GROUP 13

Introduction to IoT

GEOFENCE

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Minh Khoi - Minh Khoa - Nguyen Khoa - Duc Khang

WHAT IS GEOFENCE ?

WHAT IS GEOFENCE ?

WHAT IS GEOFENCE ?

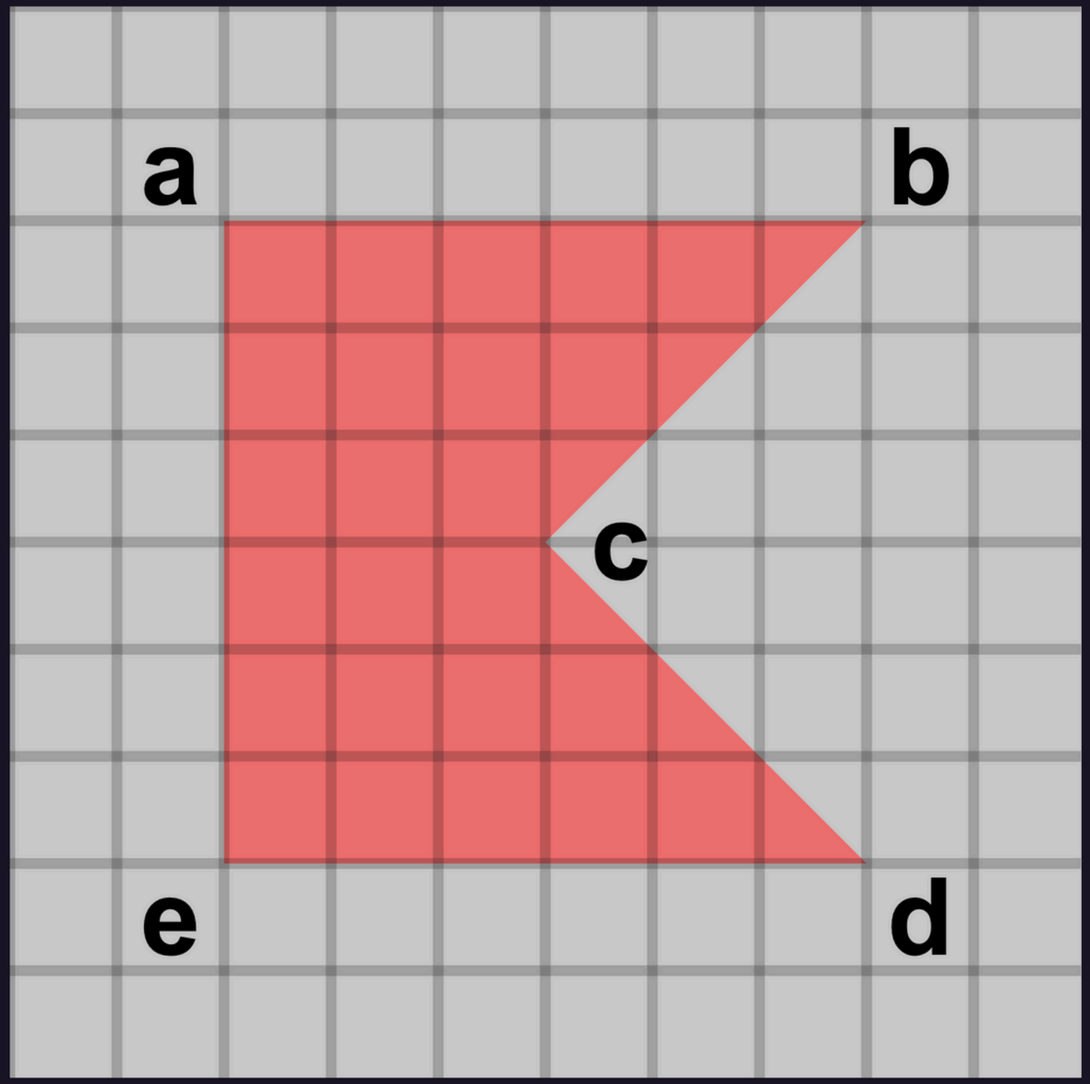
WHAT IS GEOFENCE ?

Point in Polygon

Ray Casting Algorithm

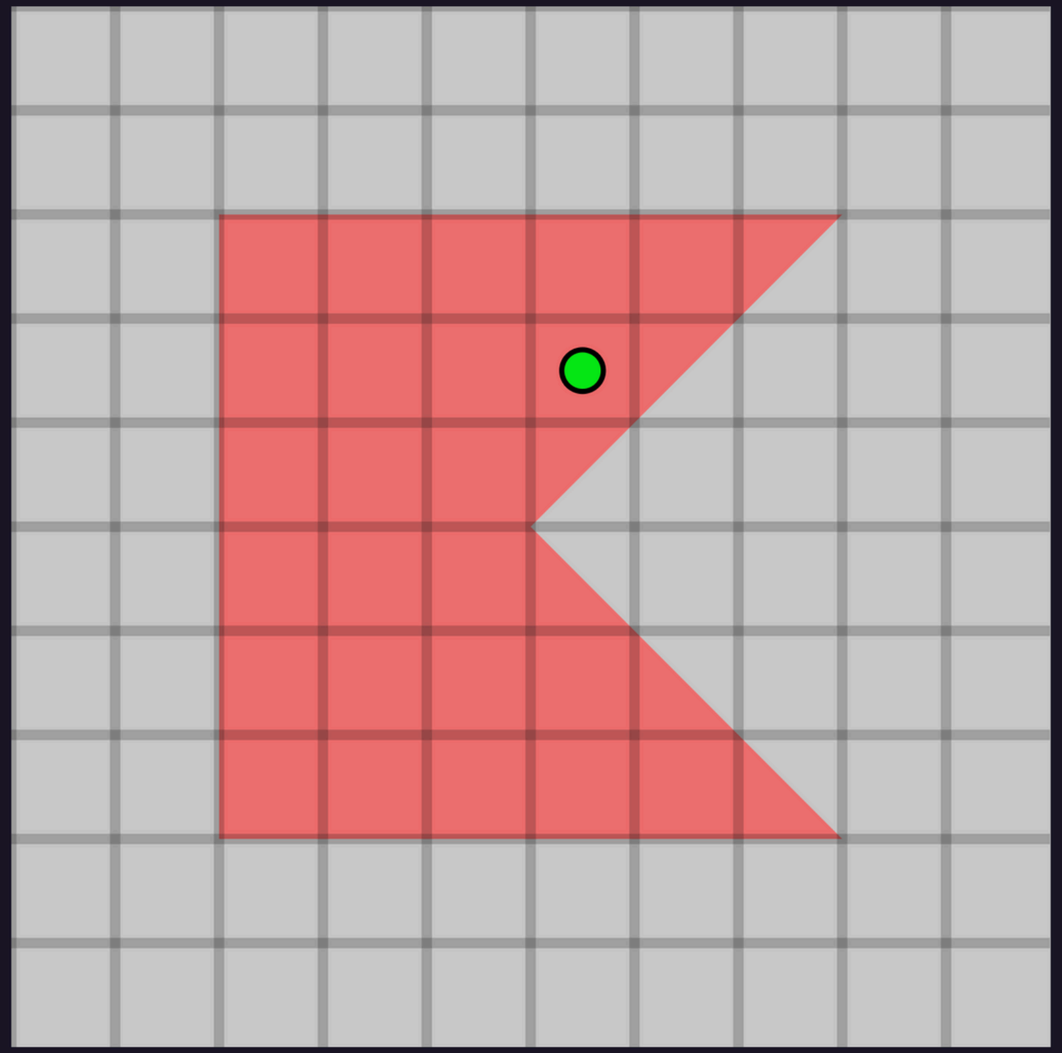
There is a polygon with vertices:

$$a = (20, 20), b = (80, 20), c = (50, 50), d = (80, 80),$$


a
b
c
e
d

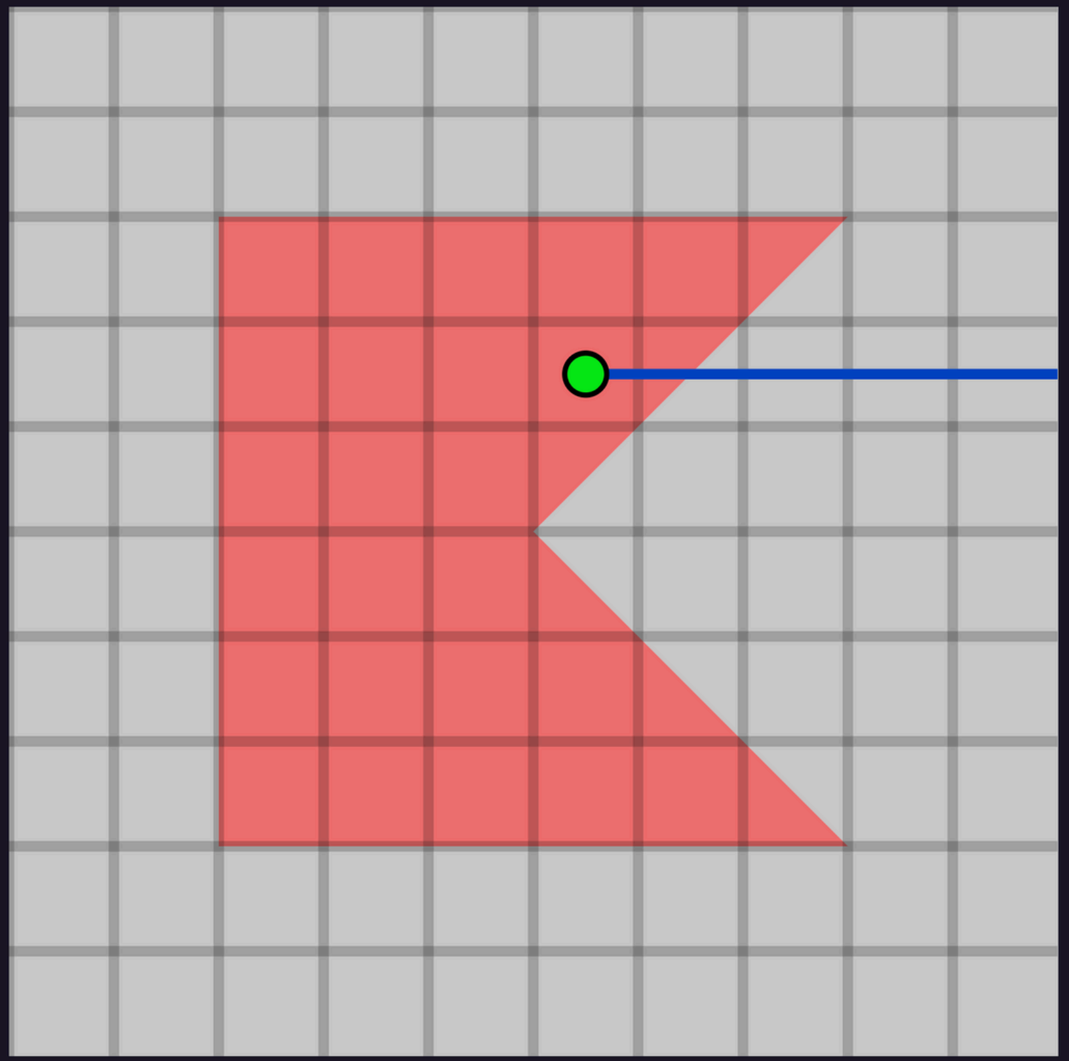
and we have to check if a point $\mathbf{p}$ is within the perimeter of that polygon:

$$\mathbf{p} = (55, 35)$$



We can see that the point is inside, but how to test it numerically ?

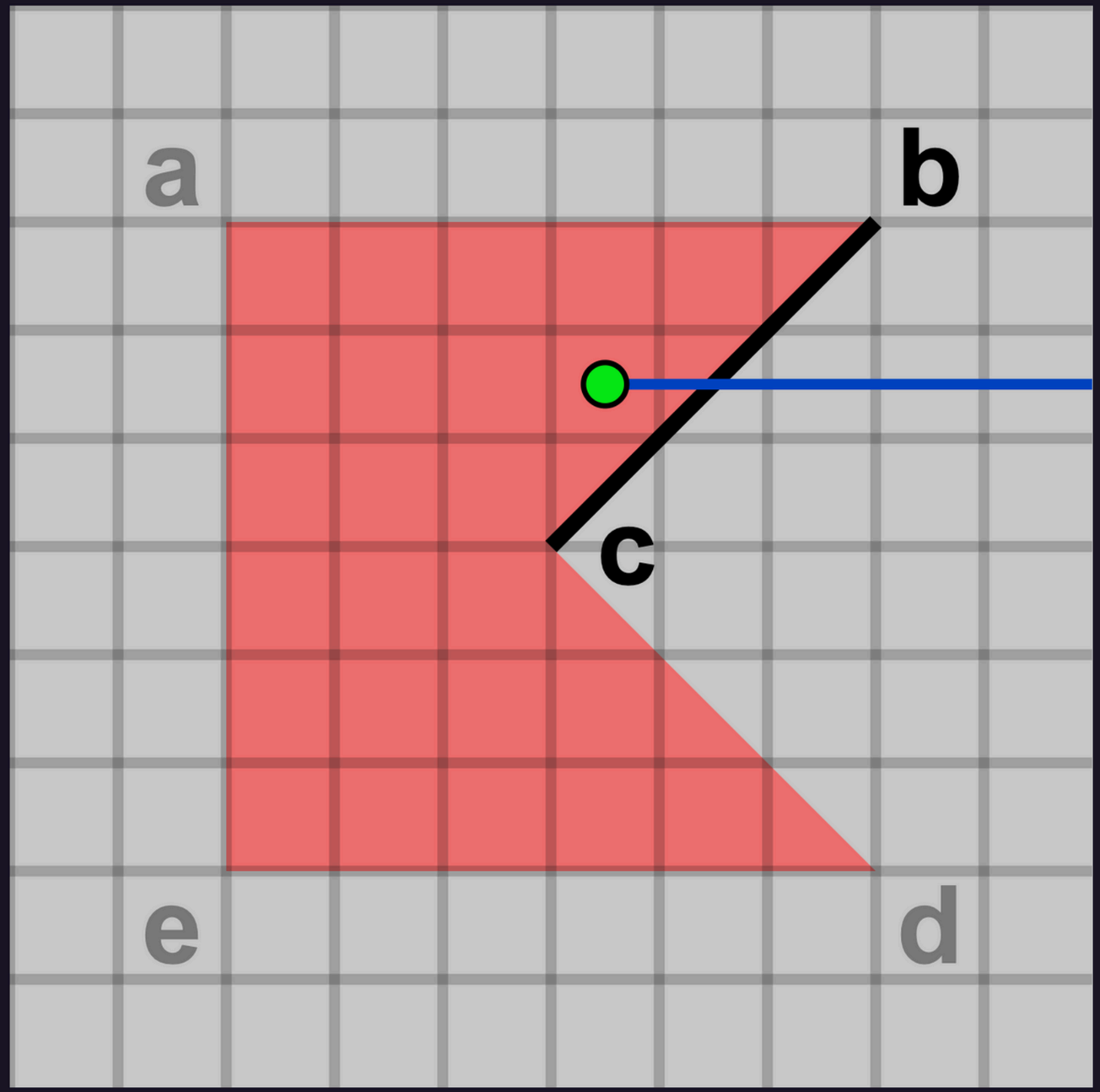
Draw a horizontal line from the point, and if this line intersects the polygon an odd number of times, the point is inside; otherwise is outside de polygon.



We do this by testing for each side whether the line crosses it or not.

For example the side $\overline{bc}$:

$$b_x = 80, b_y = 20$$
$$c_x = 50, c_y = 50$$
$$\mathbf{p}_x = 55, \mathbf{p}_y = 35$$

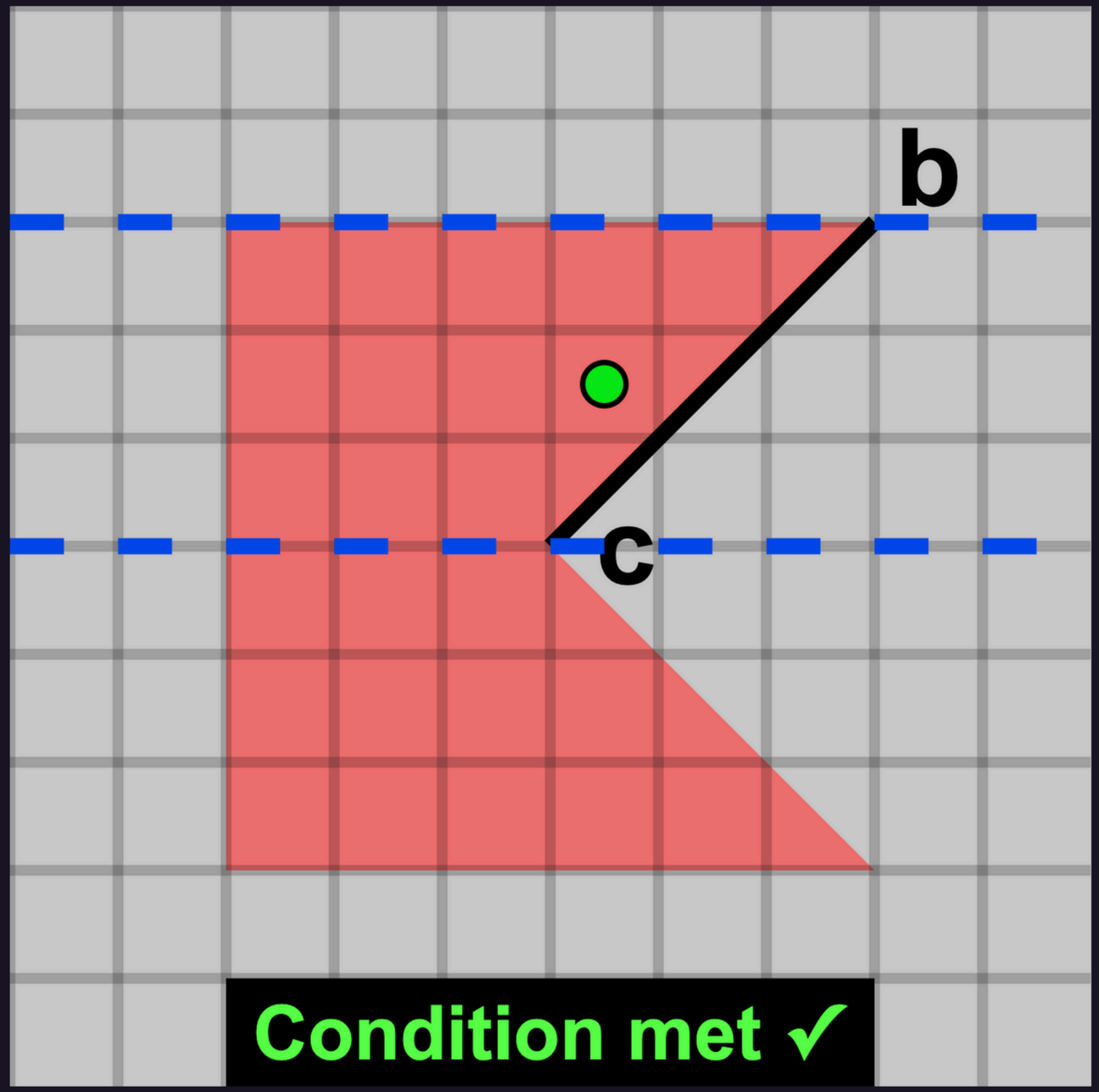

a
b
c
e
d

Two conditions must be met for the intersection to occur:

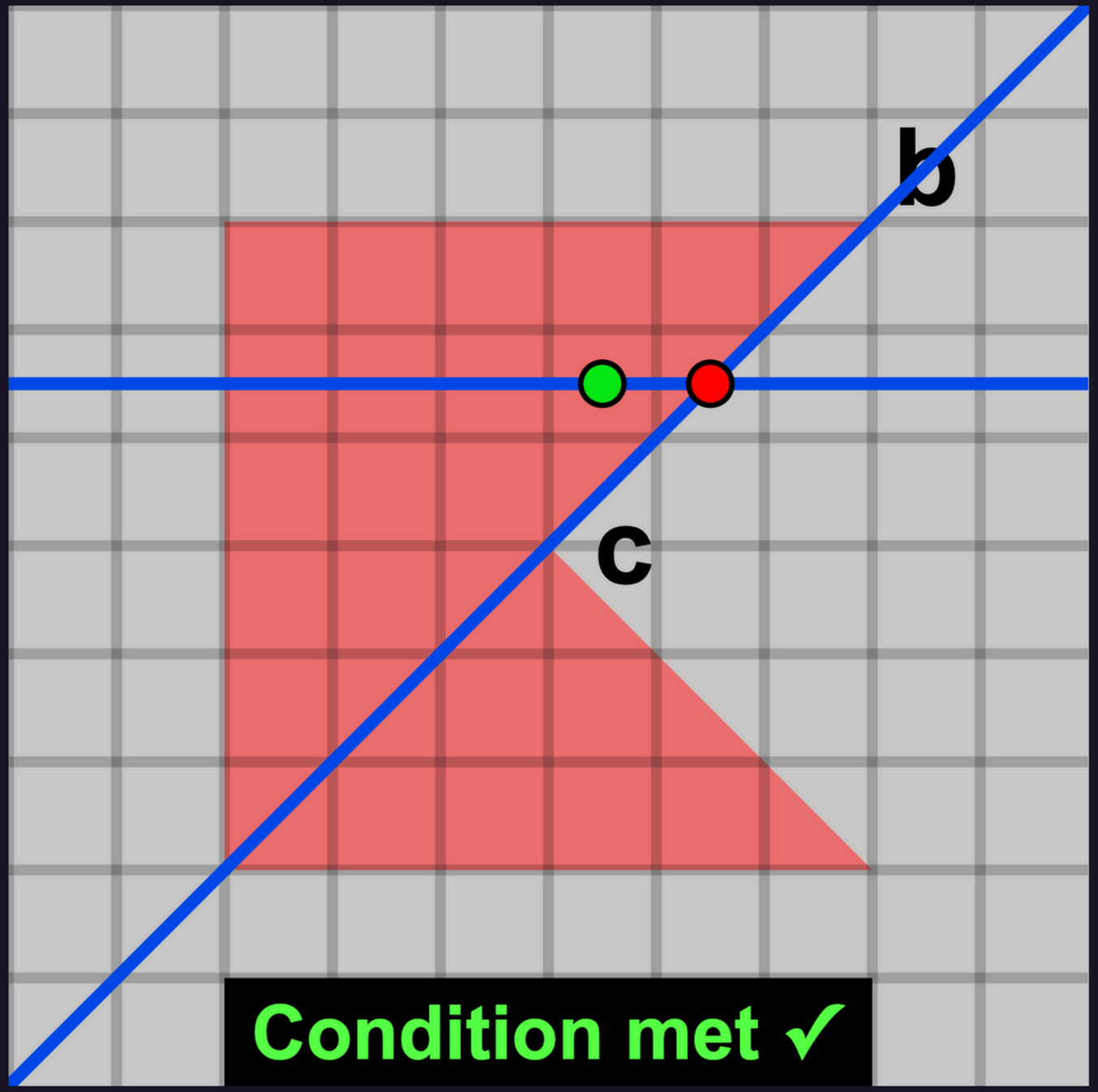
The point must be between the endpoints of the side, in the vertical axis:

$$(\mathbf{p}_y < b_y) \neq (\mathbf{p}_y < c_y)$$

$$(35 < 20) \neq (35 < 50)$$


b
c
Condition met ✓

If so, the x coordinate of the point must be less than the x coordinate of the intersection point.


b
c
Condition met ✓

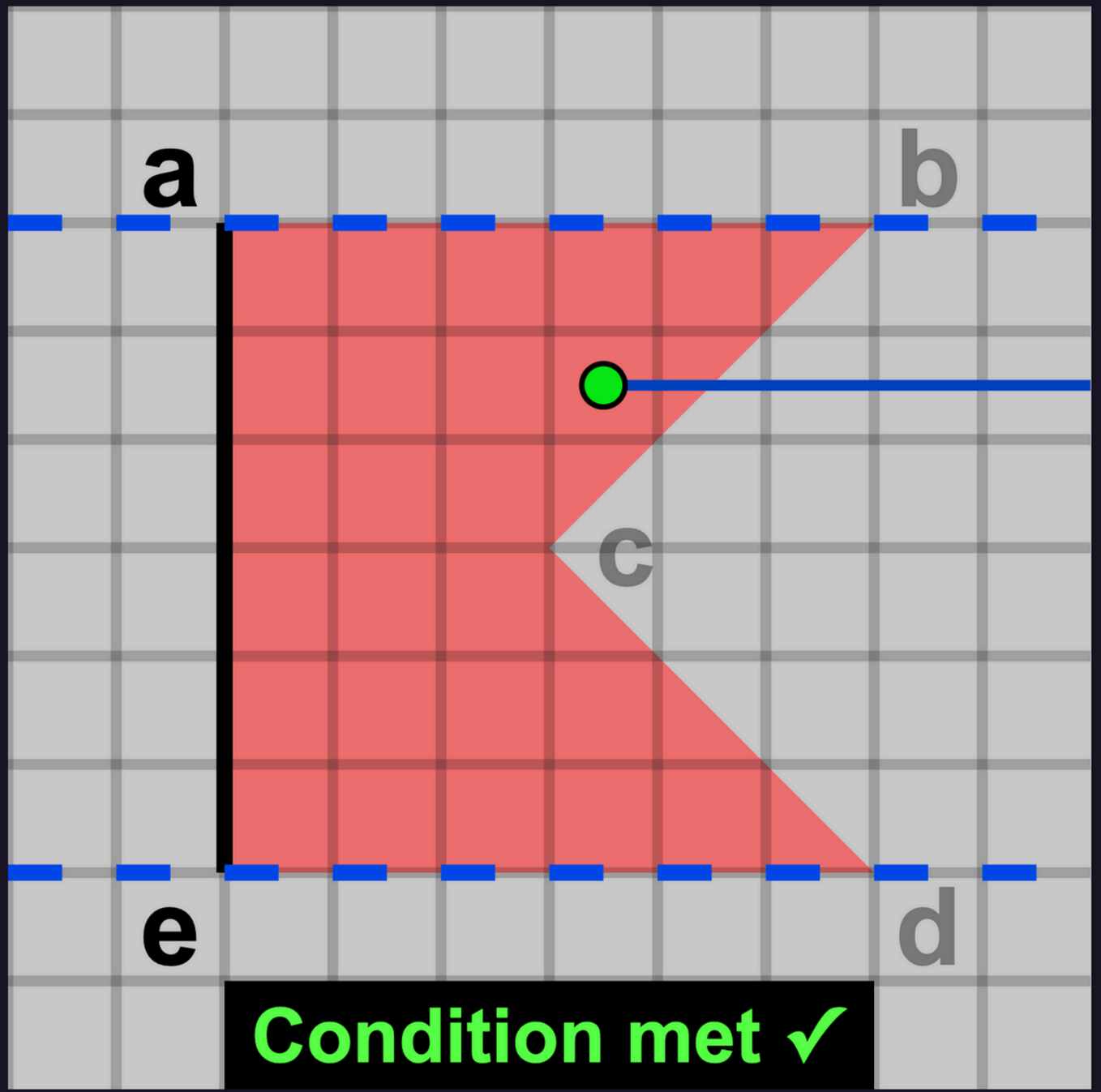
This intersection point is derived from the two-point form equation of a line:

$$(x_2 - x_1)(y - y_1) - (y_2 - y_1)(x - x_1) = 0$$

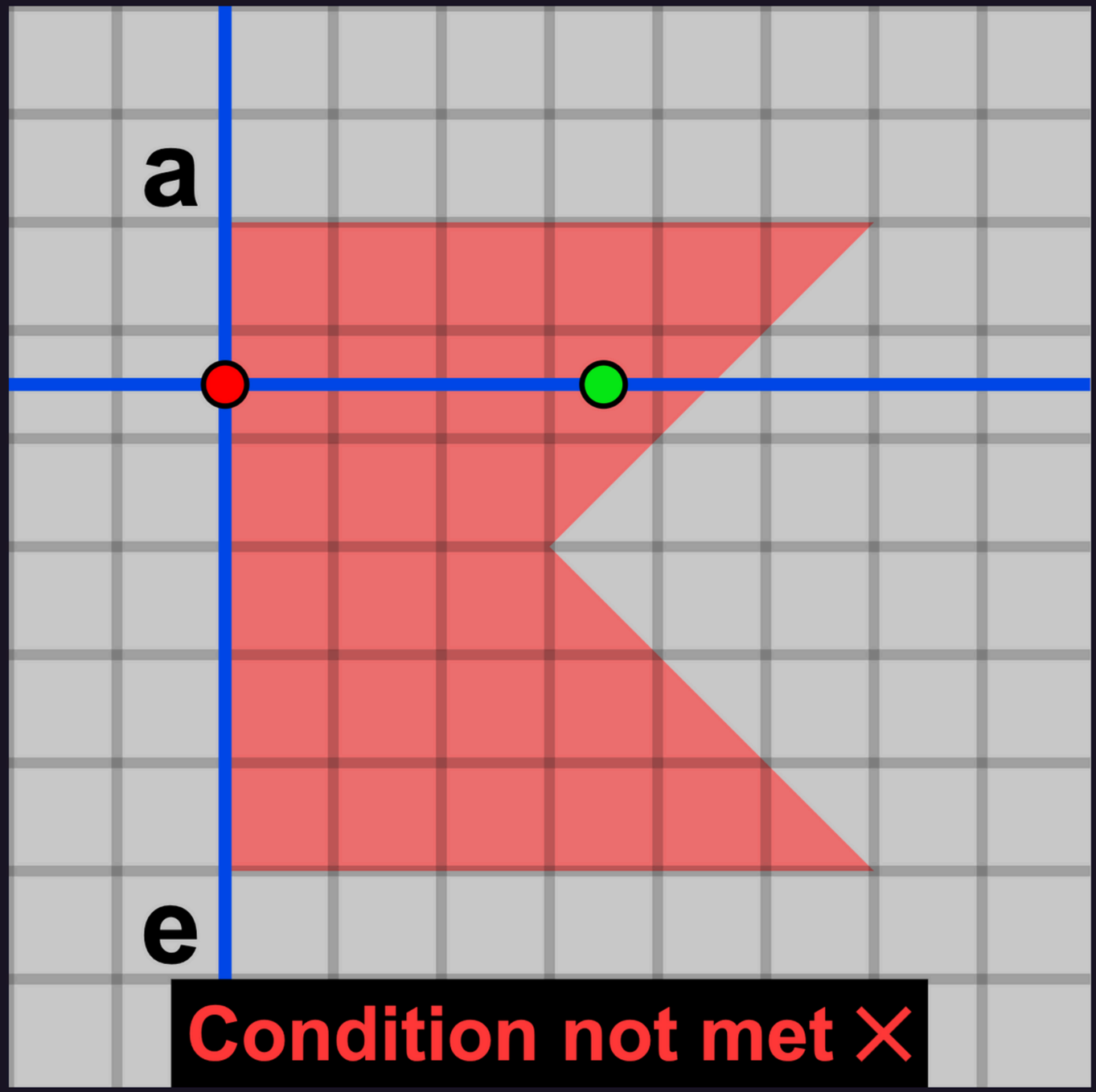
$$x = \frac{(x_2 - x_1)(y - y_1)}{(y_2 - y_1)} + x_1$$

We do this with each side. If we end up with an odd number of intersections, then the point is within the polygon.

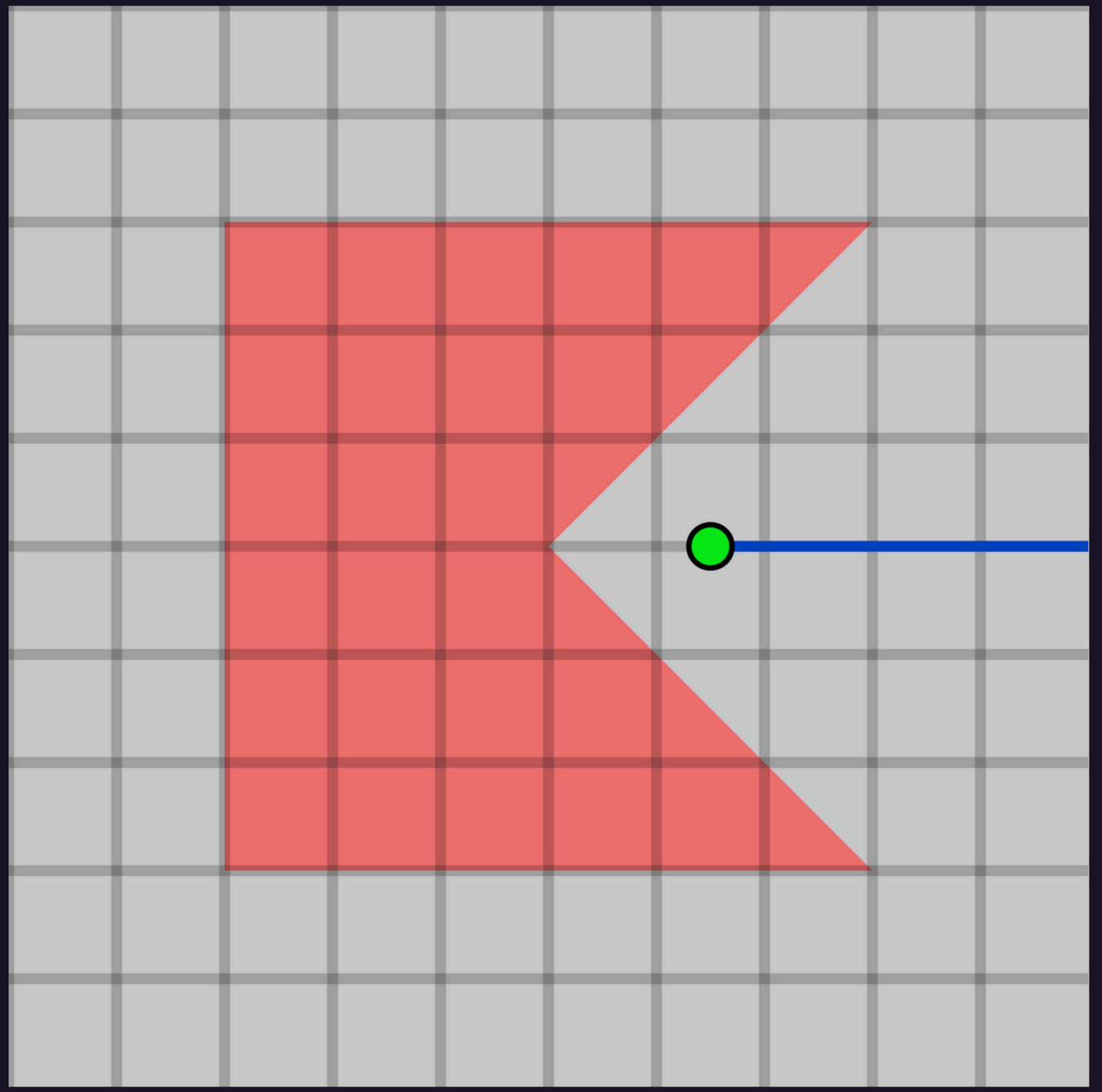
For example the side $\overline{ea}$ meets the first condition:


a
b
c
d
e
Condition met ✓

But not the second one:

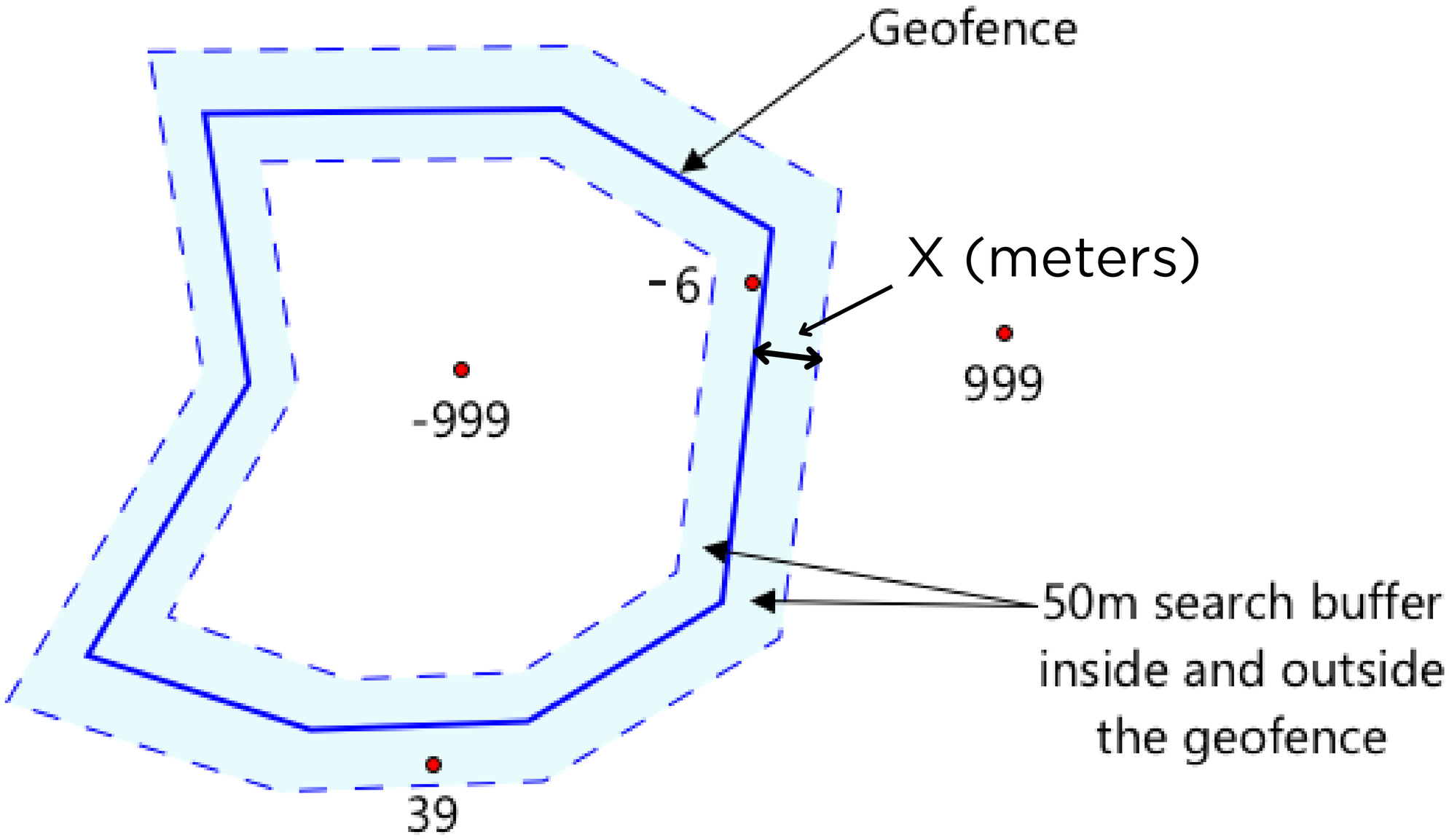

a
e
Condition not met ×

What about a point with zero intersections ?:



A point with zero intersections is outside, because zero is an even number.


SEARCH
BUFFER


Geofence
X (meters)
-6
999
-999
39
50m search buffer
inside and outside
the geofence

USAGE?

Test points against a geofence

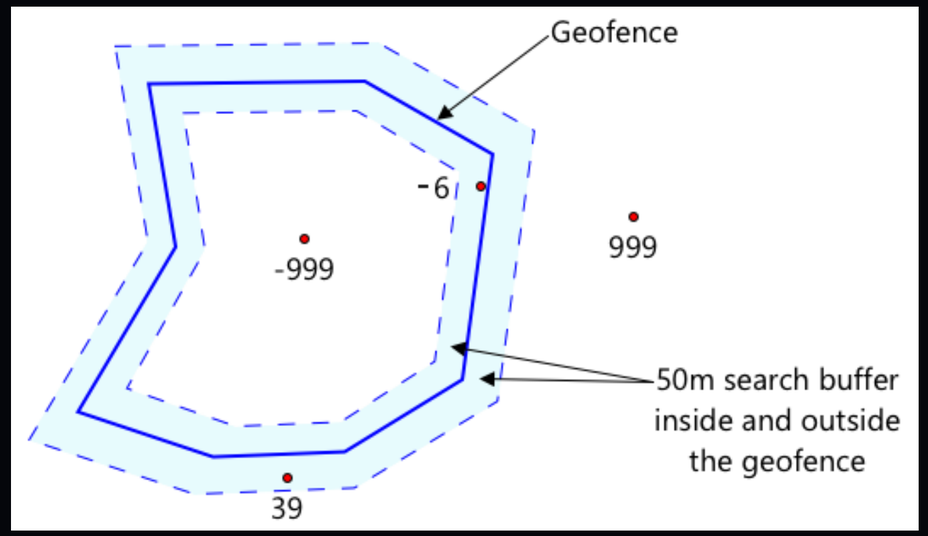
Once the polygon has been uploaded to Azure Maps, you can test a point to see if it is inside or outside the geofence. You do this by making a web API request, passing in the UDID of the geofence, and the latitude and longitude of the point to test.

When you make this request, you can also pass a value called the `searchBuffer`. This tells the Maps API how accurate to be when returning results. The reason for this is GPS is not perfectly accurate, and sometimes locations can be out by meters if not more. The default for the search buffer is 50m, but you can set values from 0m to 500m.

When results are returned from the API call, one of the parts of the result is a `distance` measured to the closest point on the edge of the geofence, with a positive value if the point is outside the geofence, negative if it is inside the geofence. If this distance is less than the search buffer, the actual distance is returned in meters, otherwise the value is 999 or -999. 999 means that the point is outside the geofence by more than the search buffer, -999 means it is inside the geofence by more than the search buffer.


DATA CONTROLLER

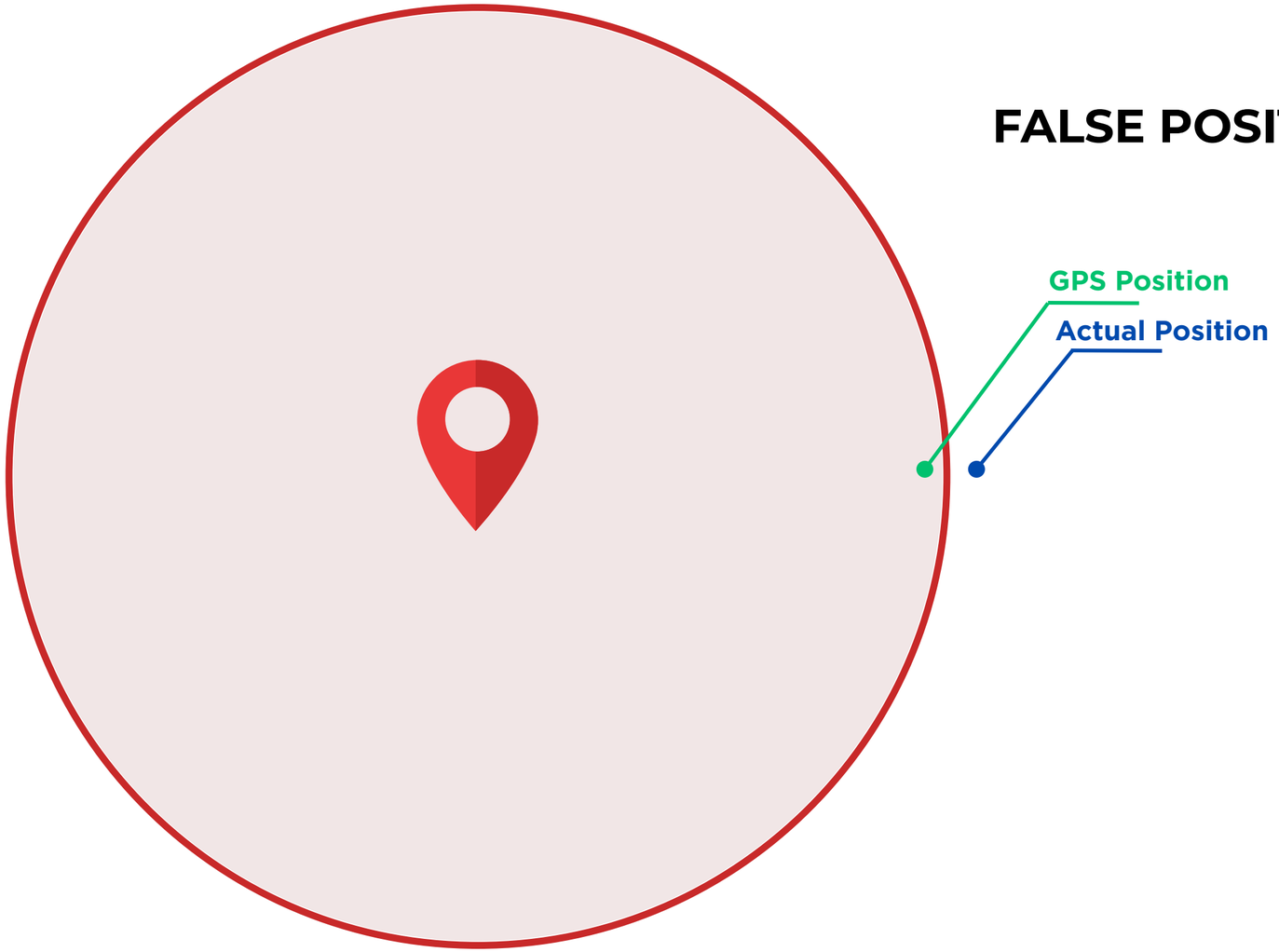

DATA CONTROLLER

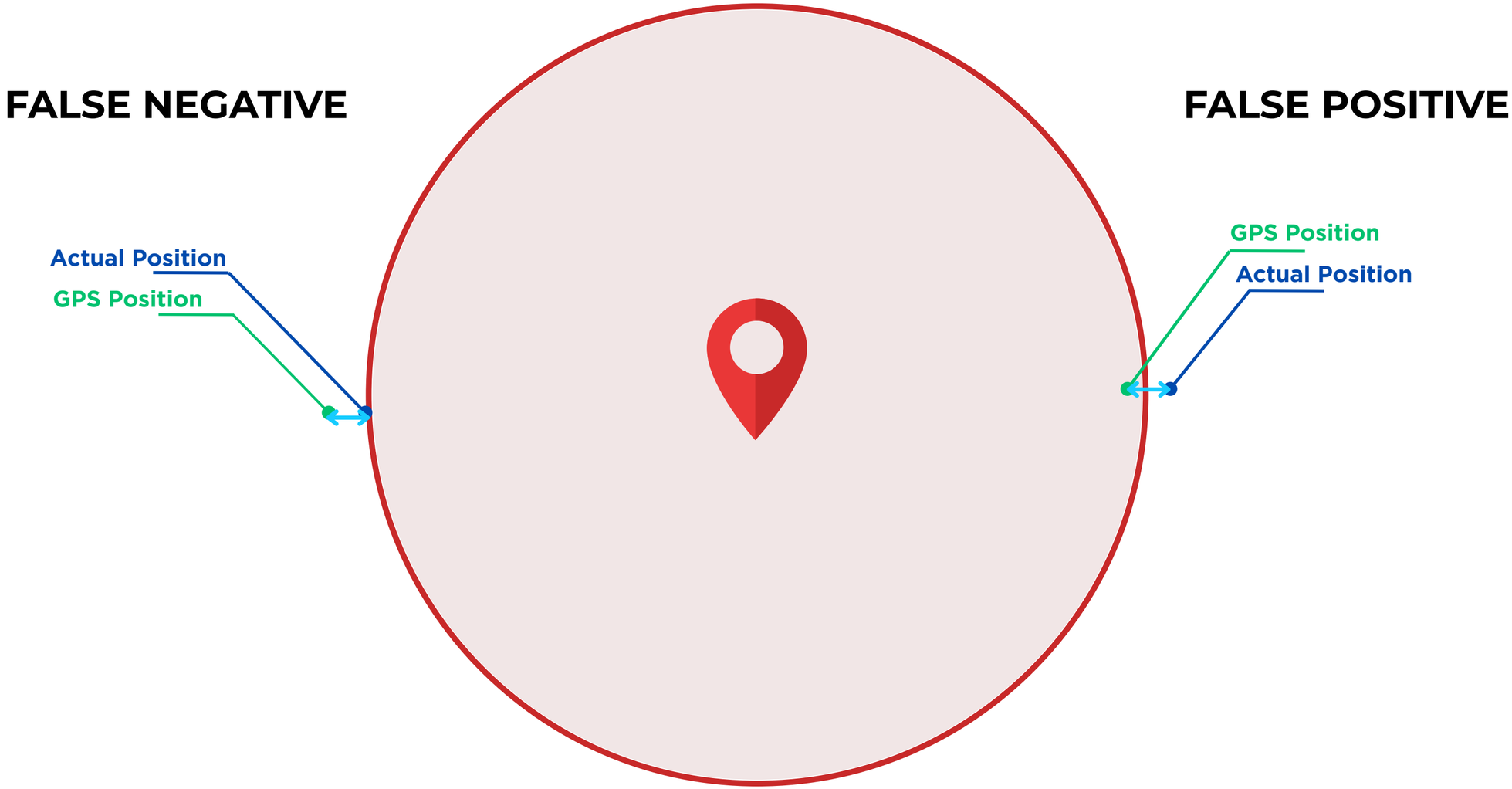

Geofence
-6
-999
999
50m search buffer
inside and outside
the geofence
39

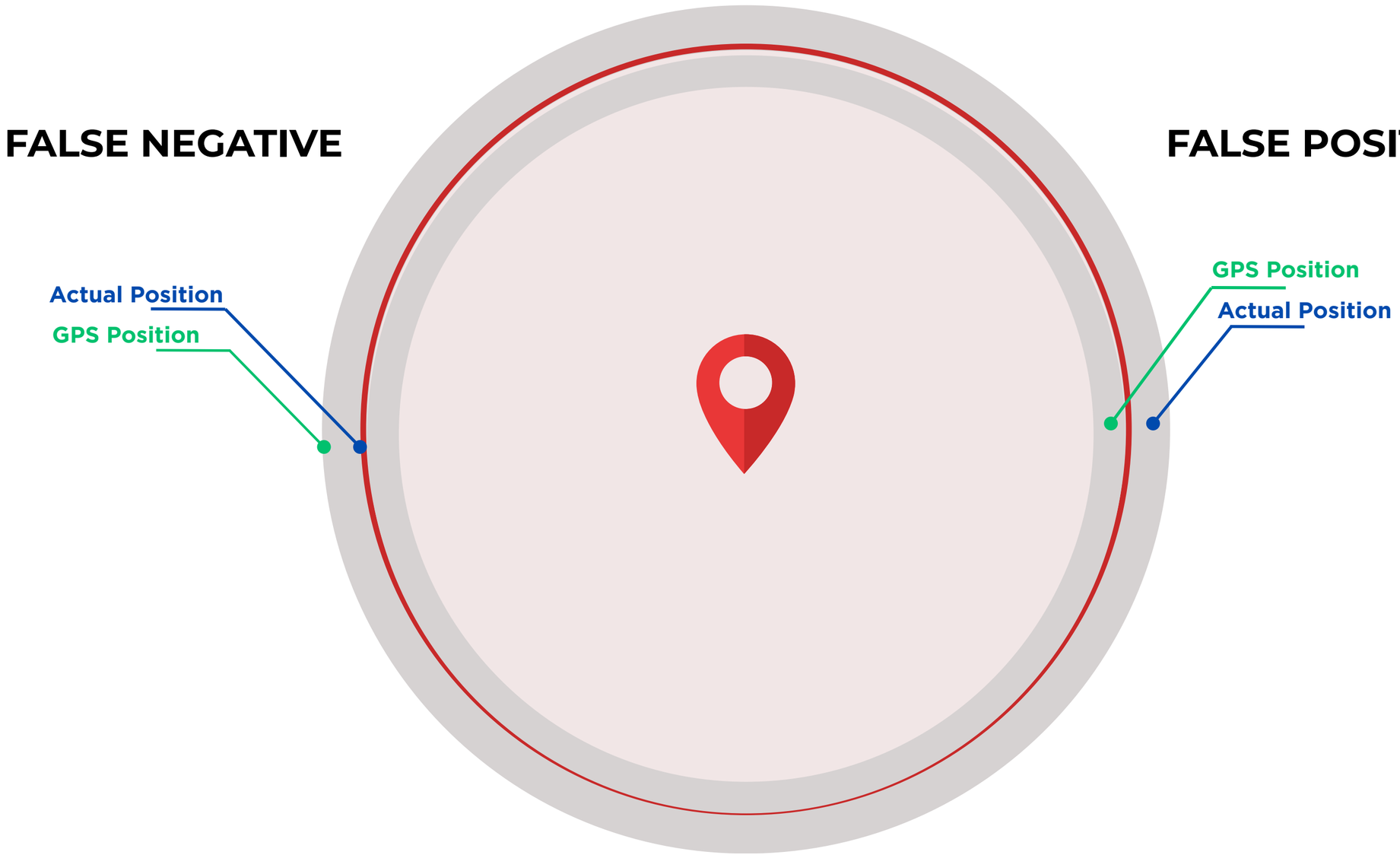
DATA INACCURACY HANDLING

(USE CASE 1: FALSE ARRIVAL ALERT)

FALSE POSITIVE

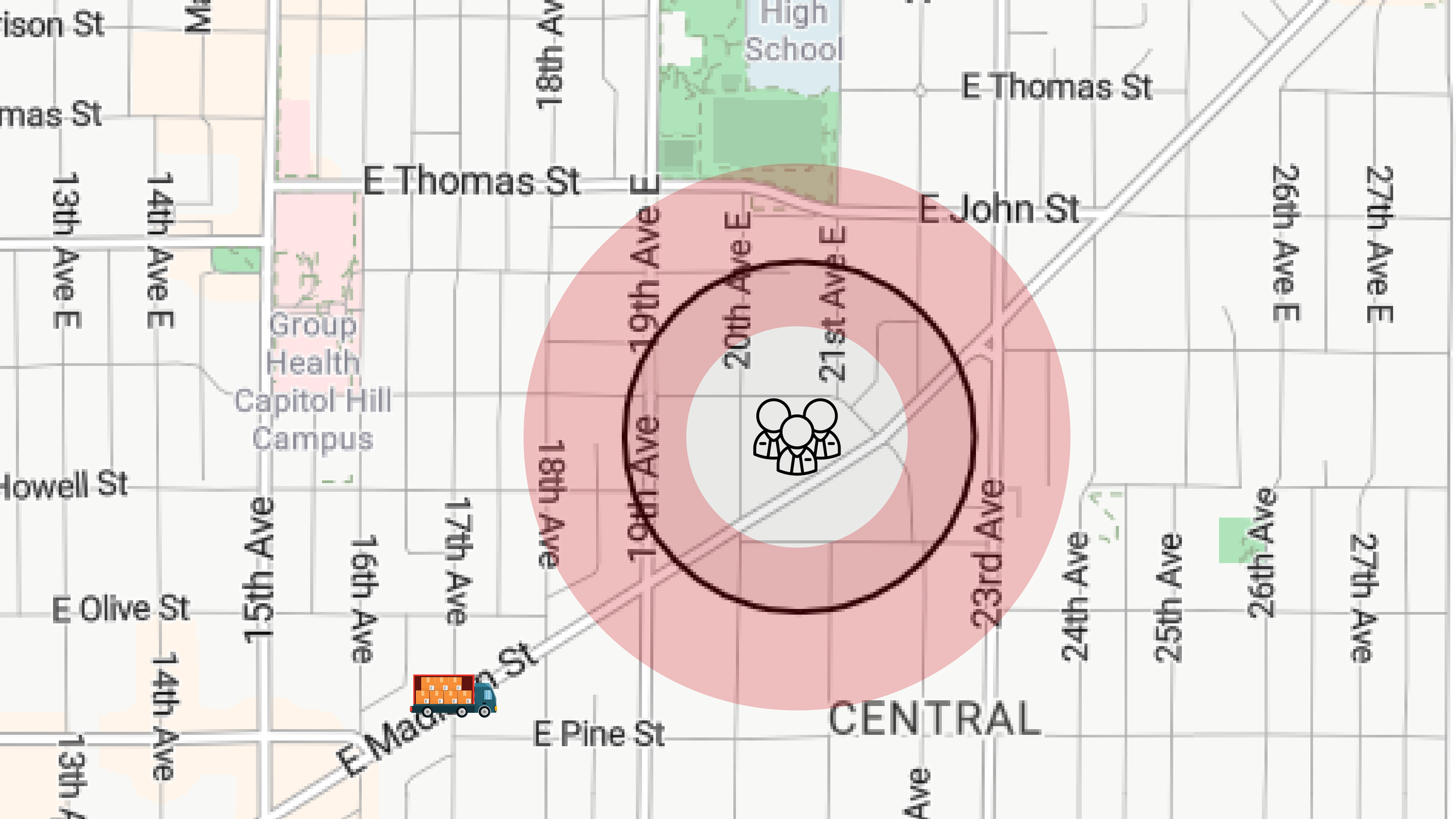


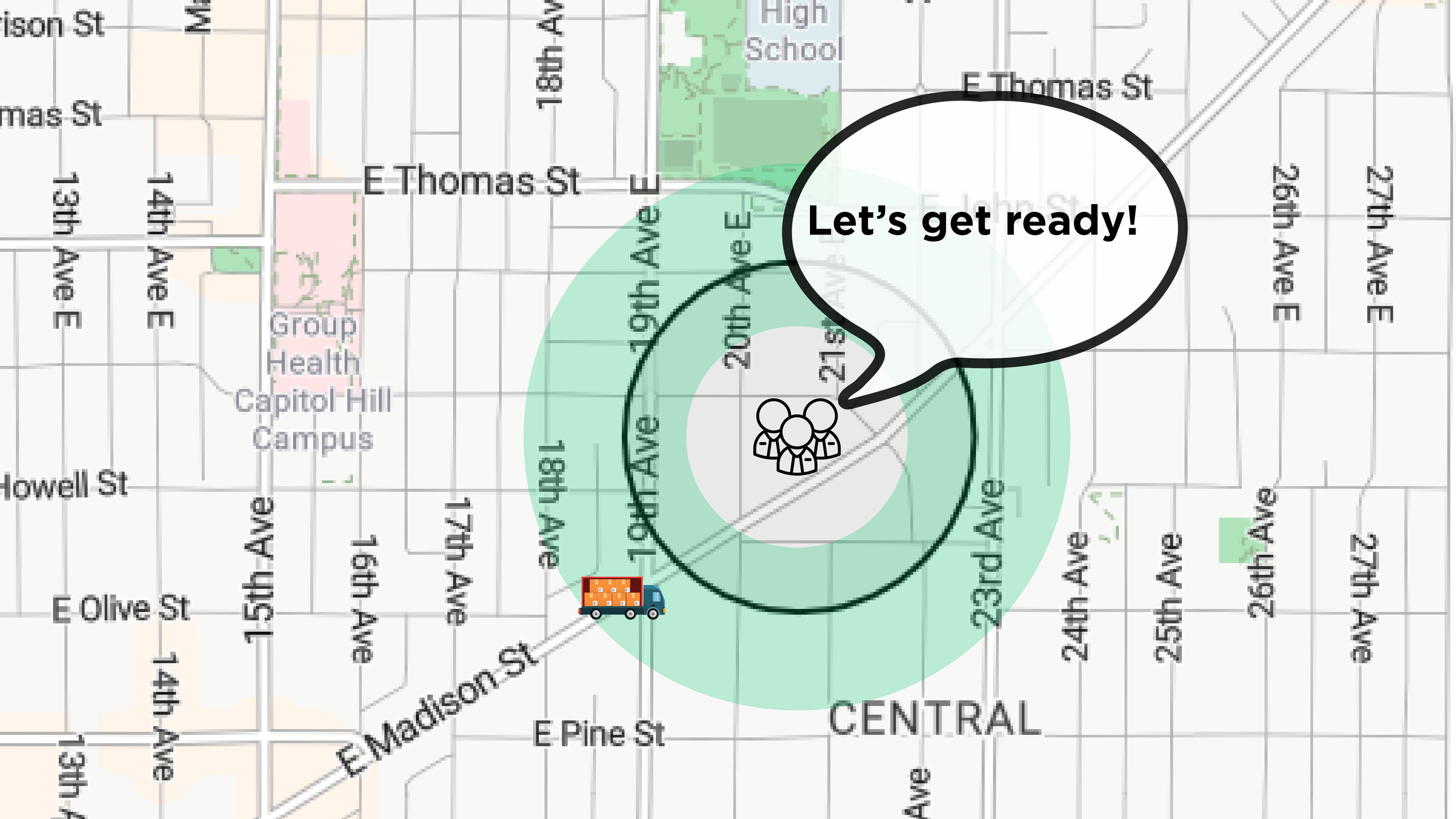

FALSE NEGATIVE
Actual Position
GPS Position
FALSE POSITIVE
GPS Position
Actual Position


FALSE NEGATIVE
Actual Position
GPS Position
FALSE POSITIVE
GPS Position
Actual Position

PRE-ARRIVAL ALERT

(USE CASE 2: TRUCK DELIVERY MANAGEMENT)


High School
E Thomas St
E Thomas St
E John St
18th Ave E
19th Ave E
20th Ave E
21st Ave E
26th Ave E
27th Ave E
13th Ave E
14th Ave E
Group Health Capitol Hill Campus
Howell St
15th Ave
16th Ave
17th Ave
18th Ave
19th Ave
23rd Ave
24th Ave
25th Ave
26th Ave
27th Ave
E Olive St
14th Ave
E Pine St
CENTRAL


Let’s get ready!
E Thomas St
E Madison St
E Pine St
E Olive St
Howell St
CENTRAL
High School
Group Health Capitol Hill Campus
13th Ave E
14th Ave E
15th Ave
16th Ave
17th Ave
18th Ave
19th Ave E
20th Ave E
21st
23rd Ave
24th Ave
25th Ave
26th Ave E
27th Ave E

TEST POINT AGAINST GEOFENCE DEMO


Acacia Teriyaki
150th Ave NE
NE 40th St
Microsoft Cafe
The Street Vendor By Typhoon!
Rudy's Barbershop
148th Ave NE
520
156th Ave NE
NE 36th
oft Studio H
159th Ave NE
Microsoft Company Store
Building 99
NE 36th St
520
oft Cafe 112

WHAT ADDITIONAL DATA COULD WE GET TO HANDLE DATA INACCURACY?

ACCURACY

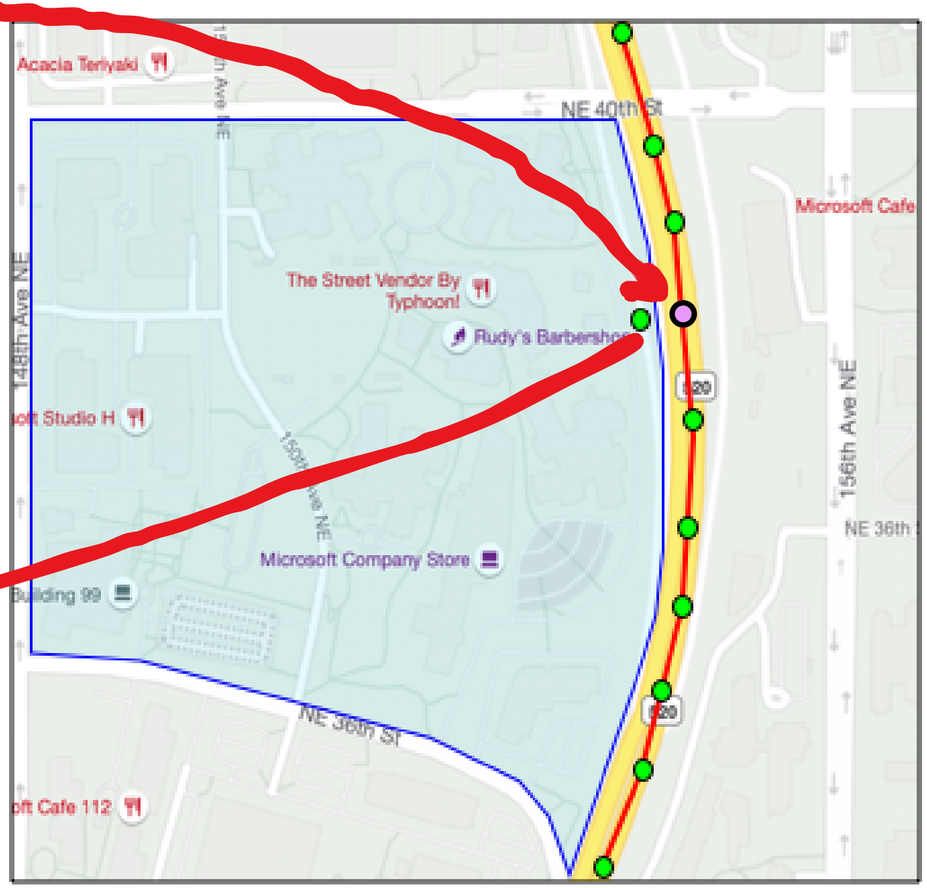
```
termux-location -p network
>> {
  "latitude": 10.8236391,
  "longitude": 106.6246496,
  "altitude": 24.300001144440918,
  "accuracy": 17.875999450683594,
  "vertical_accuracy": 9.563785552978516,
  "bearing": 0.0,
  "speed": 0.0,
  "elapsedMs": 174,
  "provider": "network"
}
```

SNAP-TO-ROAD

AZURE SERVER

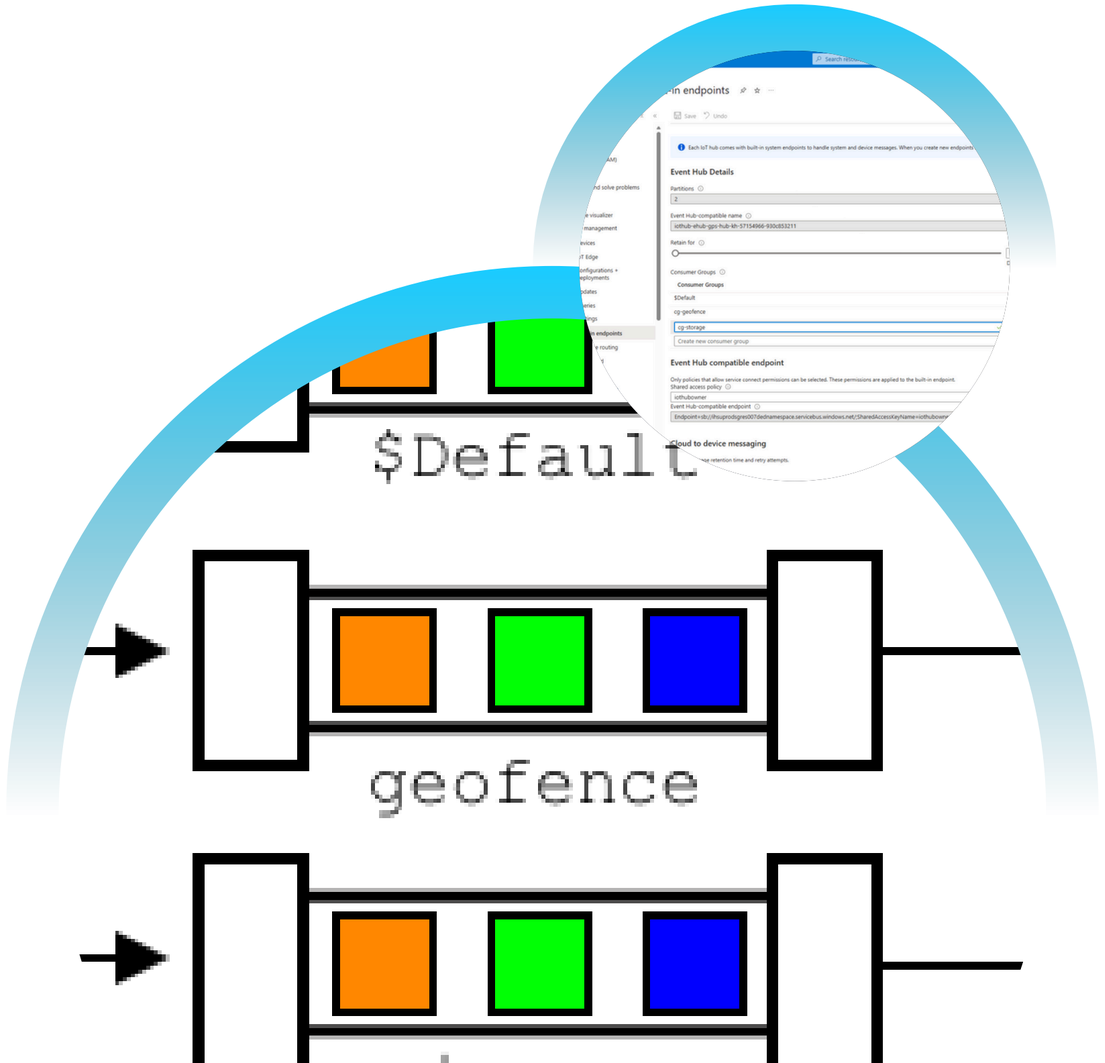
NEAREST ON-ROAD POINT

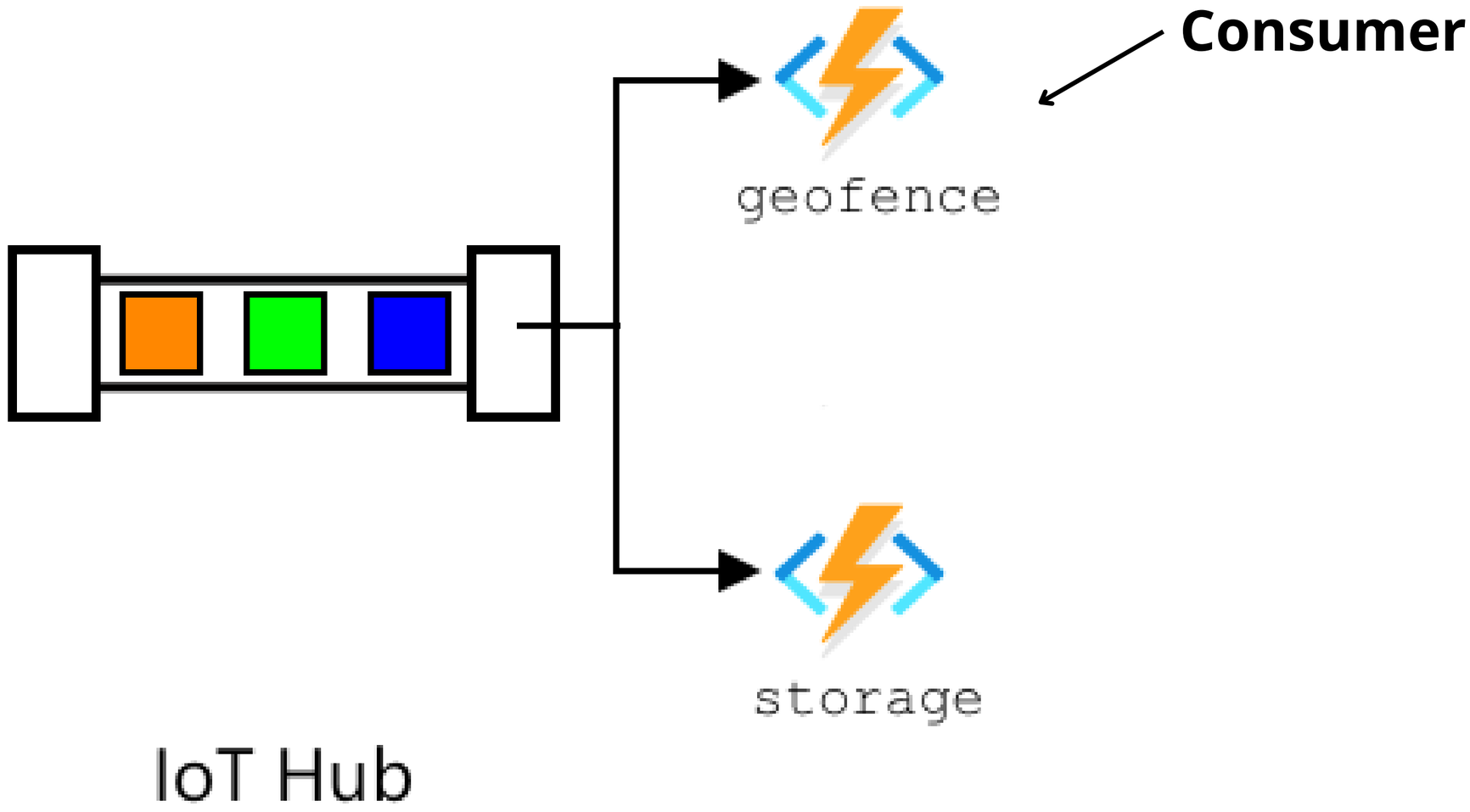
CALL AZURE SNAP-TO-ROAD API FOR THE CURRENT LOCATION



CONSUMER GROUP

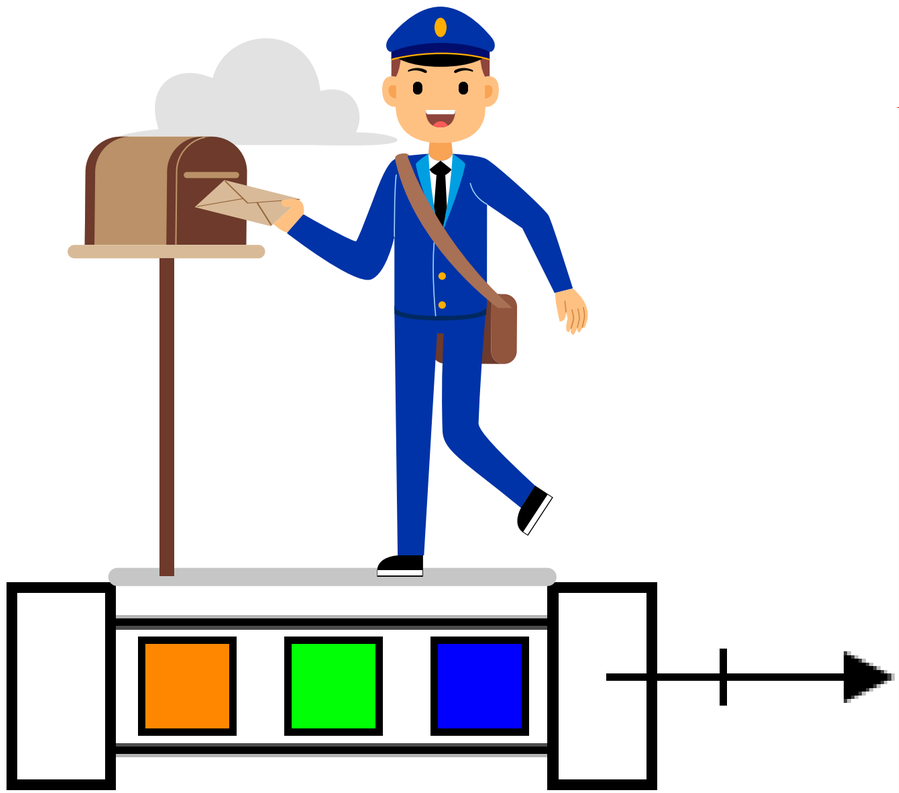
- **A publish/subscribe mechanism of Event Hubs.**



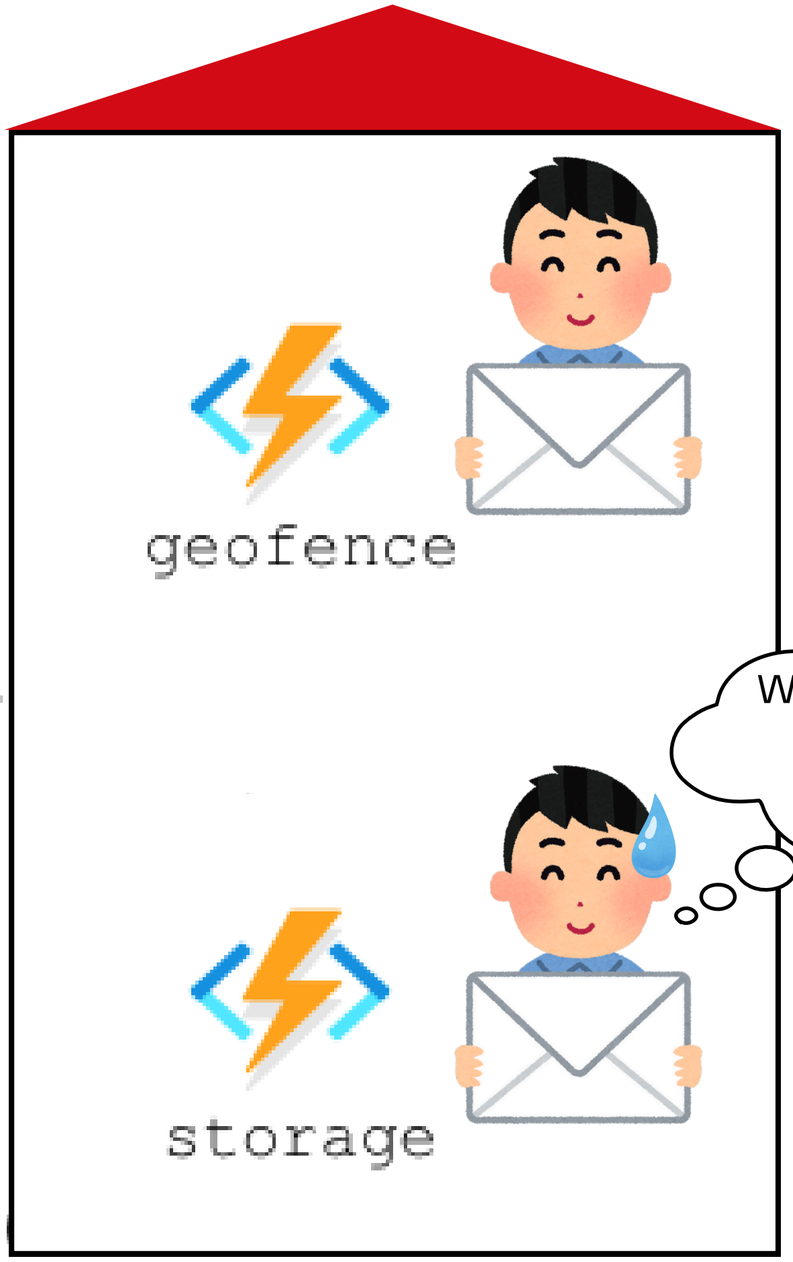


How do you think the IoT Hub could know which one has processed which events?

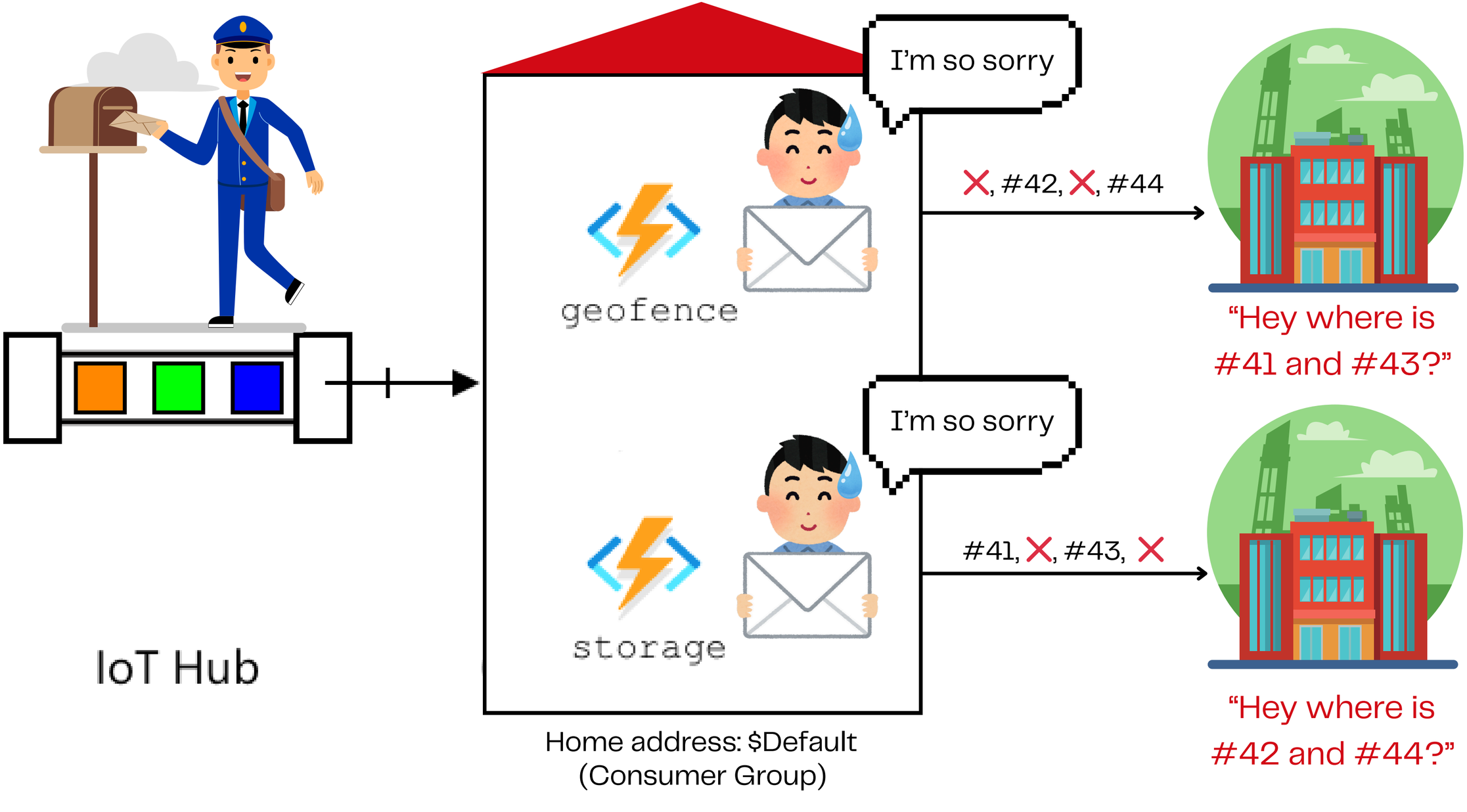
It can’t!

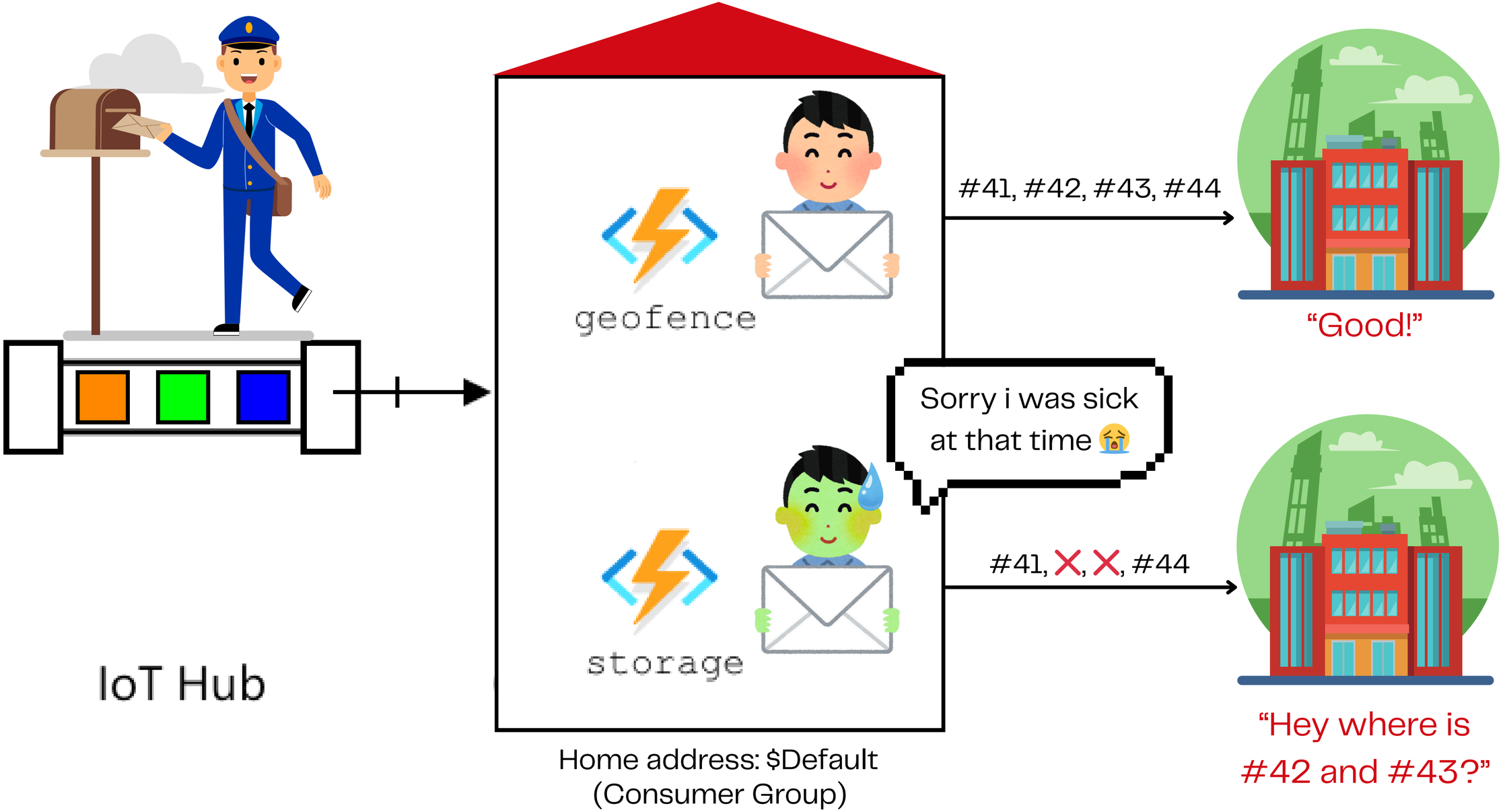


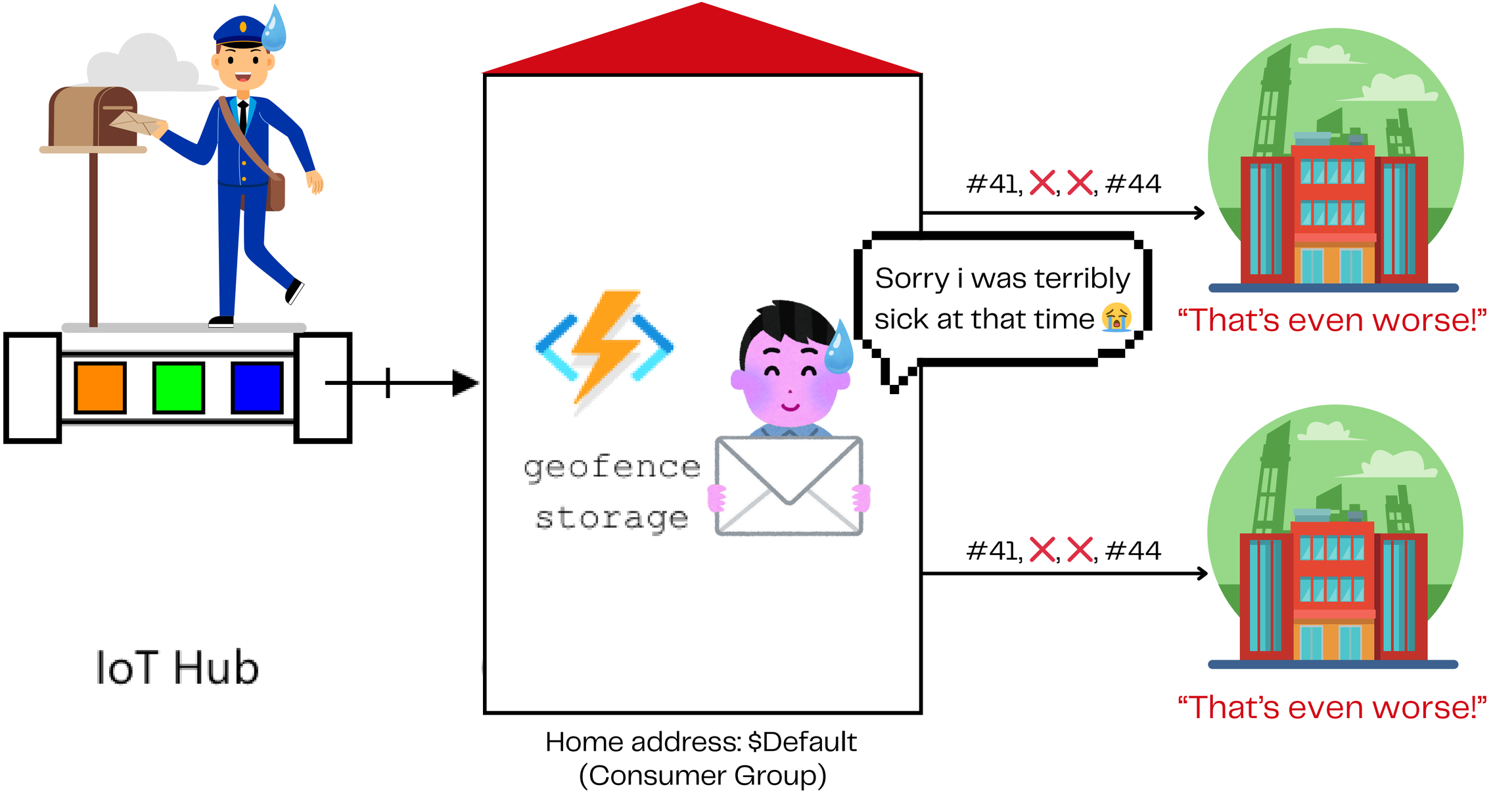
IoT Hub

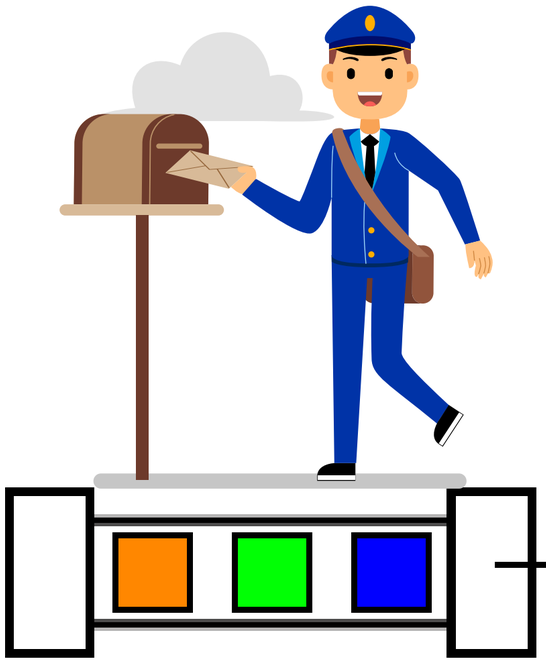


Home address: $Default
(Consumer Group)

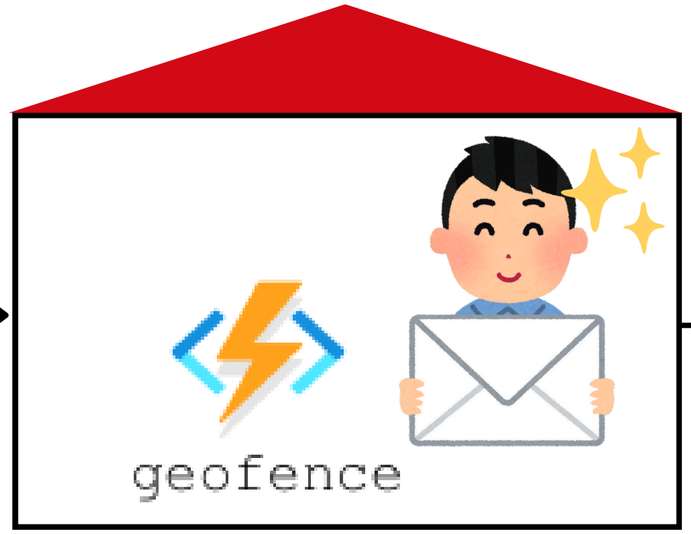

I'm so sorry
geofence
✕, #42, ✕, #44
"Hey where is #41 and #43?"
I'm so sorry
storage
#41, ✕, #43, ✕
"Hey where is #42 and #44?"
IoT Hub
Home address: $Default
(Consumer Group)


geofence
storage
#41, #42, #43, #44
"Good!"
Sorry i was sick at that time 😭
#41, ✕, ✕, #44
"Hey where is #42 and #43?"
IoT Hub
Home address: $Default (Consumer Group)


#41, ✕, ✕, #44
Sorry i was terribly sick at that time 😭
“That’s even worse!”
geofence
storage
#41, ✕, ✕, #44
“That’s even worse!”
IoT Hub
Home address: $Default
(Consumer Group)



IoT Hub

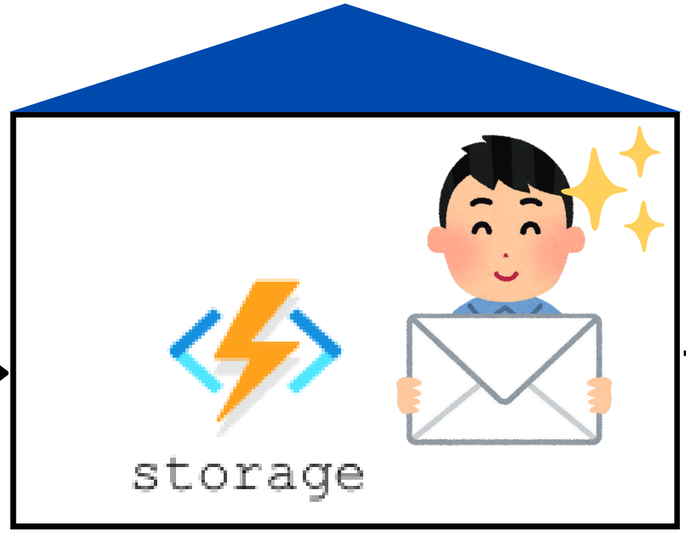


Home address: $cg-geofence
(Consumer Group)

#41, #42, #43, #44

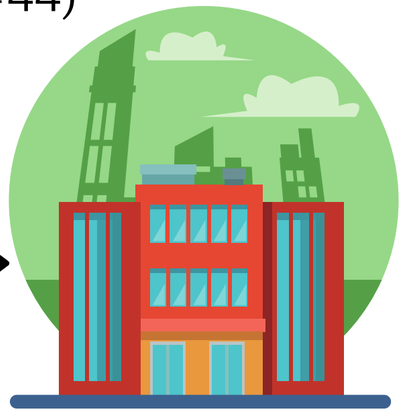
“Good!”

(It will continue at #42 and
speedrun to #44)

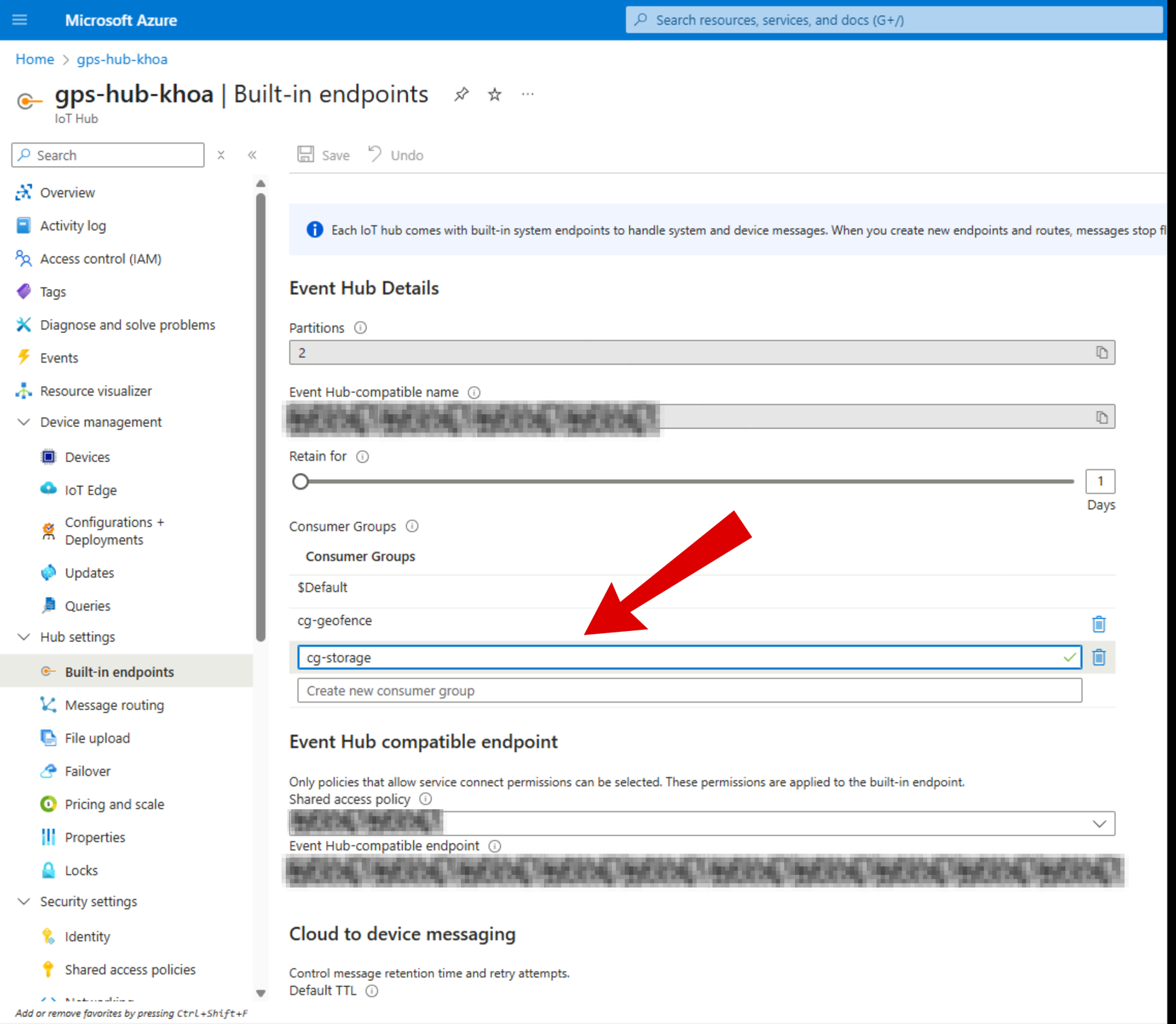


Home address: $cg-storage
(Consumer Group)

#41, ✕, ✕, #42,
#43, #44



“Okay, noch gut!”



IoT Hub

>> Built-in endpoints

>> Consumer Groups

>> cg-storage

cg-geofence

or-any-name

1. **Check your function.json (or attribute in code)**

   - If you're using a language like JavaScript or Python, open the **function.json** for that Function and look for the Event Hub binding:

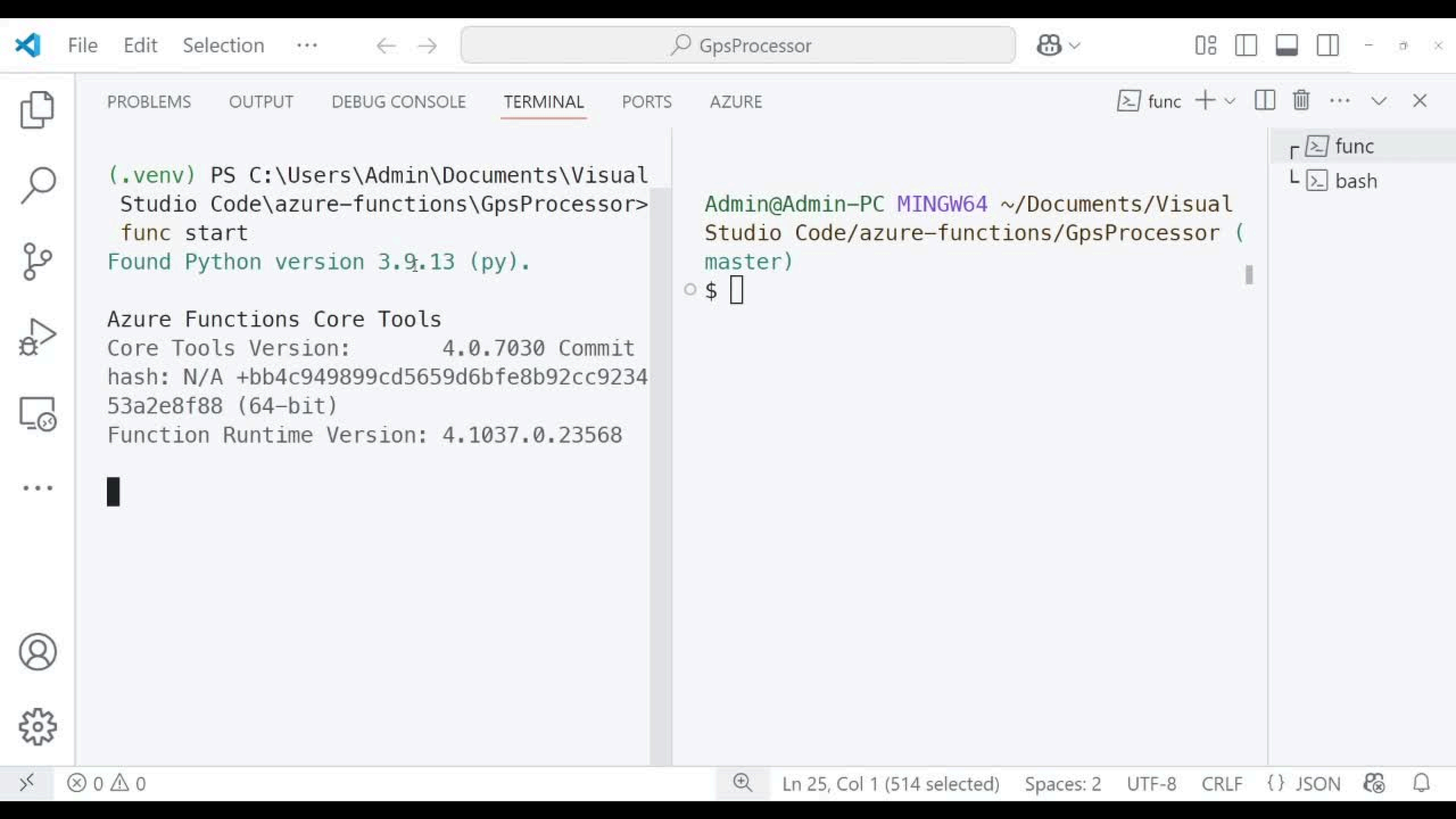
```
json                                                    Copy    Edit

{
  "type": "eventHubTrigger",
  "name": "events",
  "direction": "in",
  "eventHubName": "your-hub-name",
  "connection": "YourConnStringSetting",
  "consumerGroup": "my-consumer-group"     ← here
}
```

   If there's no `"consumerGroup"` property, it defaults to `"$Default"`.

Azure function
>> function.json
>> "consumerGroup":
>> $Default
cg-storage
cg-geofence
or-any-name


DEMO

```
Docs:       https://termux.dev/docs
Donate:     https://termux.dev/donate
Community:  https://termux.dev/community

Working with packages:

 - Search:  pkg search <query>
 - Install: pkg install <package>
 - Upgrade: pkg upgrade

Subscribing to additional repositories:

 - Root:    pkg install root-repo
 - X11:     pkg install x11-repo

For fixing any repository issues,
try 'termux-change-repo' command.

Report issues at https://termux.dev/issues
~   python send_gps.py
📡 Choose location provider to use (network/gps):
```


File
Edit
Selection
GpsProcessor
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
AZURE
func
(.venv) PS C:\Users\Admin\Documents\Visual Studio Code\azure-functions\GpsProcessor> func start
Found Python version 3.9.13 (py).
Azure Functions Core Tools
Core Tools Version: 4.0.7030 Commit hash: N/A +bb4c949899cd5659d6bfe8b92cc923453a2e8f88 (64-bit)
Function Runtime Version: 4.1037.0.23568
Admin@Admin-PC MINGW64 ~/Documents/Visual Studio Code/azure-functions/GpsProcessor (master)
$
func
bash
0 0
Ln 25, Col 1 (514 selected)
Spaces: 2
UTF-8
CRLF
JSON

SUMMARY

- Geofence and its application
- Ray casting
- Search buffer
- Test point against geofence
- Data inaccuracy handling
- Consumer Group
- Demo: GPS fetching
- Demo: Real-life scenario

quiz

thank you for listening