Distributed AI Agents for Cognitive Underwater Robot Autonomy

-Results-

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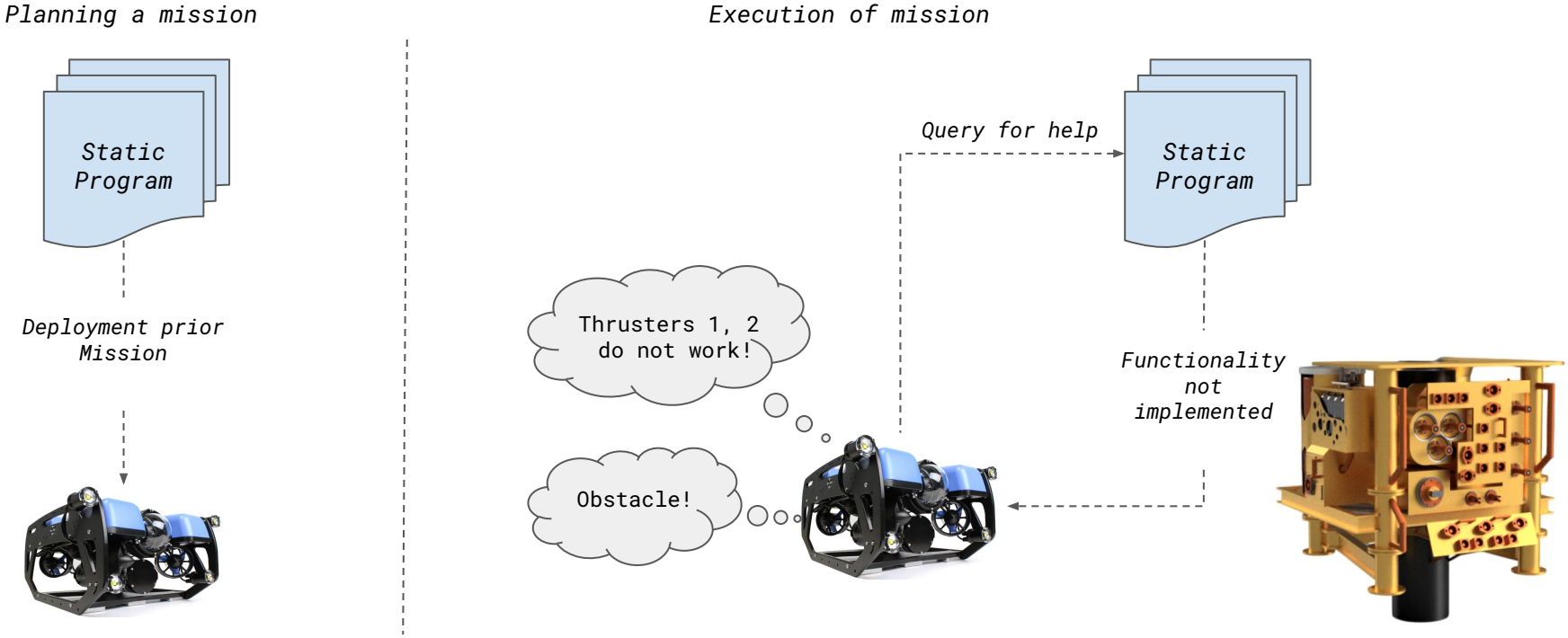
From Traditional Robotics to True Autonomy

1. Traditional robots struggle in unpredictable environment.
2. Robots rely on pre-programmed, rule-based systems that are not flexible.



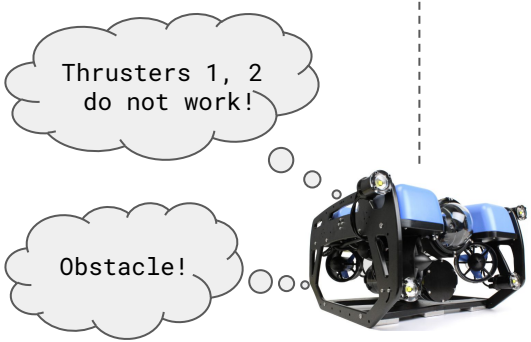
New Paradigm

UROSA is an AI-driven framework for creating "self-playing" systems that can adapt and solve problems autonomously.

Planning a mission

Inspect valve

Execution of mission



Query for help

UROSA

AI Agent

AI Agent

AI Agent

AI Agent

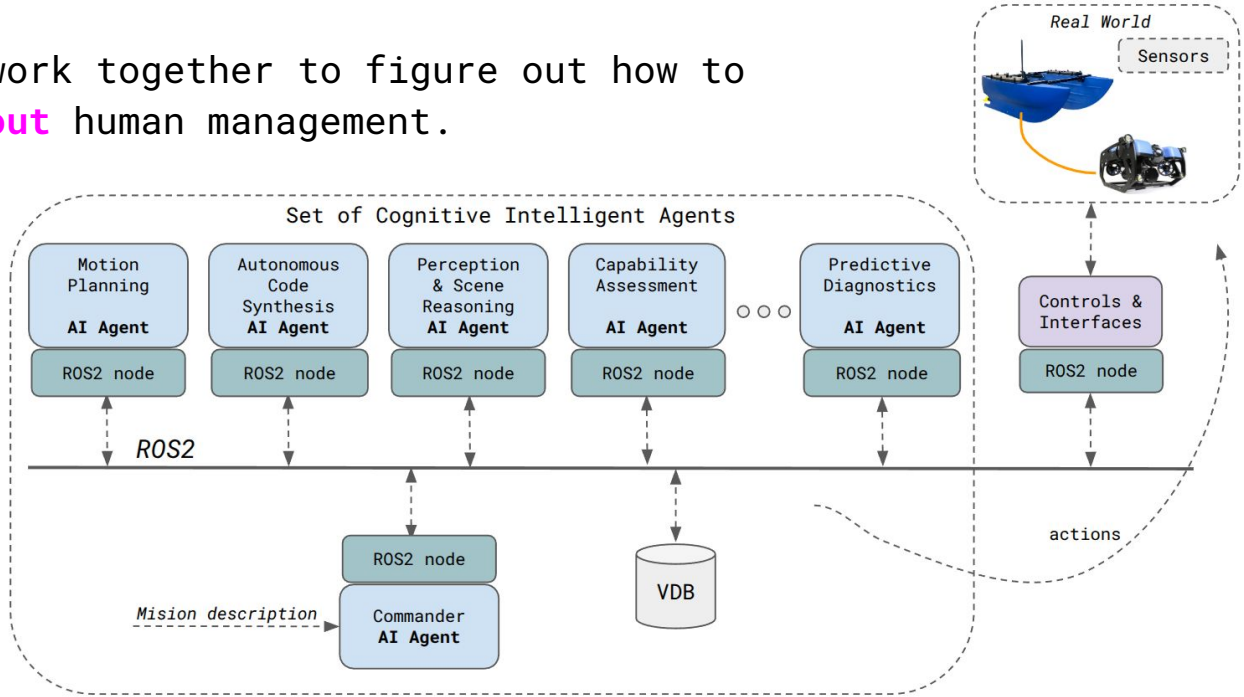
We fix !

What is UROSA?

Concept: We replace a single main program with a team of specialized AI agents communicating using ROS 2.

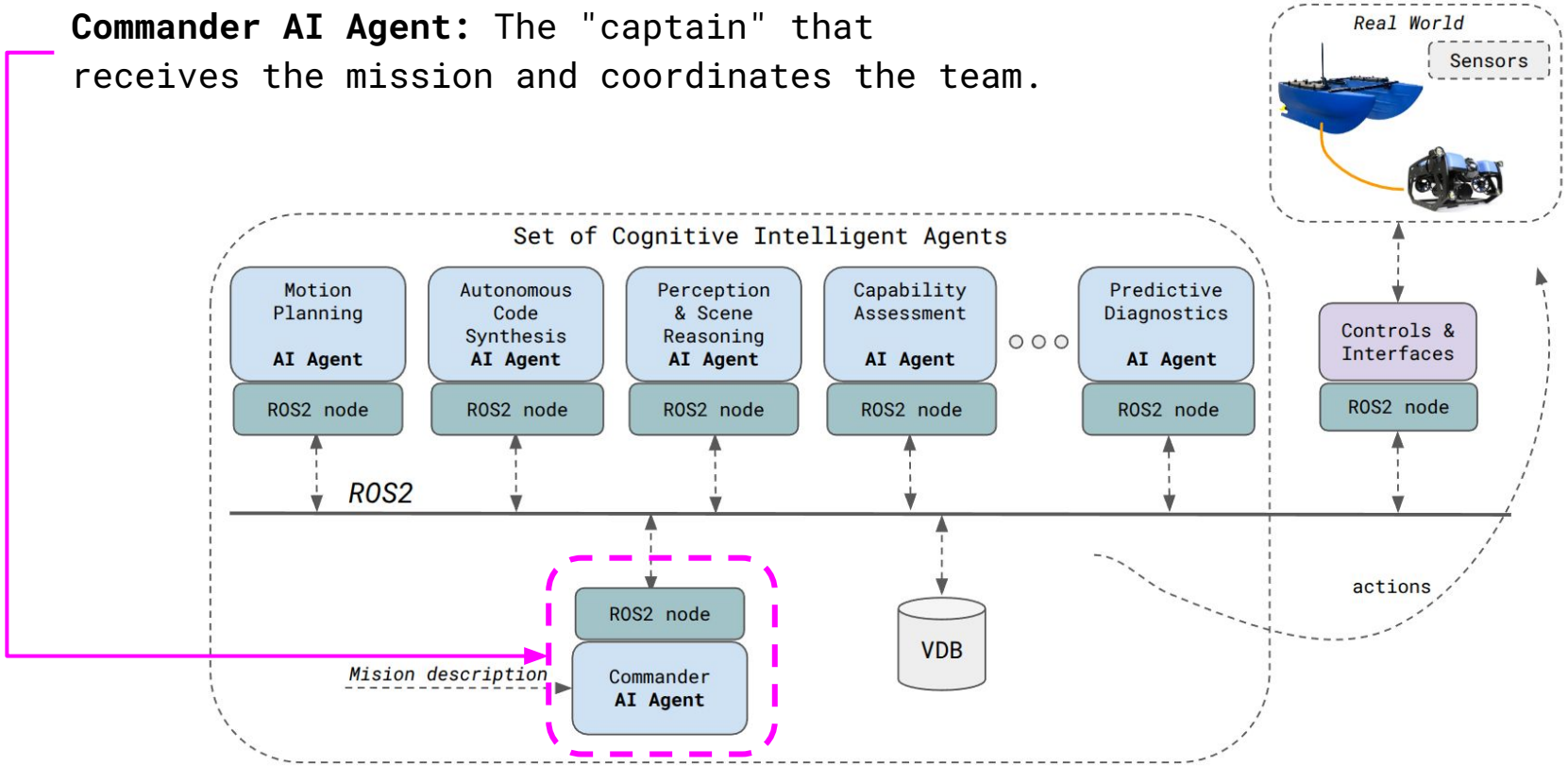
How it Works: High-level missions are given in natural language.

Core Idea: The AI agents work together to figure out how to complete the mission **without** human management.



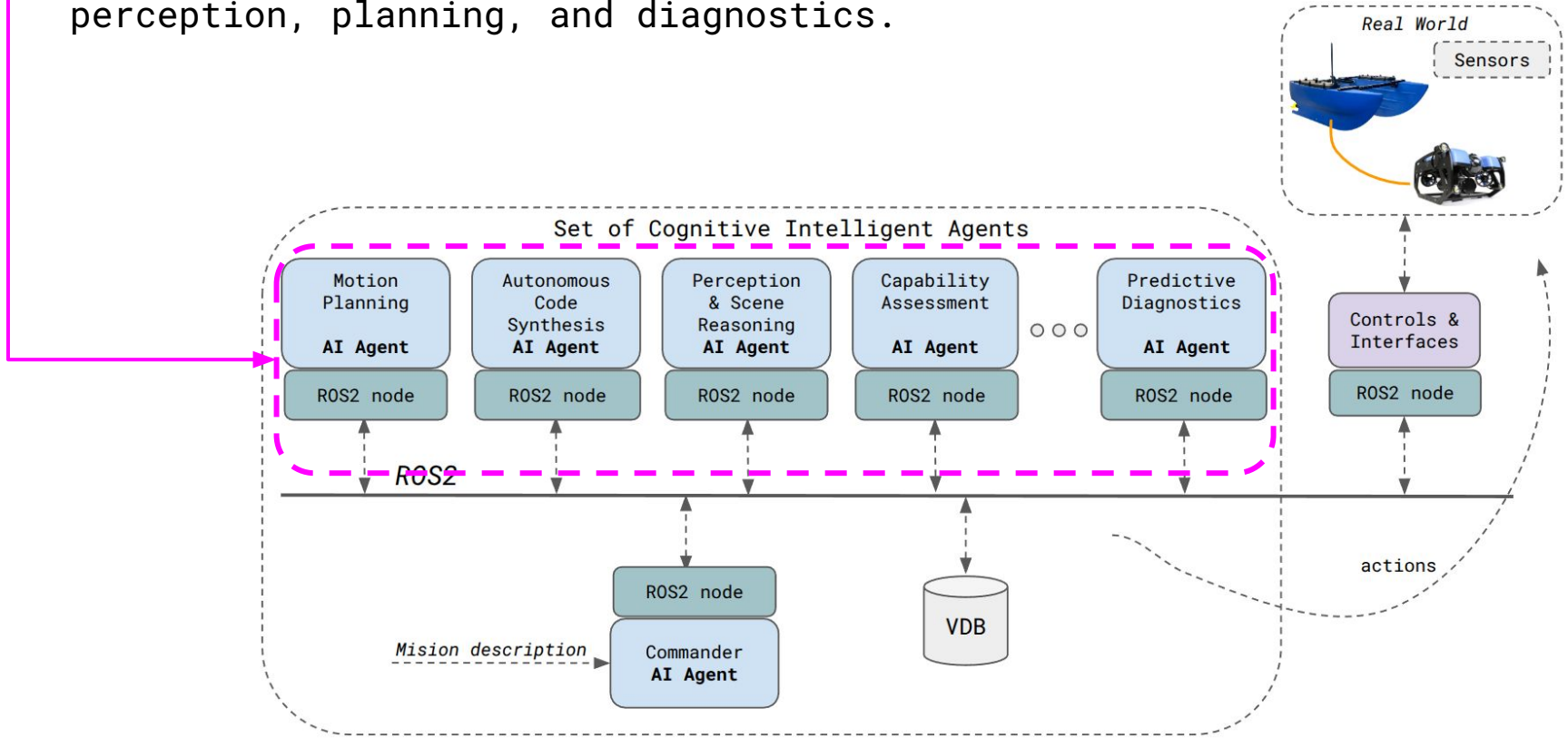
UROSA Architecture

Commander AI Agent: The "captain" that receives the mission and coordinates the team.



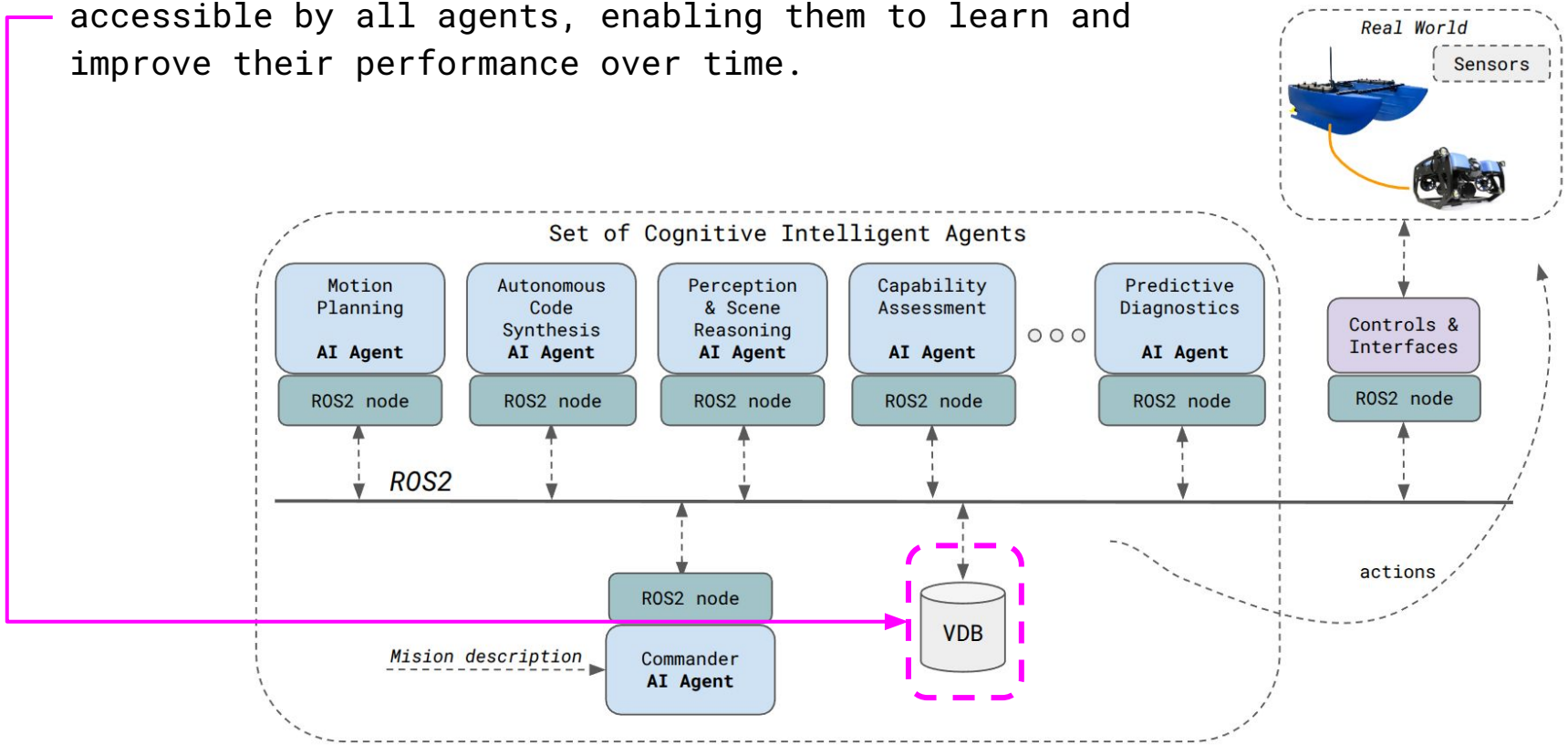
UROSA Architecture

Specialist AI Agents: An expert crew for tasks like perception, planning, and diagnostics.



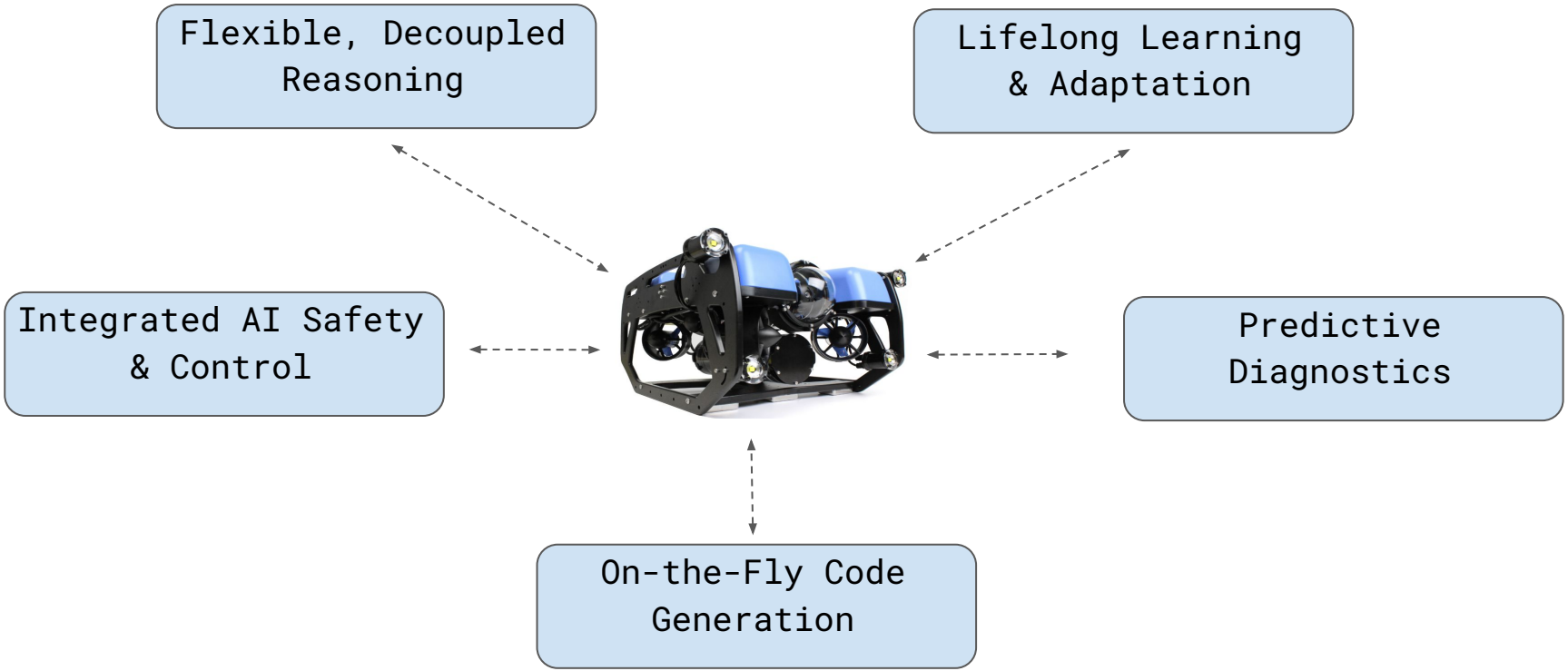
UROSA Architecture

Vector Database serves as a distributed, long-term memory accessible by all agents, enabling them to learn and improve their performance over time.



New Paradigm for Cognitive Autonomy

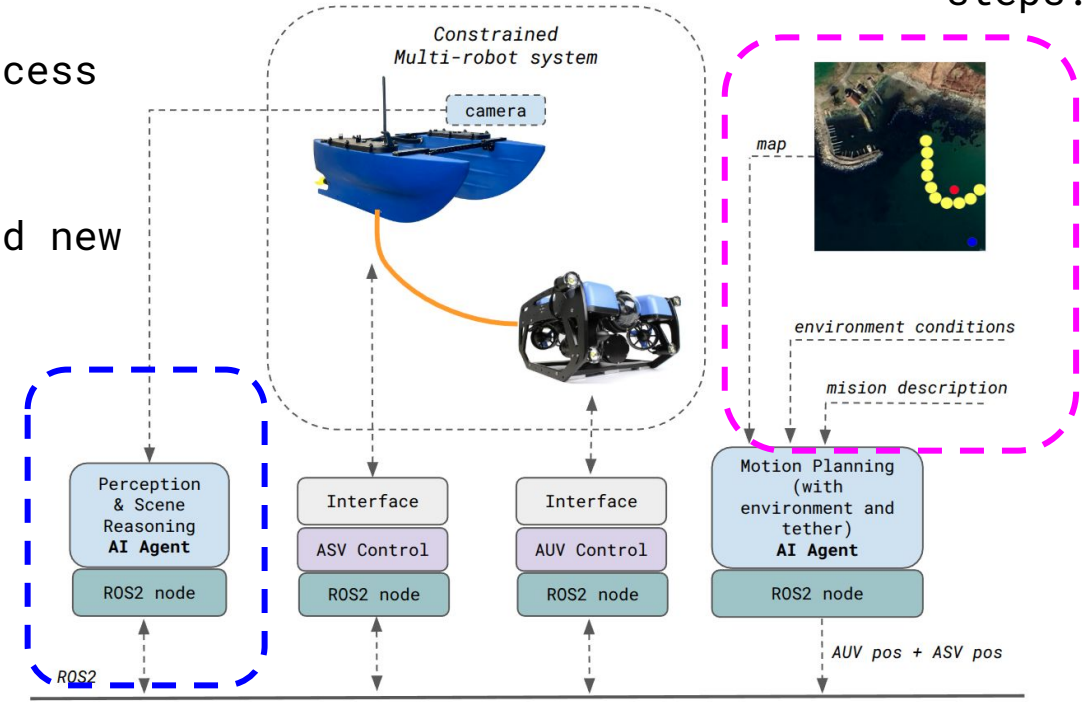
UROSA enables cognitive autonomy by **set of core innovations.**



Innovation 1. Flexible, Decoupled Reasoning

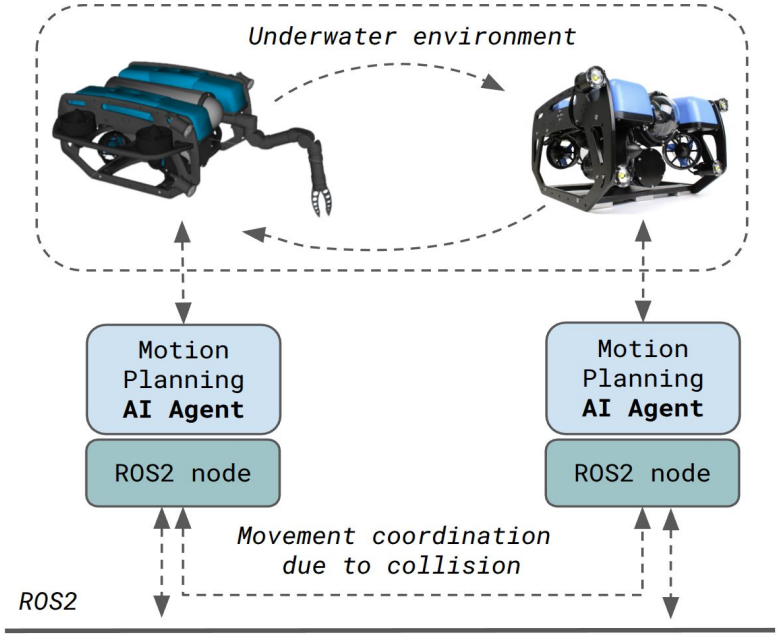
Agents interpret **high-level missions**, not rigid, pre-programmed steps.

Adapts its reasoning process to handle **unexpected situations** and new environments.



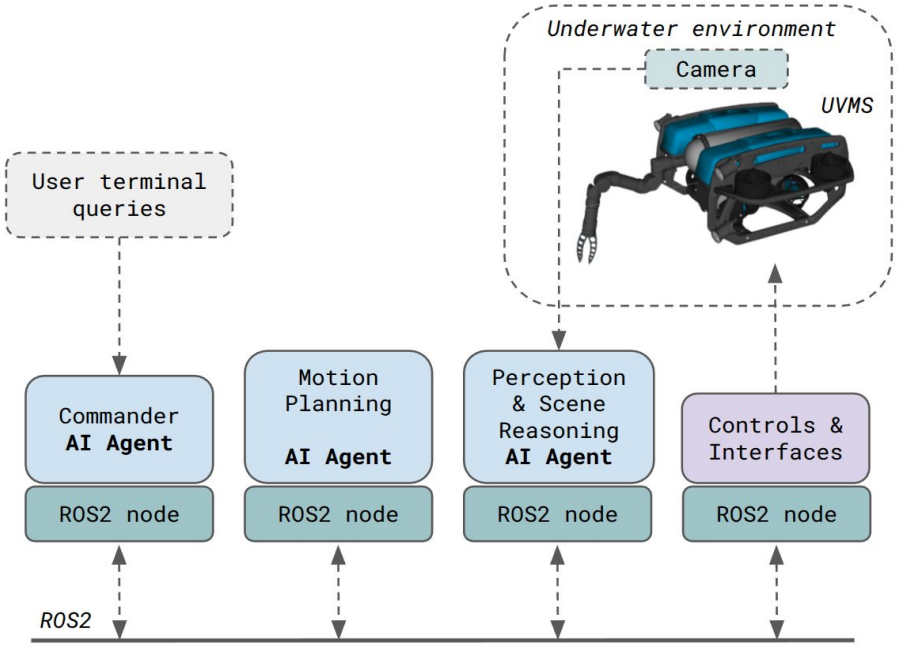
Innovation 1. Flexible, Decoupled Reasoning

Decentralized Collision Avoidance: Independent reasoning capability to negotiate directly with other agents, enabling complex coordination without a central controller.



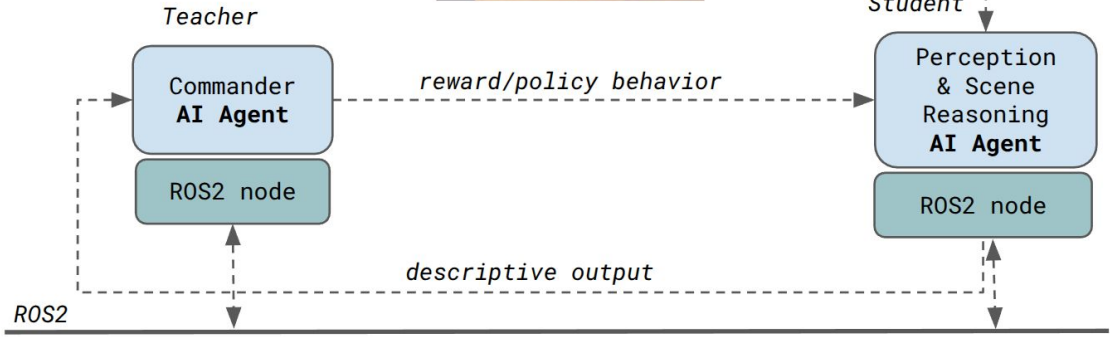
Innovation 1. Flexible, Decoupled Reasoning

Natural Language Tasking: The capability to translate a high-level, human-language command into a coordinated, multi-agent execution plan by reasoning about its underlying goal.



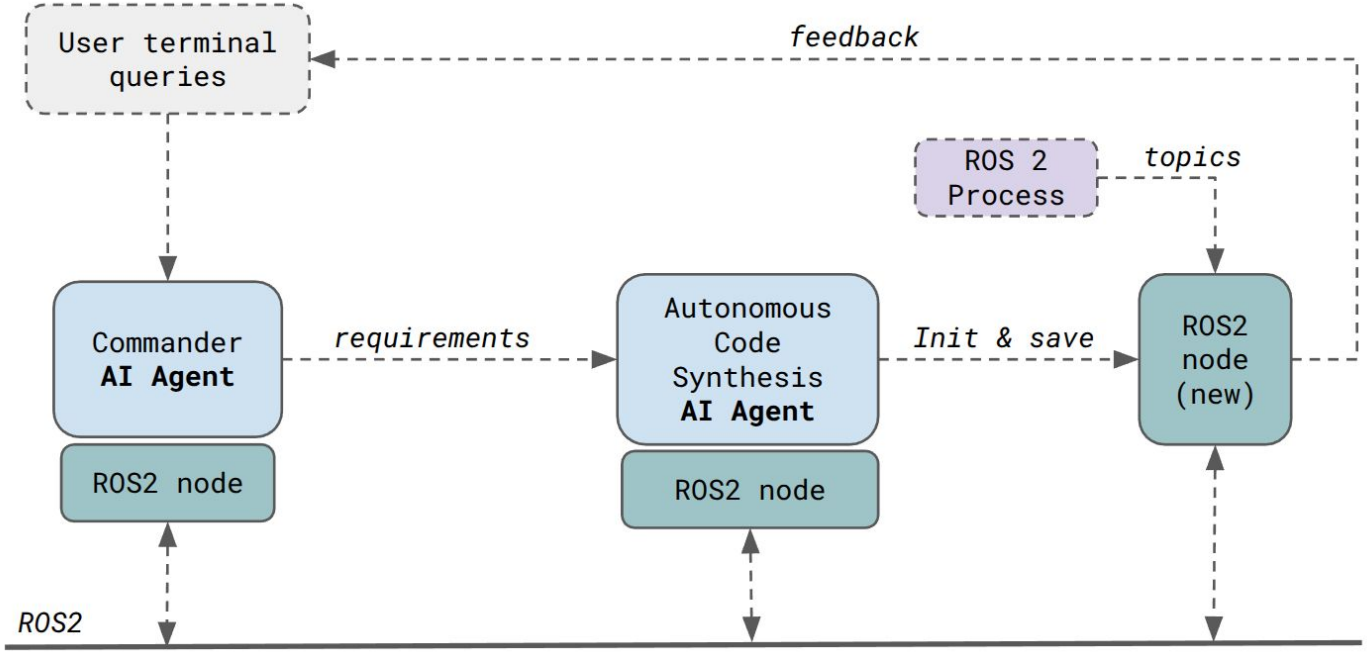
Innovation 2. Lifelong Learning & Adaptation

Real-time Behavioral Shaping: The capability for an agent's core reasoning policy to be dynamically modified during a mission, based on corrective linguistic instructions generated by "Teacher" agent.



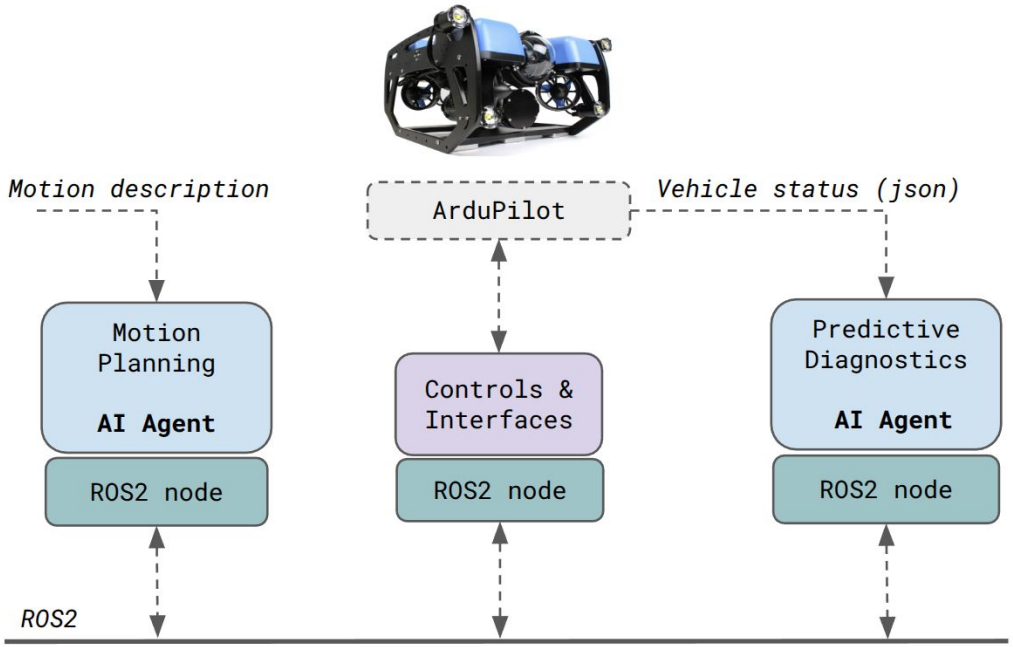
Innovation 3. On-the-Fly Code Generation

ROS 2 Node Generator: The ability for an AI agent to autonomously synthesize, integrate and validate entire ROS 2 nodes at runtime, adding new system-level capabilities to solve emergent problems.



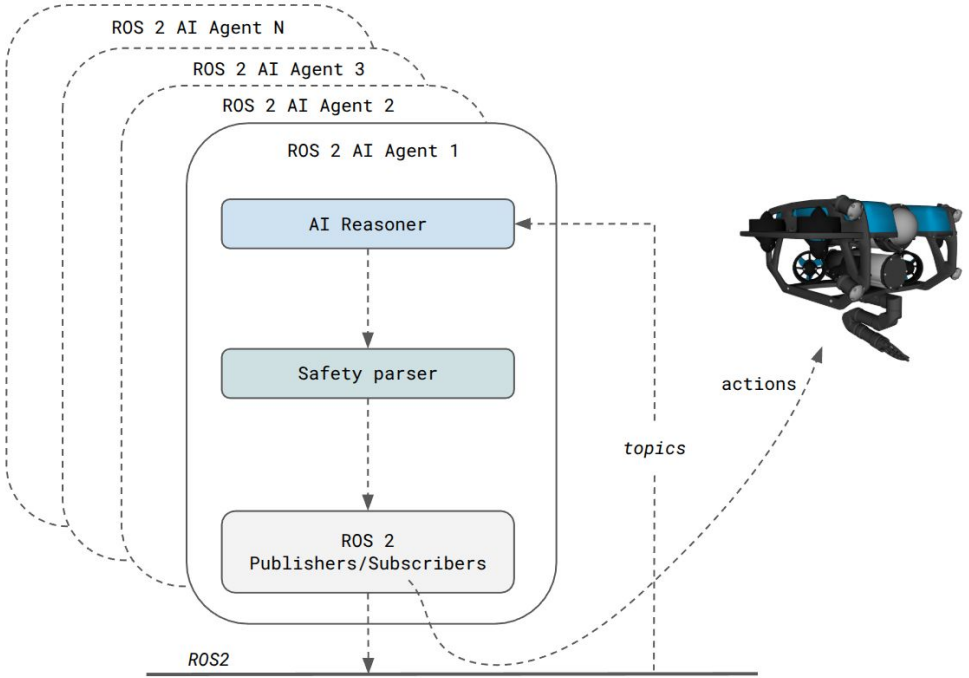
Innovation 4. Predictive Diagnostics

System reasoning: The ability to diagnose faults by comparing live sensor data against the expected behavior derived from an embedded physical model of the vehicle, not just against predefined error codes.



Innovation 5. Integrated AI Safety & Control

Safety: AI safety through an architecture of engineered **SYSTEM prompts** and a validation **parser** integrated within the **ROS 2 framework**.



ROS 2 Node Implementation

AI Reasoner

Safety parser

ROS 2
Publishers/Subscribers