From Soloist to Symphony: Cooperative Maze Navigation in ROS 2

A deep dive into multi-robot SLAM, Nav2, and collaborative task allocation.

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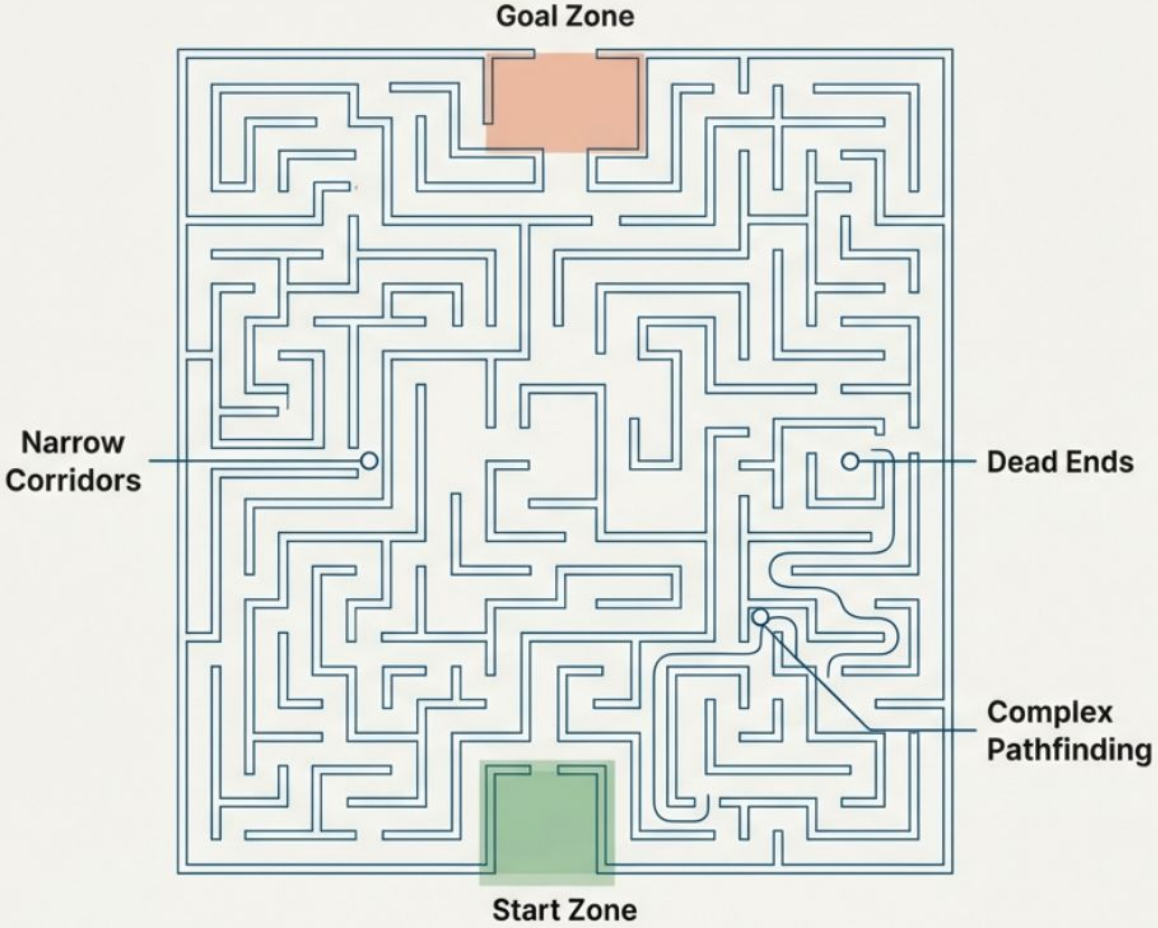
(Group 11)

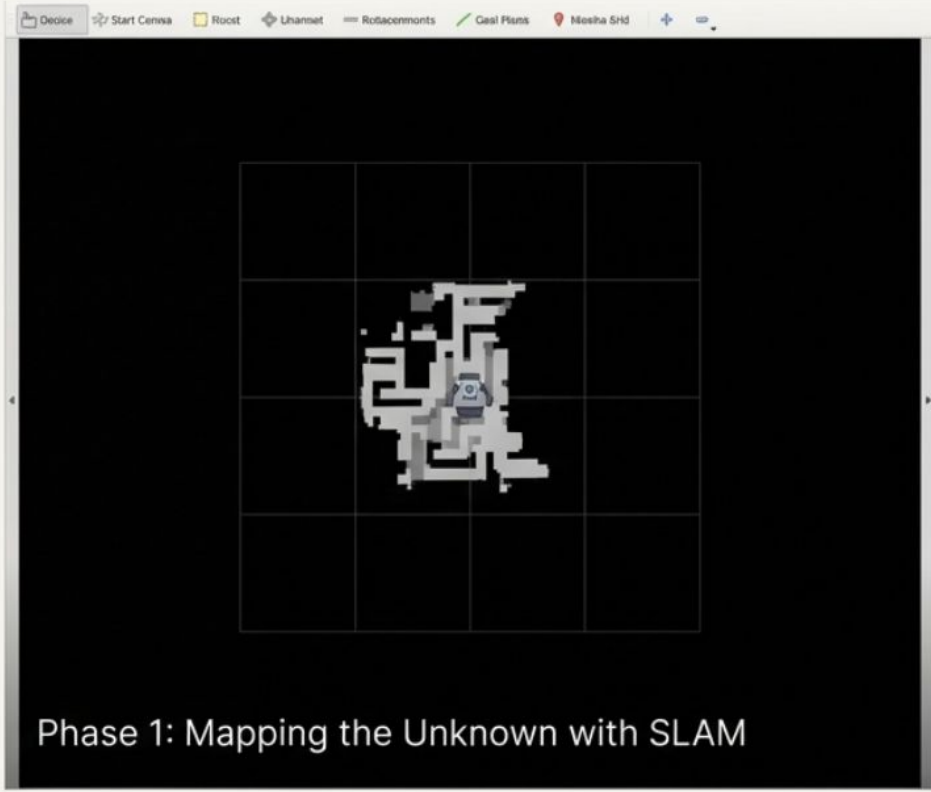


The Maze is a Classic Robotics Gauntlet

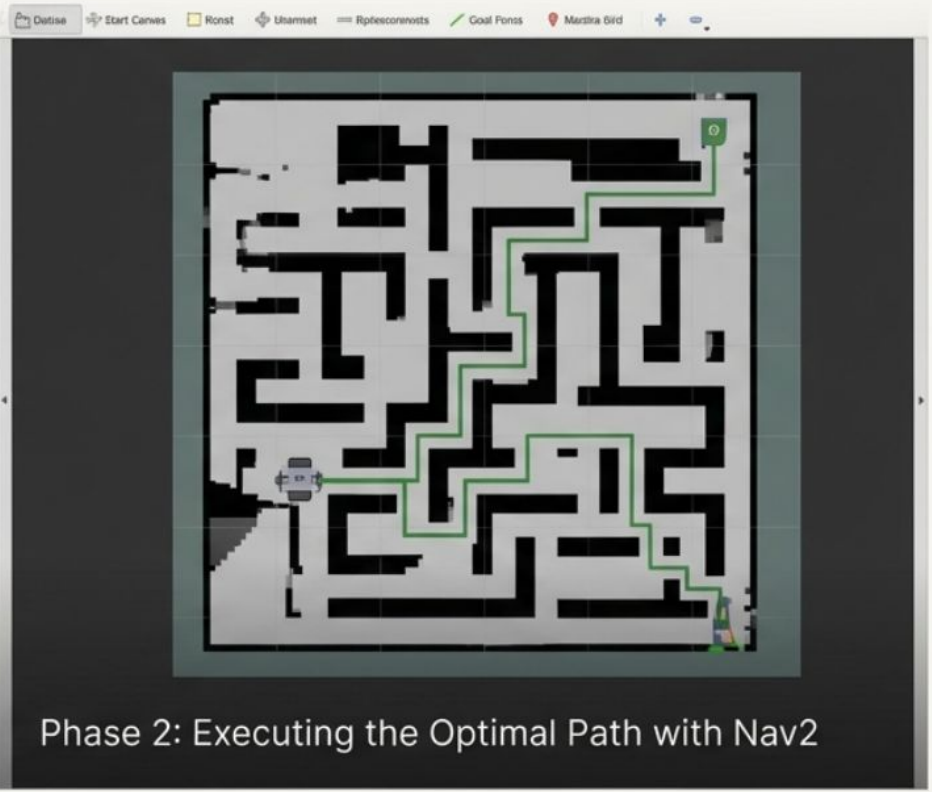
Our challenge is to autonomously navigate an unknown maze from start to goal. The environment is designed to test the limits of planning and perception, featuring:

- Narrow corridors demanding precise control.
- Loops and dead ends that require non-trivial pathfinding.

A Capable Explorer, But Is It an Efficient One?



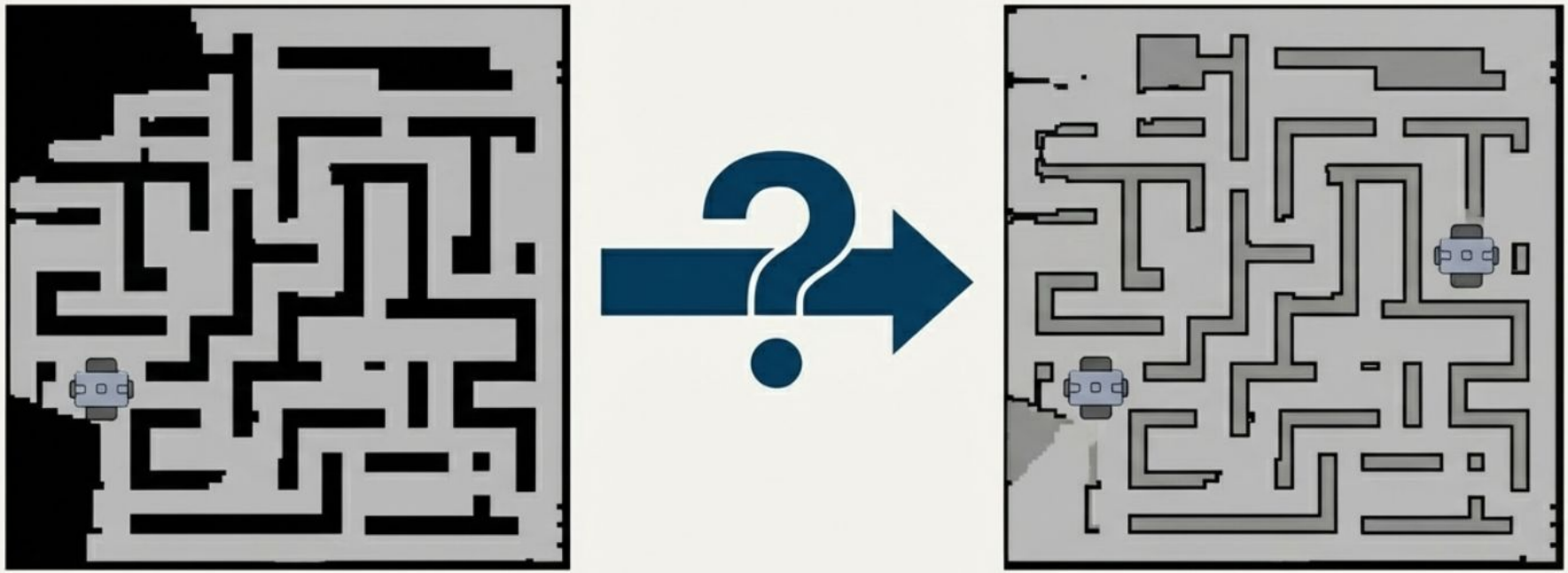
Phase 1: Mapping the Unknown with SLAM



Phase 2: Executing the Optimal Path with Nav2

The single robot system reliably maps and navigates the maze. This sets our performance baseline.

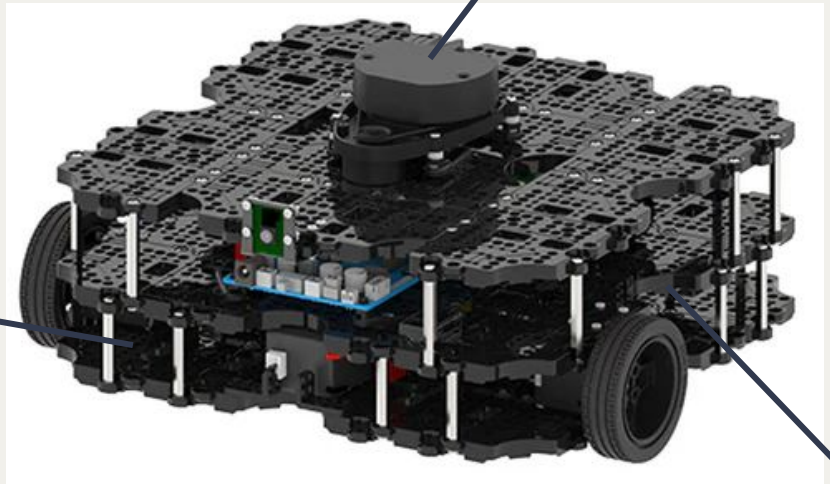
How can we solve the maze *faster* and more efficiently?



By enabling two robots to collaborate, we can significantly reduce total exploration and goal-finding time. The core challenge is designing the rules for their cooperation.

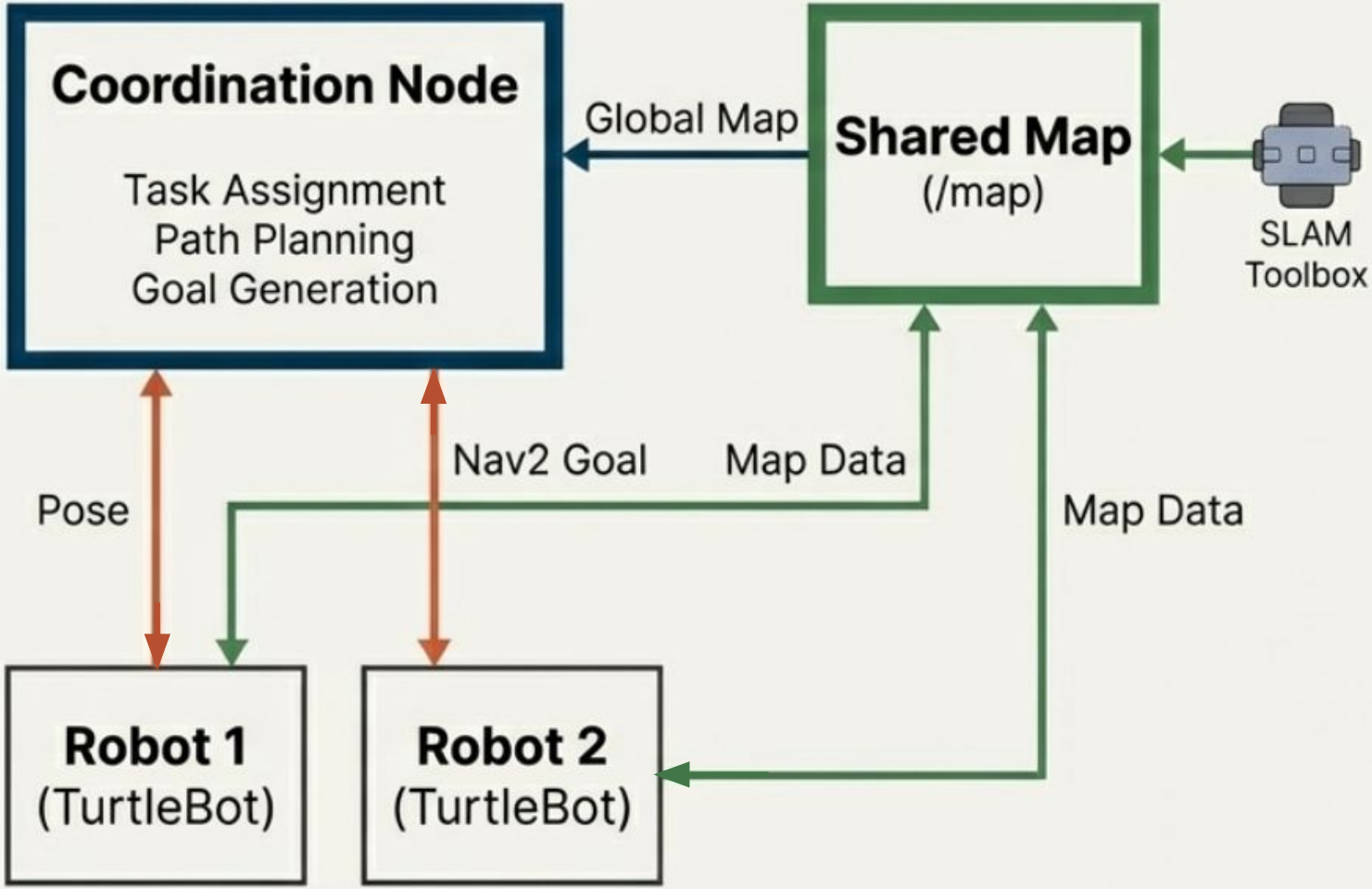
Two Turtlebots will have a LiDAR to map the Environment

Turtlebot Waffle with 2D **LiDAR** for SLAM and Navigation



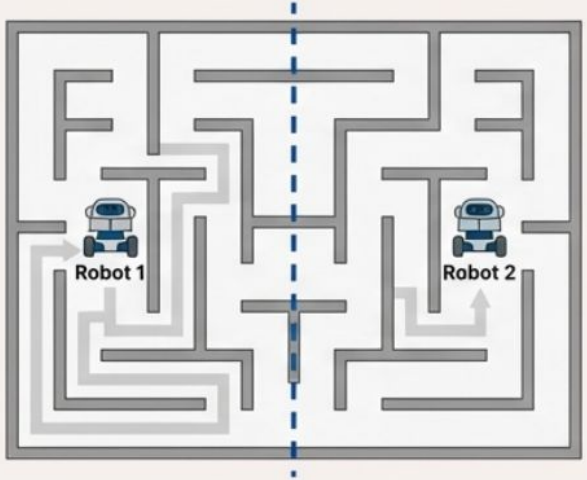
NAV2 (the brain): navigation system

ROS2 (the nervous system): connects nodes (LiDAR, SLAM, navigation, etc.) through topics

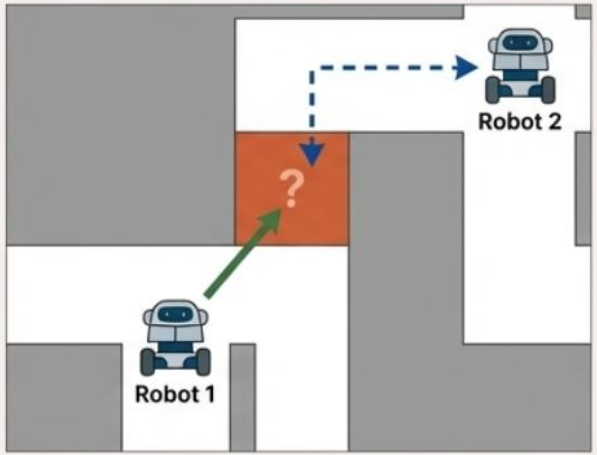

Coordination Node
Task Assignment
Path Planning
Goal Generation
Global Map
Shared Map
(/map)
SLAM
Toolbox
Pose
Nav2 Goal
Map Data
Map Data
Robot 1
(TurtleBot)
Robot 2
(TurtleBot)

The Rules of Engagement

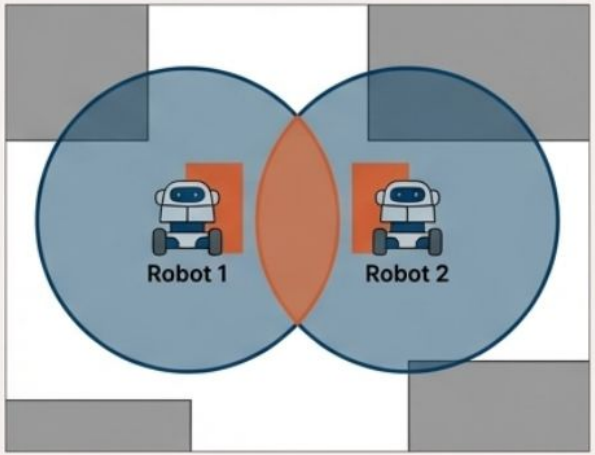
Divide and Conquer: Regional Assignment



Smart Dispatch: Assigning Goals Based on Proximity



Local Awareness: Collision Avoidance via Costmaps



Divide and Conquer: Regional Assignment

The maze is split into a “left half” and “right half” to guide initial exploration.

Smart Dispatch: Assigning Goals Based on Proximity

Our coordinator assigns unexplored frontiers to the closest available robot, preventing redundant work.

Local Awareness: Collision Avoidance via Costmaps

Robots treat each other as dynamic obstacles, using Nav2’s local planner to navigate around one another.

Work Split

Daniel: Nav2, A*, Global/Local Maps, Gazebo Environment

Joe: SLAM toolbox, synchronization logic to avoid duplicate exploration/navigation conflicts

Martin: Multi robot coordination module, frontier or region based task allocation

Hopes

- SLAM Map and Understand Position In an unknown maze
- Use a Frontier Path planning algorithm to explore the maze environment
- Coordinate between robots in order to explore different regions
- Reach goals more efficiently than a single robot