MADEin4

Robots, Social Behavior Development for Automotive Manufacturing

Giving robots and machines
human-like skills to collaborate

Alfio Minissale – EU project manager, COMAU S.p.A.
Meirav Hadad-Segev – CEO & Founder, BRILLIANETOR

Agenda

COMAU:

Robots and Automotive Manufacturing Overview:

- Challenges today
- Use cases
- Architecture approach

BRILLIANETOR:

Collaborative Social AI Overview:

- Advantages
- How does it work?
- Results with COMAU

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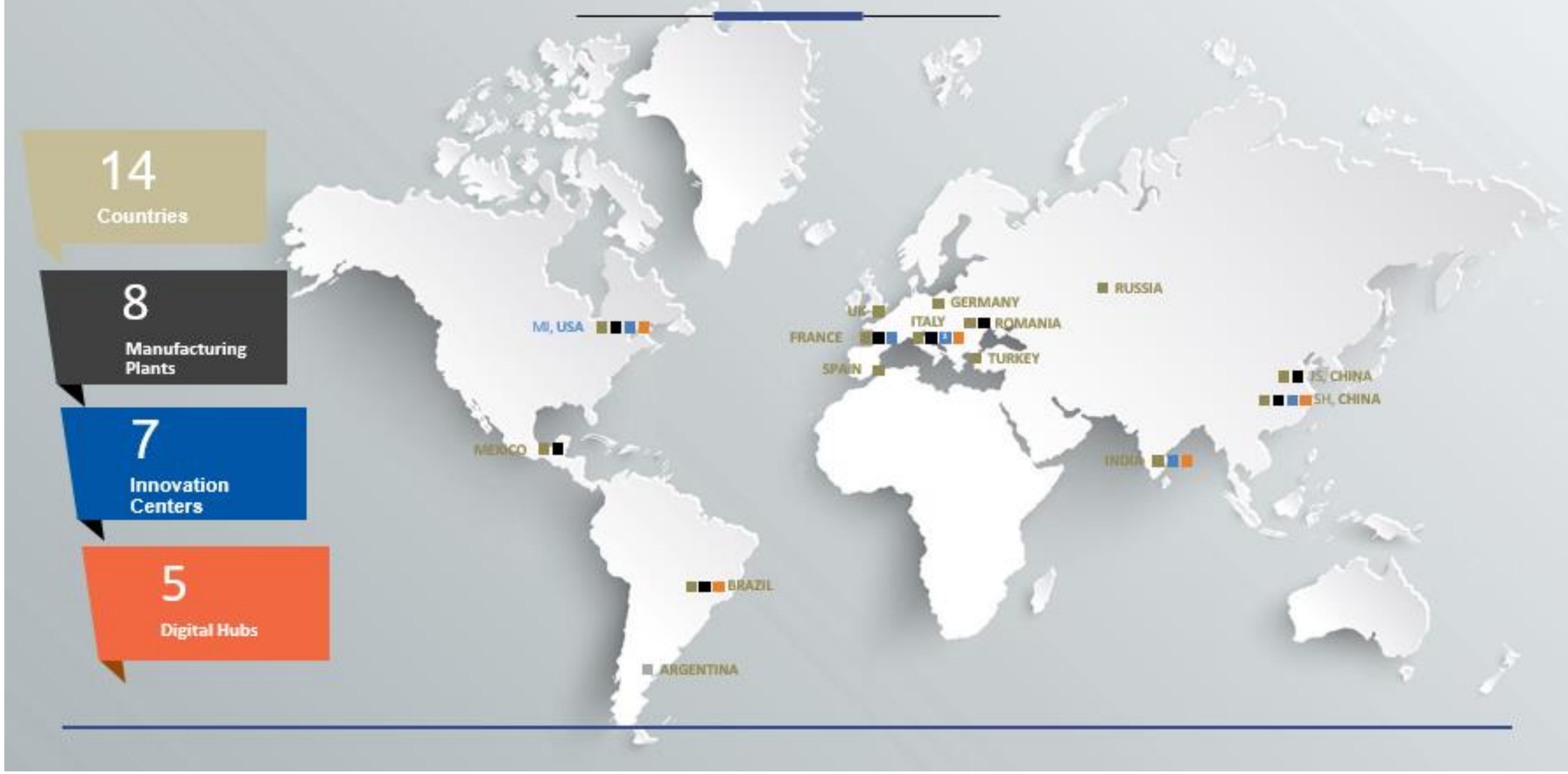
COMAU

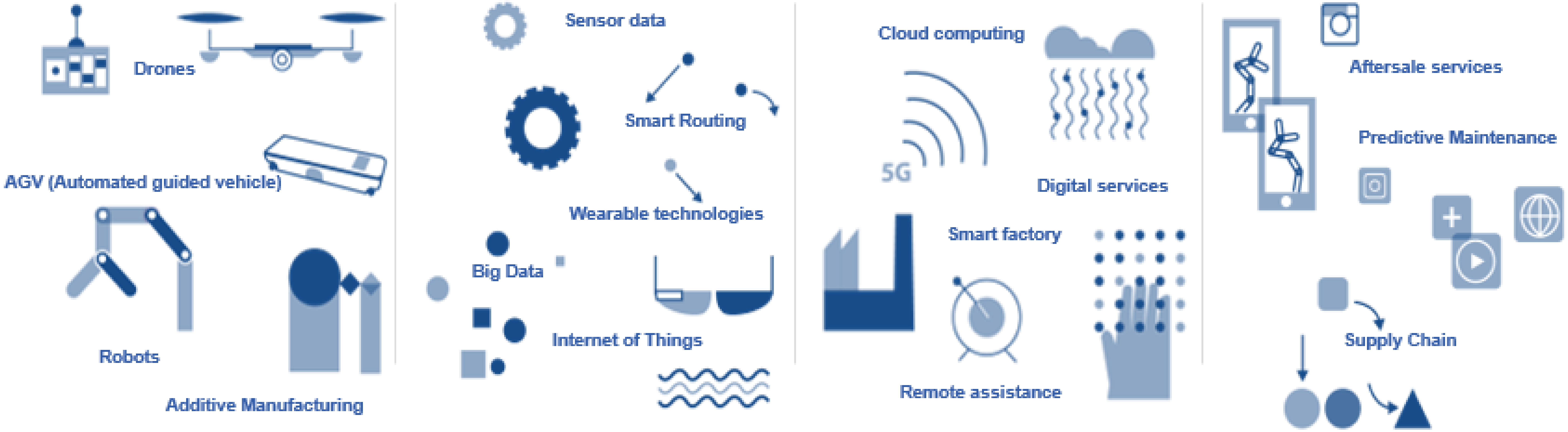
Comau trademark is Expertise in Making: robots, automation, machines and global solutions delivered as turn-key systems.



- Large enterprise
- Headquarter: Torino, Italy
- Employees: 8500
- Founding: 1973
- Sector: Automation
- Market: robots, automation, industry

Industry 4.0: factory transformation

AUTOMATION	DIGITALIZATION	CONNECTIVITY	ANALYTICS



Drones

AGV (Automated guided vehicle)

Robots

Additive Manufacturing

Sensor data

Smart Routing

Wearable technologies

Big Data

Internet of Things

Cloud computing

5G

Digital services

Smart factory

Remote assistance

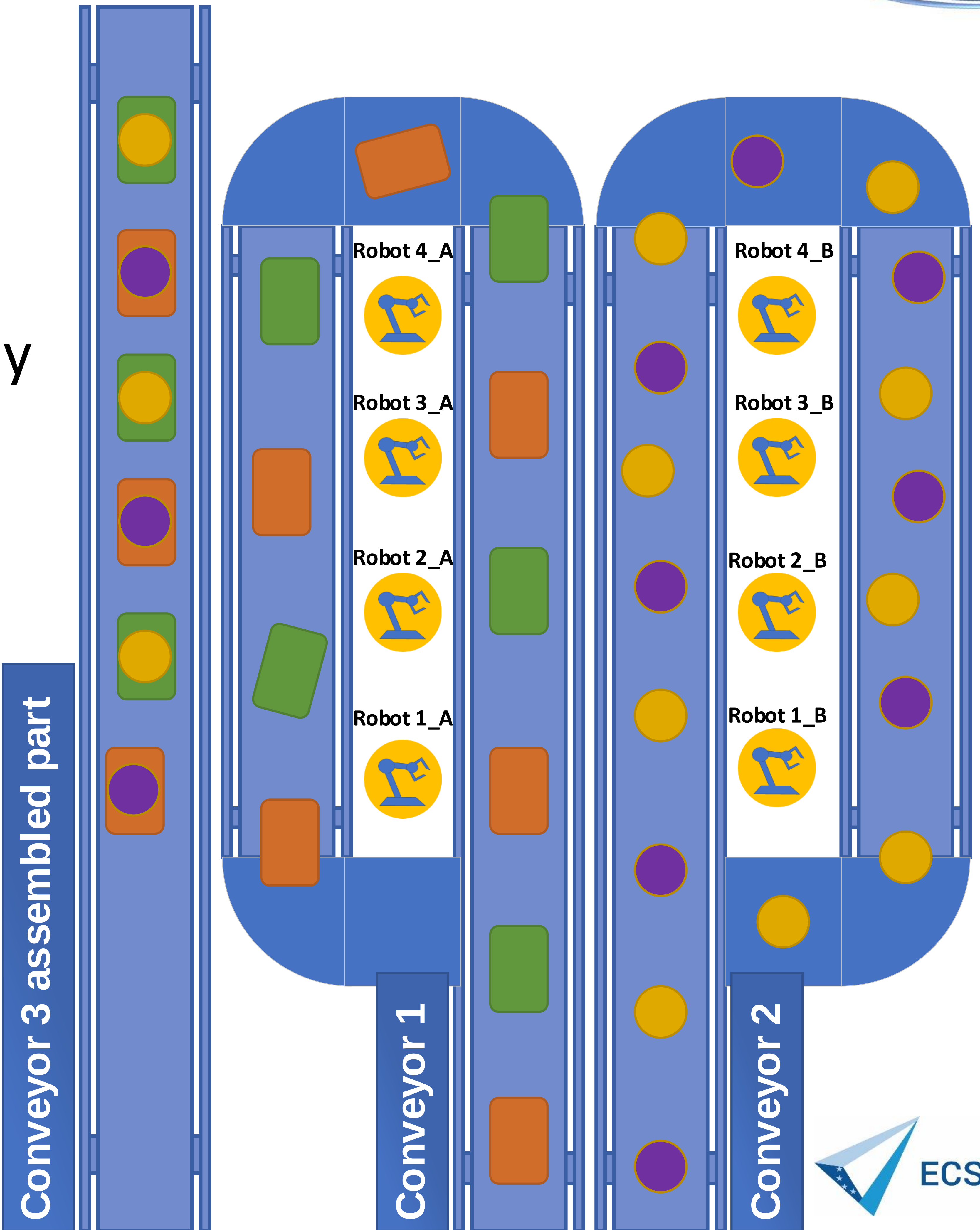
Aftersale services

Predictive Maintenance

Supply Chain

The Challenges –
Example 1: Assembling Process

- The robots arms need to collaborate with each other to assemble parts
- The robots need to avoid any collisions since they share same area
- They need to cover each other in case of malfunction



The Challenges –
Example 2: Autonomous Mobile Robots

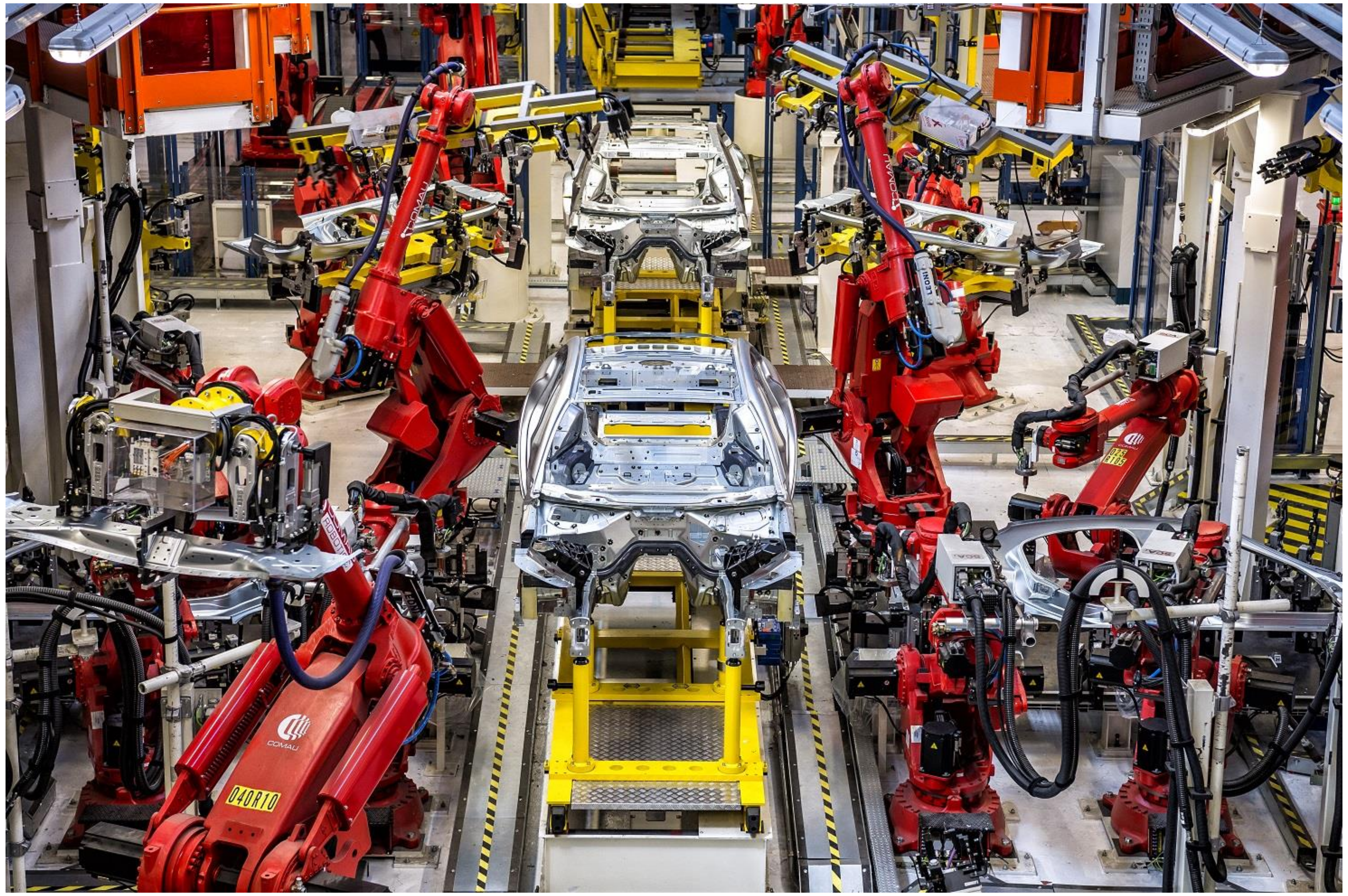
How can we enable the robots to:

- share space and avoid collision
- overcome variation of flow
- switch tasks according
- react to priority changes
- optimize performance
- react to delay
- overcome malfunctions

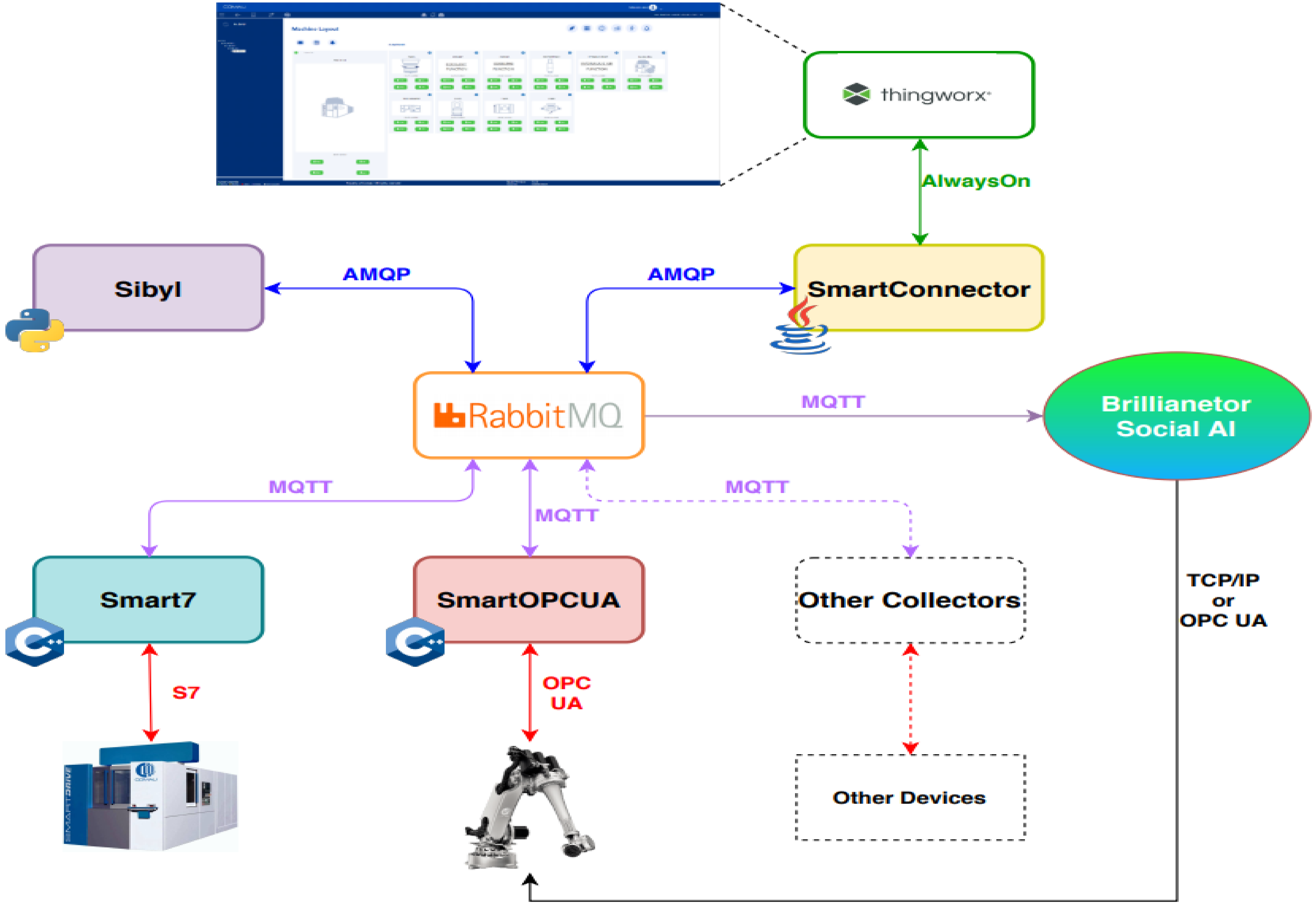
Real case: Alfa Romeo Giulia - Cassino Plant

16 robots work simultaneously on the same car frame
Production rate is really high (up to 30 cars per hour)

But…
if just 1 robot stops



IOT Architecture



Within MADEin4 project a novel architecture for the IoT operation has been developed supporting an open framework to be deployed in the production plants. Definiotn and analysis of data are based on the requirements coming from the application levels.

IoT Protocols & Data Sources

IEC 62541

OPC UA™

- Unified Architecture
- Interoperability
- Security
- Scalability
- Complex

Industrial Control Systems

ISO/IEC 20922

MQTT.ORG

- Reliability
- QoS
- Lightweight

Business Applications

ISO/IEC 19464

AMQP
Advanced Message Queuing Protocol

- High reliability
- Security

Sensors

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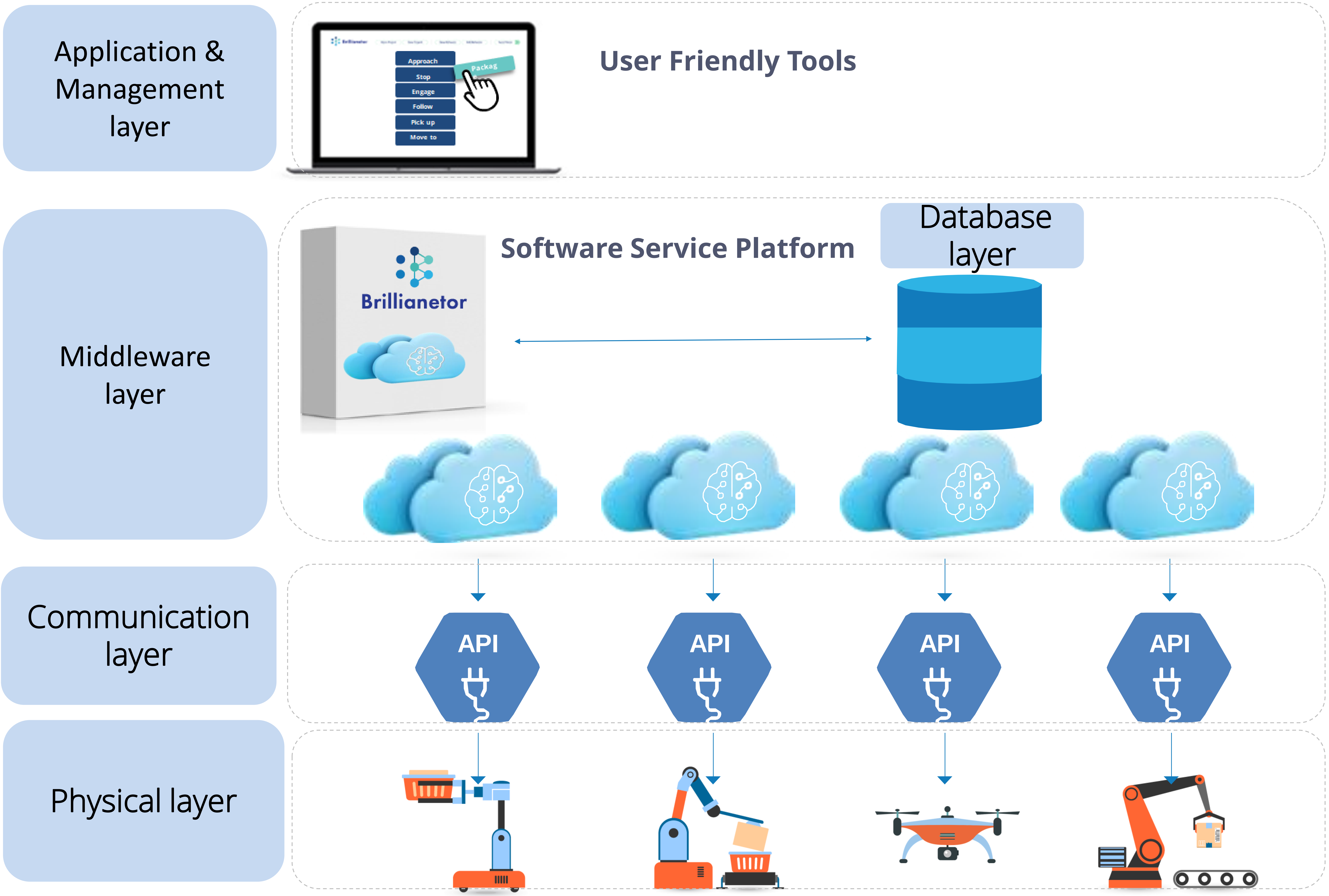
BRILLIANETOR

- SME start-up
- Location: Jerusalem, ISRAEL
- Founder: Dr. Meirav Hadad-Segev
- Founding: July, 2014
- Sector: Artificial Intelligence (AI) / Robotic
- Market: Industry 4.0
- Business: AI software to optimise collaboration (i) between robots and (ii) between robots and humans

The Solution – Social Collaborative AI

A software platform that mimics **human collaboration** to enable robots to optimize problem solving by **working intuitively together**



Application & Management layer

User Friendly Tools

Middleware layer

Software Service Platform

Database layer

Communication layer

Physical layer

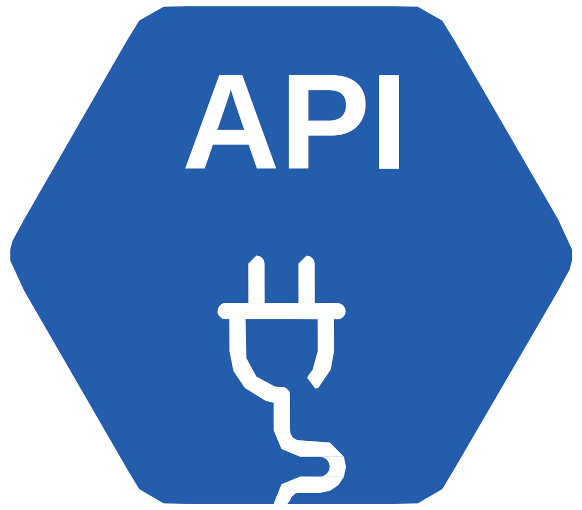
Plugin Solution:

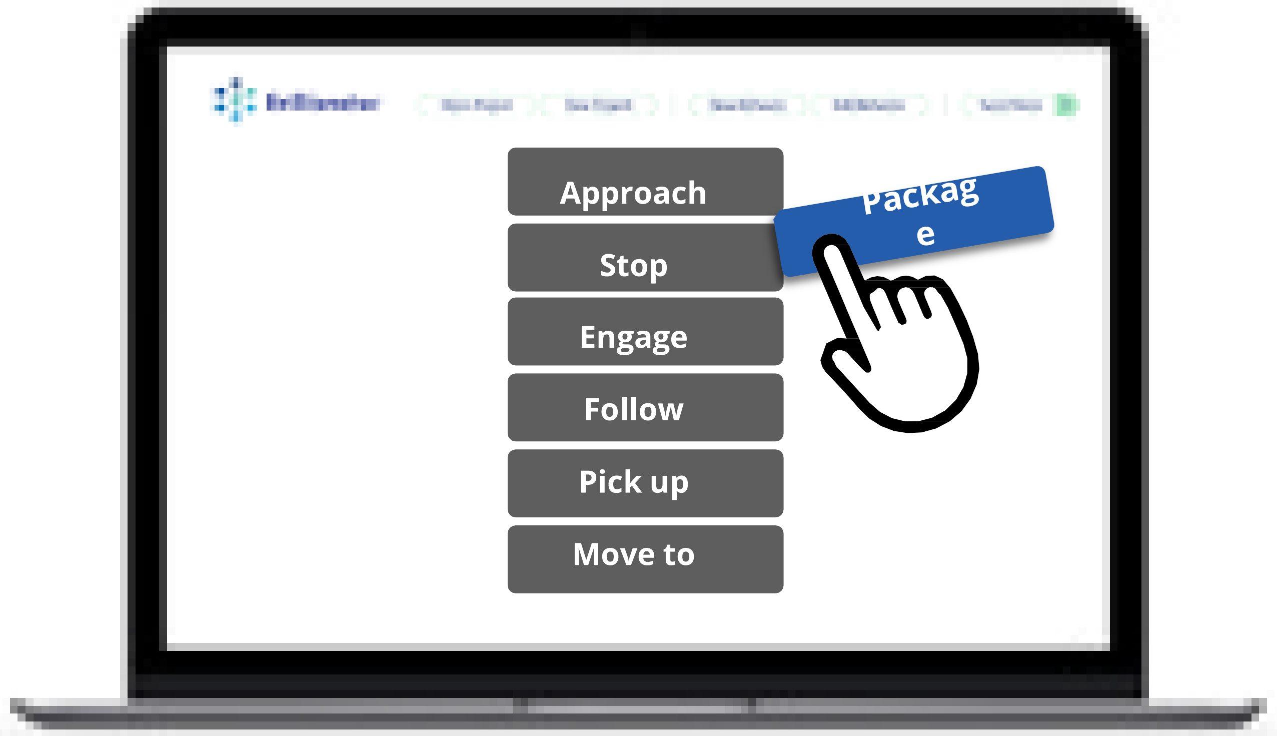
DOESN'T REQUIRE A SINGLE LINE OF CODE!

Collaborative Social AI Product Components

Brilliant MIND: Software service connected to any robot

Brilliant TOOL BOX: An SDK that provides ease and speed in deployment of the system





How Does it work?
Using Brillianetor requires 3 major, simple phases:

Phase **1**

Define Meta Data and Install APIs:

Defining information about robots and installing the API on the side of the robot's controller.

API

Phase **2**

Define Goals for the robots (to perform):

The customer defines the rules of the goals that the robots are required to achieve at the TOOLBOX's Editor.

Phase **3**

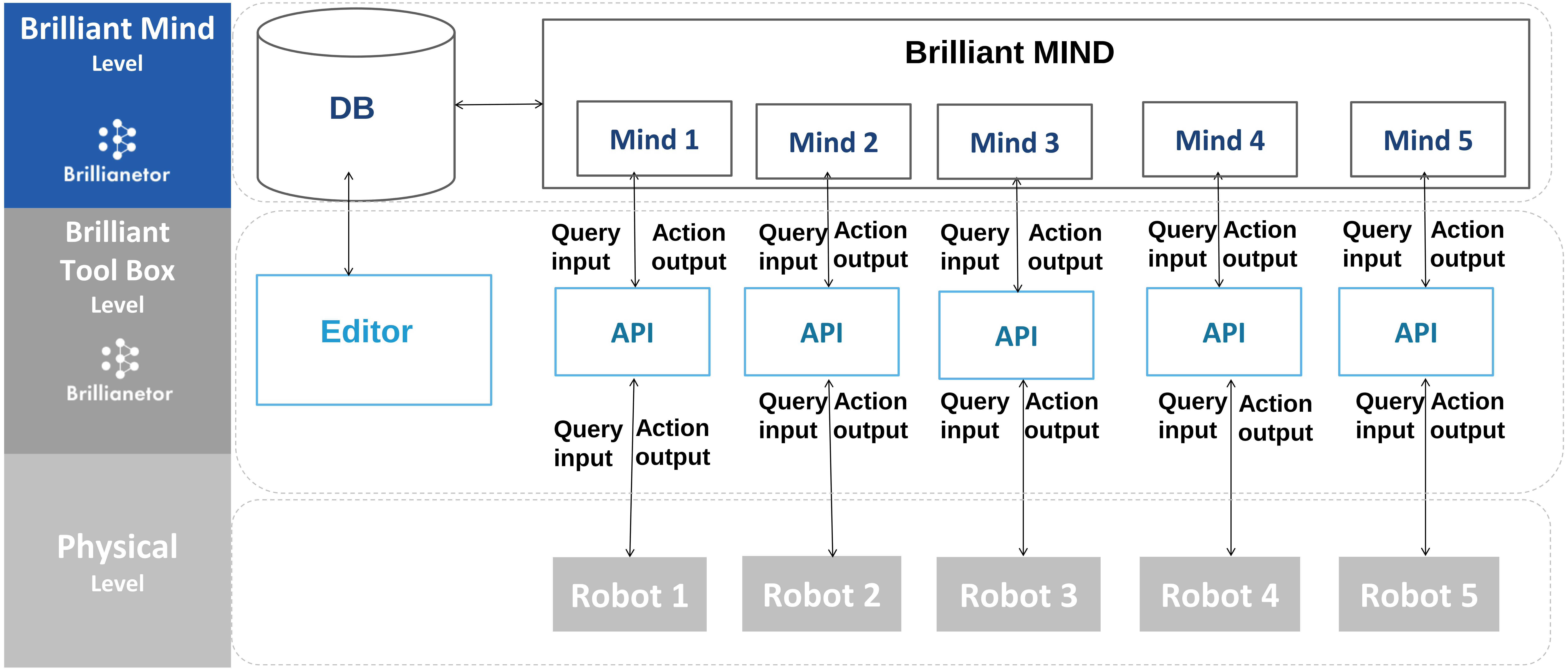
Operation:

Any robot with an API installed can contact the server and request a mind from the Brilliant MIND service that creates a mind for this robot.

The robot is now controlled by its mind in the Brilliant MIND.

The Brilliant MIND

Includes AI algorithms which use the input data from phase 1, phase 2 and from the sensors, to decide for each robot how to behave (to achieve the defined goals of the individuals and of the team).

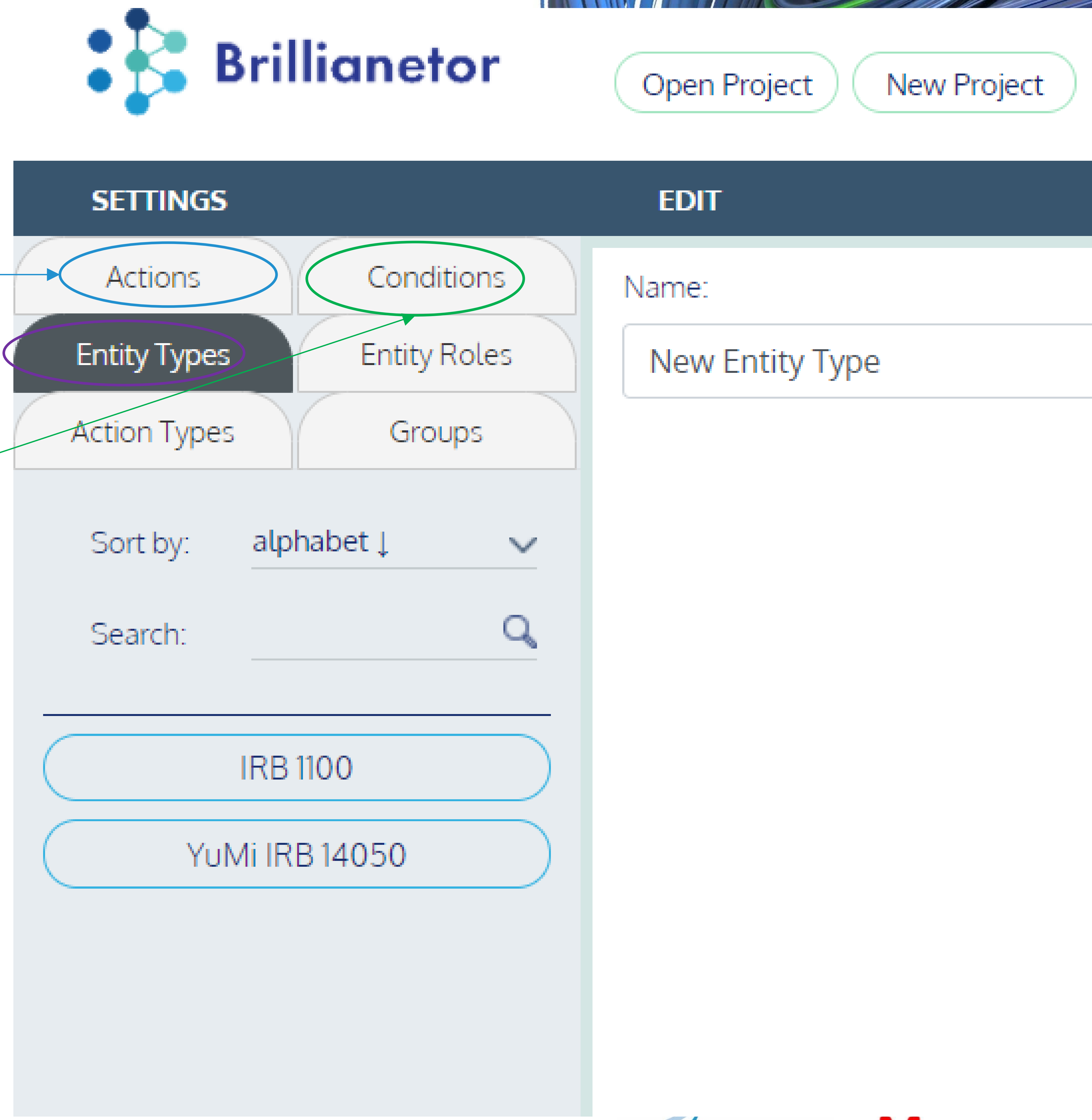


Sensors send real-time information about the environment.
The "minds" decide and instruct them which actions to execute

ECSEL JU MADEin4

Phase 1:
Define Meta Data and Install APIs

1) Types of the robots
2) Basic actions for each type of robot. For example, actions: 'Move to', 'Close Gripper', 'Open Gripper', 'Grasp'
3) Conditions (or queries) and dynamic information that each robot/robot's sensor is able to answer/provide. For example: 'robot's position', 'Is the safety distance maintained between objects?', 'Is robot broken?' etc.
4) Implement functions to handle the communication between the robots and its mind in the Brilliant MIND service, by utilizing Brillianetor's API



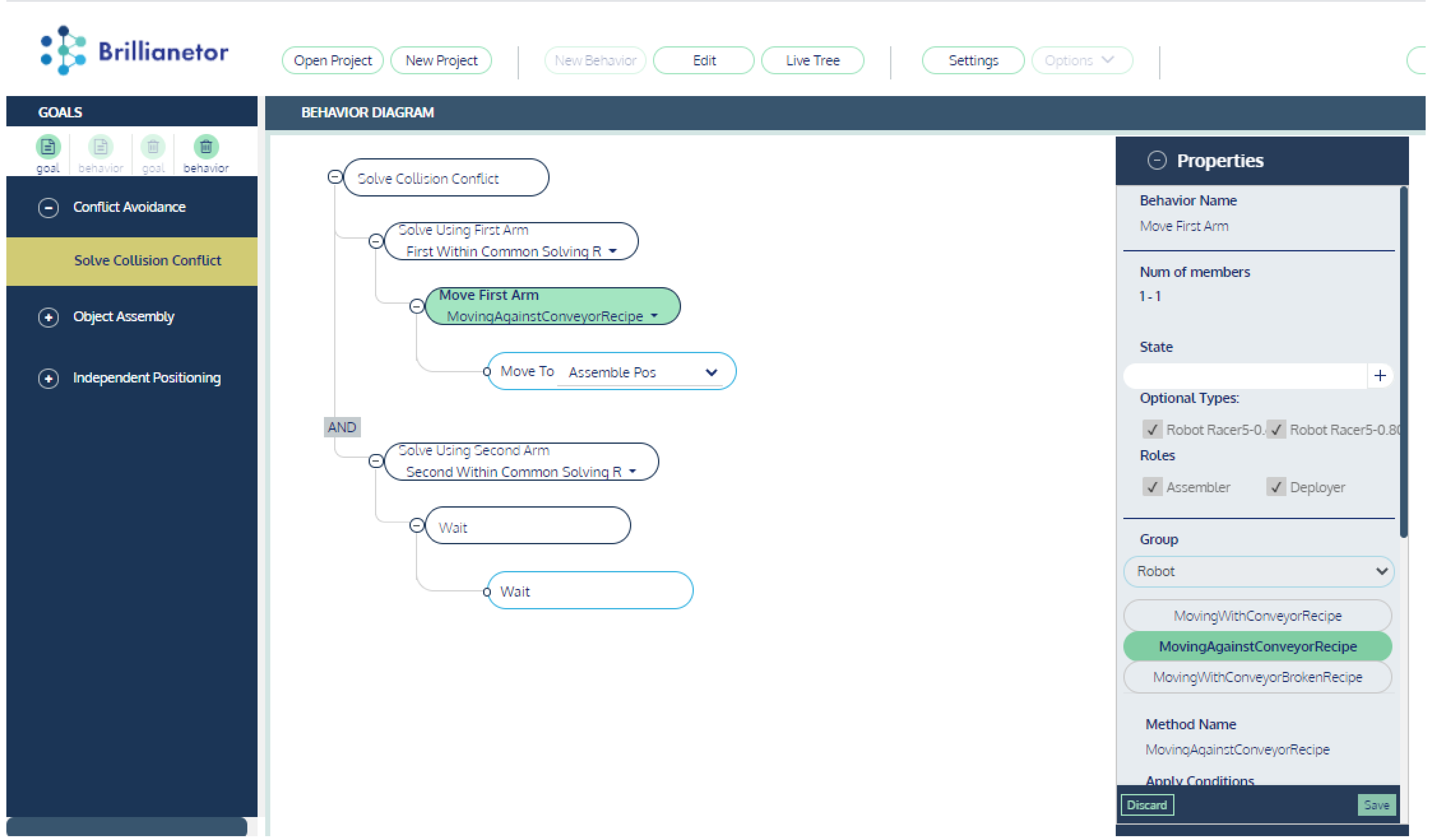
Name:

New Entity Type

Phase 2:
Define Goals for Robots

The entities, basic actions, and the queries, which were defined in phase 1, are used as basic blocks to define goals for the robots.

The customer defines the rules of the goals that the robots are required to achieve.



Behavior Name
Move First Arm

Num of members
1 - 1

State

Optional Types:
☑ Robot Racer5-0. ☑ Robot Racer5-0.8

Roles
☑ Assembler ☑ Deployer

Group
Robot

MovingWithConveyorRecipe
MovingAgainstConveyorRecipe
MovingWithConveyorBrokenRecipe

Method Name
MovingAgainstConveyorRecipe

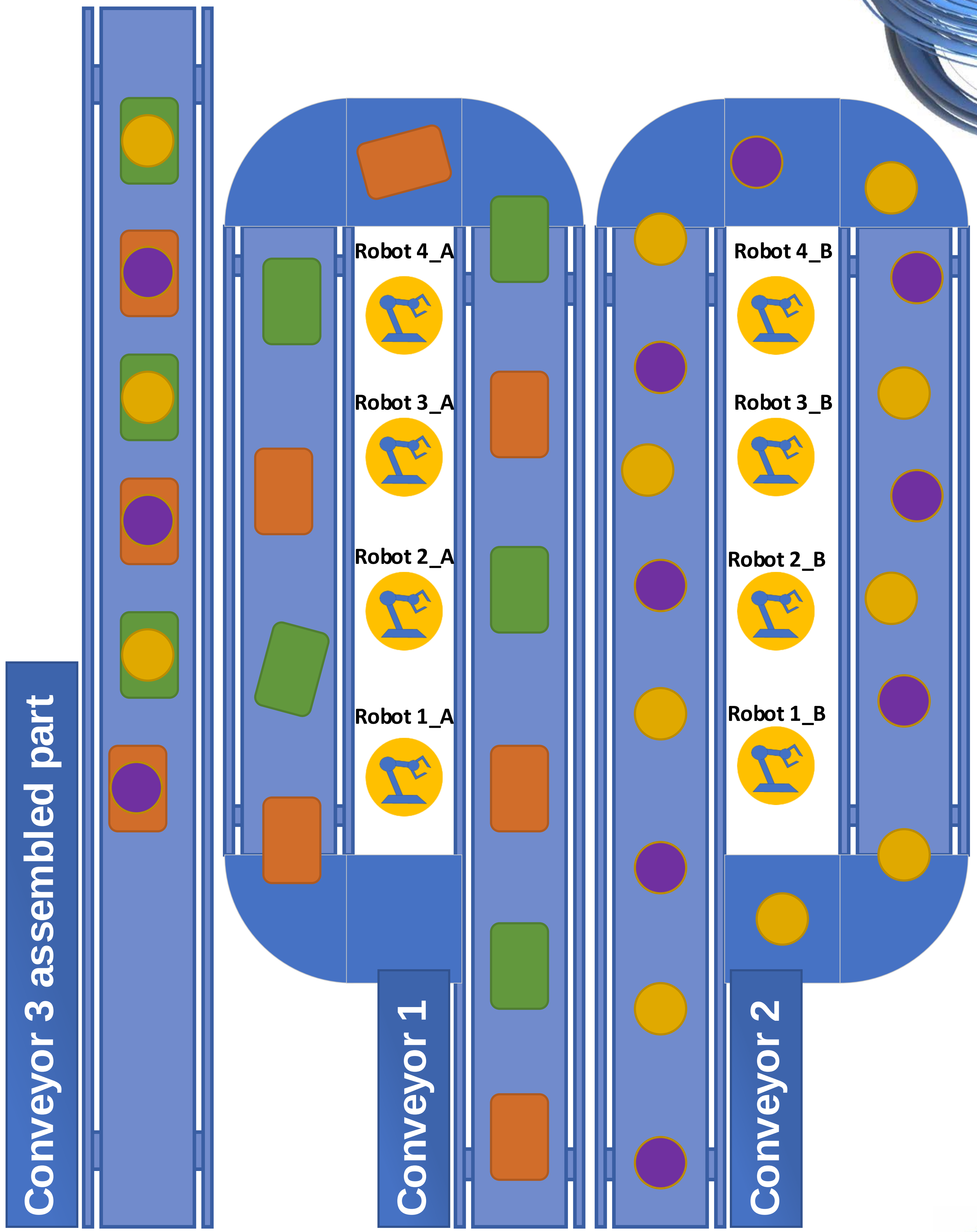
Apply Conditions

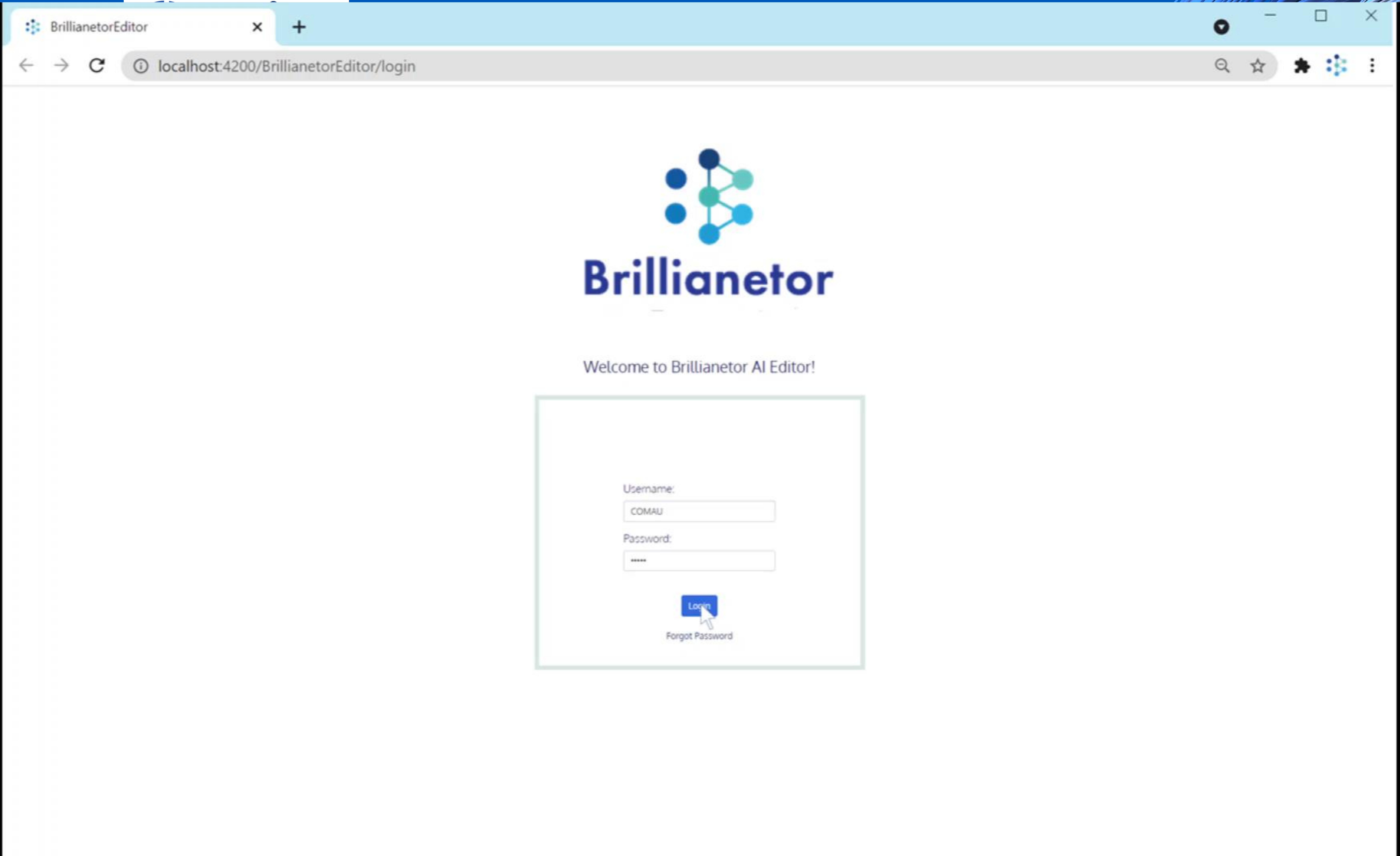
Easy to use drag & drop editor
Without a single line of code!

Assembling Process Use Case

Example of assembling process in the electronics field.

The robots need to coordinate the movement, avoid collisions, and assemble parts together.



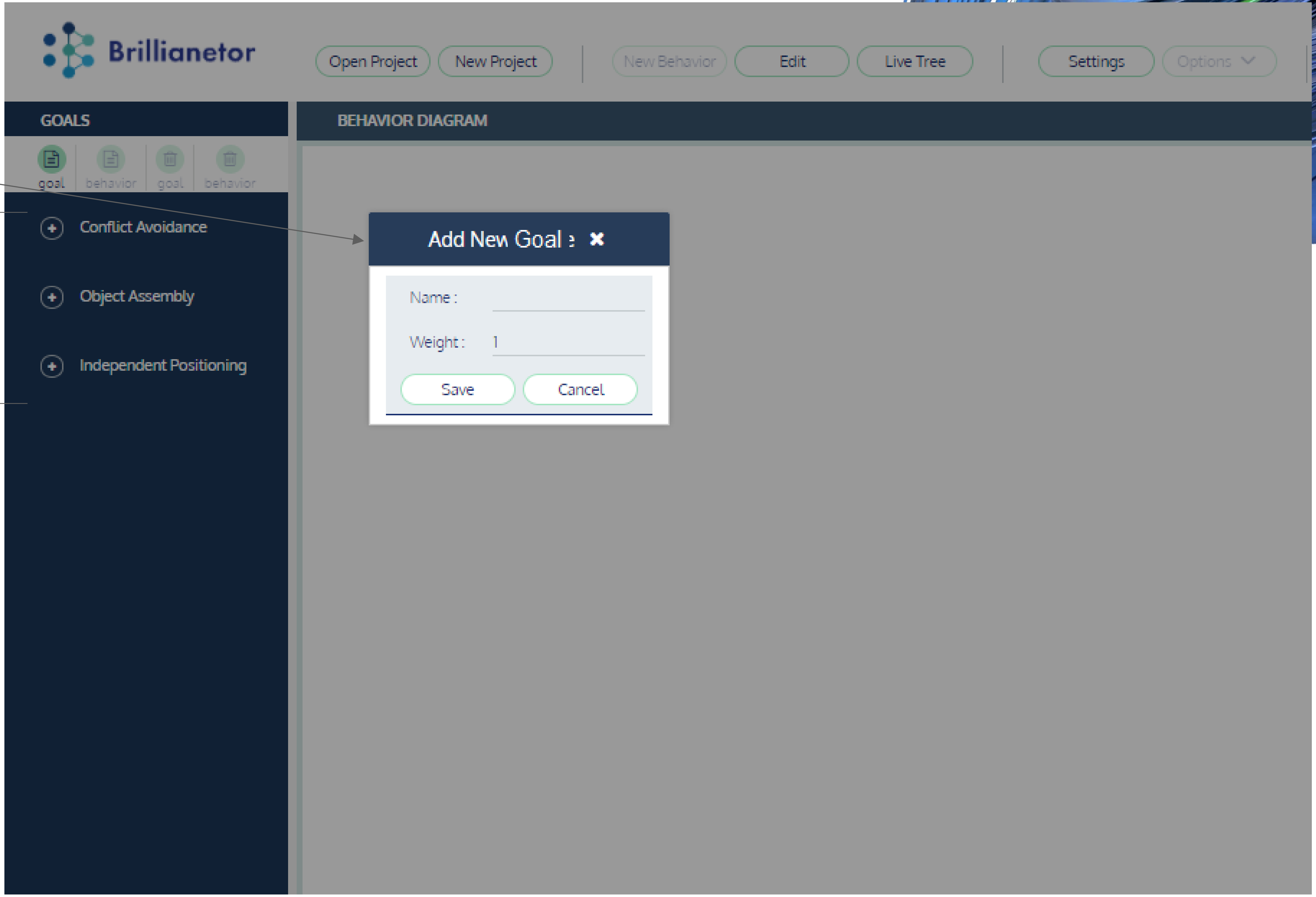


Welcome to Brillianetor AI Editor!

Username: COMAU

Password: •••••

Define the Robots' goals



Conflict Avoidance

Object Assembly

Independent Positioning

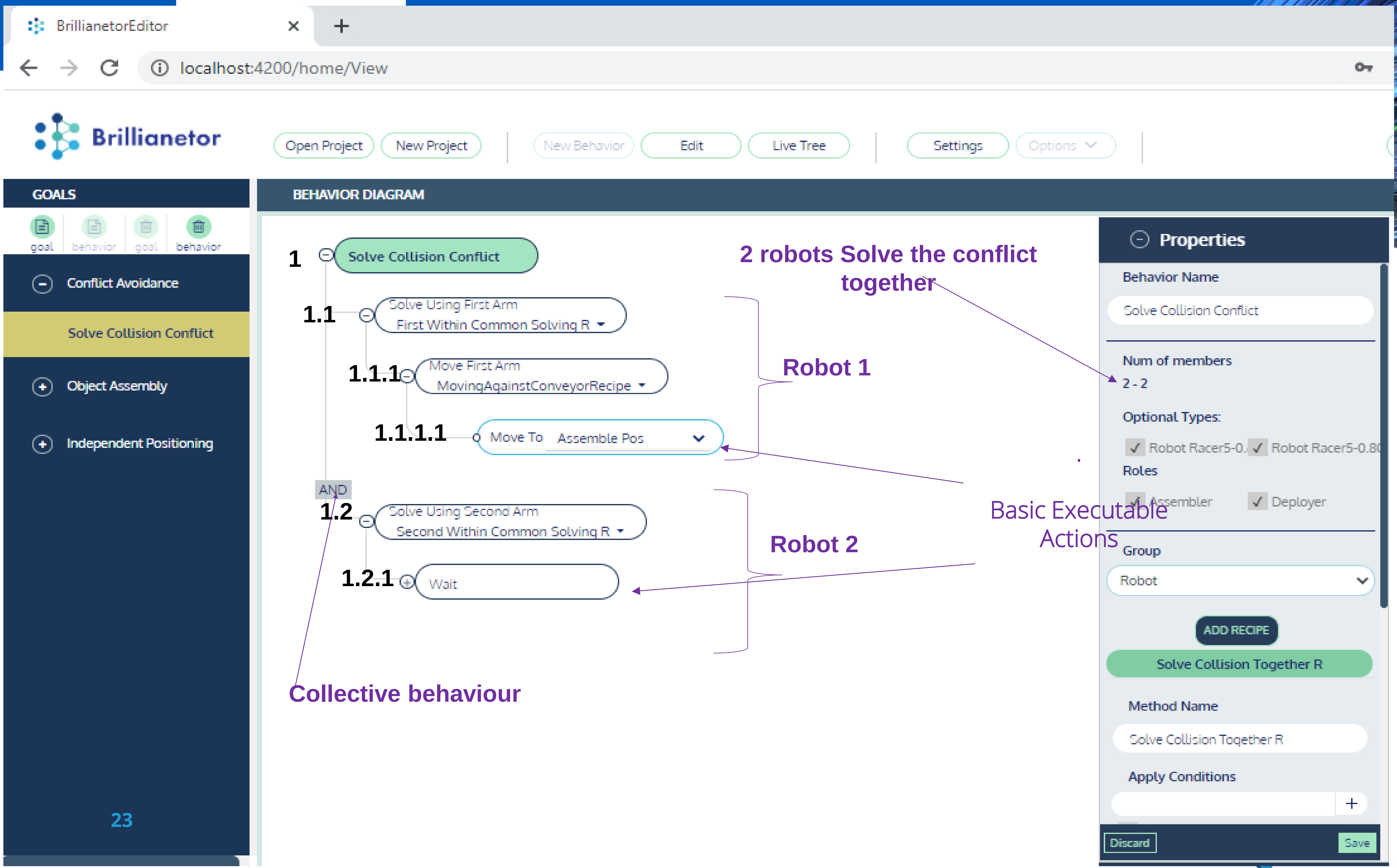
Add New Goal :

Name :

Weight : 1

Example of Goals:

- **Conflict Avoidance**
- **Object Assembly**
- **Independent Positioning**



BrillianetorEditor

localhost:4200/home/View

Brillianetor

GOALS

- Conflict Avoidance
  - Solve Collision Conflict
- Object Assembly
- Independent Positioning

BEHAVIOR DIAGRAM

1 Solve Collision Conflict

1.1 Solve Using First Arm — First Within Common Solving R

1.1.1 Move First Arm — MovingAgainstConveyorRecipe

1.1.1.1 Move To — Assemble Pos

AND

1.2 Solve Using Second Arm — Second Within Common Solving R

1.2.1 Wait

2 robots Solve the conflict together

Robot 1

Robot 2

Basic Executable Actions

Collective behaviour

Properties

Behavior Name: Solve Collision Conflict

Num of members: 2 - 2

Optional Types: ✓ Robot Racer5-0. ✓ Robot Racer5-0.80

Roles: ✓ Assembler ✓ Deployer

Group: Robot

Solve Collision Together R

Method Name: Solve Collision Together R

Apply Conditions

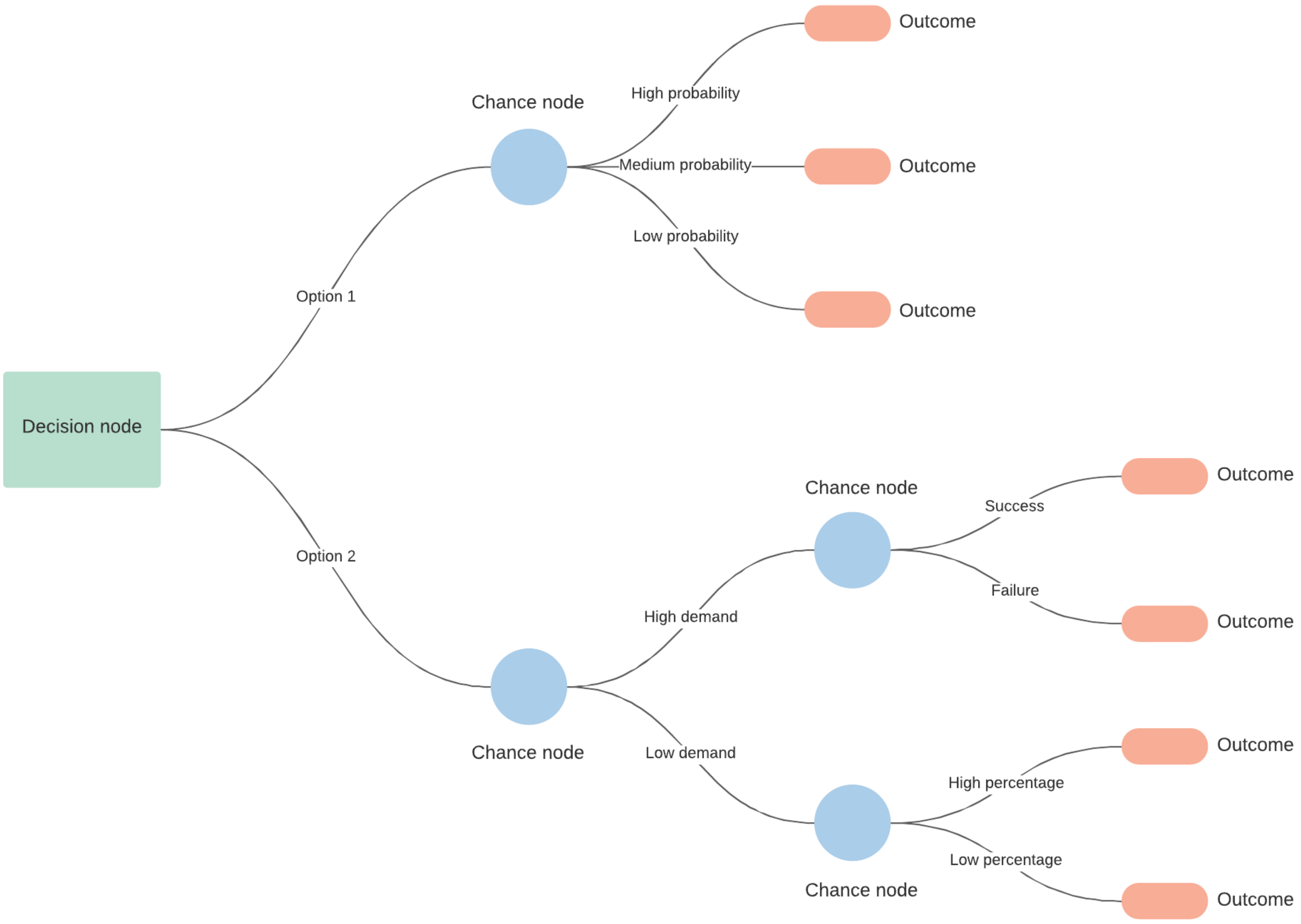
Phase 3 - Operation

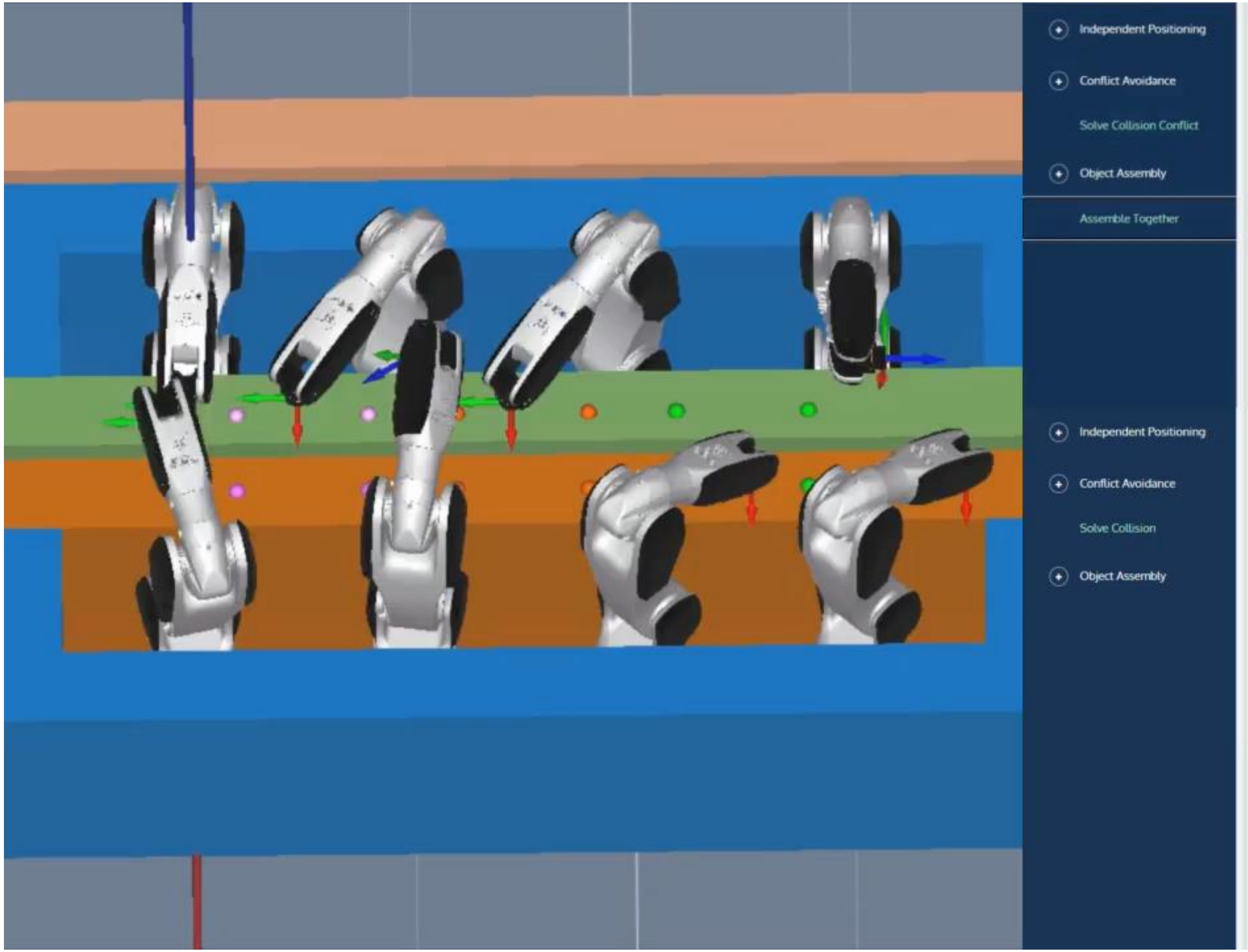
- Any robot with an API installed can contact the Brilliant MIND service and request a “mind”.

- The Brilliant MIND service creates a mind for this robot.

- The robot is now controlled by its mind in the Brilliant MIND service.

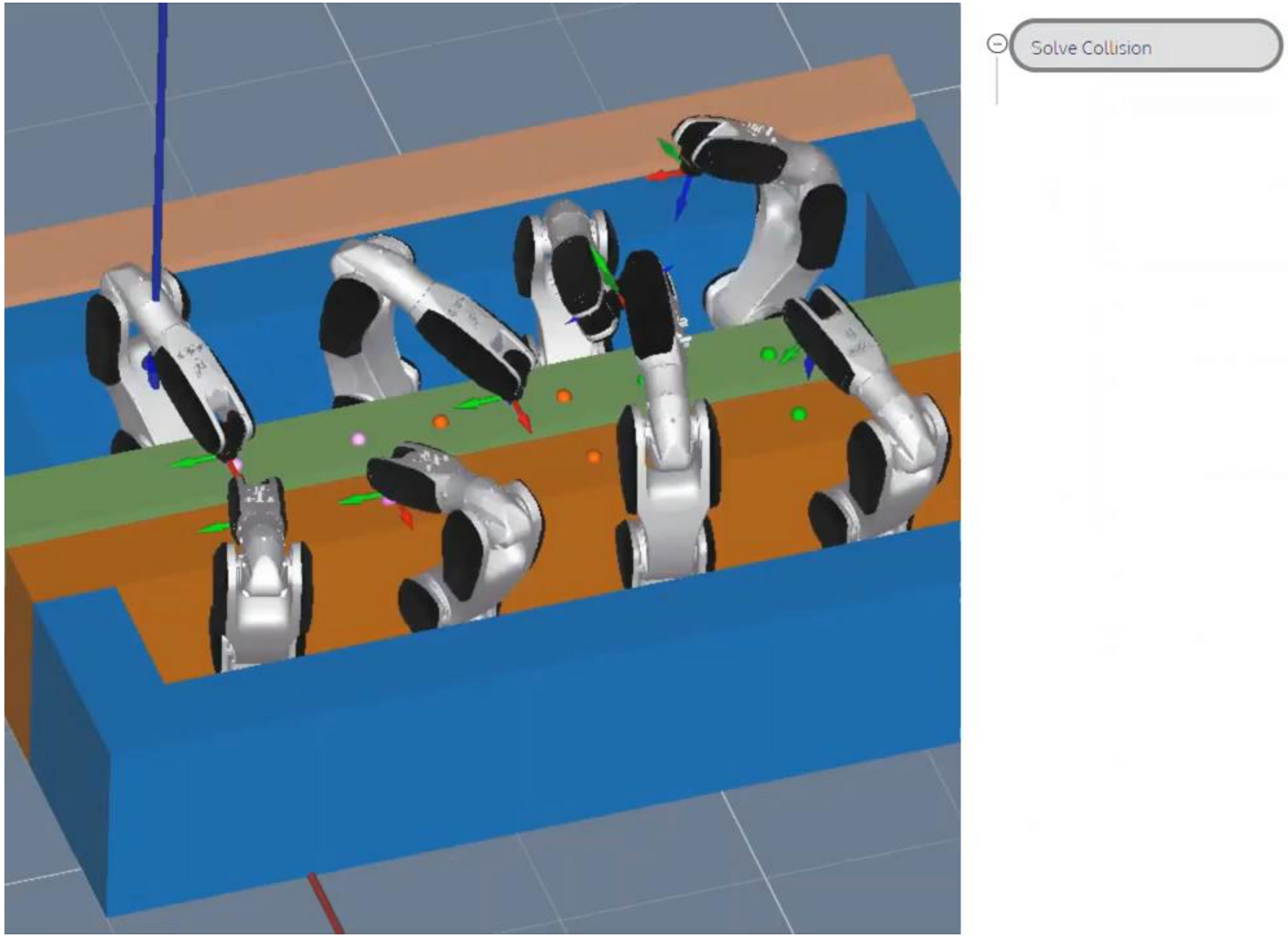
- All stages of the decision-making process are visually presented to the operator as a collective decision tree diagram.



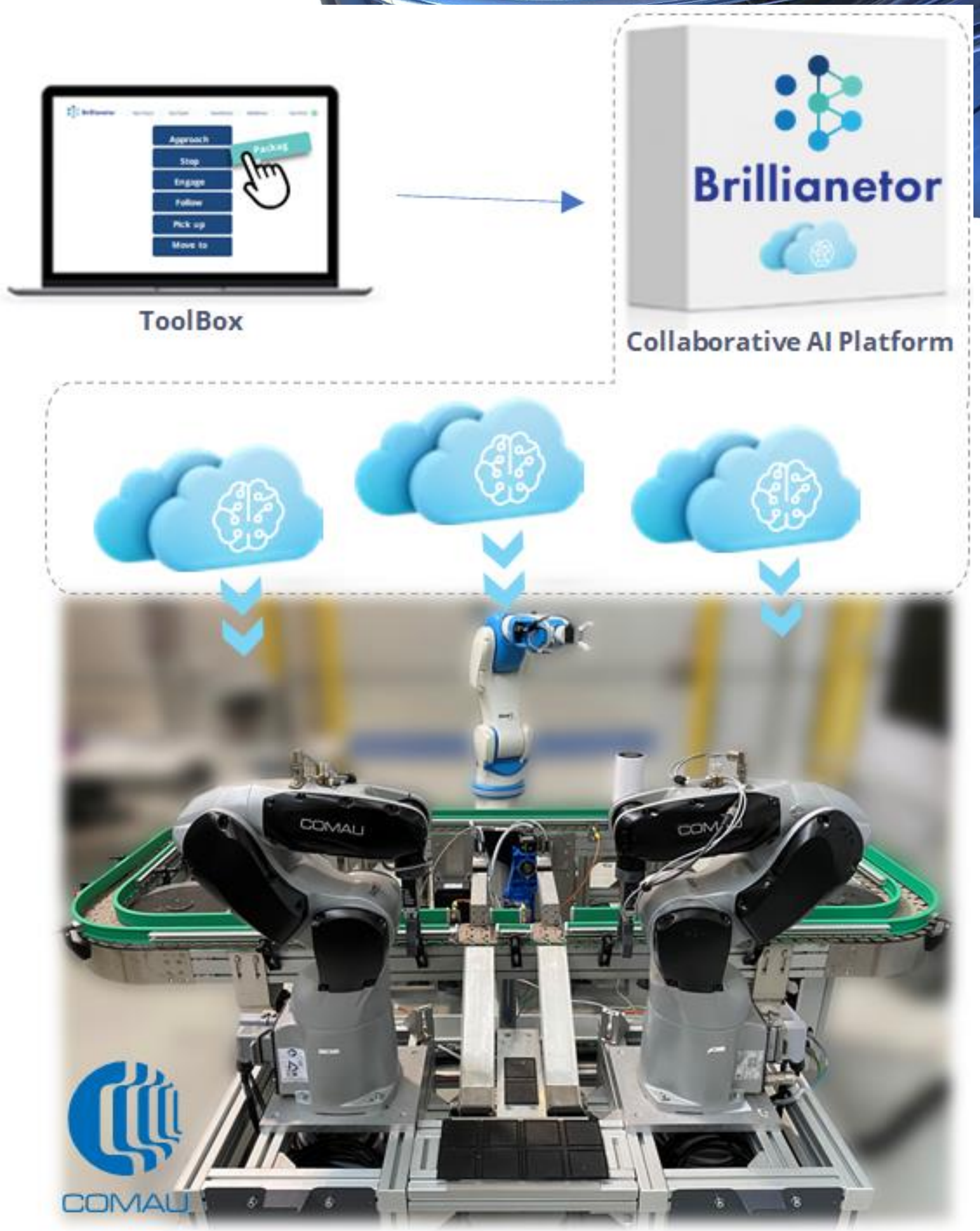

Independent Positioning
Conflict Avoidance
Solve Collision Conflict
Object Assembly
Assemble Together
Independent Positioning
Conflict Avoidance
Solve Collision
Object Assembly

Assemble Together
Solve Collision
Wait Together

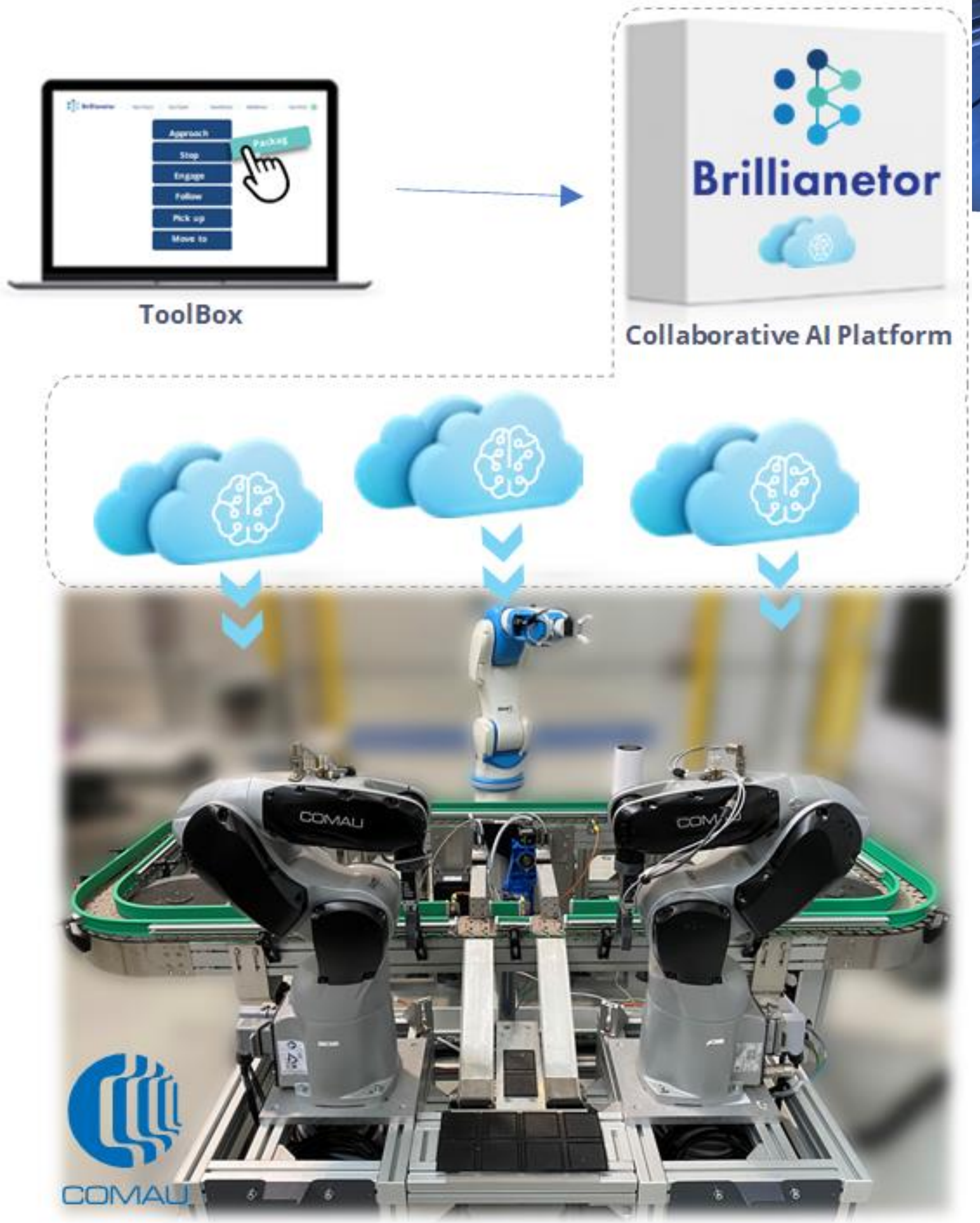
Conflict Avoidance 1 (slow motion)



Integration with Comau’s robots (Racer-3)



Integration with Comau’s robots – Malfunction case

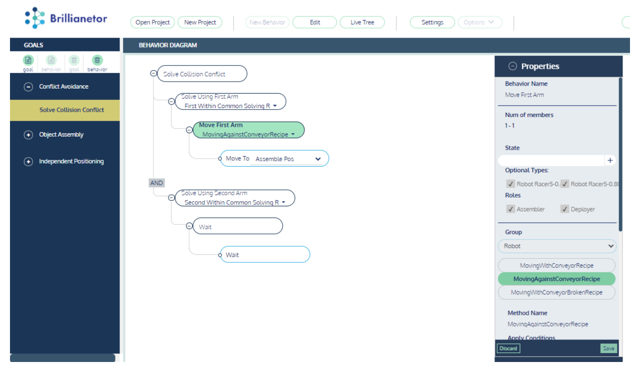


Brillianetor’s Product - Summary

The combination of **Brilliant Mind** and **Brilliant Tool Box** is designed for ease of integration and use, reducing the time and costs involved with multi-robot system deployment.

Through **Brilliant MIND** robots are integrated with collaborative AI capabilities enabling them to cooperate and communicate with each other autonomously, react to unexpected events, make collective decisions and act together to optimize performance.

The **Brilliant TOOL BOX** is an **SDK** that provides developers with an ease and speed in integration in their own system, featuring: (a) user-friendly drag and drop editor; (b) plug-in API that connects to the Brilliant Mind



+ API

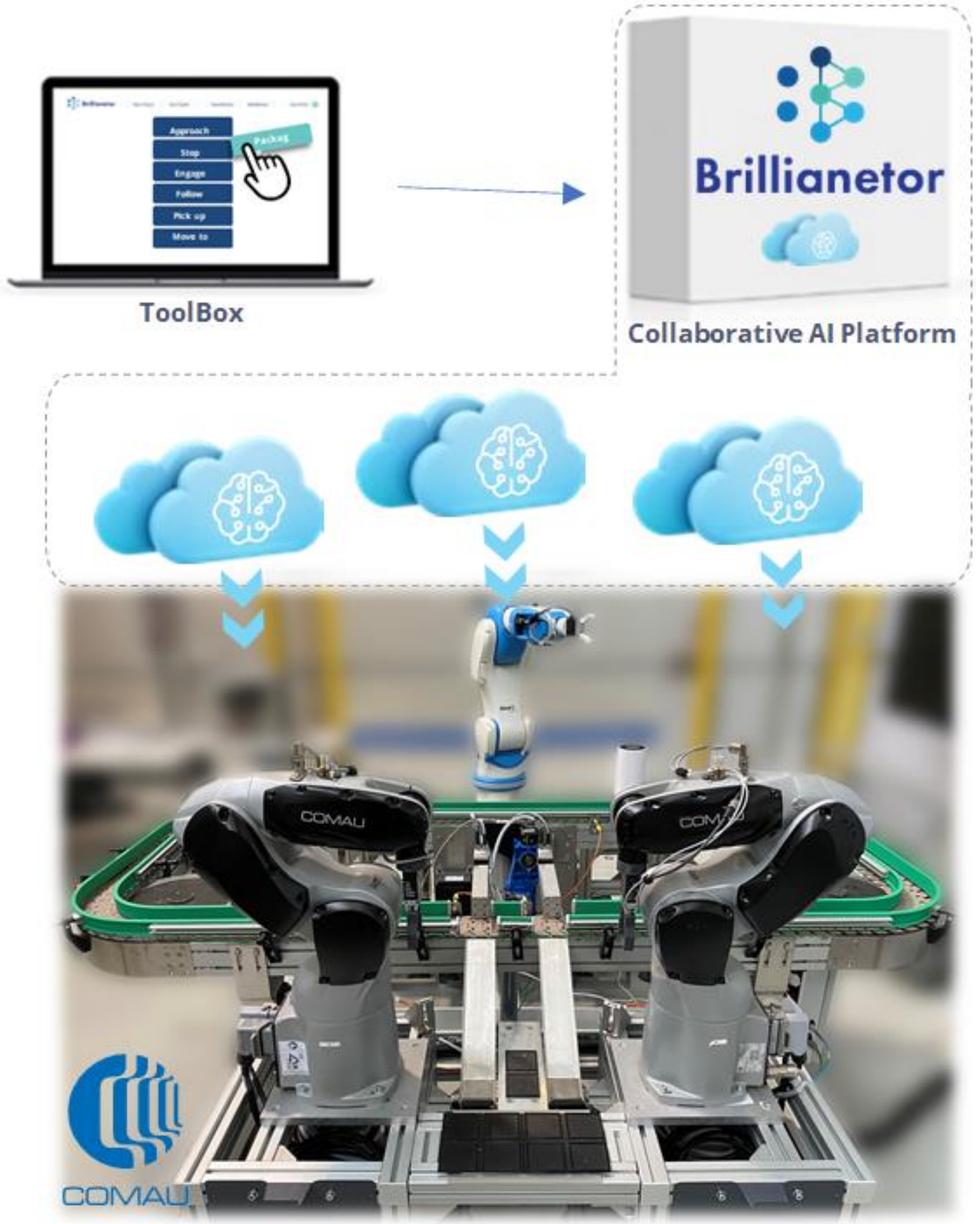
Summary

Collaborative Social AI successfully integrated Comau's robots, allows deployment of multiple robots with:

- **User friendly** Plug and Play tools without pre-programming
- **Saving** in setup and development time
- **Reduction downtime** – real time reaction
- **Faster** production speed

Use Cases

- Industrial robotics
- Team of mobile robots
- AGV and Robot Coordination
- Swarm of drones



Thank You

Alfio Minissale: **alfio.minissale@comau.com**

Meirav Hadad-Segev: **meirav@brillianetor.com**

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