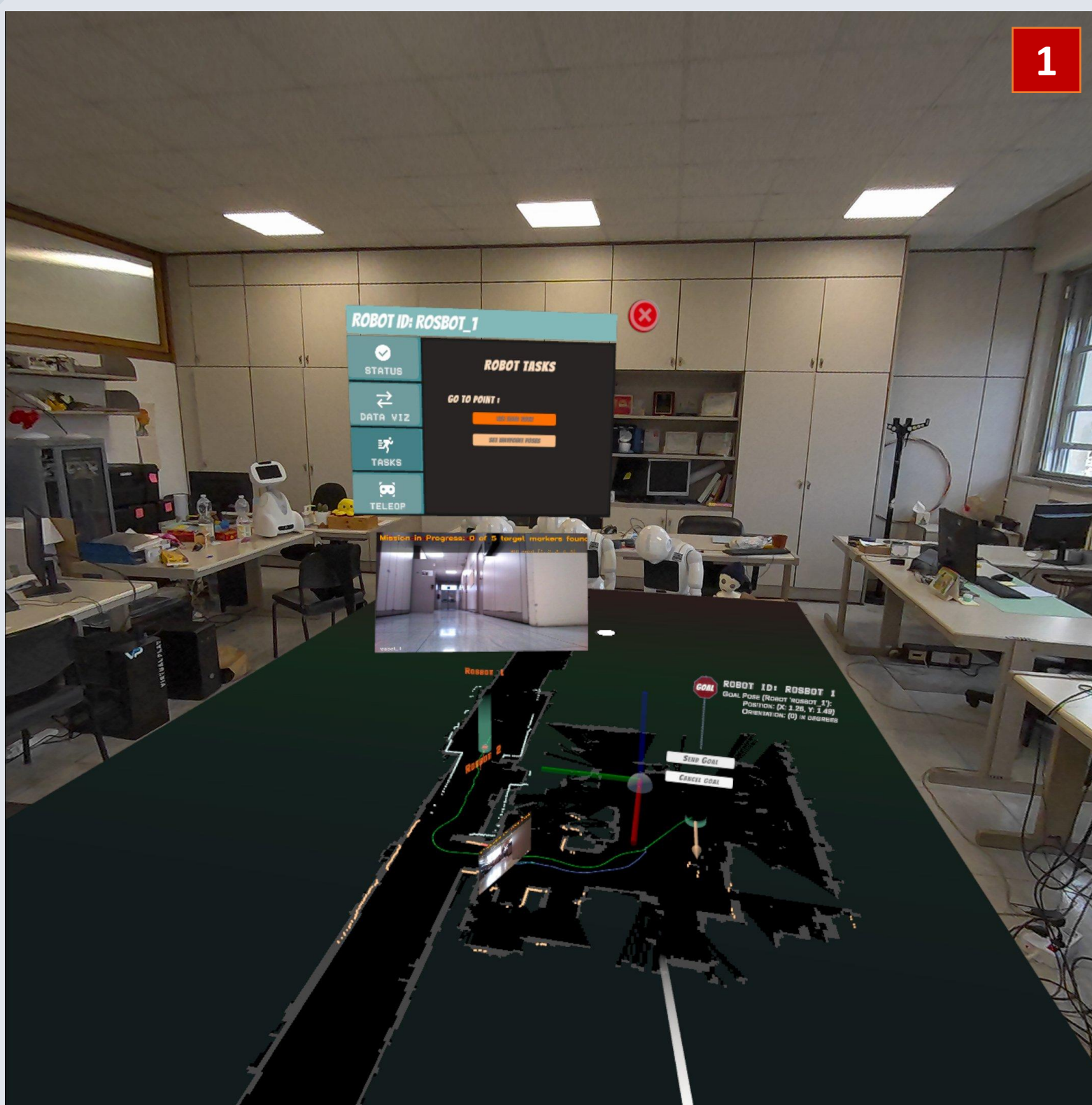


## Introduction

Mixed reality reduces the fragmentation of 2D robotics visualization by spatially anchoring robot state, maps, and controls. We present HORUS, an MR interface on Meta Quest 3 for supervisory control of heterogeneous teams: wheeled, legged, and aerial. HORUS combines a shared mini-map “Ground Station,” per-robot manager panels, and a semi-immersive teleop view, all over ROS 2. A single multi-robot SLAM map supports control, planning and monitoring, while an LLM copilot explains plan intent via concise text and lightweight 3D highlights.



MiniMap (GroundStation) with 3 connected ROSBot, ROSBot with ID 1, is selected which shows the Robot Manager Panel for checking the robot status, sending task, switching on/off specific data to visualize, sending a task, and activating robot teleoperation

## References

- [1] M. Tranzatto et al “Cerberus in the darpa subterranean challenge,” 05 2022.
- [2] K. C. Hoang et al, “Arviz: An augmented reality-enabled visualization platform for ros applications,” 03 2022.
- [3] A. Zea, U. D. Hanebeck, “iviz: A ros visualization app for mobile devices,” Software impacts, vol. 8, pp. 100057–100057, 05 2021.
- [4] M. E. Walker et al “Robot teleoperation with augmented reality virtual surrogates,” 03 2019.
- [5] M. Allenspach et al “Mixed reality human-robot interface to generate and visualize 6dof trajectories: Application to omnidirectional aerial vehicles,” 06 2023.



Try HORUS yourself!  
Scan the QR code below to access the HORUS GitHub repository. You can download the beta version of the application on your Meta Quest 3 and test it with your wheeled robot by following the instructions in the README file. We welcome your feedback and contributions!

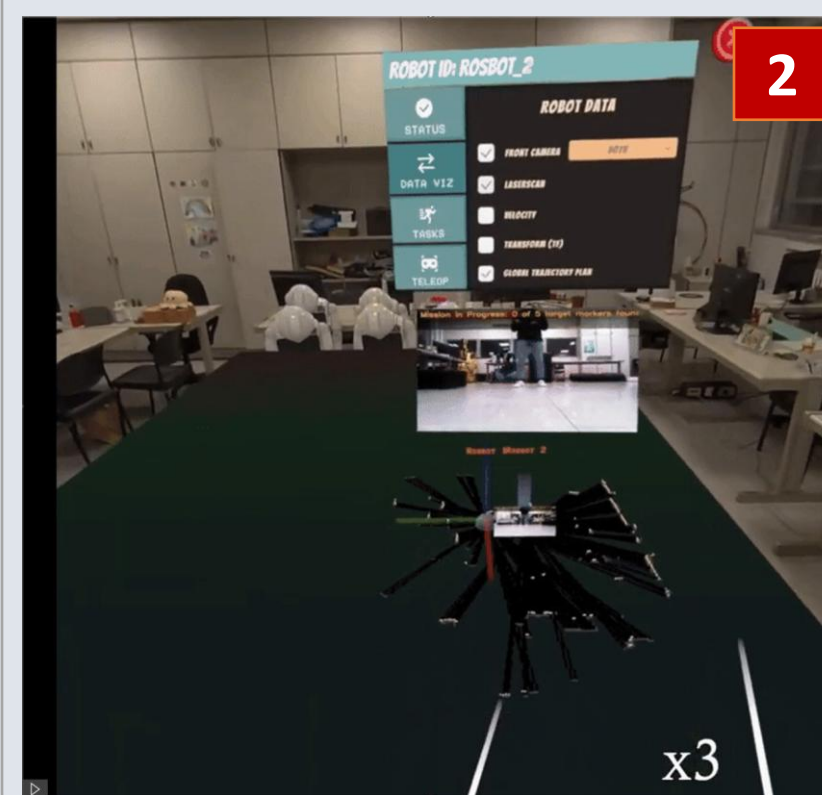


## Methodology

HORUS is a Mixed-Reality (MR) interface on Meta Quest 3 for supervisory control of heterogeneous robot teams. It anchors robot state, maps, and controls in a shared mini-map with per-robot manager panels for managing a robot member in the team and a semi-immersive teleop view, all over ROS 2 with a single multi-robot SLAM map. Below are the features of the HORUS applications.

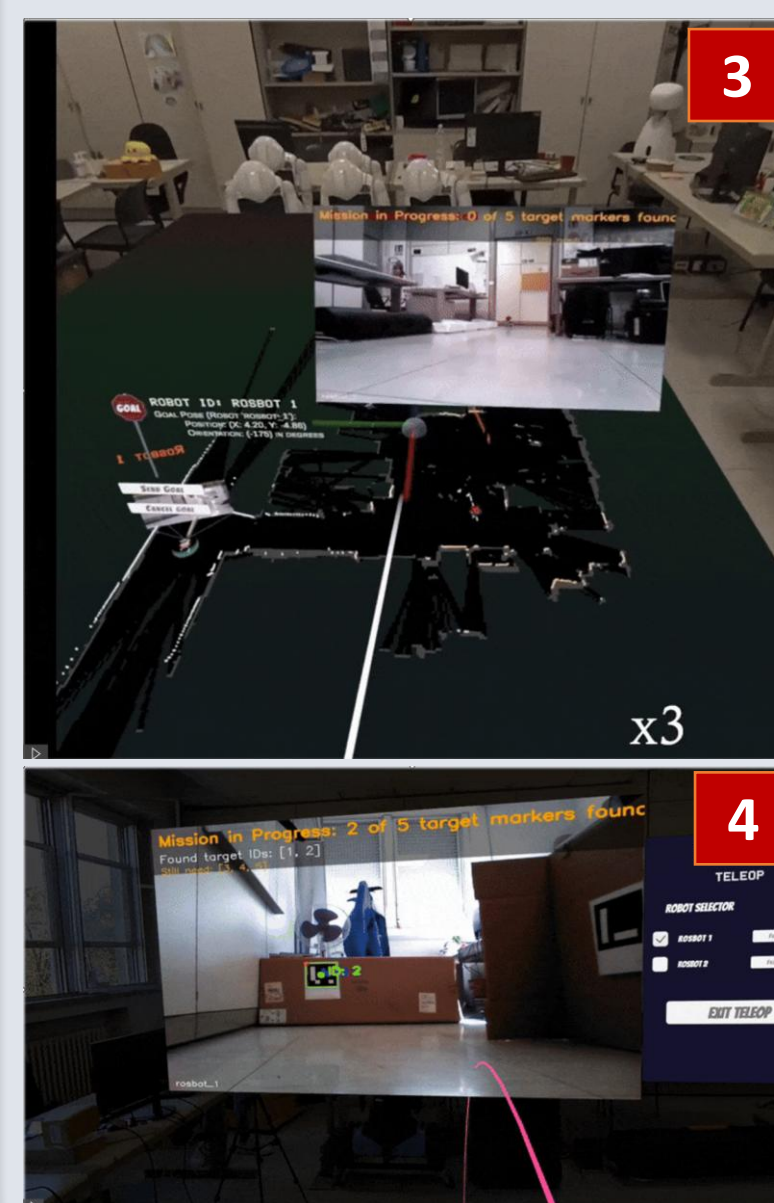
### Data Visualization

- **Sensor Data:** Camera(Projected/Overhead), laserscan, etc
- **Operational Data:** Nav Plan, Velocity, Transform etc

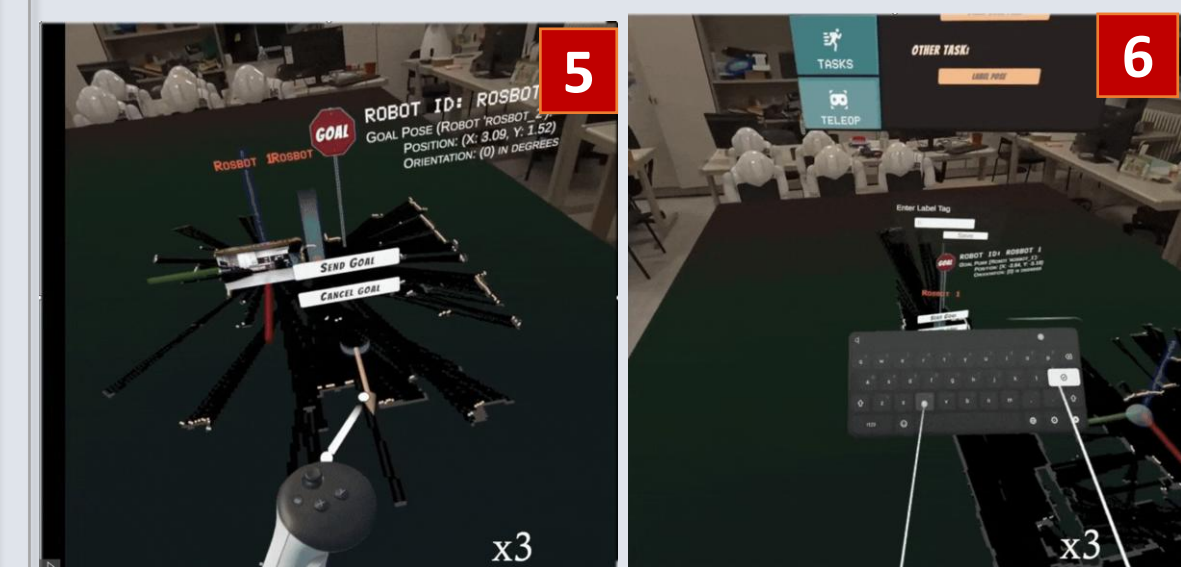


### Teleoperation

- MiniMap Teleop
- Semi Immersive Teleop



### Task Allocation

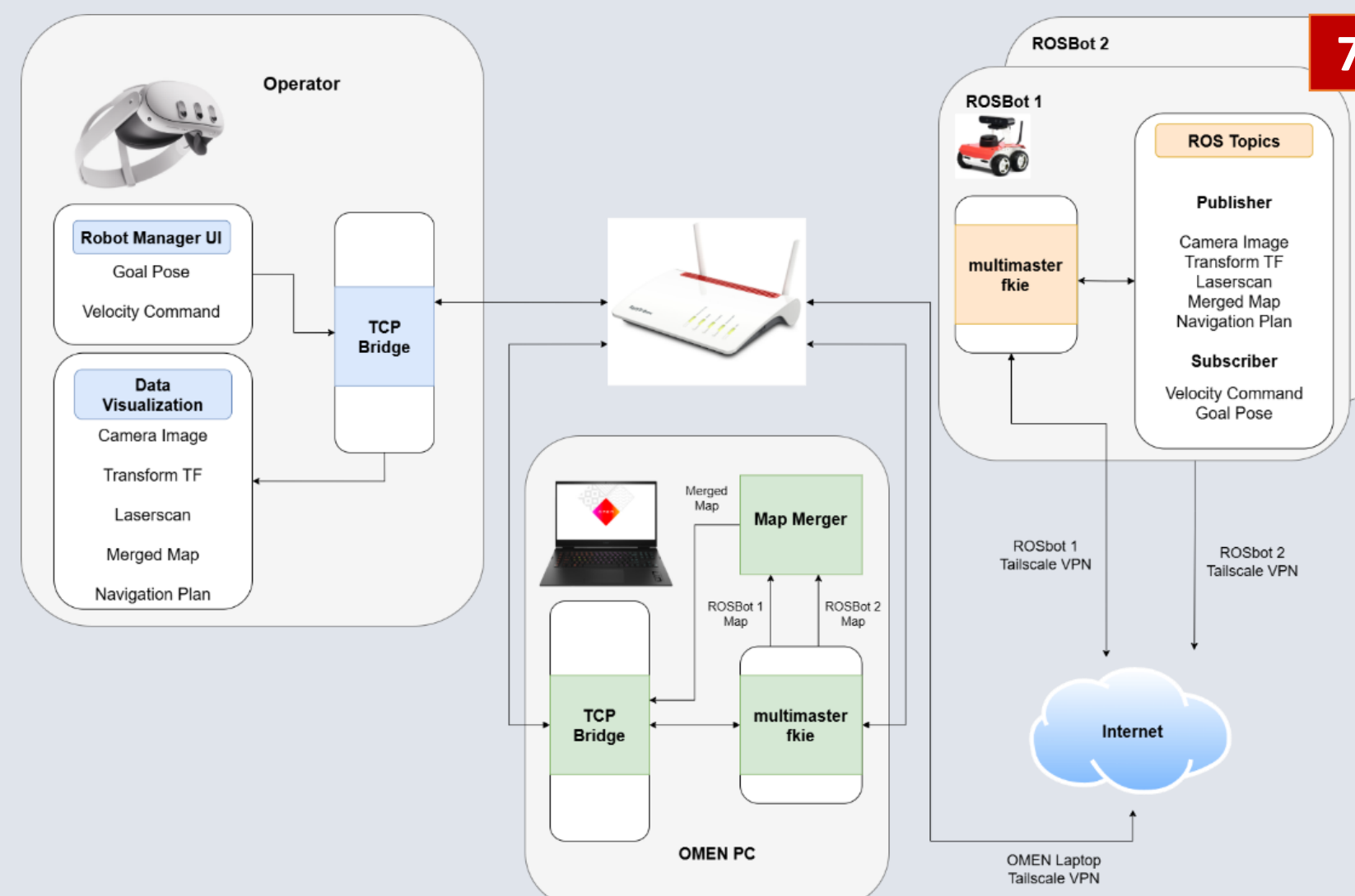


- Single/Multi Robot
- GoToPoint
- Label Pose
- Go To Pose Label
- Trajectory Drawing follower

### LLM/VLAM Intent Visualization/Editing (ONGOING WORK)

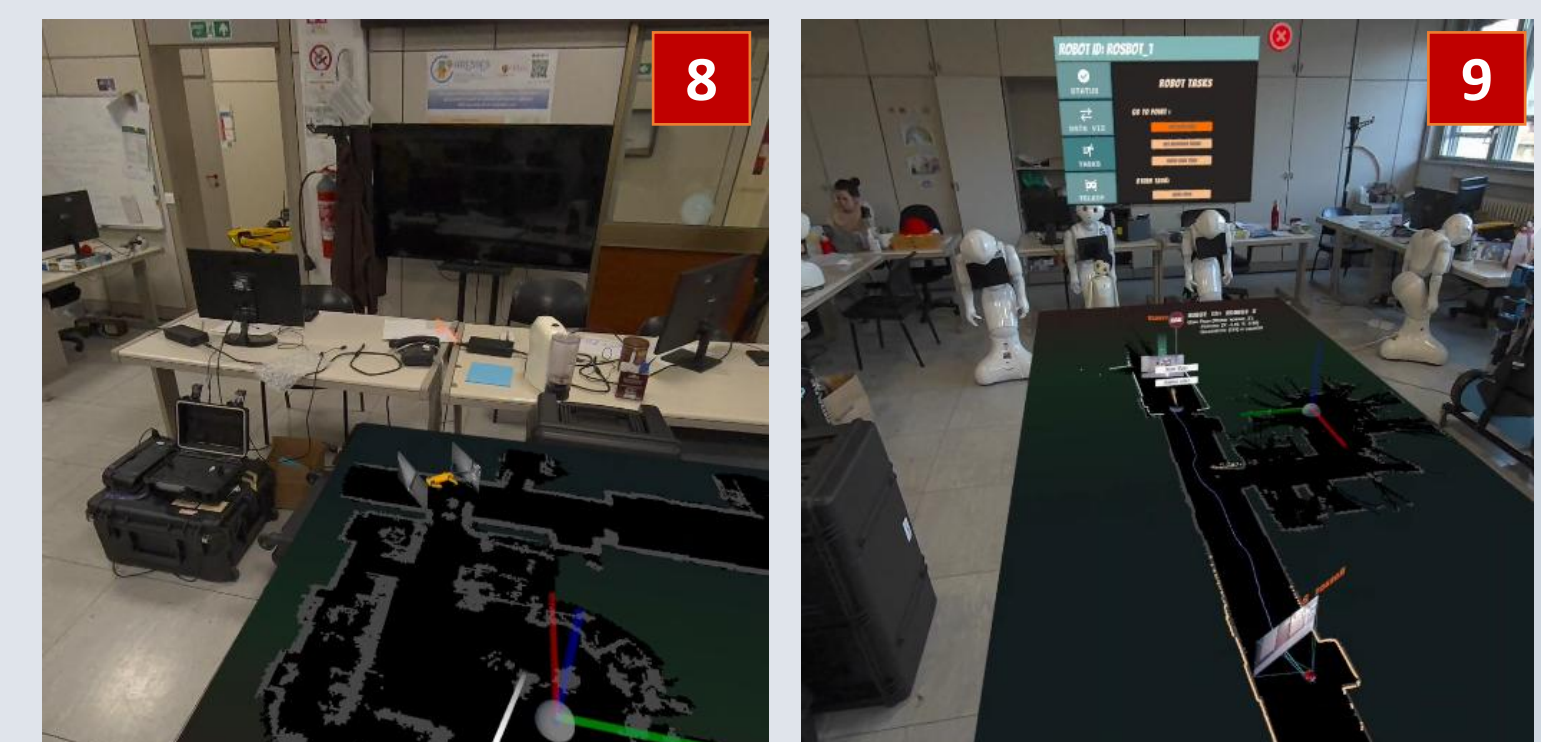
- Operators would be able to visualize the intent of the AI with appropriate 3D visualizer/Text Panel/Audio and would be able to make changes to it or accept the plan
- The HORUS Backend would generate plan and action with the help of connected LLM/VLAM

### System Architecture for HORUS Application Experiment



- **Network Configuration:** Connects all devices via a VPN Network
- **ROS-Unity Bridge:** Enables real-time data exchange using the ros\_tcp\_endpoint package.
- **HORUS Application:** Compiled directly on Meta Quest 3 for untethered operation, reduced latency, and enhanced portability.

### Platform Supported



One interface three classes of mobile robots, **Wheeled, Legged and Aerial**. The interface has been tested with multi robots (wheeled), boston dynamics spot robot (legged) and currently ongoing work integrating custom coaxial quadcopter with 3D map and goals.

## Discussion

HORUS runs on ROS 2 with a single shared multi-robot SLAM map and now supports wheeled, legged (Spot), and aerial workflows; early wheeled-user results were positive. Future is focused on LLM copilot: integrate planning, concise intent summaries, and editable constraints with uncertainty cues; validate with a focused user study on decision speed and trust.

## Conclusion

HORUS unifies supervisory control of wheeled, legged (Spot), and aerial robots in MR over ROS 2 with a shared multi-robot SLAM map; next we'll harden aerial/legged ops, add multi-operator workflows, integrate the LLM copilot end-to-end, and run broader user studies.