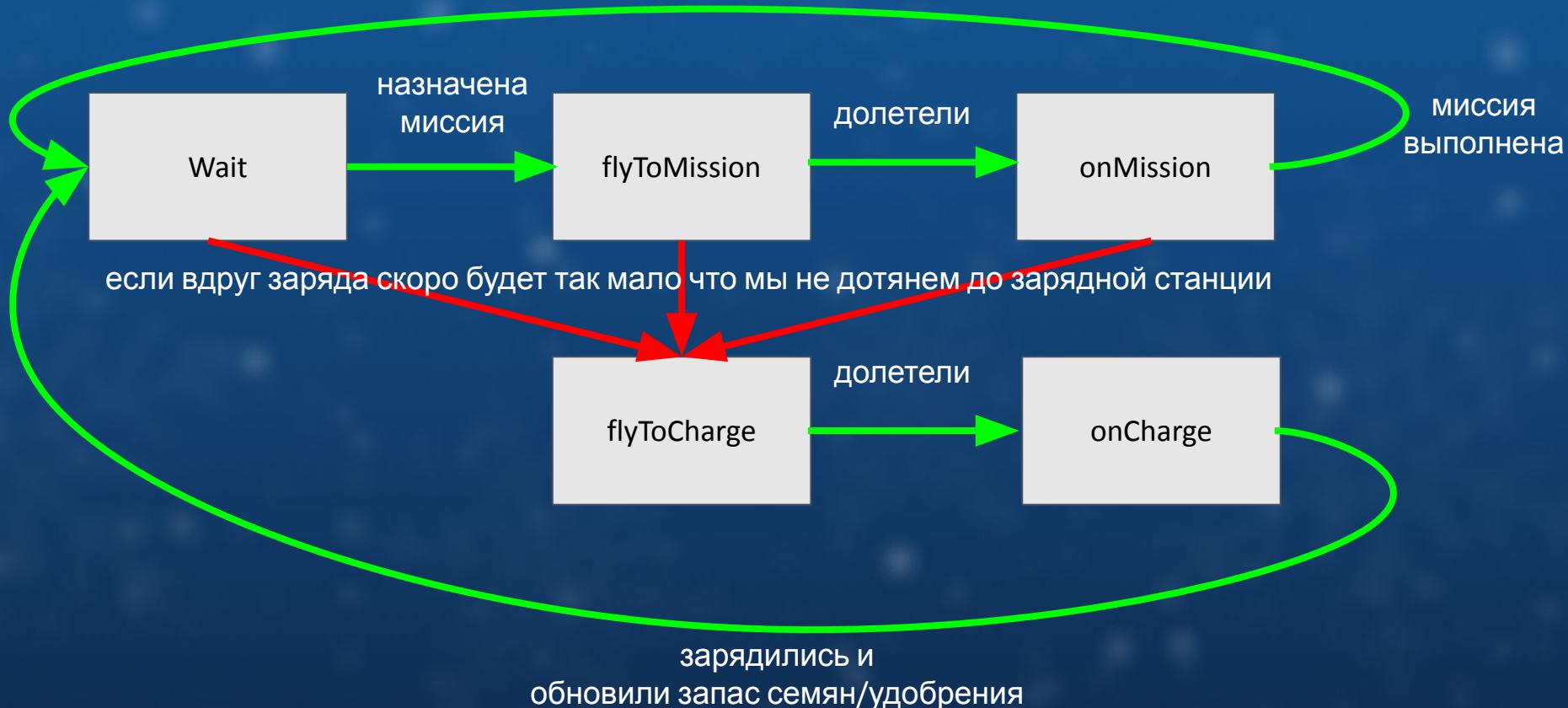
# Управление дроном: Finite-state Machine



# Управление дроном: Finite-state Machine



# Управление дроном: Finite-state Machine



world.json

```
1 {  
2   "world": {  
3     "dem_resolution": 100.0,  
4     "dem_path": "data/dem.png",  
5     "maximum_allowed_height": 227,  
6     "simulation_step": 10,  
7     "wireless_range": 10000,  
8     "charge_power": 10  
9   }  
10 }  
11 
```

stations.json

```
1 {  
2   "stations": [  
3     {  
4       "type": "control",  
5       "x": 3000,  
6       "y": 2500  
7     },  
8     {  
9       "type": "charge",  
10      "x": 19000,  
11      "y": 17000  
12    },  
13    {  
14      "type": "charge",  
15      "x": 2000,  
16      "y": 13000  
17    }  
18  ]  
19 }  
20 
```

drones.json

```
1 {  
2   "drones": [  
3     {  
4       "isMaster": true,  
5       "payload": [  
6         "agro",  
7         "3dLidar",  
8         "highresCamera",  
9         "geoRadar"  
10      ],  
11      "payloadAgroVolume": 1000,  
12      "speed" : 8,  
13      "lifetime" : 7500  
14    },  
15    {  
16      "isMaster": false,  
17      "payload": [  
18        "highresCamera"  
19      ],  
20      "speed" : 6,  
21      "lifetime" : 7500  
22    },  
23    {  
24      "isMaster": false,  
25      "payload": [  
26        "patrolCamera"  
27      ],  
28      "speed" : 6,  
29      "lifetime" : 12000  
30    }  
31  }  
32 }  
33 
```

missions.json

```
1 {  
2   "missions": [  
3     {  
4       "type": "agro",  
5       "agroVolumePerSecond": 1000,  
6       "polygon": [  
7         [5000, 8000], [7500, 10000]  
8       ]  
9     },  
10    {  
11      "type": "patrolCamera",  
12      "patrolpolygon": [[4000, 5000], [6000, 5000], [6000, 7000], [4000, 7000]]  
13    },  
14    {  
15      "type": "highresCamera",  
16      "rect": [13000, 5000, 15000, 6000]  
17    },  
18    {  
19      "type": "highresCamera",  
20      "rect": [2800, 4800, 3000, 5200]  
21    },  
22    {  
23      "type": "highresCamera",  
24      "rect": [5000, 20000, 5200, 22000]  
25    },  
26    {  
27      "type": "patrolCamera",  
28      "patrolrect": [12000, 10000, 14000, 12000]  
29    },  
30    {  
31      "type" : "cargo",  
32      "destination" : [9000, 10000]  
33    }  
34  }  
35 }  
36 
```

# Алгоритм распределения рабочих задач

**Модификация Венгерского алгоритма:**

- учет связности по радиосигналу
- учет наличия требуемой полезной нагрузки

# Алгоритм распределения рабочих задач

**Модификация Венгерского алгоритма:**

- учет связности по радиосигналу
- учет наличия требуемой полезной нагрузки
- учитывается хватит ли дрону аккумулятора для того чтобы долететь и выполнить существенную часть миссии
- учитывается хватит ли дрону полезной нагрузки (удобрений/семян)

# Алгоритм распределения рабочих задач

**Модификация Венгерского алгоритма:**

- учет связности по радиосигналу
- учет наличия требуемой полезной нагрузки
- учитывается хватит ли дрону аккумулятора для того чтобы долететь и выполнить существенную часть миссии
- учитывается хватит ли дрону полезной нагрузки (удобрений/семян)
- учитывается насколько мы “заменяемы” на этой миссии: если рядом скоро закончит работу другой дрон, то получаем небольшую пенальти (лучше взять другую задачу)
- в целом реализация гибкая и легко чуть изменить приоритеты

# Спасибо за внимание!



[https://github.com/PolarNick239/  
HackathonDroneSwarm](https://github.com/PolarNick239/HackathonDroneSwarm)

Команда “Может по ржать?”

- Николай Полярный [PolarNick239@gmail.com](mailto:PolarNick239@gmail.com)
- Борис Симиютин [simiyutin.boris@yandex.ru](mailto:simiyutin.boris@yandex.ru)

