



## **Distributed AI Agents for Cognitive Underwater Robot Autonomy**

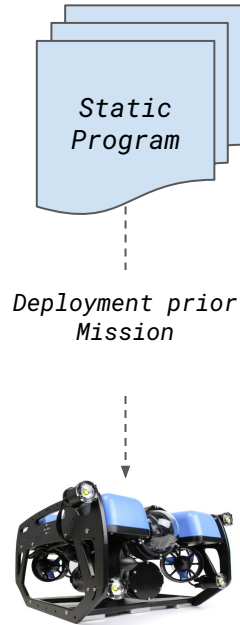
**-Results-**

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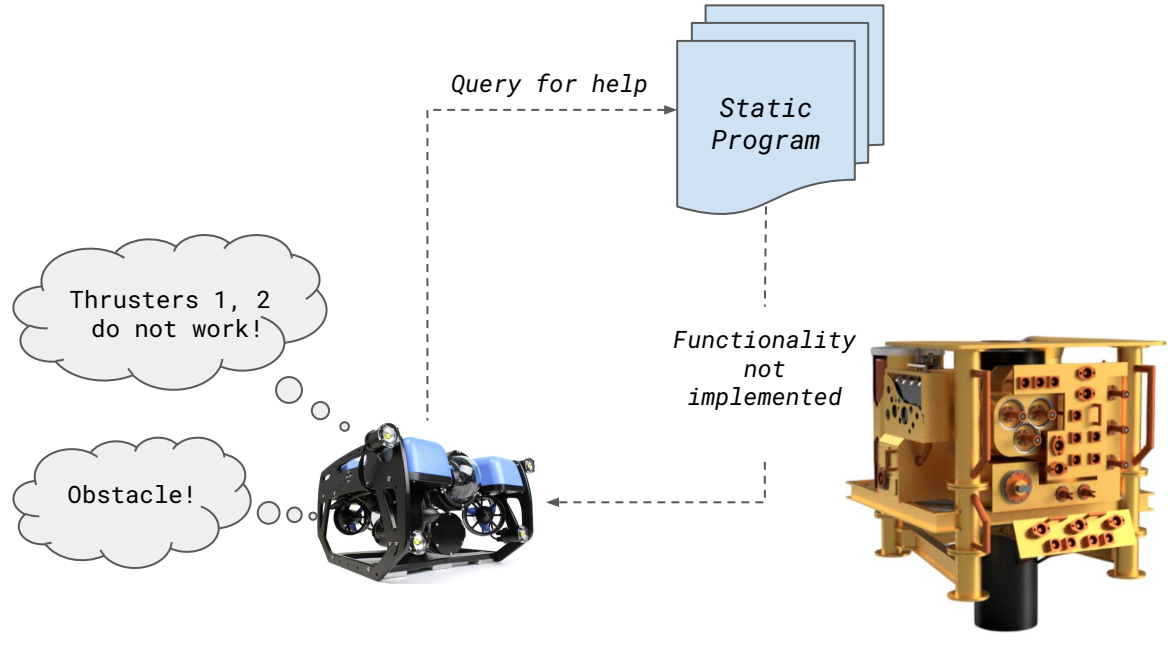
# From Traditional Robotics to True Autonomy

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

*Planning a mission*



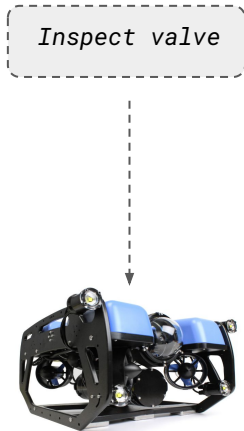
*Execution of mission*



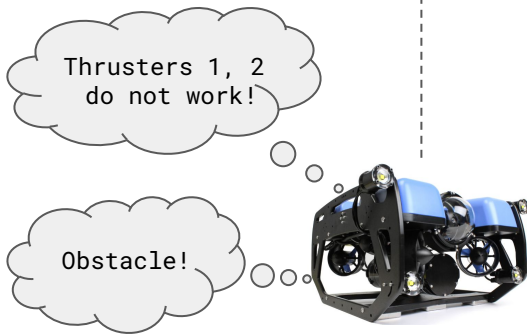
# New Paradigm

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

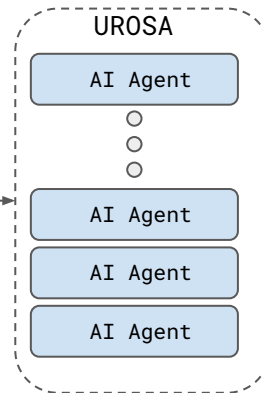
*Planning a mission*



*Execution of mission*



*Query for help*



*We fix !*

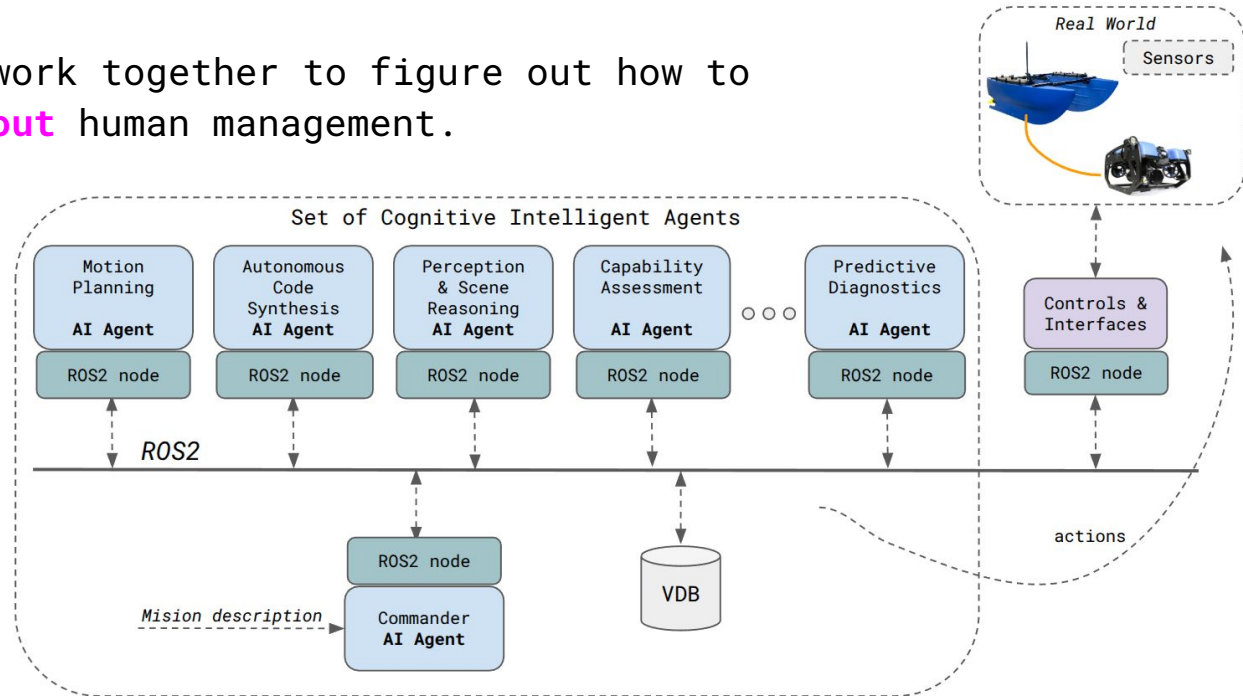


# What is UROSA?

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

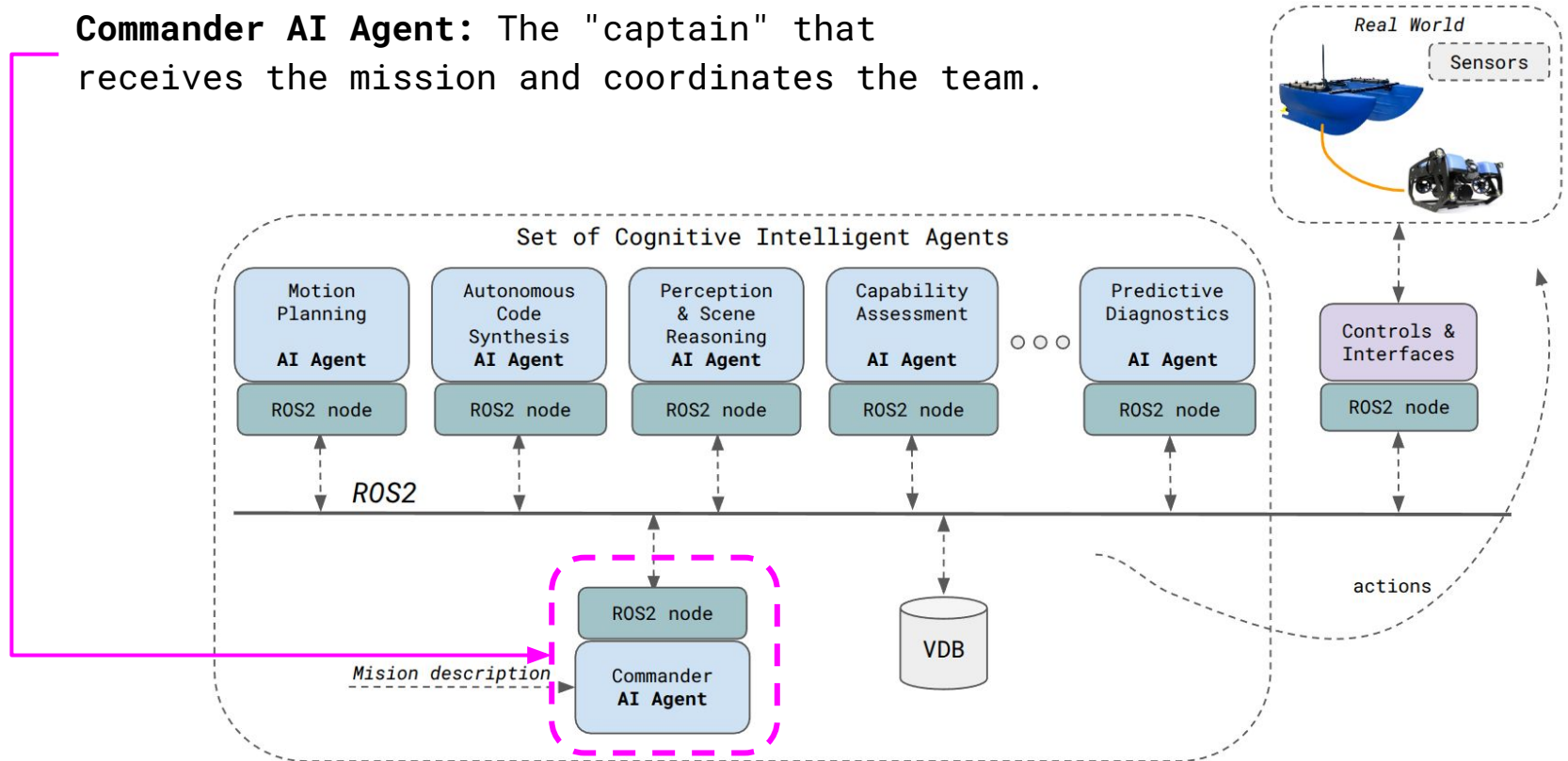
**How it Works:** High-level missions are given in natural language.

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



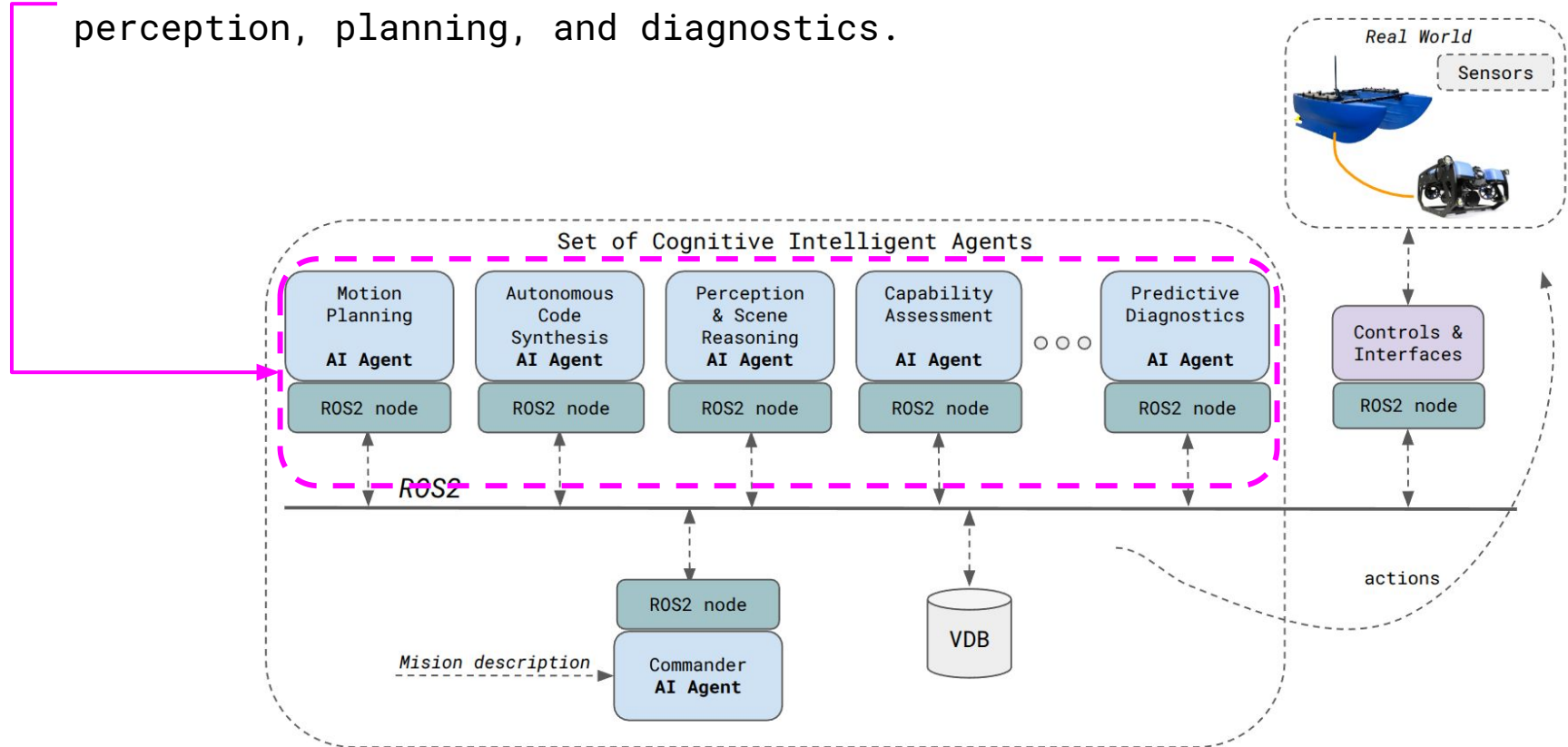
# UROSA Architecture

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



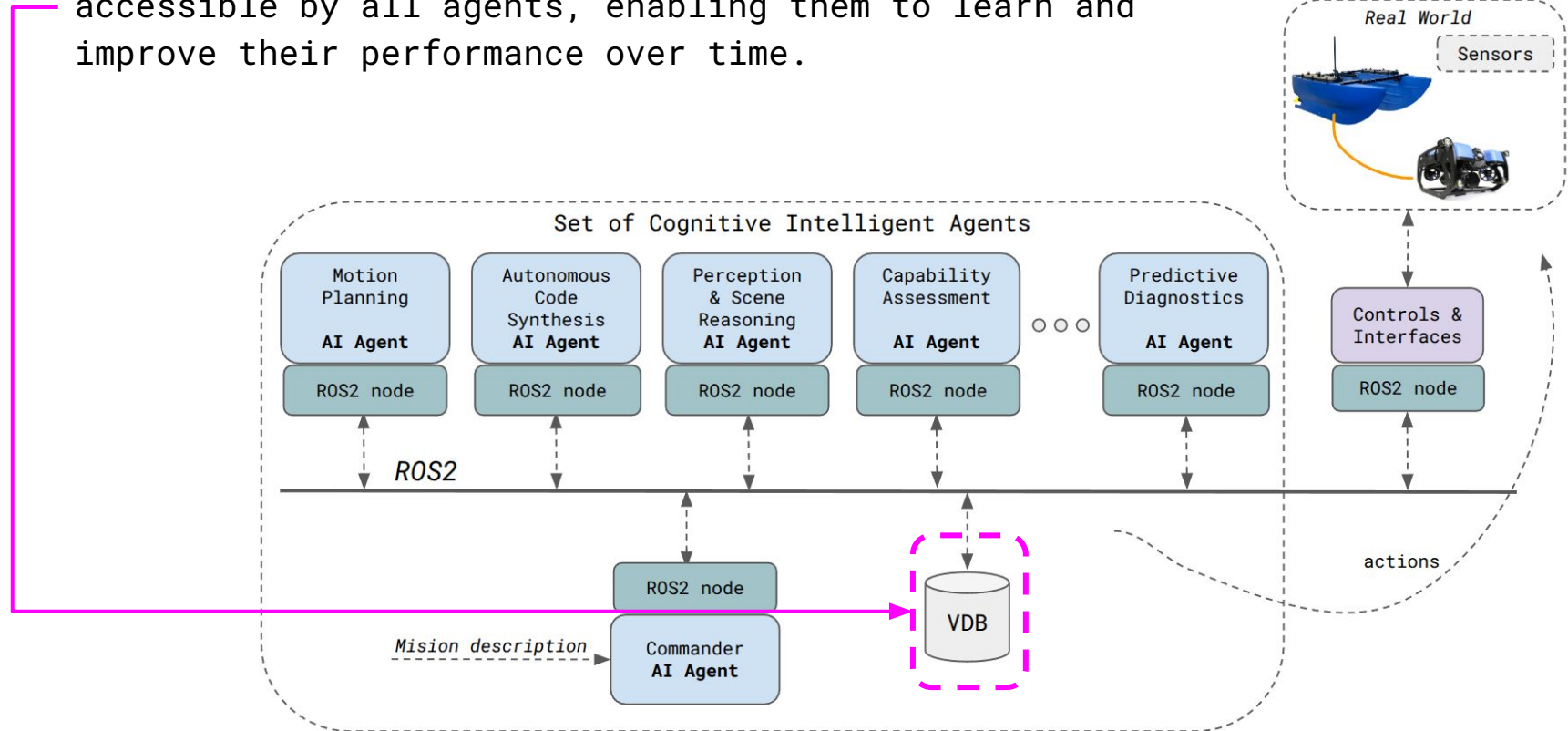
# UROSA Architecture

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



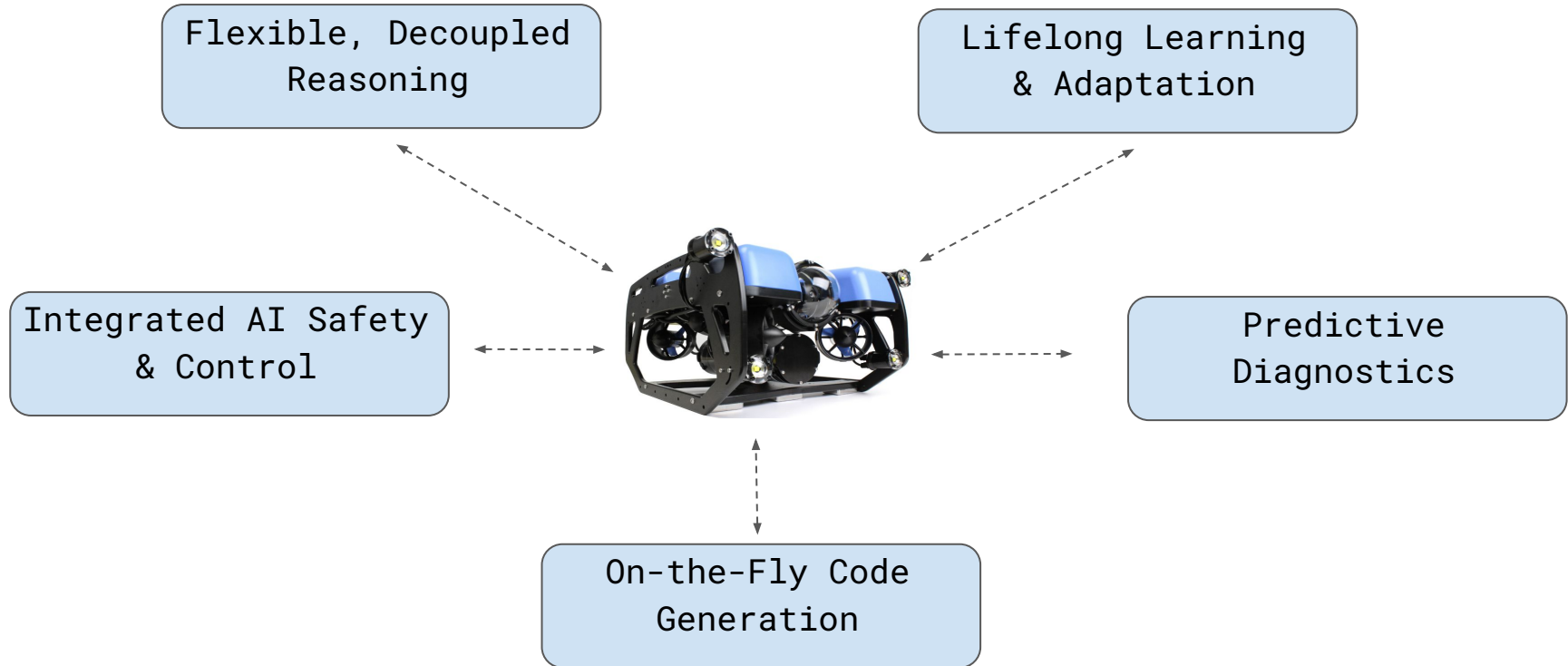
# UROSA Architecture

**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

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

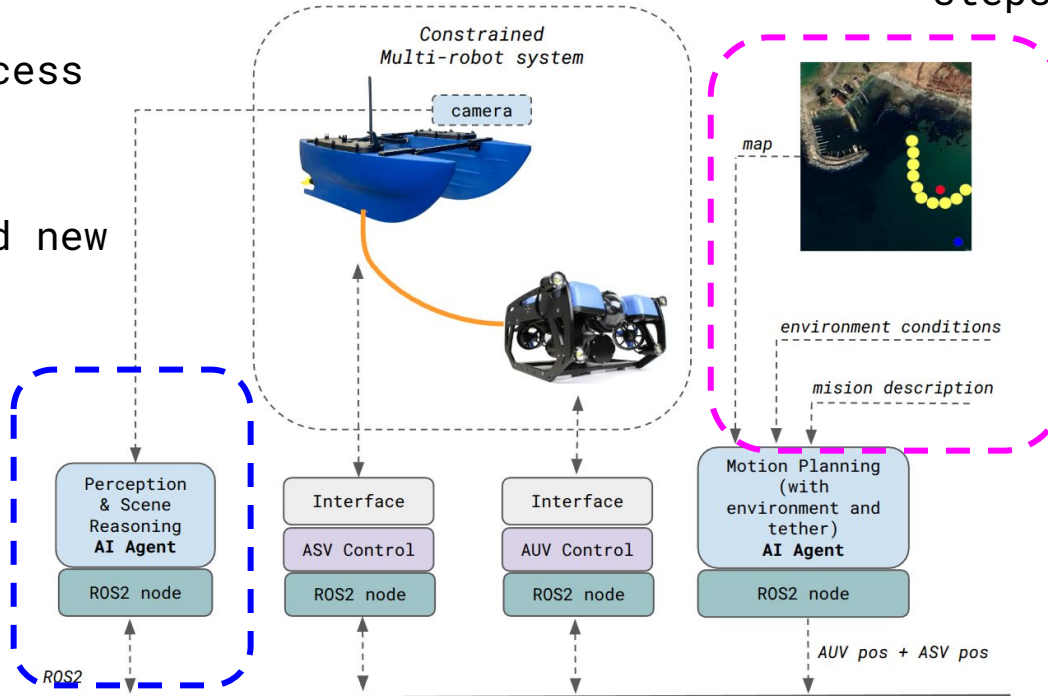




# Innovation 1. Flexible, Decoupled Reasoning

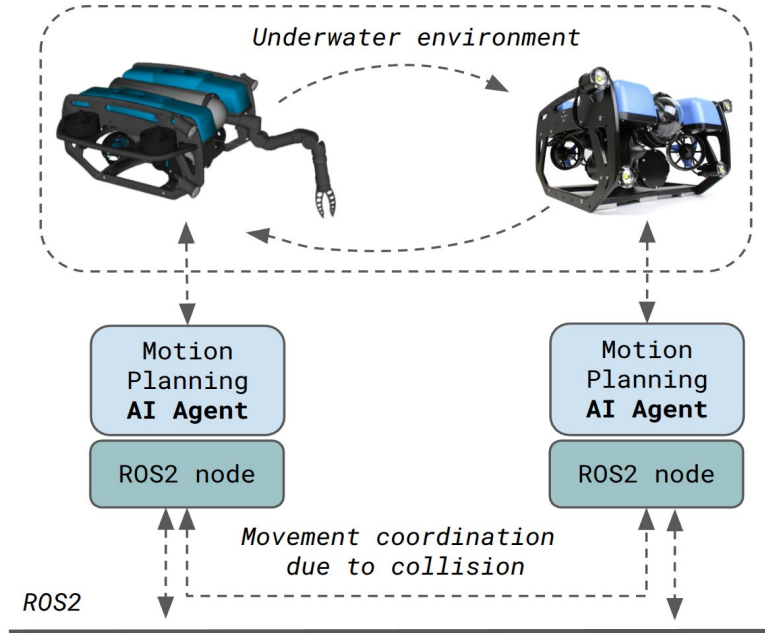
Adapts its reasoning process to handle **unexpected situations** and new environments.

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



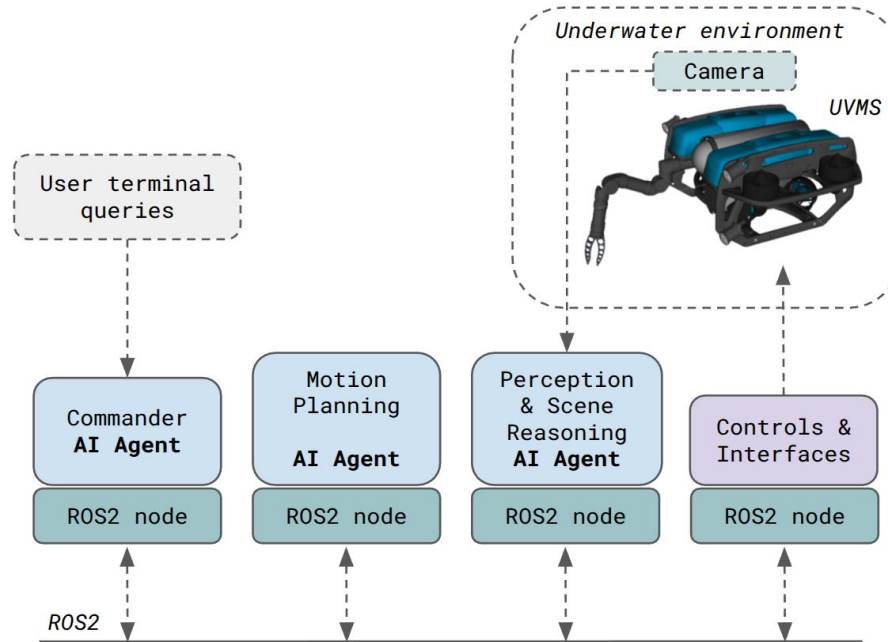
# Innovation 1. Flexible, Decoupled Reasoning

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



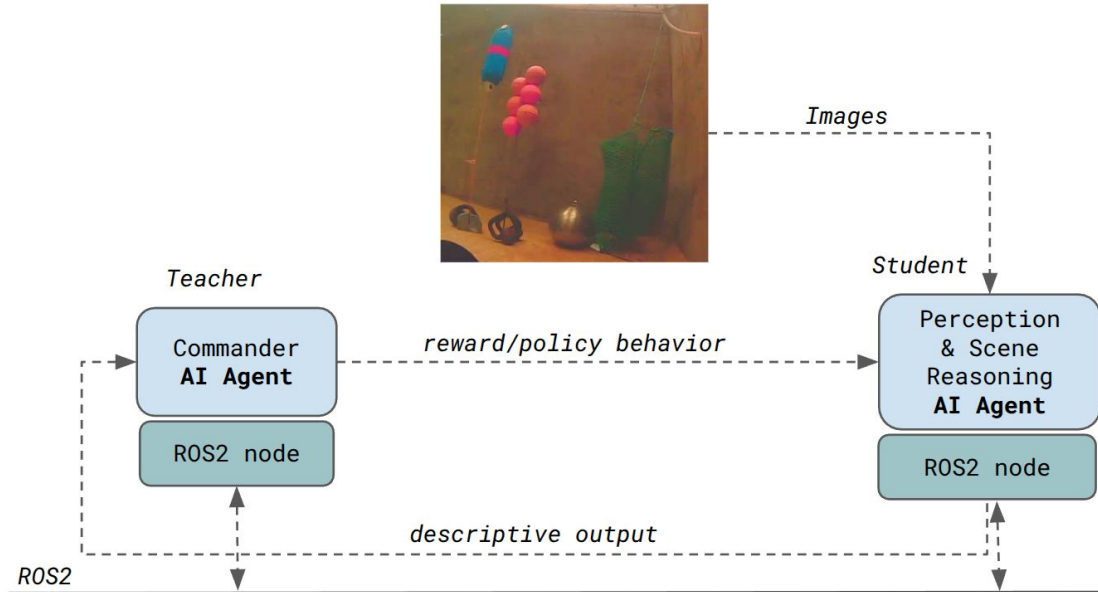
# Innovation 1. Flexible, Decoupled Reasoning

**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.



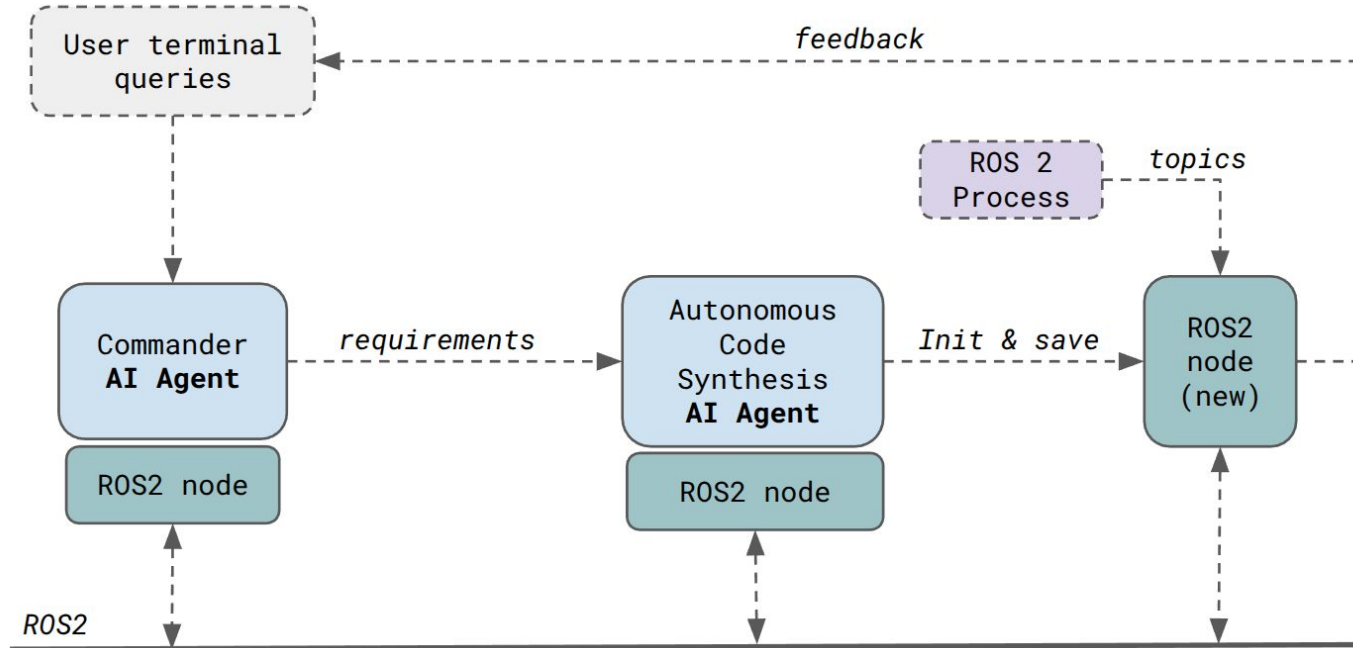
## Innovation 2. Lifelong Learning & Adaptation

**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.



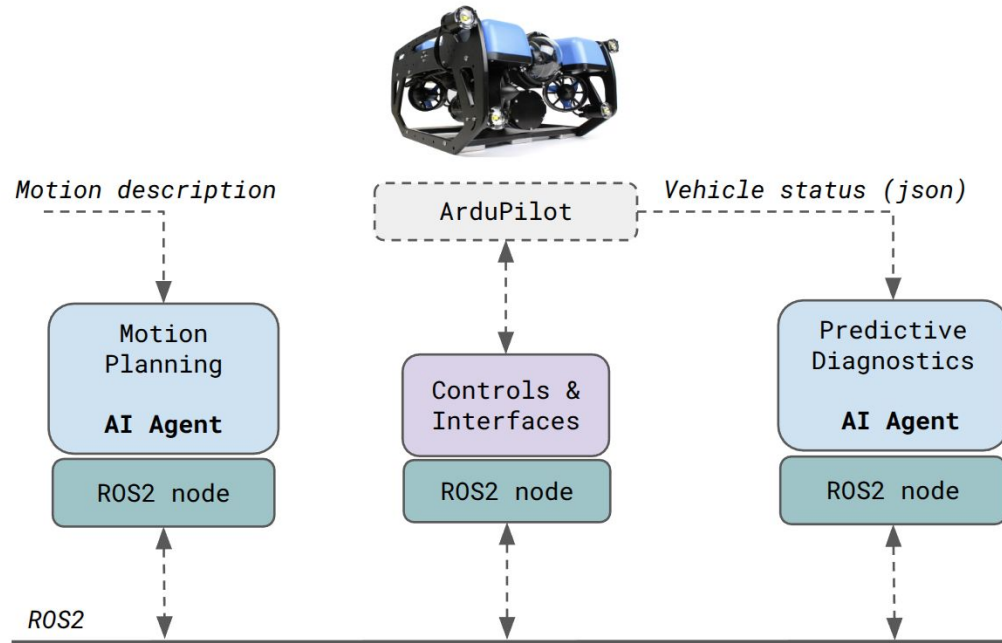
## Innovation 3. On-the-Fly Code Generation

**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.



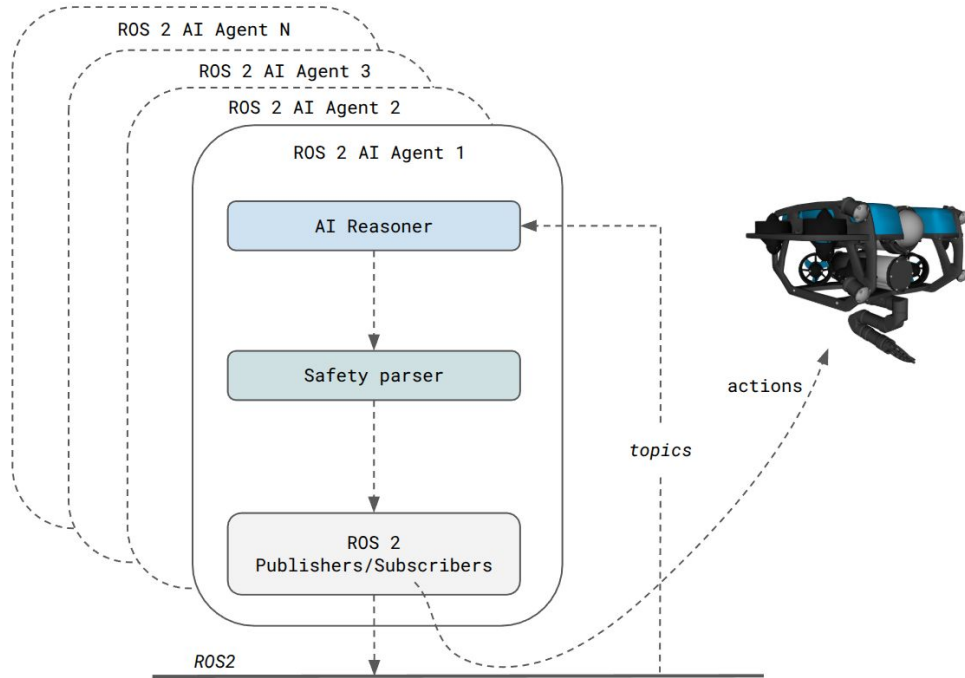
## Innovation 4. Predictive Diagnostics

**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