SLAM as Graph Optimization II

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Today’s goal

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Toy Example with Linear Observations, Linear Dynamics

- Localization: When Pose is **unknown**, but Landmarks are **known**
- SLAM: When Pose is **unknown**, Landmarks are **unknown**
- Both result in Linear Least Squares

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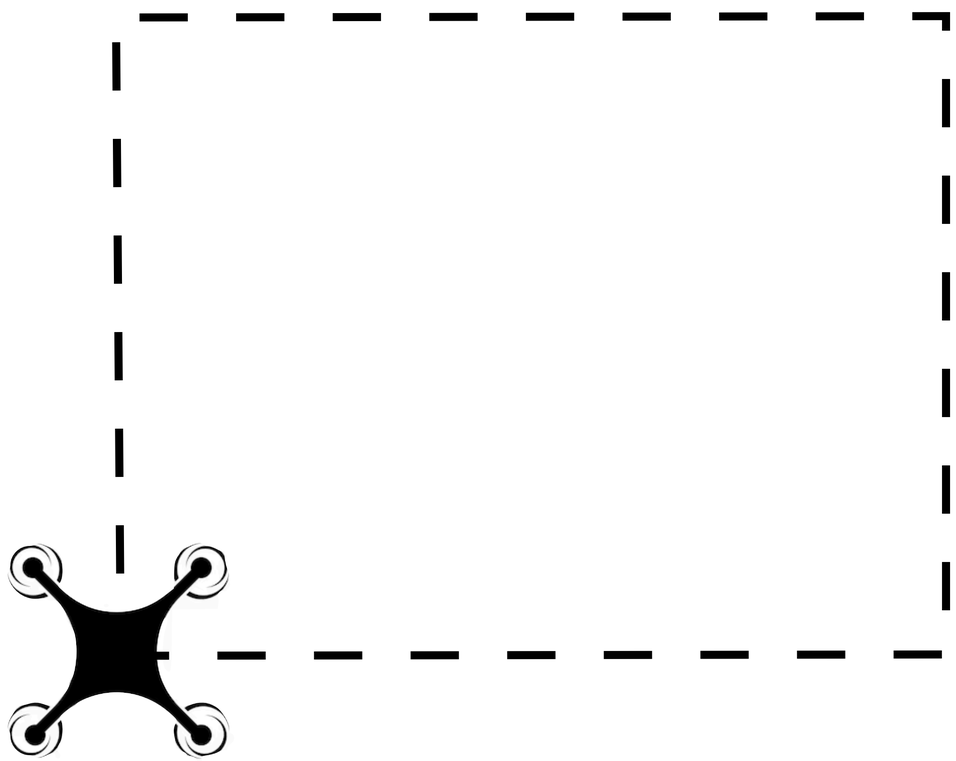
General Example with Nonlinear Observations, Nonlinear Dynamics

- Define a **Factor Graph**
- Non-linear Least Squares
- Practical Application

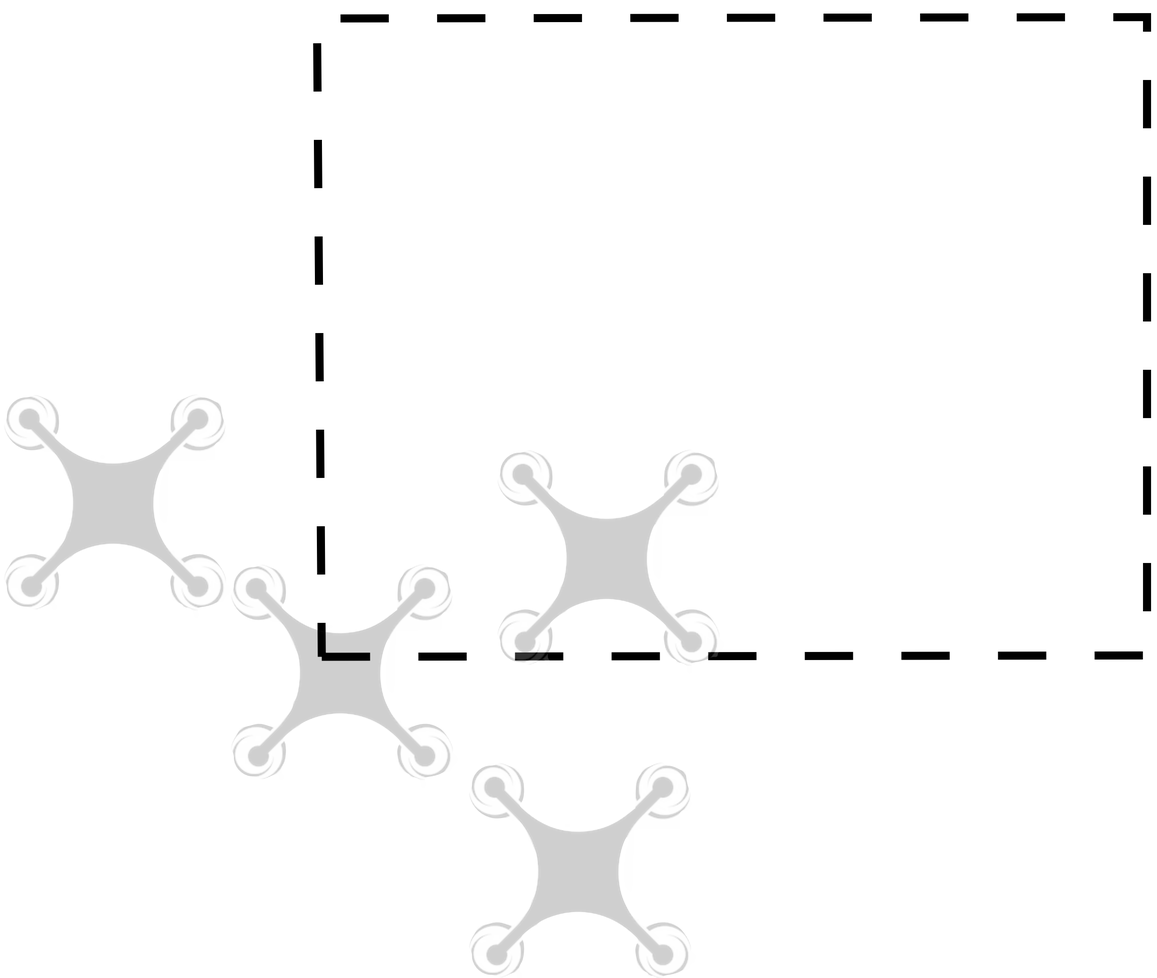
Recap

A Toy Example



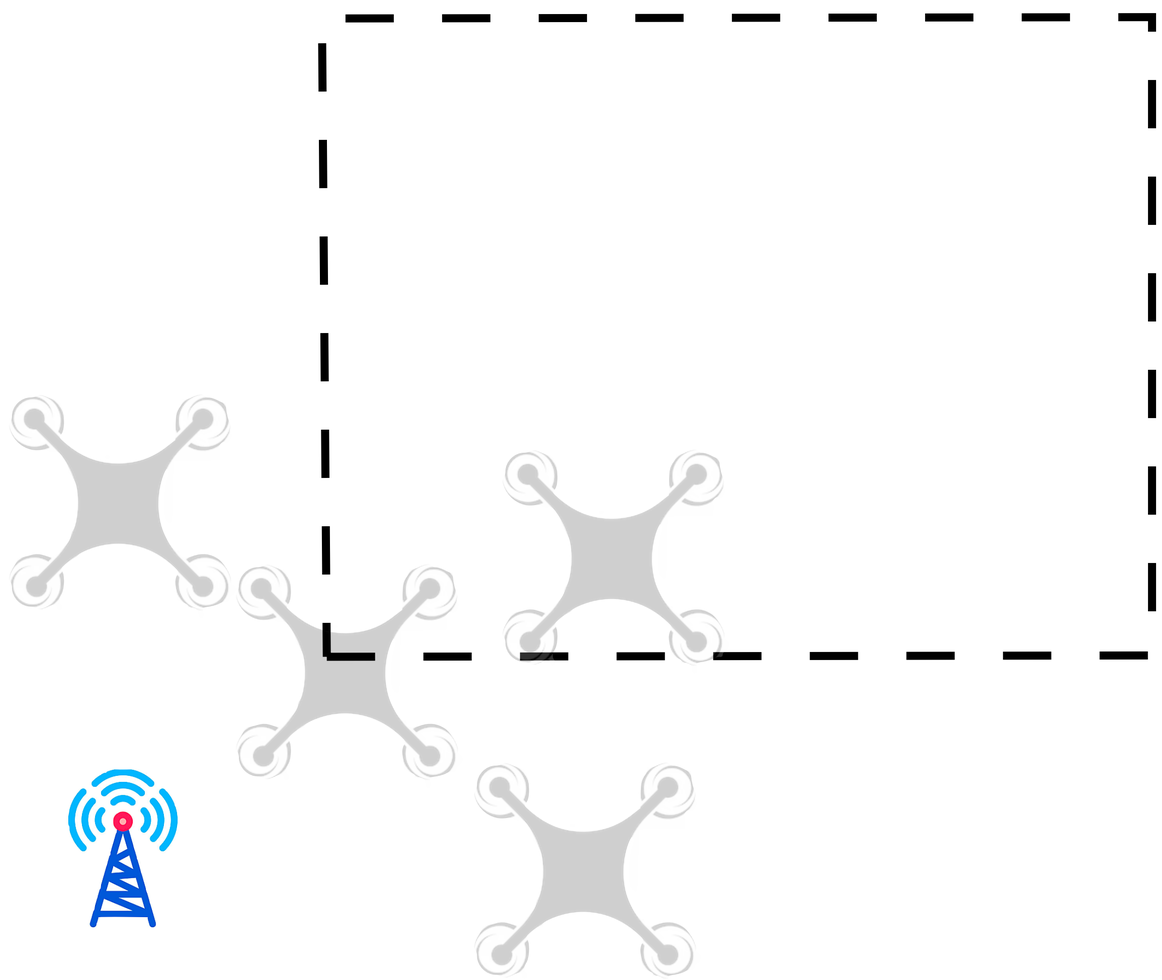
We have a drone that we are flying around in a circuit

T=0



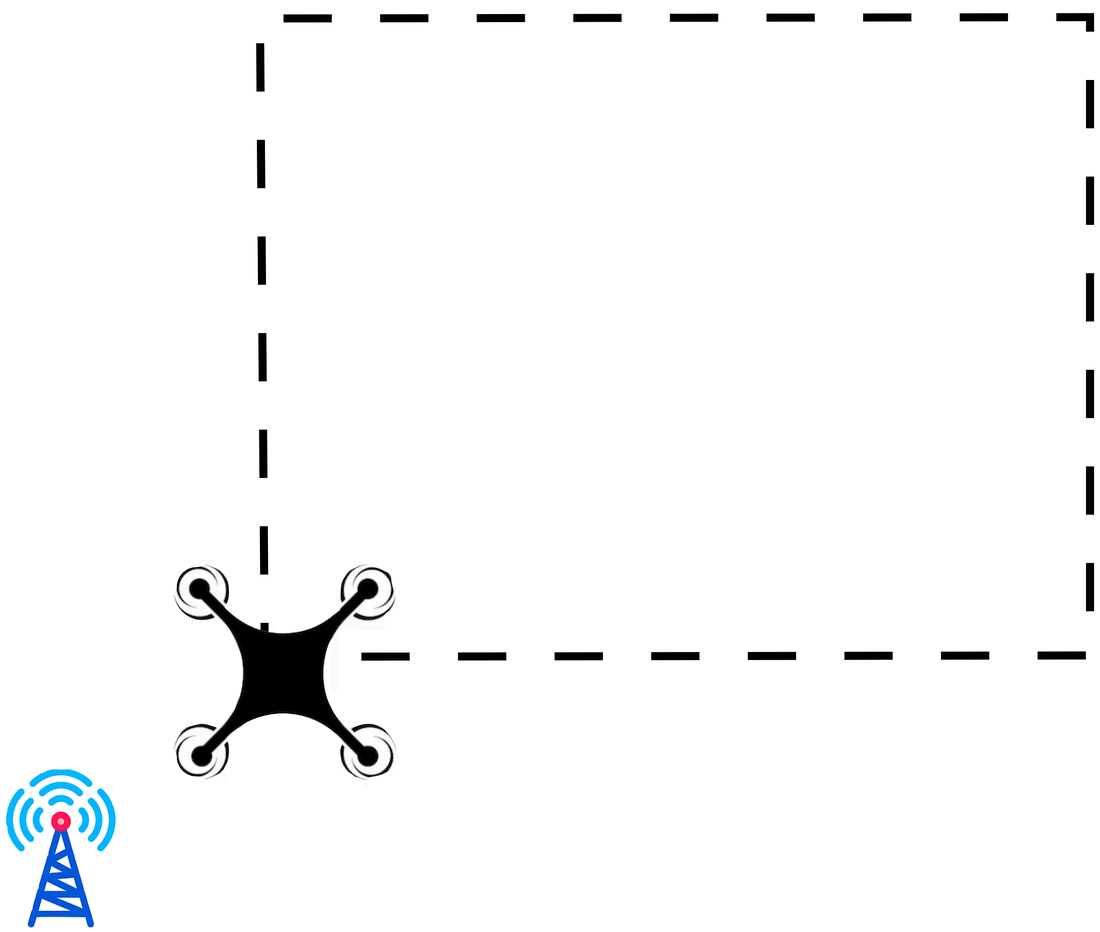
The 2D position is unknown

T=0



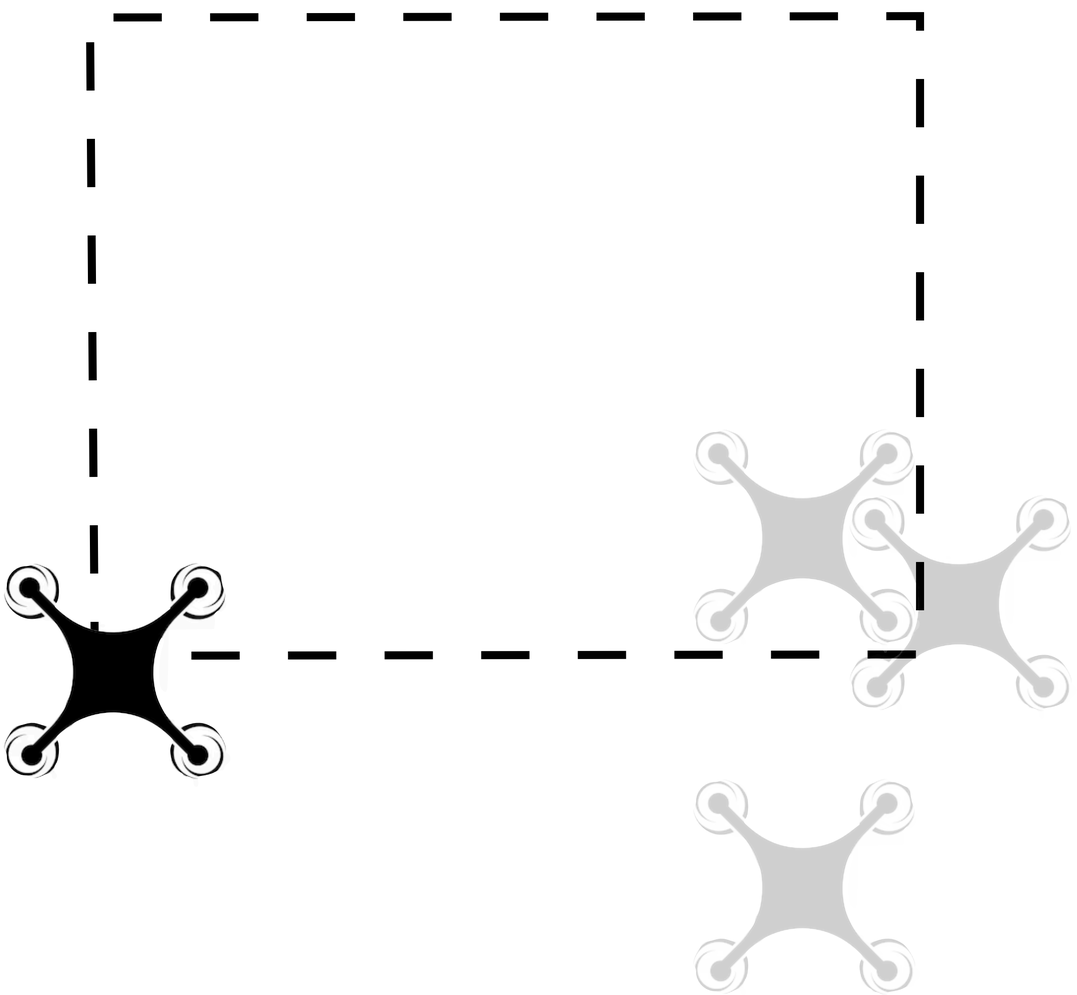
It observes a **landmark** whose position is known

T=0



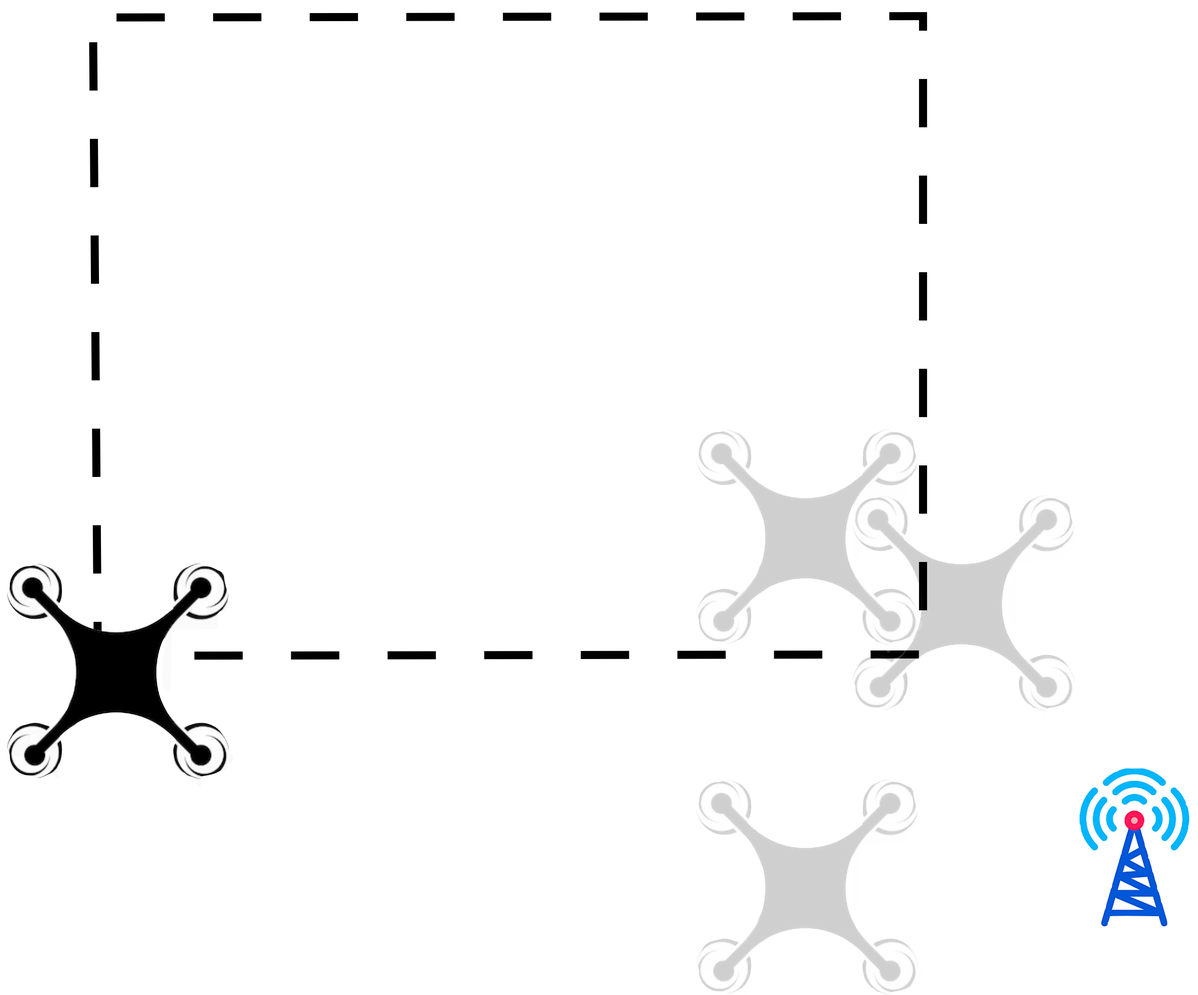
Using this observation, the robot updates it's position

T=1



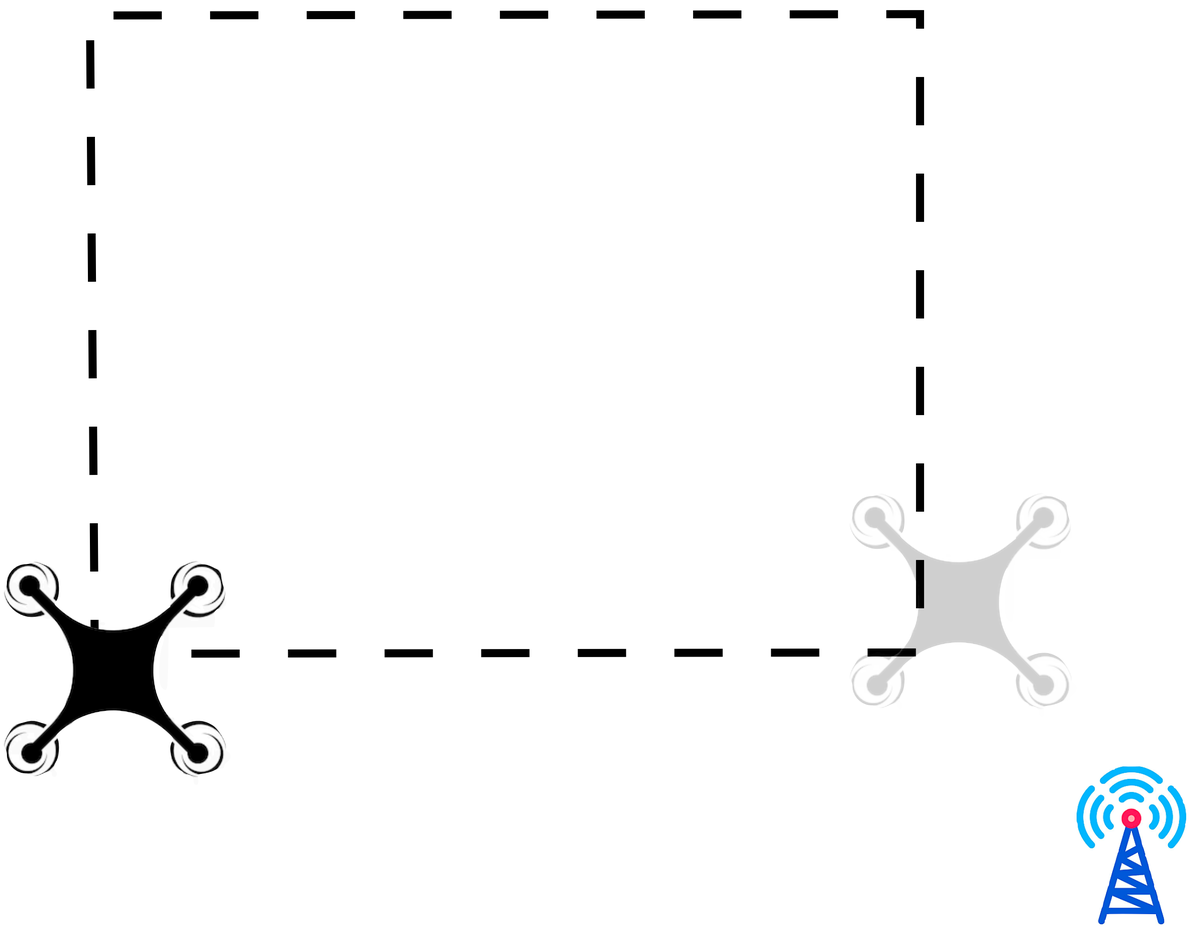
Predict the next pose based on dynamics

T=1



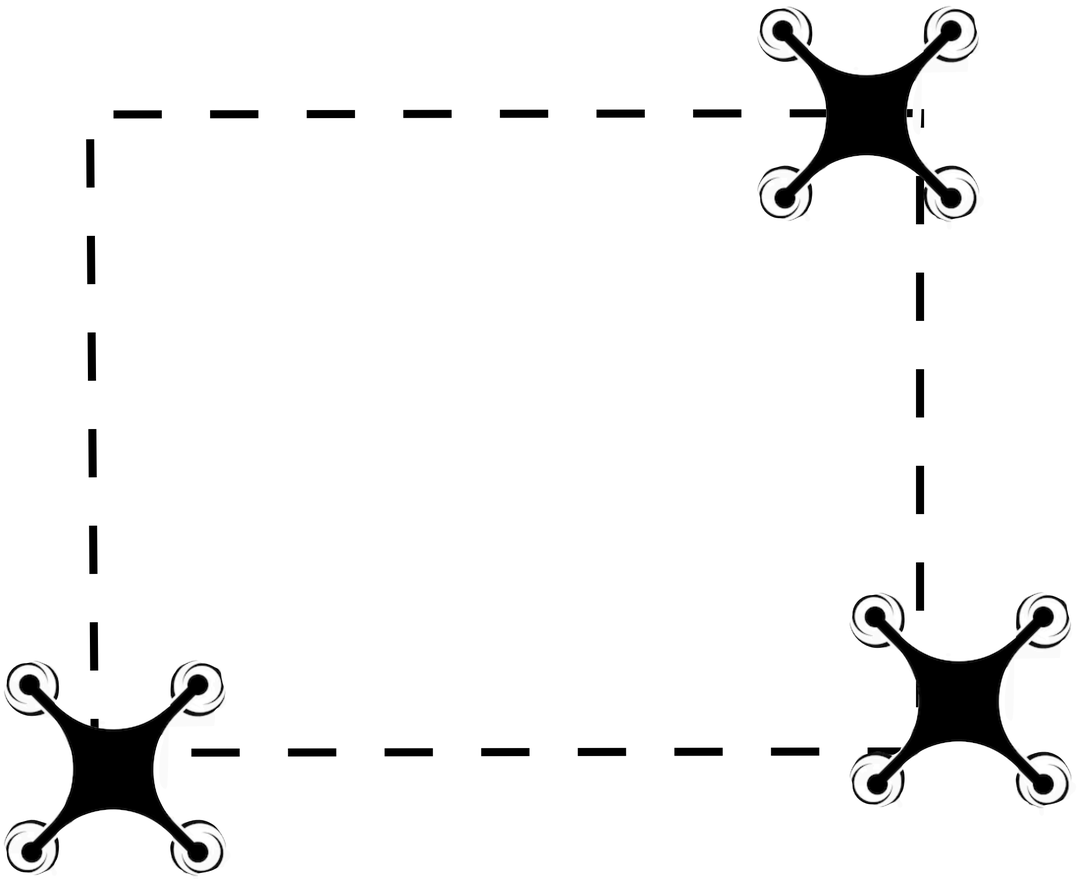
Observe a landmark

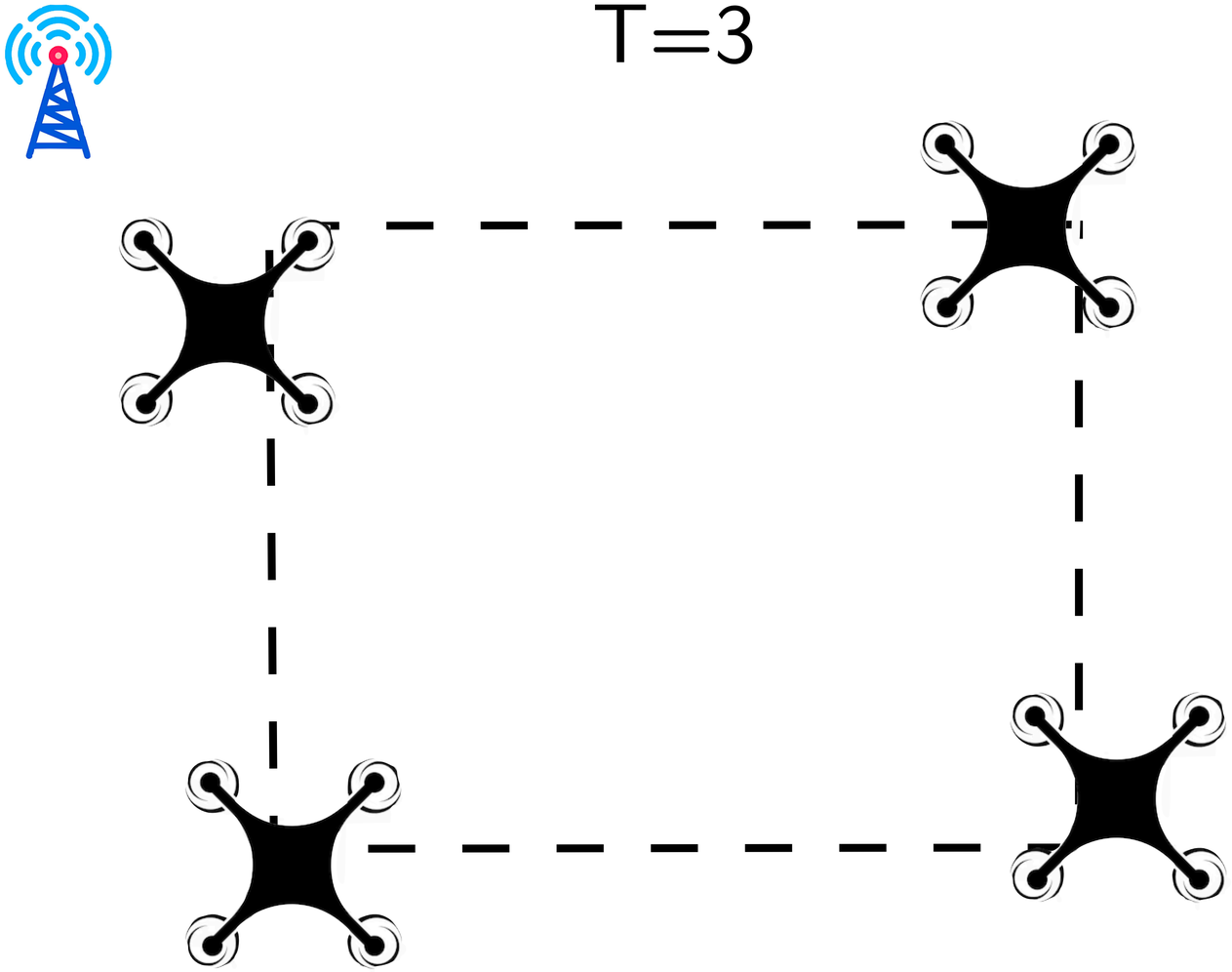
T=1



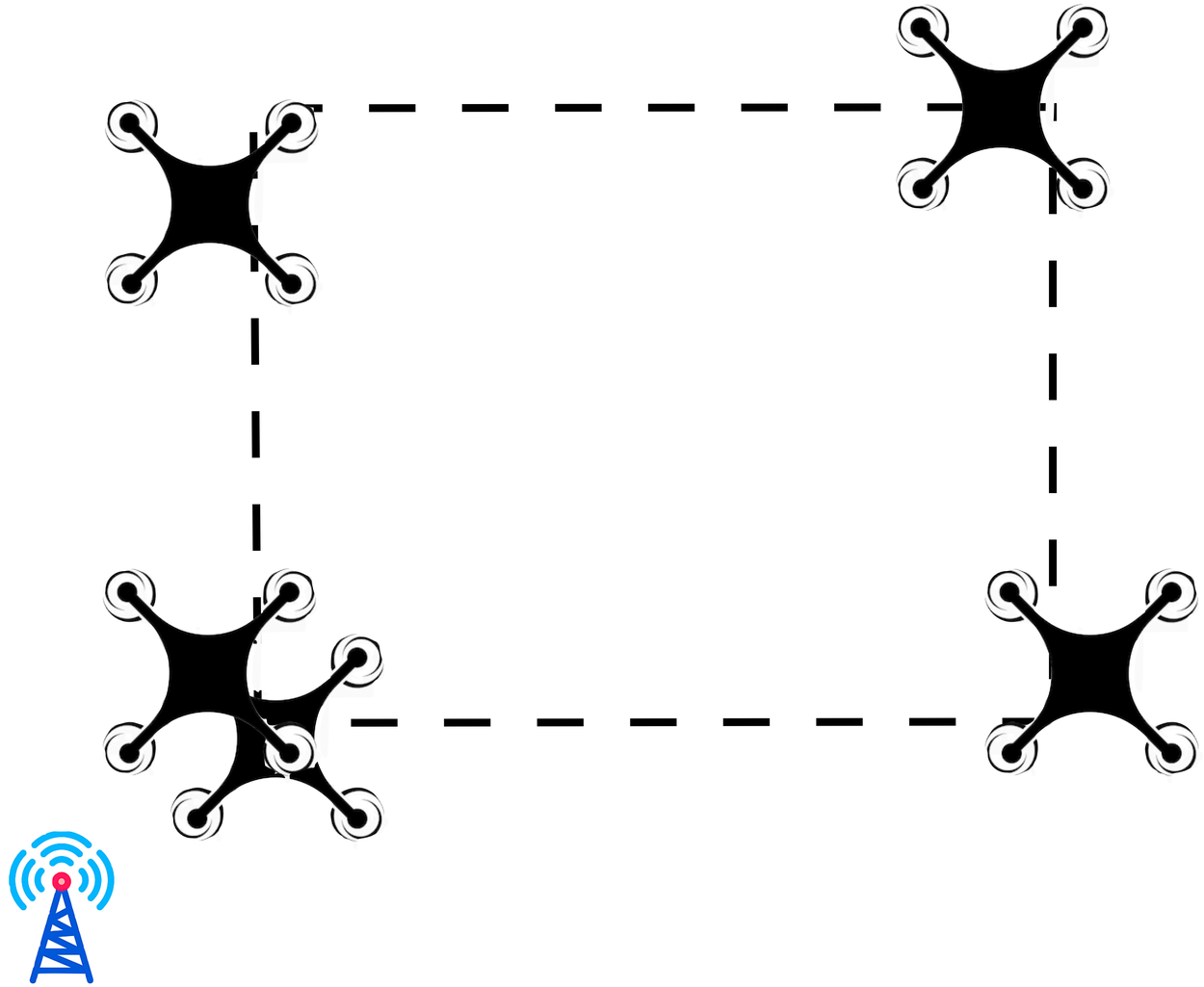
Update pose

T=2



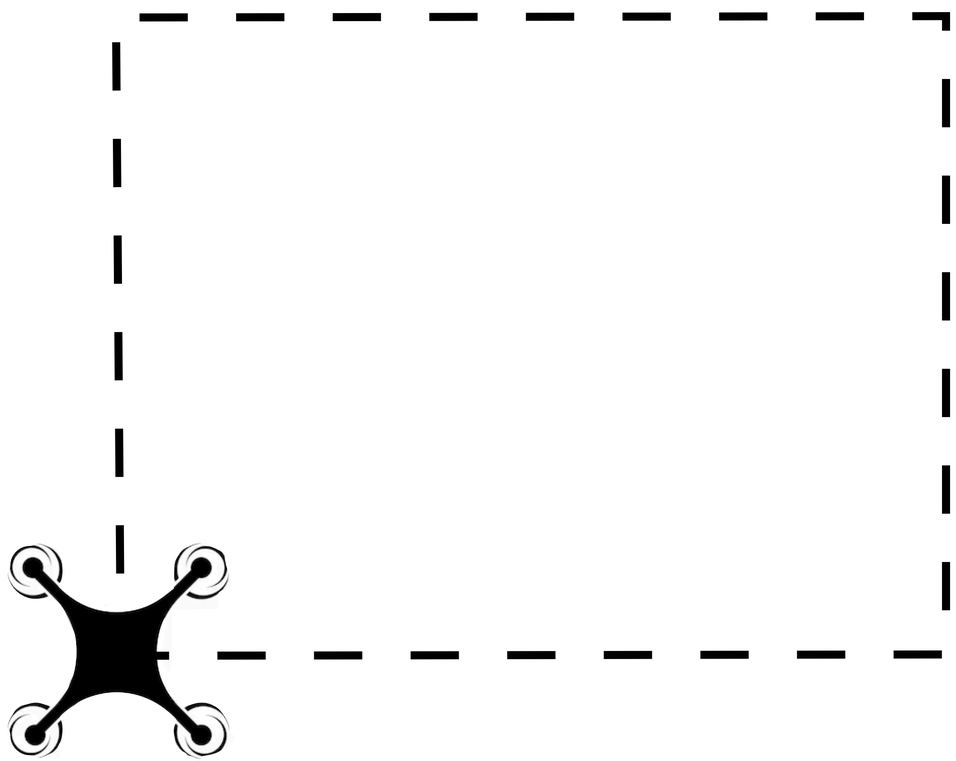

T=3

T=4



How do we mathematically solve for the poses at t=0,1,2,3,4 ?

Now … what if we don’t know all the landmarks?



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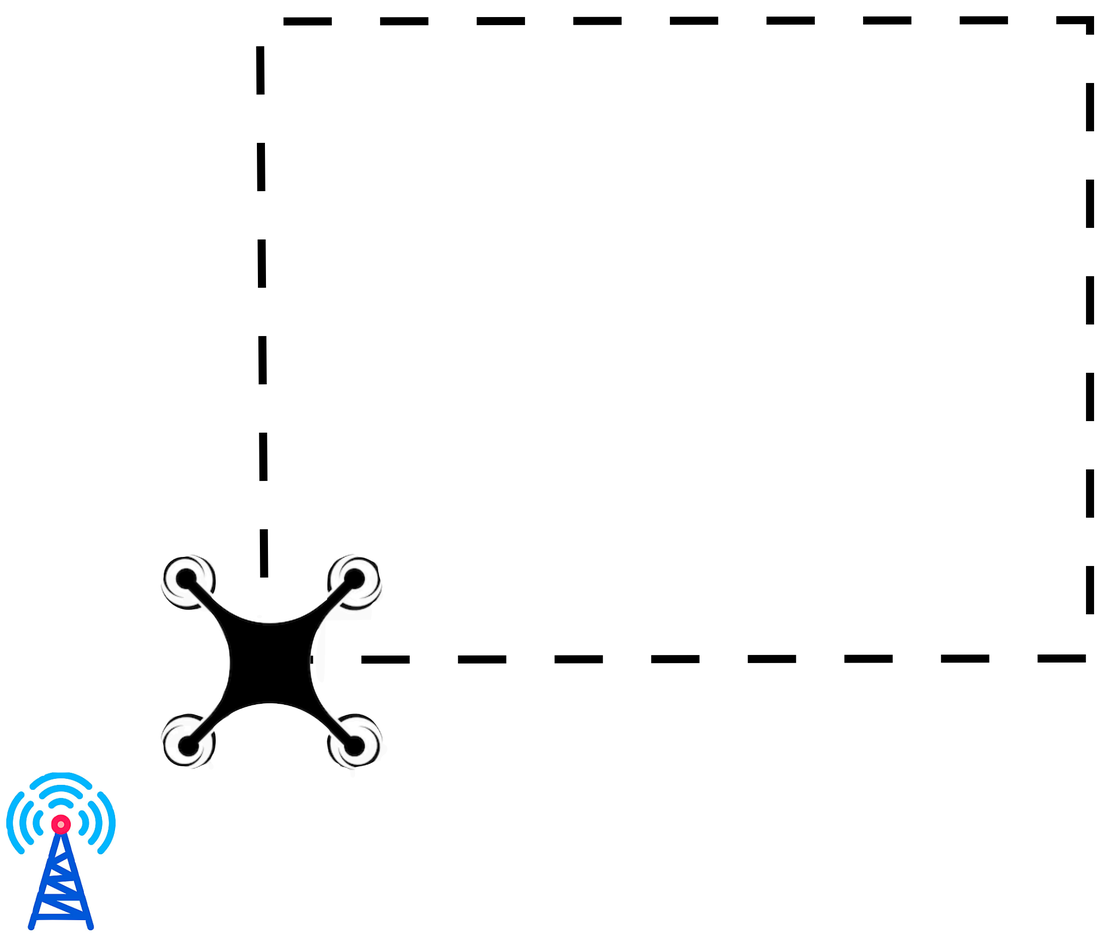
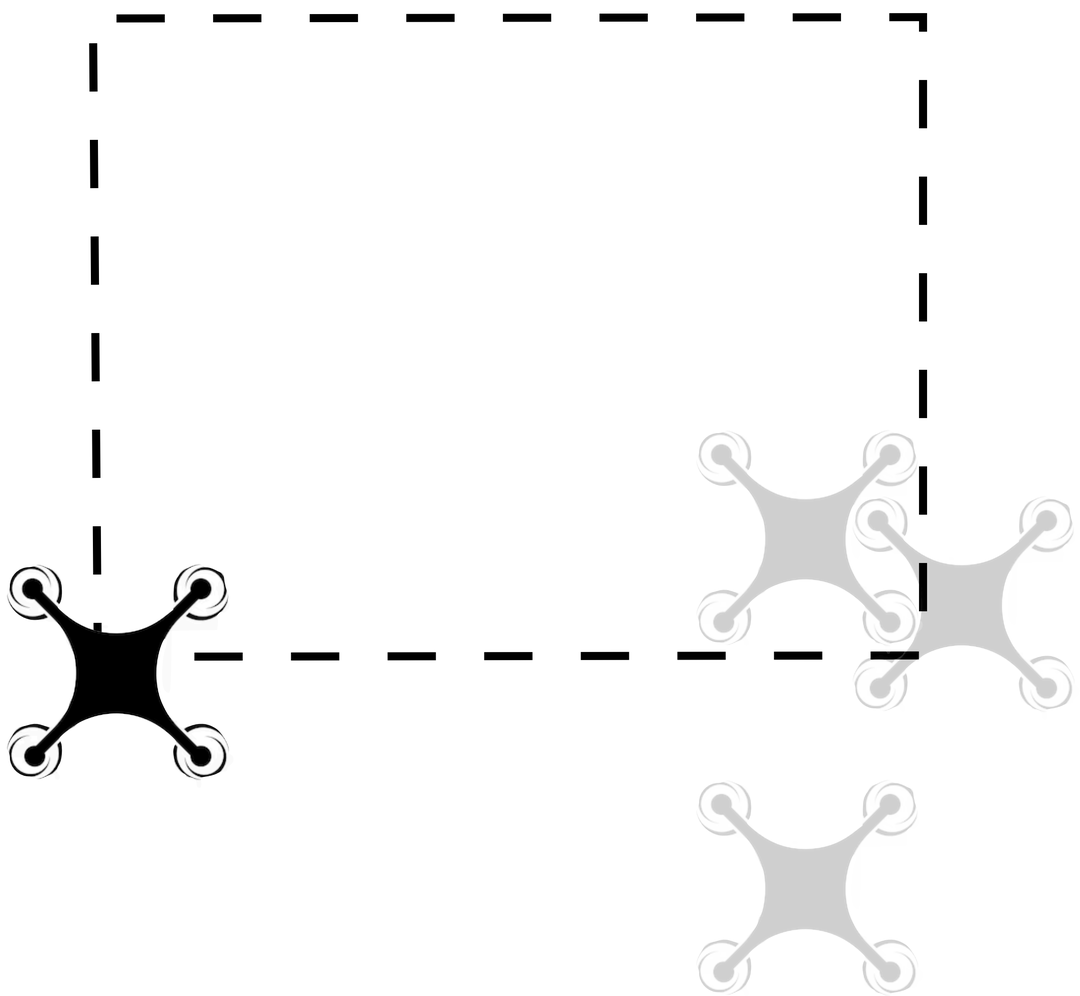


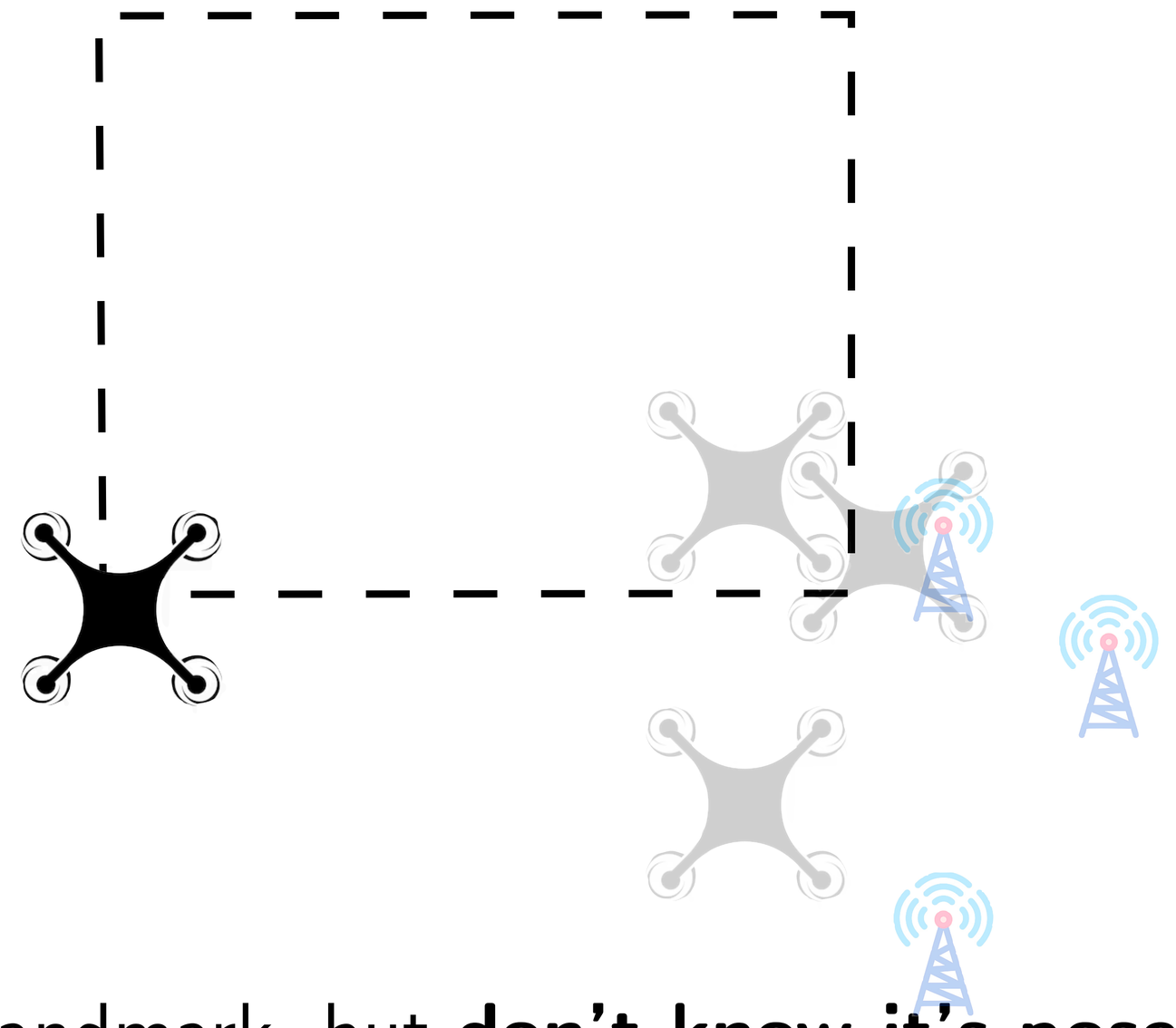
Let's say we know the pose at t=0, landmark at t=0

T=1



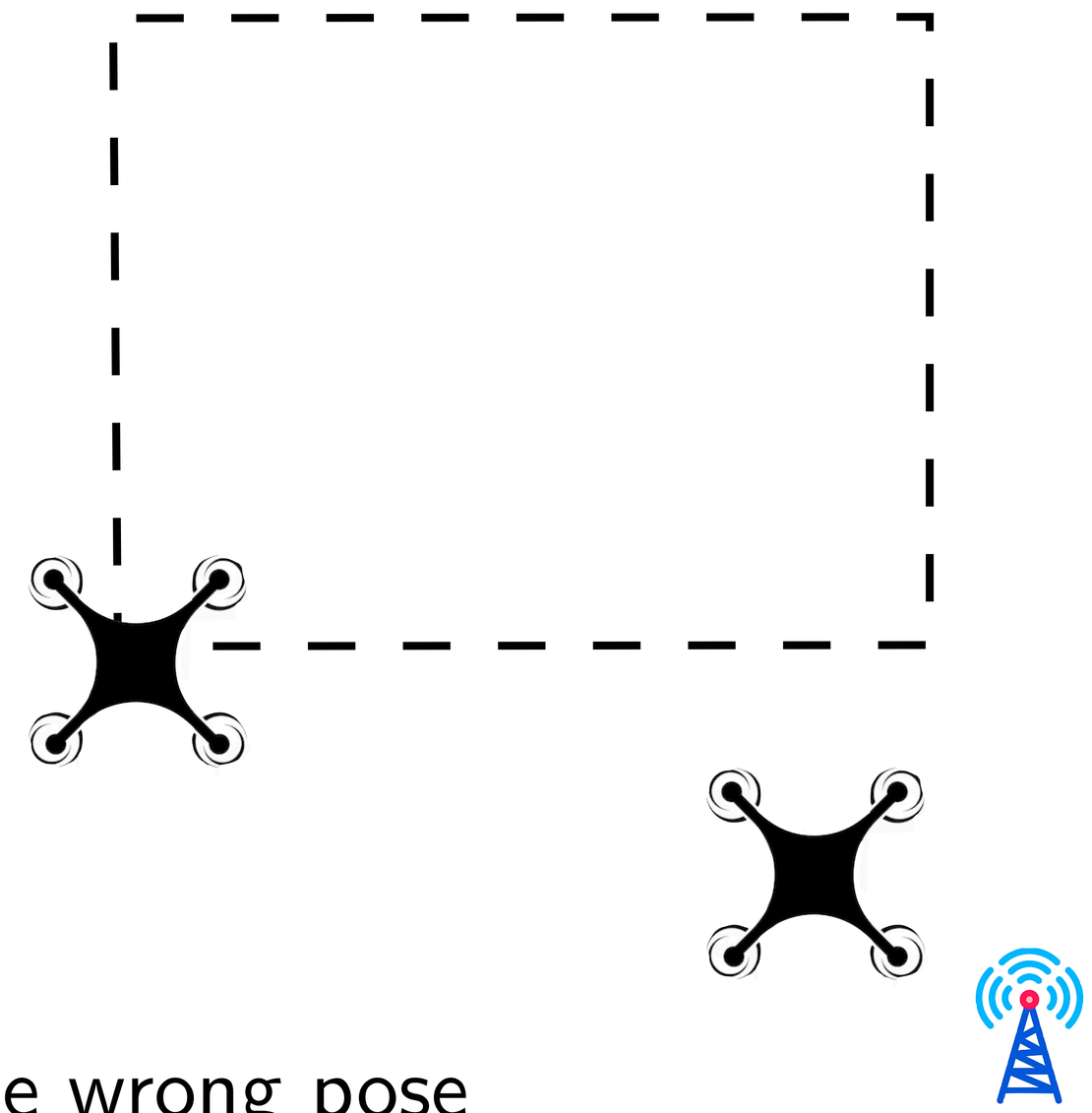
The pose at t=1 is **unknown.**

T=1



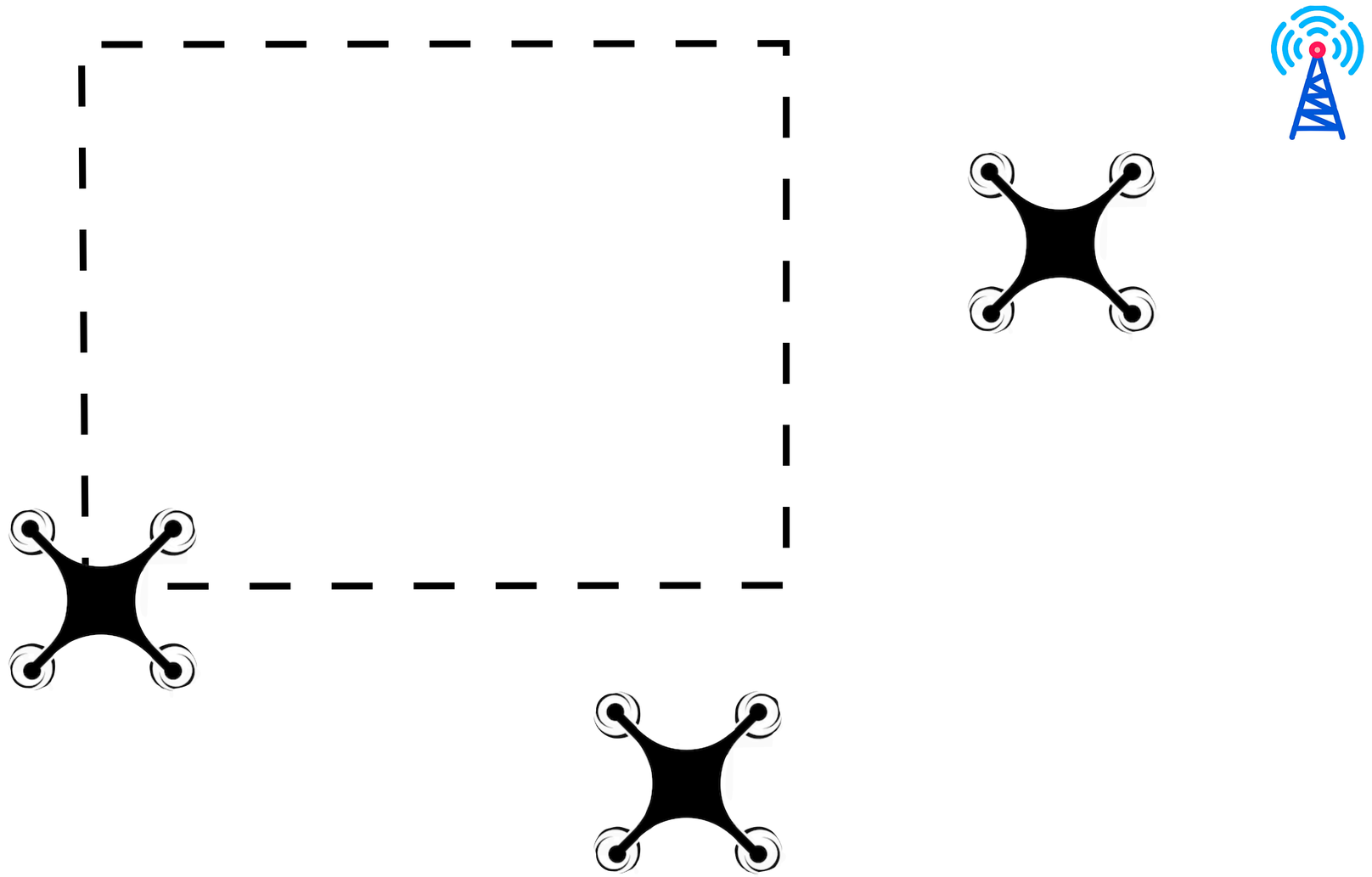
We observe a landmark. but **don’t know it’s pose either.**

T=1

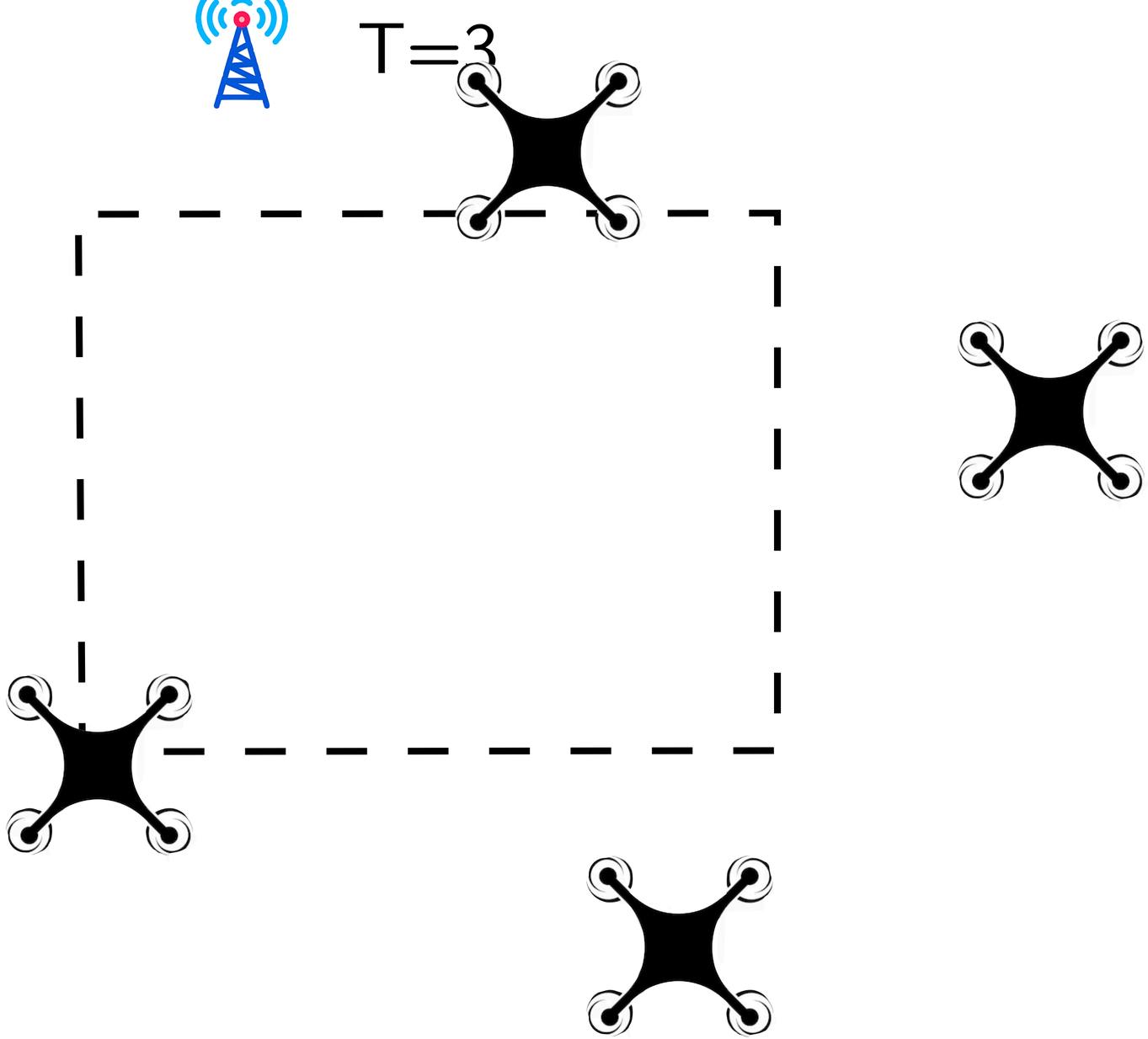


We latch on to the wrong pose

T=2



Continue deviating further ..



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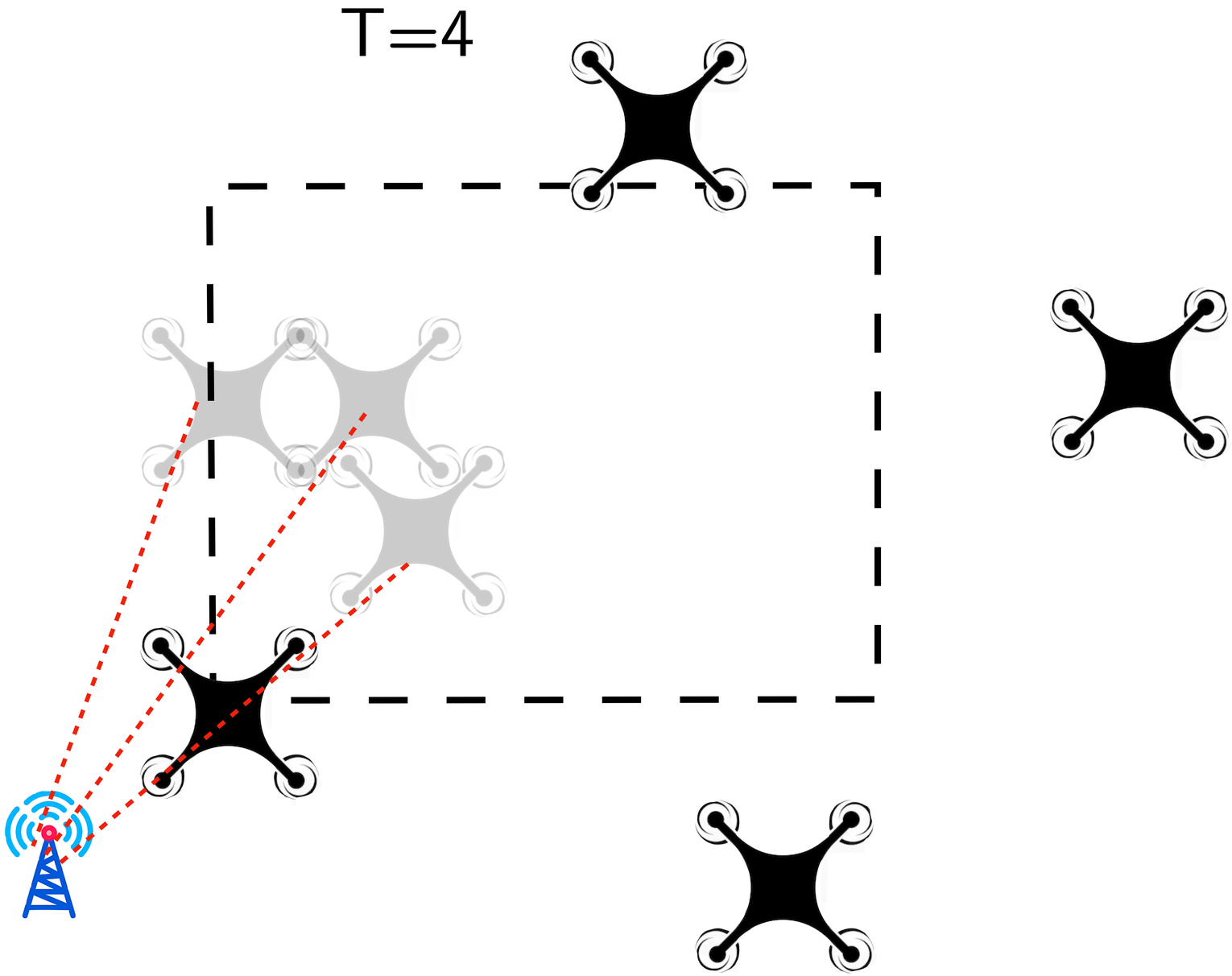
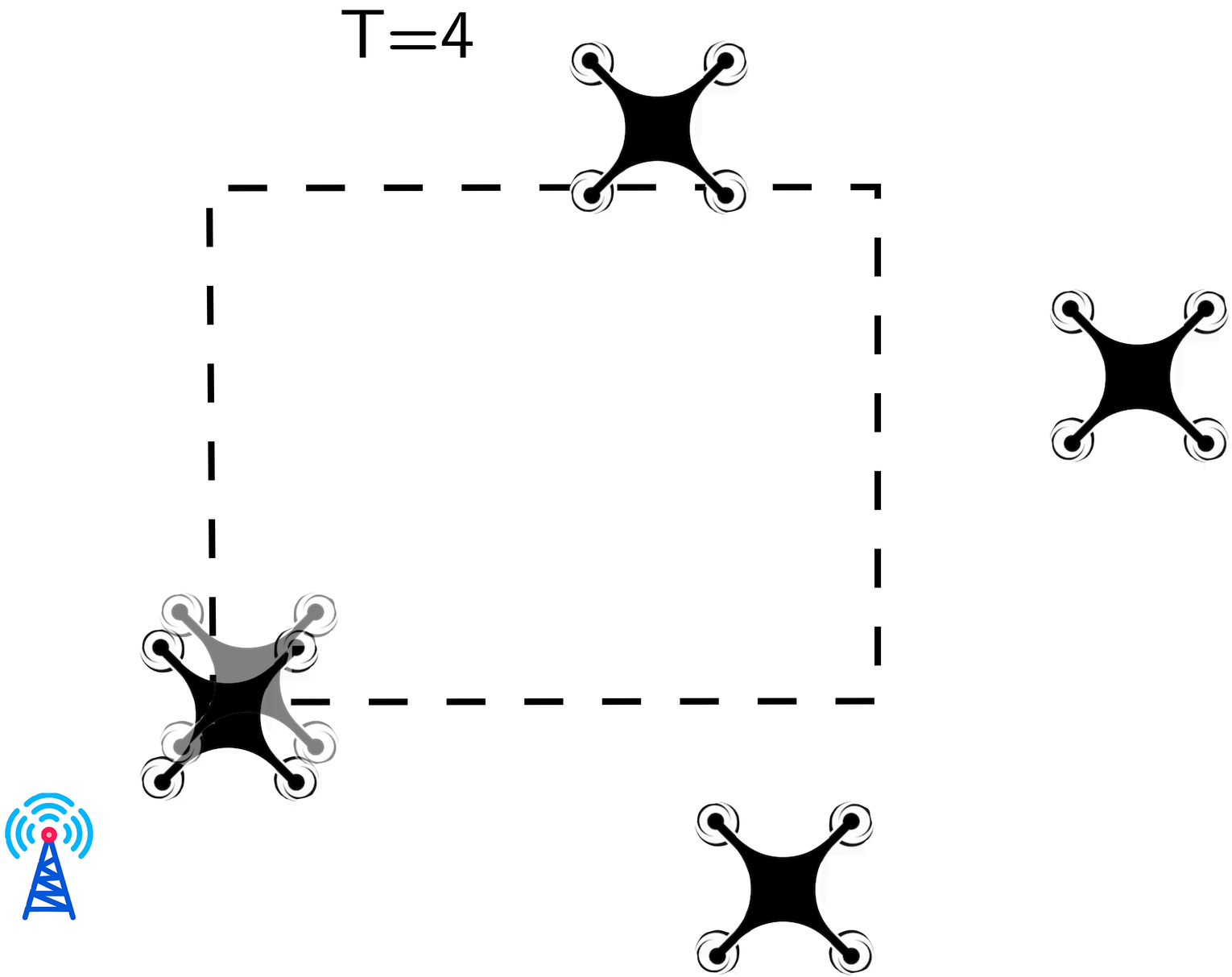
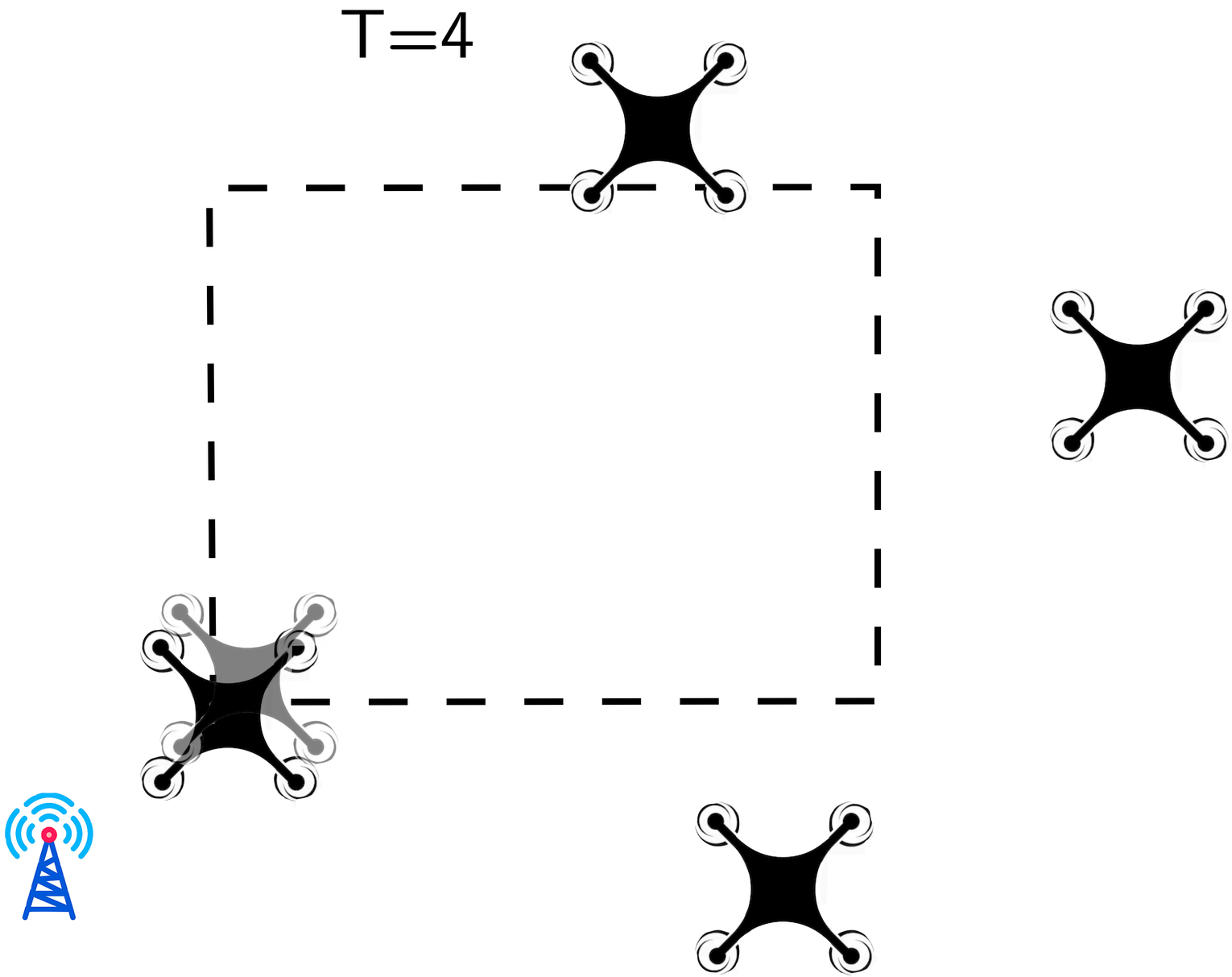


Now at t=4, we see the **same landmark** as t=0

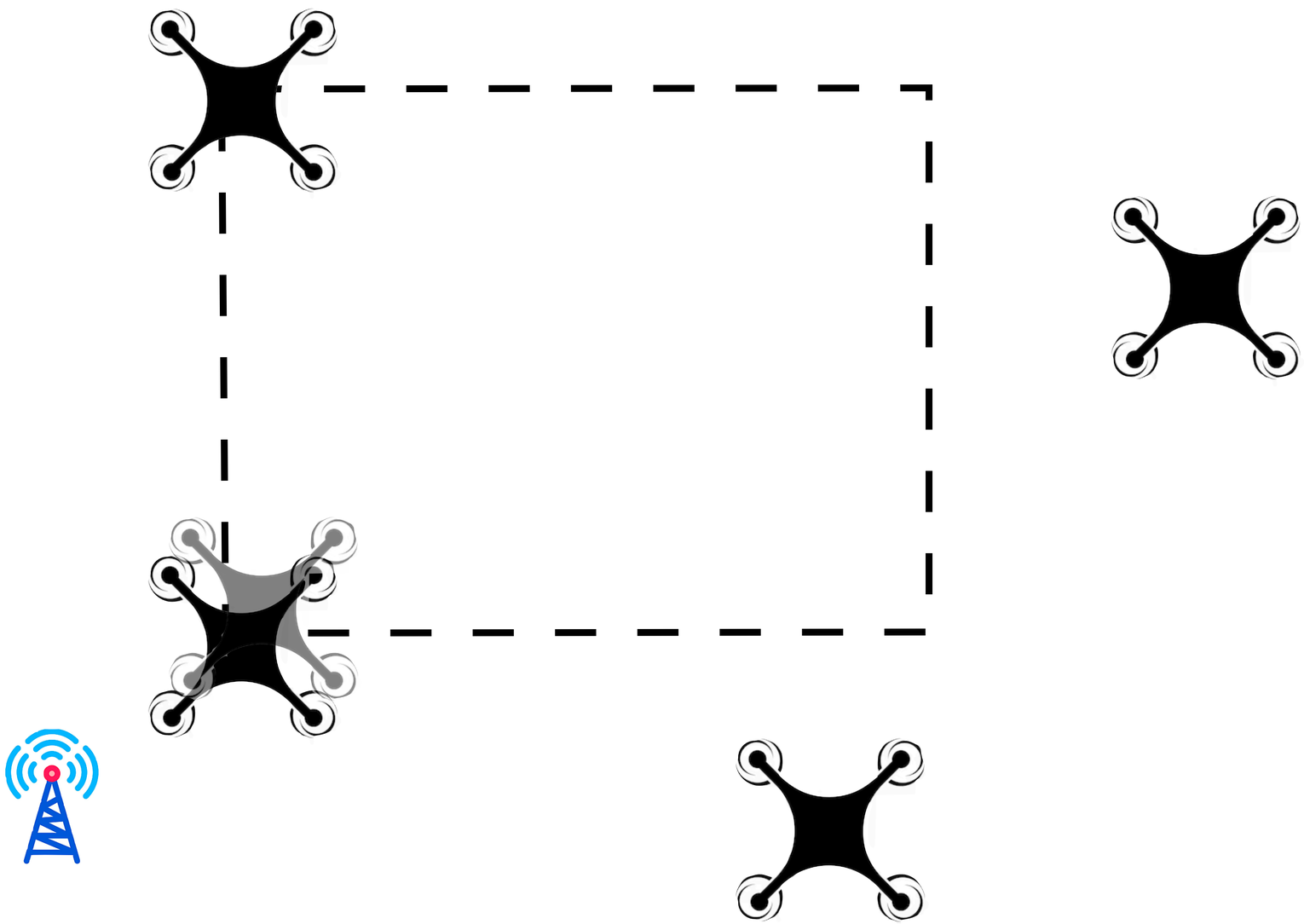


This should “snap” us to the correct position!



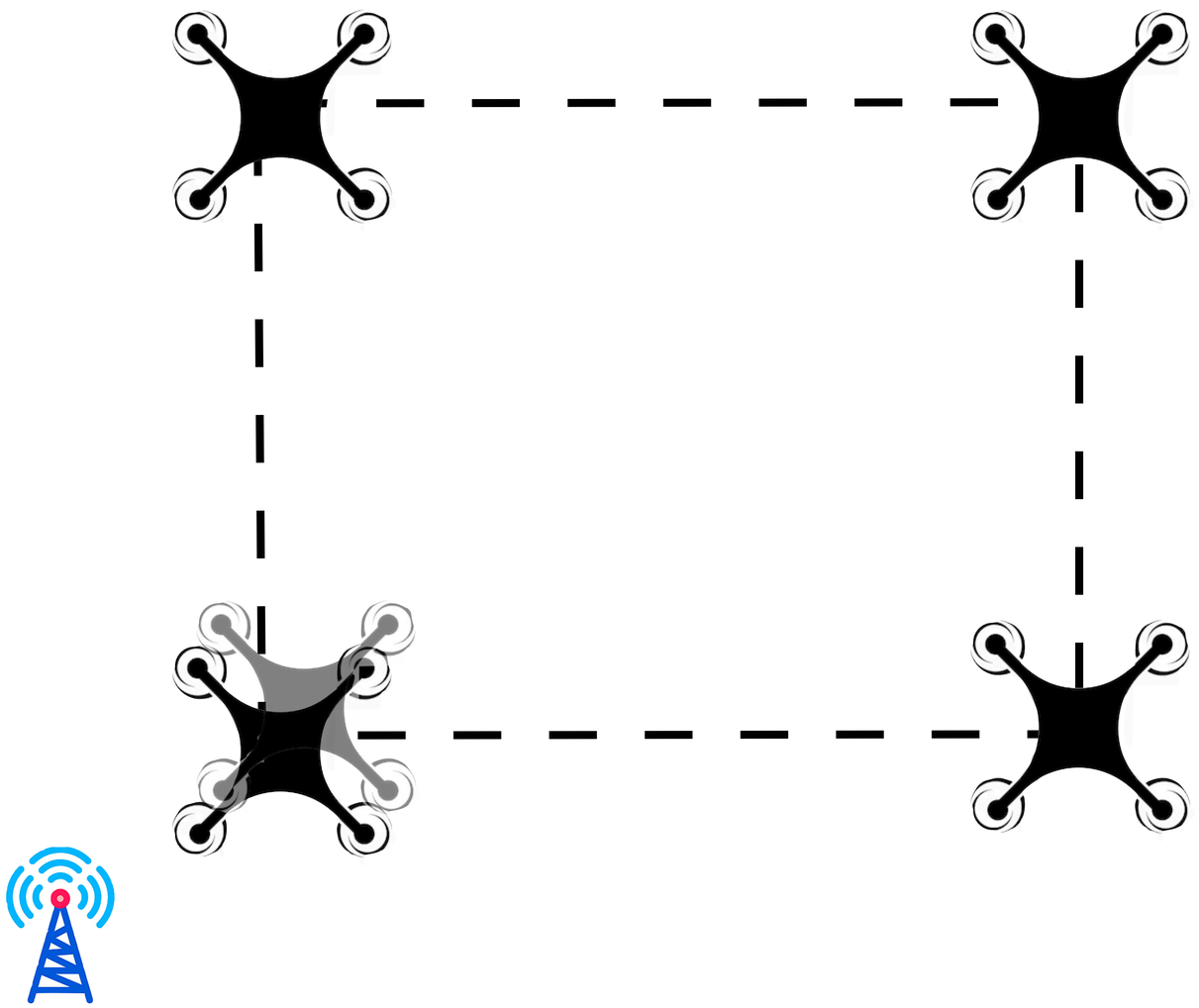
Now the estimate at T=3 is inconsistent

T=4



We correct that one as well

T=4



Correct t=2, t=1!

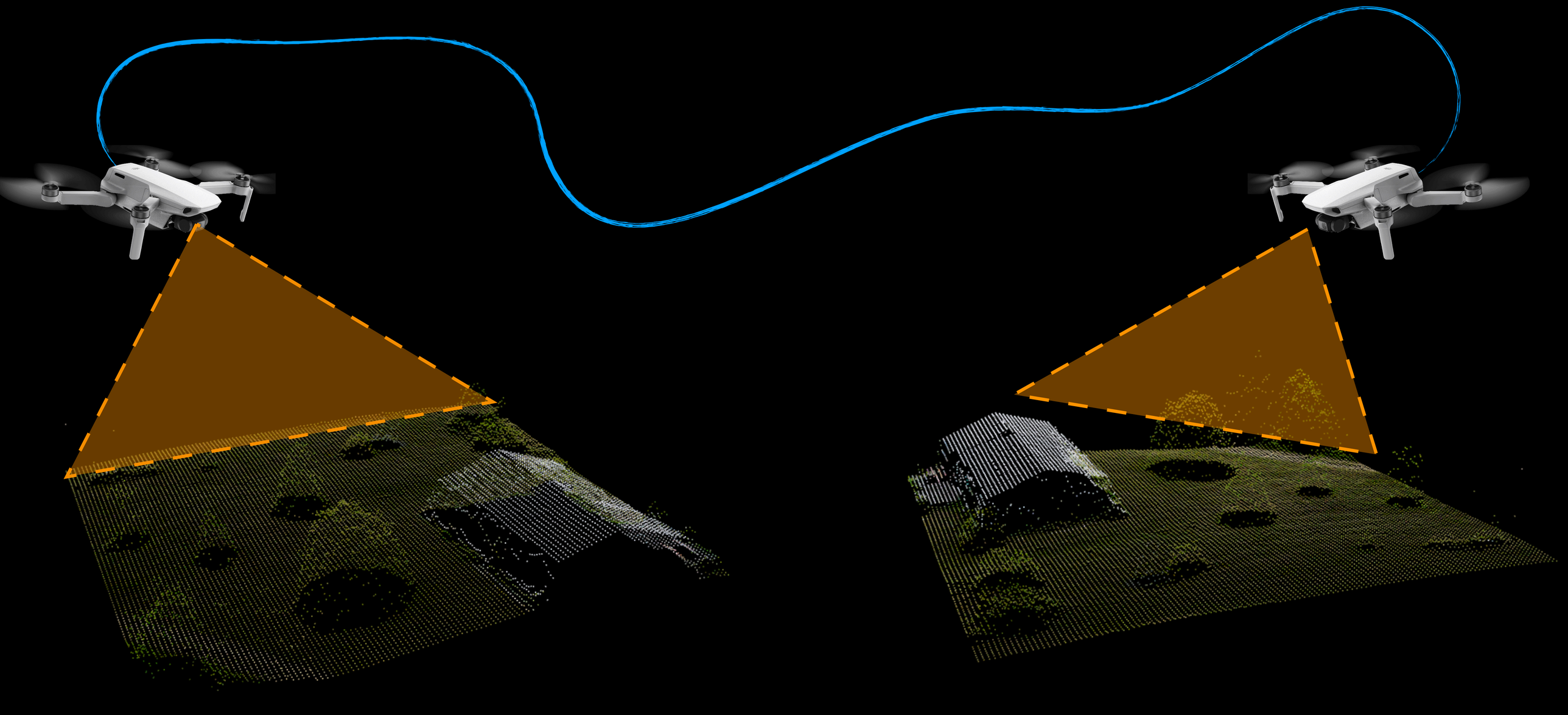
Let’s do math!

Application:
SLAM for self-driving


TRACKING – KFs: 703 , MPs: 49427 , Tracked: 157

Application:
SLAM for UAV Mapping

Rotation? Translation?



Let’s formulate

Takeaways

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