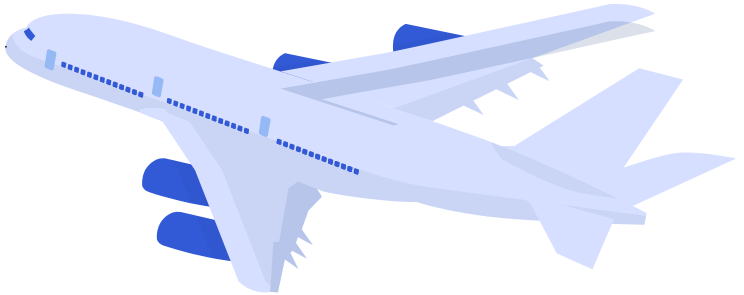
Self-Flying Airplane



MARL application in the context of Aviation Control using the VMAS environment and BenchMARL

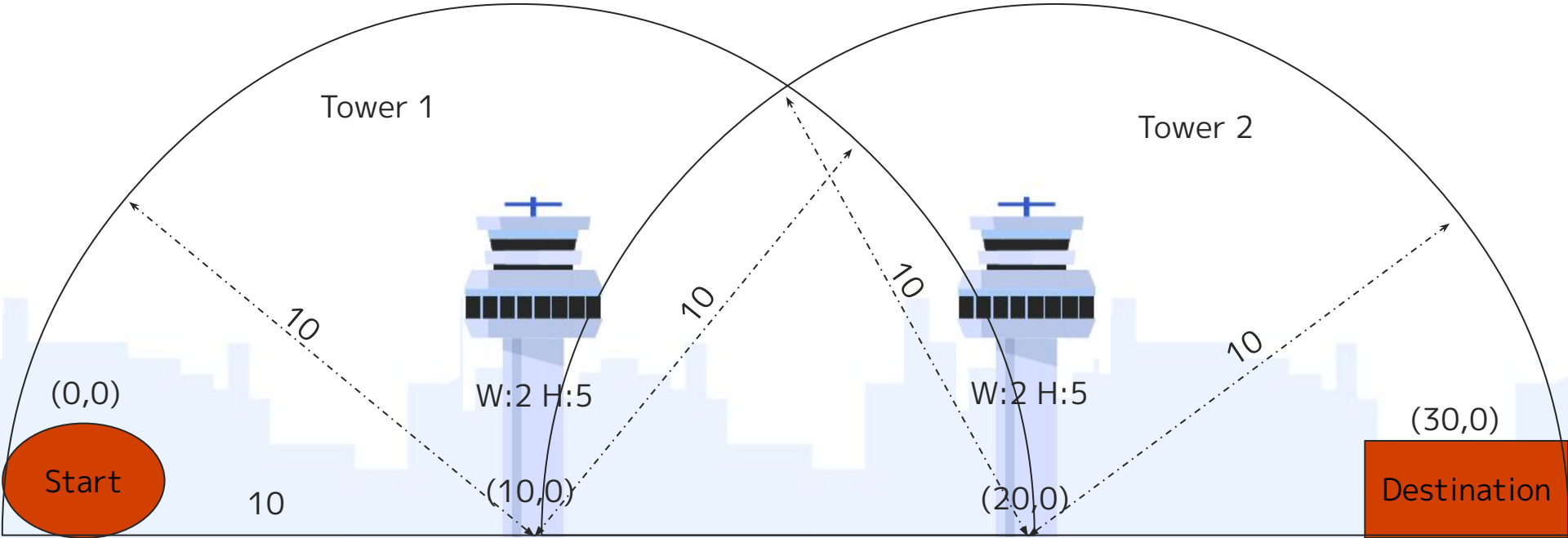
Emi Chan, Yunan Huo

IMAGINE THIS>>>

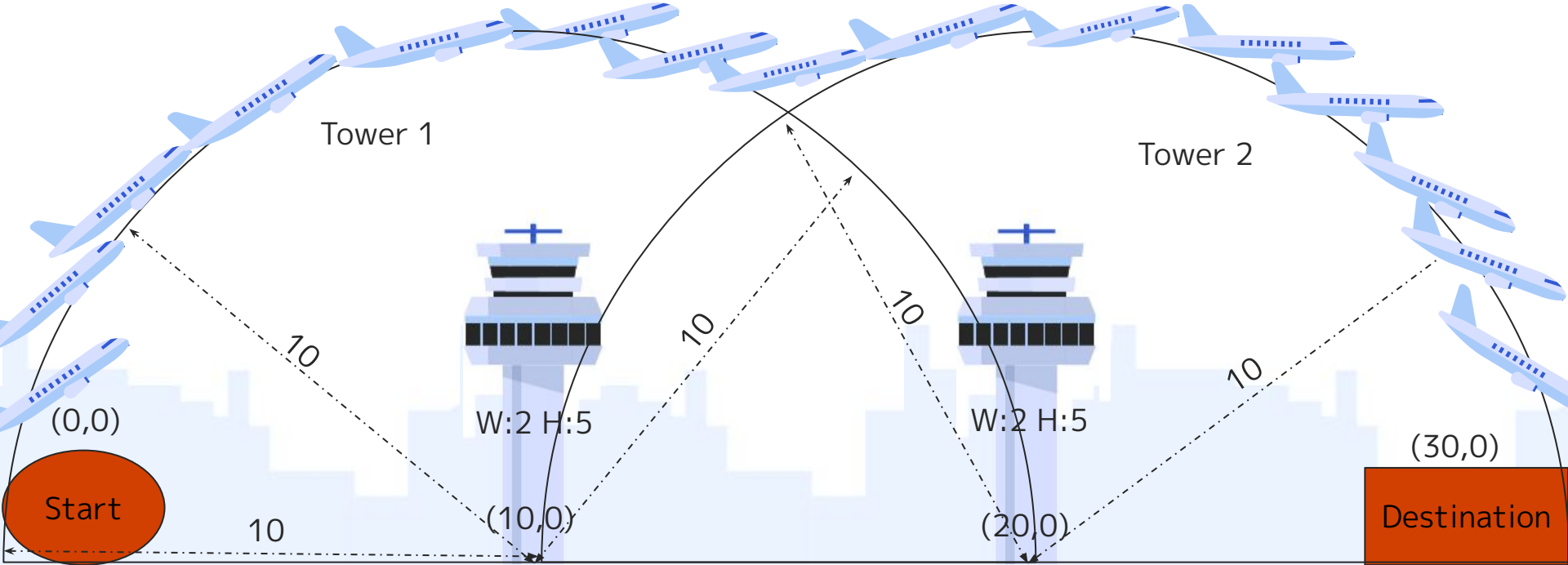
>>> AIRPLANES CAN FLY THEMSELVES (SAFELY!) GIVEN THERE IS PROPER COMMUNICATION WITH THE ATC TOWERS

Scenario 1 (without blockage of communication)

Sphere(radius=5)



(One of the) Ideal Trajectory...

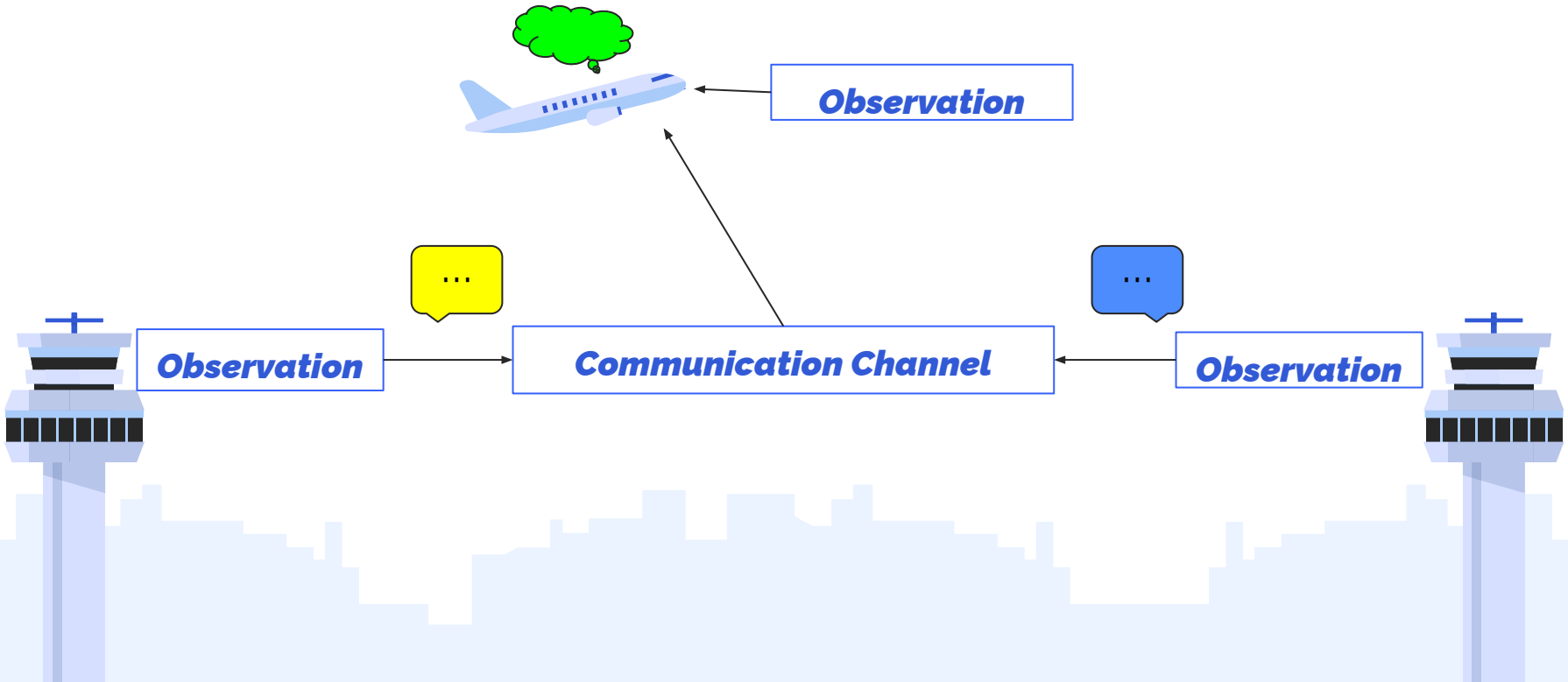


Towers & Airplane Capabilities

	Tower	Airplane
Awareness of own position in space	✔	✔
Speak	✔	✘
Listen	✘	✔
Move	✘	✔

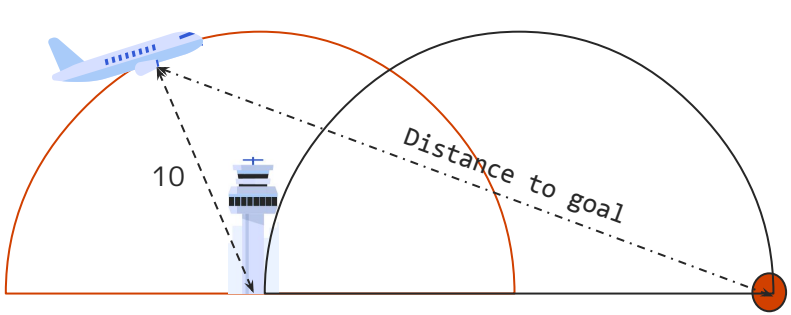
From project B Stub

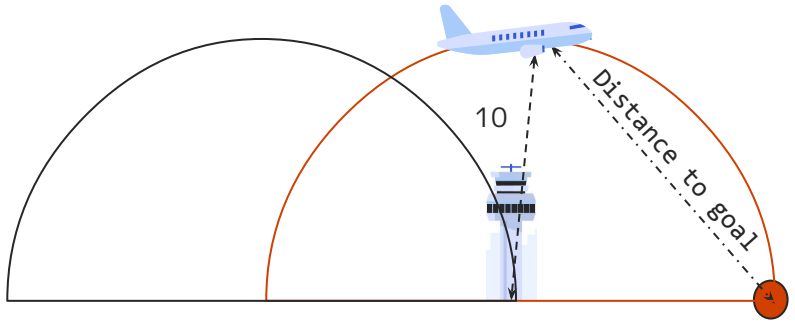
In order to achieve the Ideal Trajectory...



Rewards

- We want the airplane to minimize distance between itself and City2.
- We want the airplane to maintain its distance with the tower they are communicating with. Preferably 10 units, which is the radius of the reachable communication distance of the Tower.



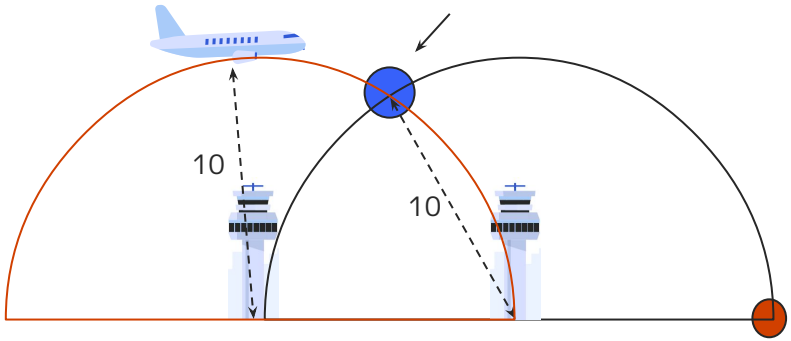


Rewards (cont.)

- We want to reward the behaviors for having the airplane be in the communicable distance with the towers.
- We want to reward proper switching from arc path 1 to arc path 2.

Note:

Ideal Spot at which the airplane switches to Tower 2 Arc



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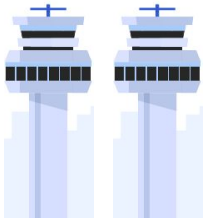
The Same spot that Airplane will start being able to hear Tower 2 if the Airplane was following Tower 1 Arc

So, if airplane is incentive is to max reward, then it will switch to listening to Tower 2

Observations and the Communication Channel



Communication Channel

Speaker Observation

the distance between the tower and the plane: $\sqrt{[(x2 - x1)^2 + (y2 - y1)^2]}$.

When the airplane is out of the tower's range, the distance will be set to an arbitrarily large number, 10000.

The position of the airplane (important for another scenario)

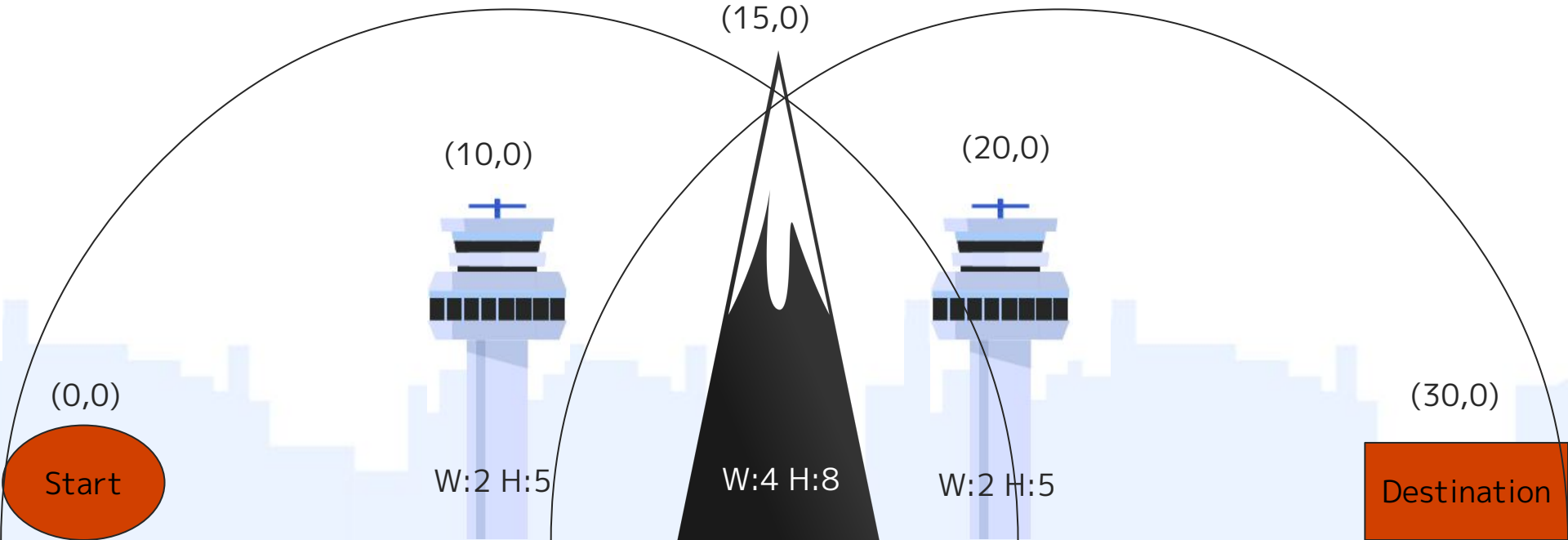
Listener Observation

What is being spoken into the communication channel

Airplane’s own velocity, torque, position, distance to City2.

Scenario 2 (with the mountain)

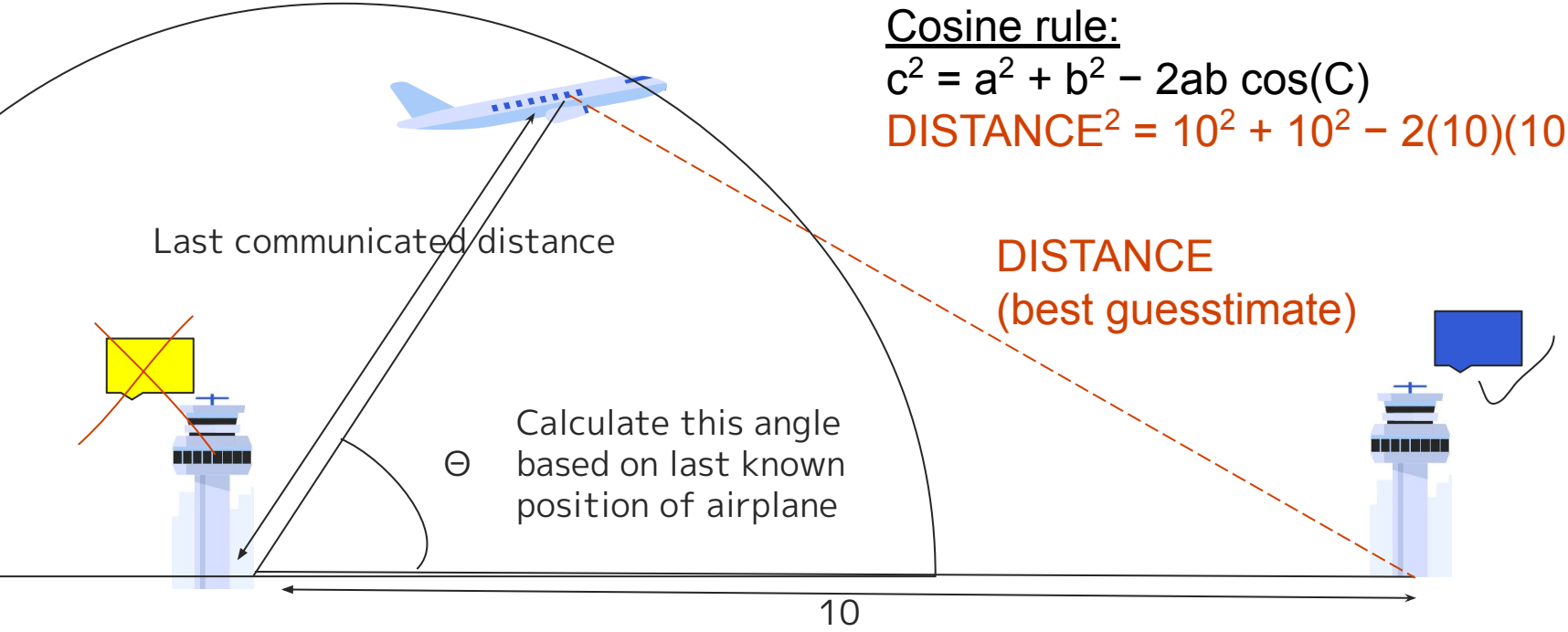
Sphere(radius=5)



The Mountain can block the communication from one tower to the communication channel

- Assuming one of the speaker’s communication was blocked.
- The other tower will notice the anomaly (no message is sent to the communication channel).
- The other tower will contribute to the communication channel on behalf of the blocked Tower.

Observations and the Communication Channel



Cosine rule:

$c^2 = a^2 + b^2 - 2ab\cos(C)$

$DISTANCE^2 = 10^2 + 10^2 - 2(10)(10)\cos(\Theta)$

Since airplane knows from which tower this distance value was coming from, it can optimize its action to minimize distance with Tower 2

Implementation

- VMAS Environment: Simple_Speaker_Listener Scenario
- BenchMARL library
- MAPPO
  - Central learning and decentralized execution
  - During training, there is full-observability in critic

Results and Insights.

- The results is still a work in progress (Runtime error: tensor dimension problems)
- Yet, this study has allowed us to look into the importance of communication between towers (speakers) and possible mitigation strategies when blockage of communication happens.

- The **importance** of speakers having access to the **same** communication channel
- It has also been shown that it is **crucial** for the speakers to **tell information** to the communication channel.
- So that when communication blockage happen, the other party can make a **good enough guesstimates** from the **previous available information**