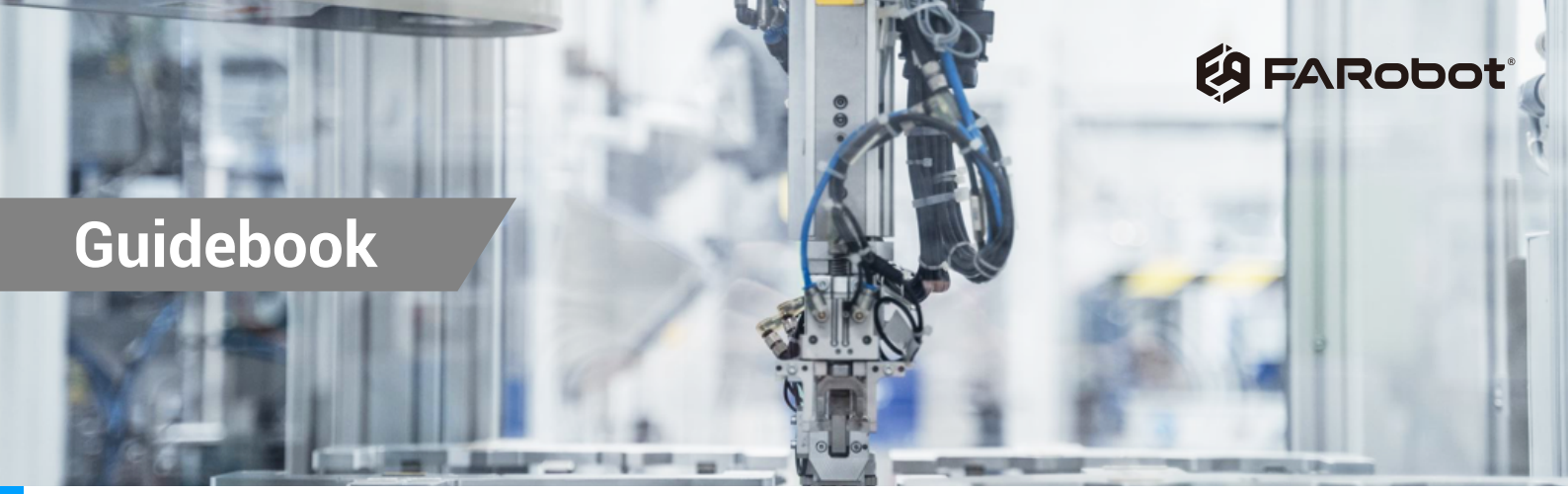


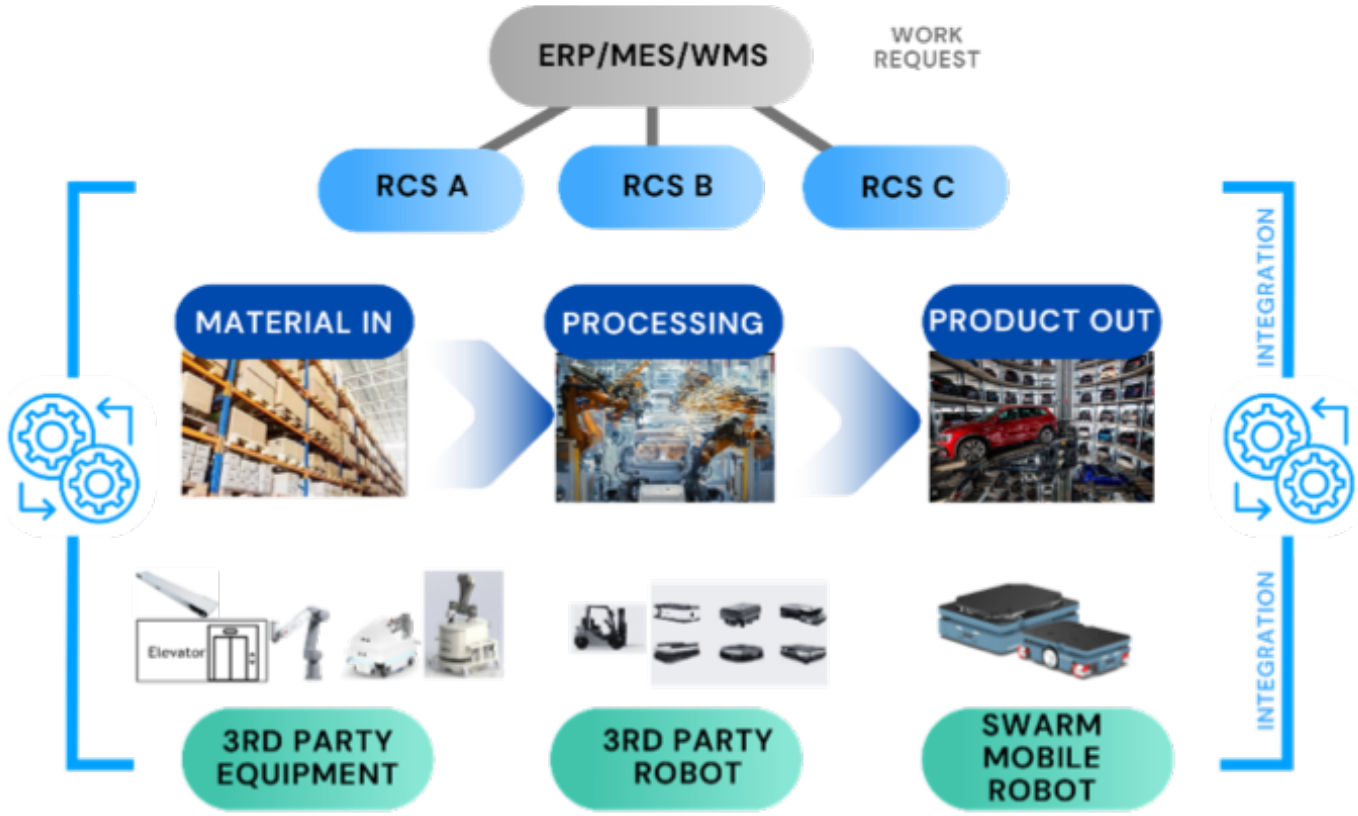
FARobot®

Guidebook

Automated Material Handling Made Simple with SWARM TOOLS

As the global economy faces uncertainty and global markets embrace rapidly-changing customer demands, automation has become a vital element in global industries, particularly in shifting the 3D (Dull, Dirty, Dangerous) tasks to AMRs (Autonomous Mobile Vehicle) in manufacturing and warehousing industries. However, when automation system architects or integrators consider integrability, scalability, and field deployment of a solution, several key challenges can pose significant obstacles:

- Existing factory systems and equipment have various data formats and interfaces.
- High learning curves for integrating and deploying intended applications from scratch.
- An easy-to-use UI is almost unavailable in the market for managing multi-brand robot fleets, task logic setups, and performance monitoring.



An example in the factory illustrating challenges for easy integration of robotics workforces.

Revolutionize your integration efforts with SWARM TOOLS

The industry has long anticipated a suite of tools for efficient and effective integration, with the following benefits in mind:

- A well-designed framework that is easy to extend applications and connect to existing infrastructures, with data availability and transparency.
- Reduced programming requirements, leading to a faster integration and deployment process.
- Ability to control multi-brand mobile robot fleets within one UI, with standardized data format for robot-to-robot and robot-to-equipment communication.

In this article, we will introduce how FARobot can help you achieve the aforementioned benefits through SWARM TOOLS, including the Swarm Wrapper and Swarm API. We will also discuss how you can benefit from an unified Swarm protocol to achieve efficient communication across heterogenous robotics and equipment.


Swarm Wrapper SDK


Swarm API


Swarm Protocol

SWARM TOOLS

Building up applications efficiently

SWARM TOOLS at a glance, usage scenarios, decision criteria

Swarm TOOLS consist of two types of the tool, Swam Wrapper and Swarm API, both unifies data sharing through Swarm Protocol across all assets used in automated material handling workflows:

Swarm Wrapper

A FARobot's software adapter that facilitates system integration and control for AMR-integrated workflows. It connects and translates major industrial interfaces and standards e.g. controller, PLC, IO gateway into FARobot's Swarm Protocol.

Swarm API

A FARobot's open Restful application programming interface, which enables seamless service requests and responses between extended applications and robot fleets.

Swarm Protocol

Converted by Swarm Wrapper or Swarm API from disparate industrial communication protocols, it is a DDS-based FARobot's proprietary protocol which ensures safe real-time data sharing and P2P device communication across robots, devices, IT and OT systems.

Below table demonstrates the recommended tool by usage scenarios:

Swarm API

AMR tasks triggered by IT systems e.g. ERP, WMS, MES.

Swarm Wrapper

AMR tasks integrated with top-modules and factory equipment, all of which are controlled by AMR's fleet management software e.g. SWARM CORE®.

Integration	System	Top module	Equipment
Example	ERP, WMS, MES...etc.	Robotic arm	Conveyors, elevators, air showers, doors...etc.
Swarm tools	Swarm API	Swarm Wrapper	Swarm Wrapper
Benefits	General accepted methed	• Reliable handshaking mechanism • Low latency communication • Low code SDK	• Reliable handshaking mechanism • Low latency communication • Low code SDK

SWARM TOOLS, key advantages in factories, and warehouses

Factories and warehouses differ in the type of equipment they use, the cycle time they face, and the batch size they use. This difference set the integration challenge and value at different points.

Swarm Tools in Factory Automation

- Factories machinery and intralogistics equipment are often using industry-specific protocol (semiconductor, SMT, automotive, etc).
- Factory automation requires highly predictable cycle time, **Swarm Wrapper** is thus recommended to achieve real-time and fail-safe handshakes execution.
- The **Swam API** will be useful in integrating planning systems, building task schedules and flows. It will act as a good bi-directional tool for integrating IT systems (ERP, MES, MCS) and factory assets operated by the systems.

Swarm Tools in Warehouse Automation

- Warehouses are filled with high density storage systems, ASRS, and material transfer equipment. The main goal of automated warehousing is to improve the efficiency and accuracy of goods handling and delivery.
- **Swarm API** enables flexible trigger and reassignment of existing workflows, supporting efficient storage under the dynamics of goods retrieval.
- **Swarm API** can also support synchronised decision-making between WMS and robotics controlling system such as FARobot's fleet management software SWARM CORE®, particularly for important, complex order management of different trigger points (picking stations, kitting stations…etc).
- When it comes to integrating top-modules and conveyors systems, **Swarm Wrapper** will provide advanced safety and robot-equipment handshakes.

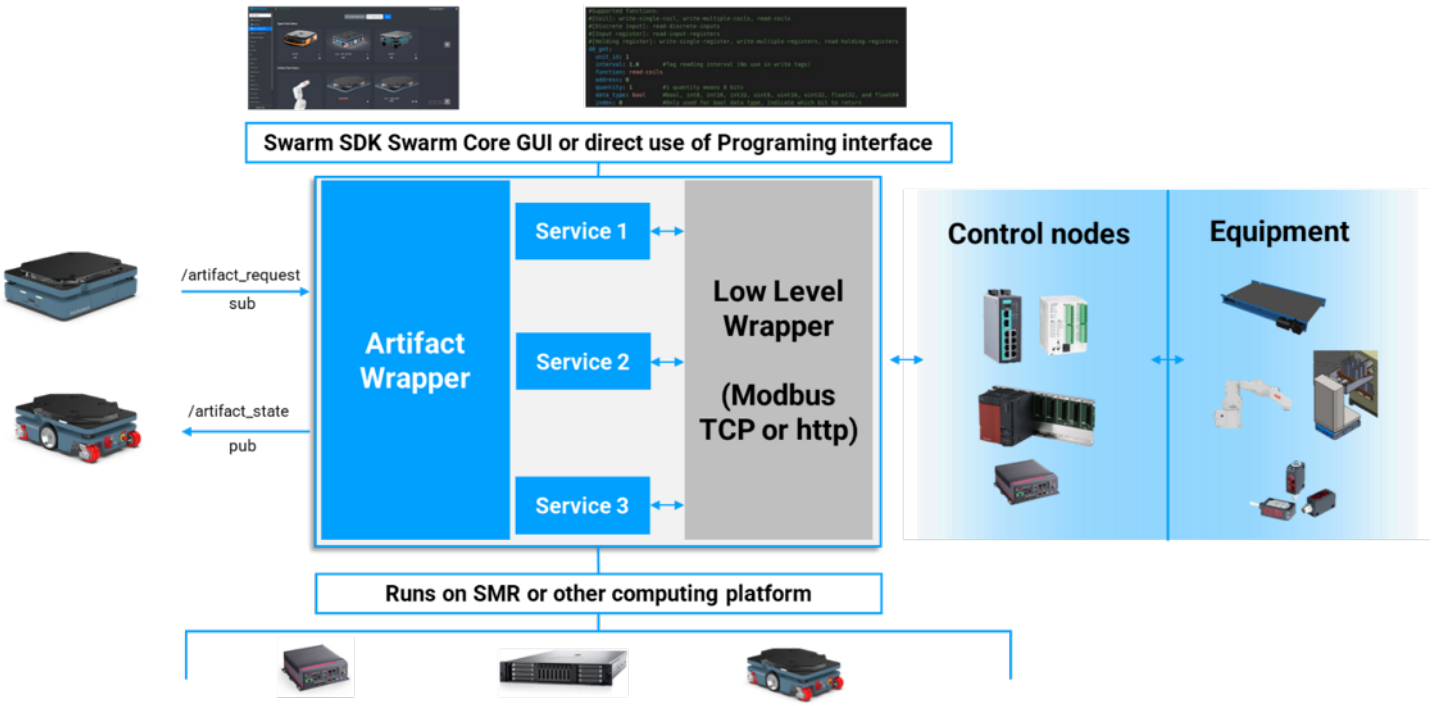
SWARM WRAPPER

Low-code development kit Swarm Wrapper SDK available

The Swarm Wrapper is a software adapter developed by FARobot. It enables system integration and control by the SWARM CORE® which connects to and translating major industrial interfaces and standards into FARobot's Swarm Protocol.

The Swarm Wrapper acts as a bridge between SWARM CORE® and other industrial systems, allowing for seamless integration and communication. Thanks to its Python GUI programming, the learning curve can be shortened to a few days of practice.

FARobot provides the low-code development kit Swarm Wrapper SDK, extended training, and documents to help SIs partners get started faster in factory integration and deployment.



The table illustrates needed efforts integrating a robotic arm using Swarm Wrapper:

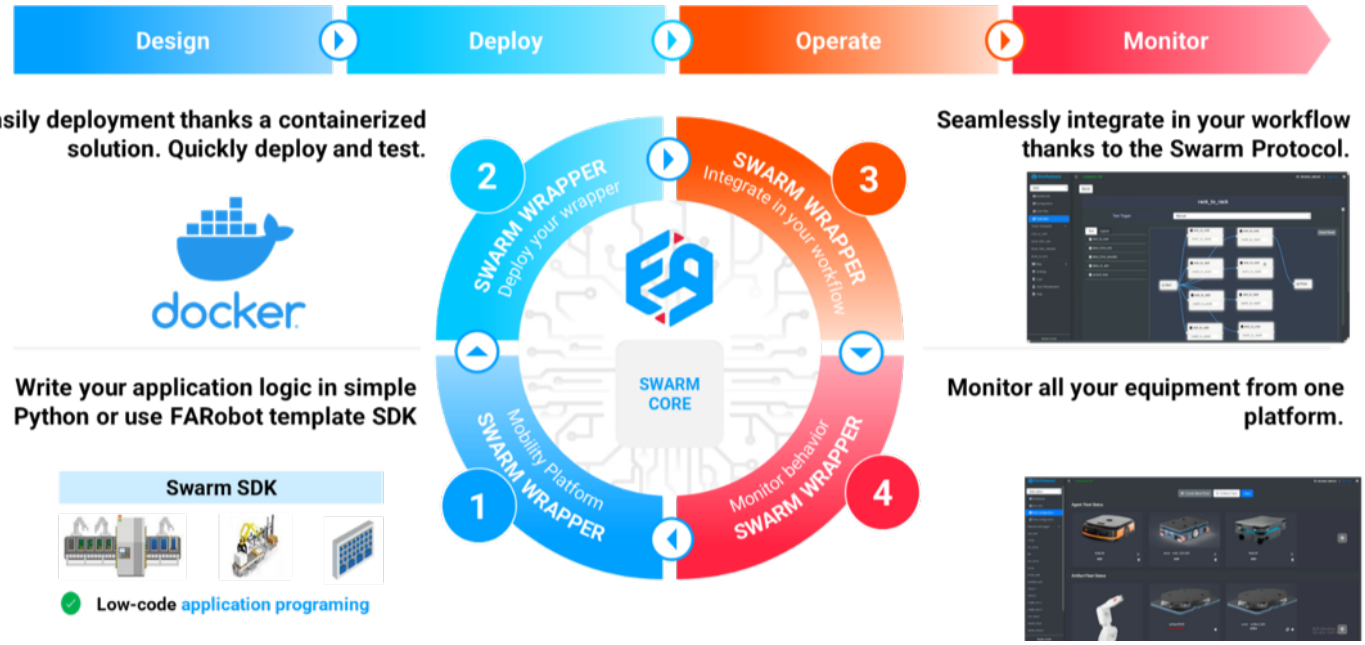
#	Steps	Effort
1	Environment set-up	Select a device and operating system and setup environment
2	Create a new artifact* type	Define a name and the low-level protocol you will use
3	Write code and configure	Program logic, signal mapping, configuration setting
4	Build and debug	Compile and debug your wrapper
5	Deploy to artifact container	Deploy the code to the target device (IPC, server, controller)
6	Testing	Test commands from the SDK to the device(s)
7	Operate	Set up workflows* able to trigger the robotic arm

** Artifact: a container where Swarm Wrapper runs*
** Workflows: combination of tasks for mobile robots and equipment allowing the transfer of goods*

Key benefits of utilizing the Swarm Wrapper SDK

Reduce development time.

Integrating multiple equipment, their services and logic is a laborious task that occupies resources from the most experienced staff. With the Swarm Wrapper SDK, most engineers with low to no programming experience can integrate equipment into SWARM CORE® in hours.

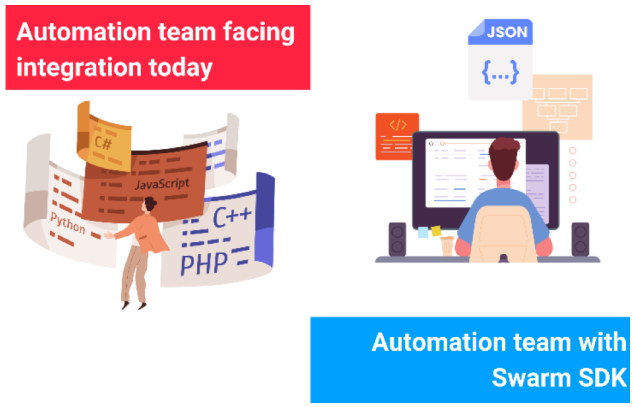


Below table illustrate the comparison of required time of integrating an robotic arm between traditional method and Swarm Wrapper SDK:

Robotic arm	Week 1	Week 2	Week 3	Week 4	Week 5
Traditional	Program	Configure	Debug	Test	Deploy
Swarm	Configure	Deploy and Test			

Enhance integration quality

The Swarm Wrapper serves as a template that can be extended and reused in various applications, facilitating a streamlined copy-and-paste process for partial development across different projects. The adoption of a common and standardized tool also helps in reducing errors and mitigating the risk of maintaining complex code bases.



Use cases in three types of artifacts

The term “artifact” can be broken down into 3 types of containers where Swarm Wrapper runs:

Operational artifact

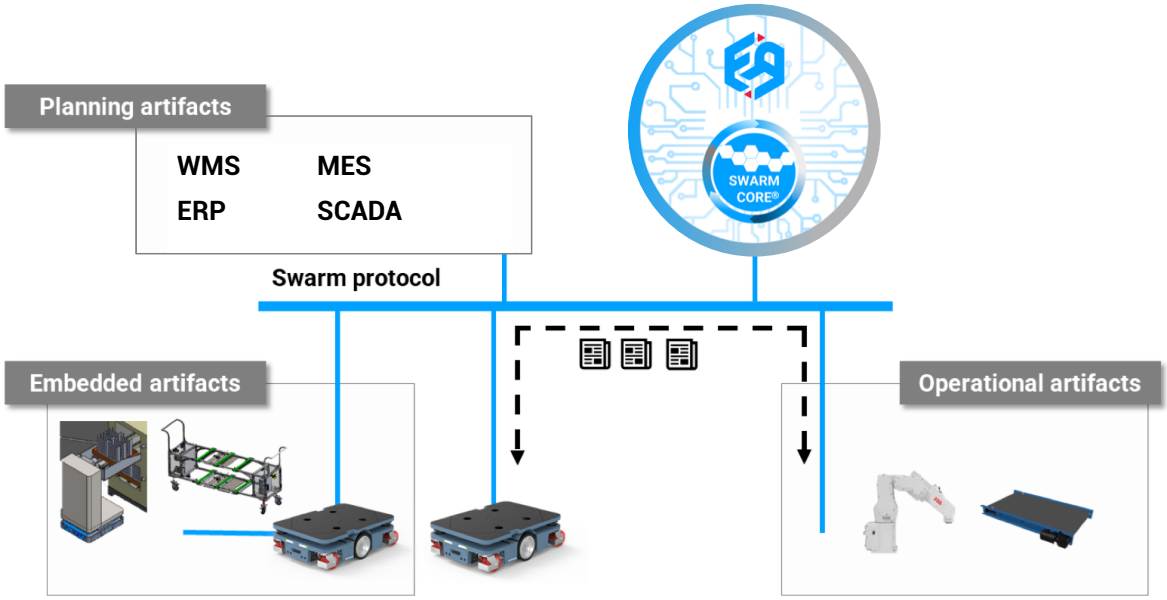
All industrial equipment involved in the automation process, such as elevators, conveyors, robotic arms, palletizers, and more, can be considered as operational artifacts.

Embedded artifacts

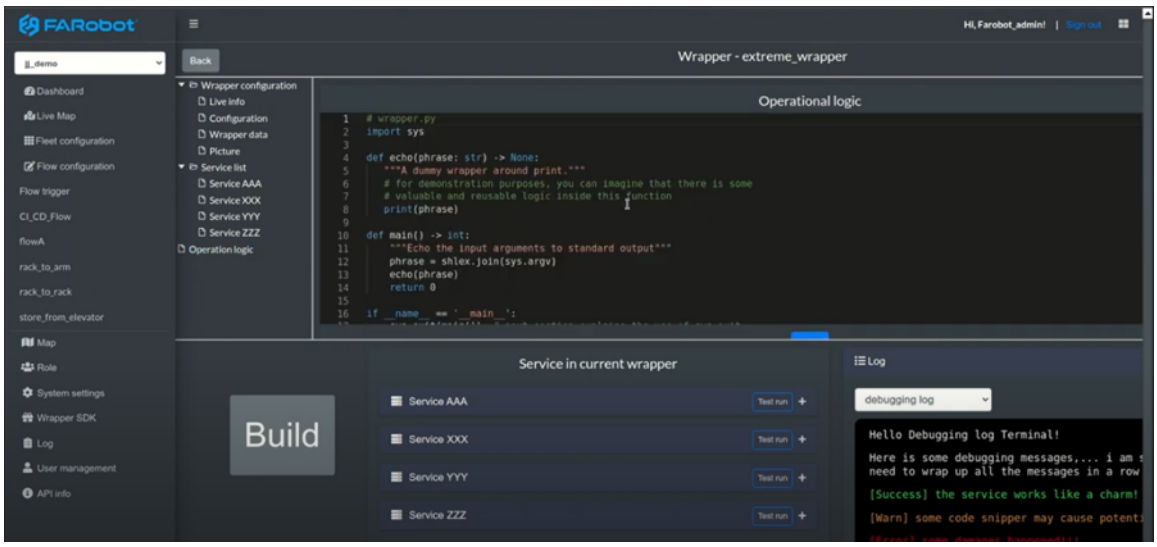
Embedded artifacts refer to the operation and control of embedded devices, such as robot peripherals or top modules.

Planning artifacts

Planning artifacts encompass all triggers and task request commands, such as ERP, WMS, MES, which enables SWARM CORE® to sequence and execute the workflow.



Swarm SDK user interface, directly accessible from SWARM CORE®

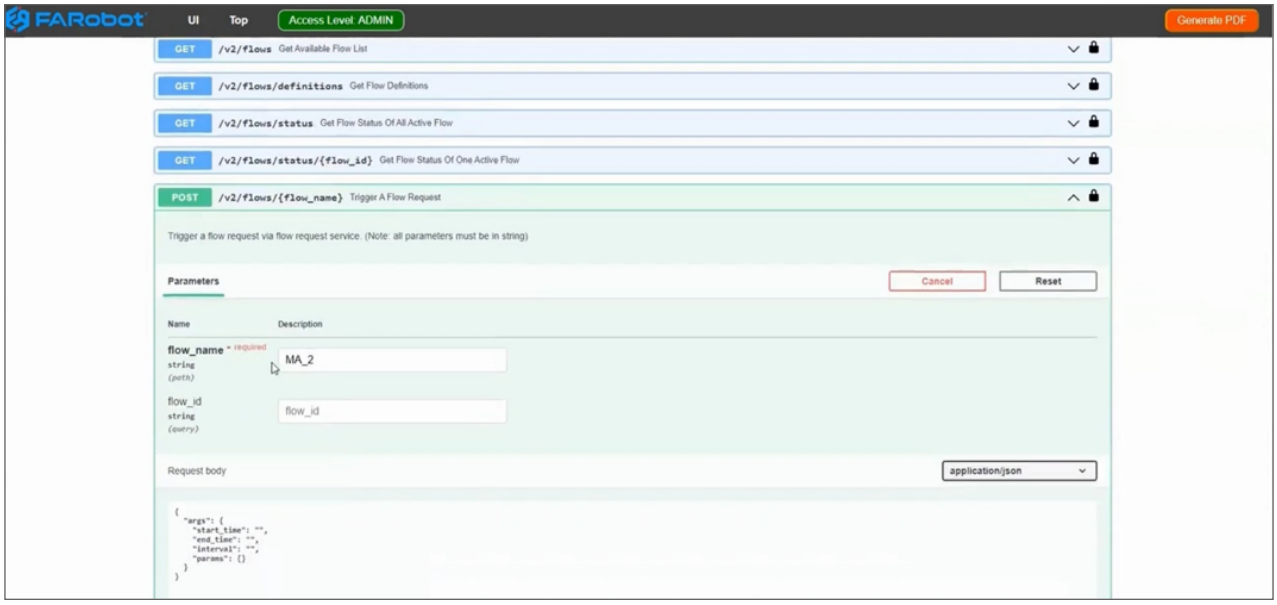


SWARM API

A Restful API accessible directly from SWARM CORE® UI

The Swarm API, developed by FARobot, is an open API that provides access to SWARM CORE® data. Engineers can easily integrate and deploy SWARM CORE® into various applications through direct accessibility from the SWARM CORE® UI, meeting automation needs across industries.

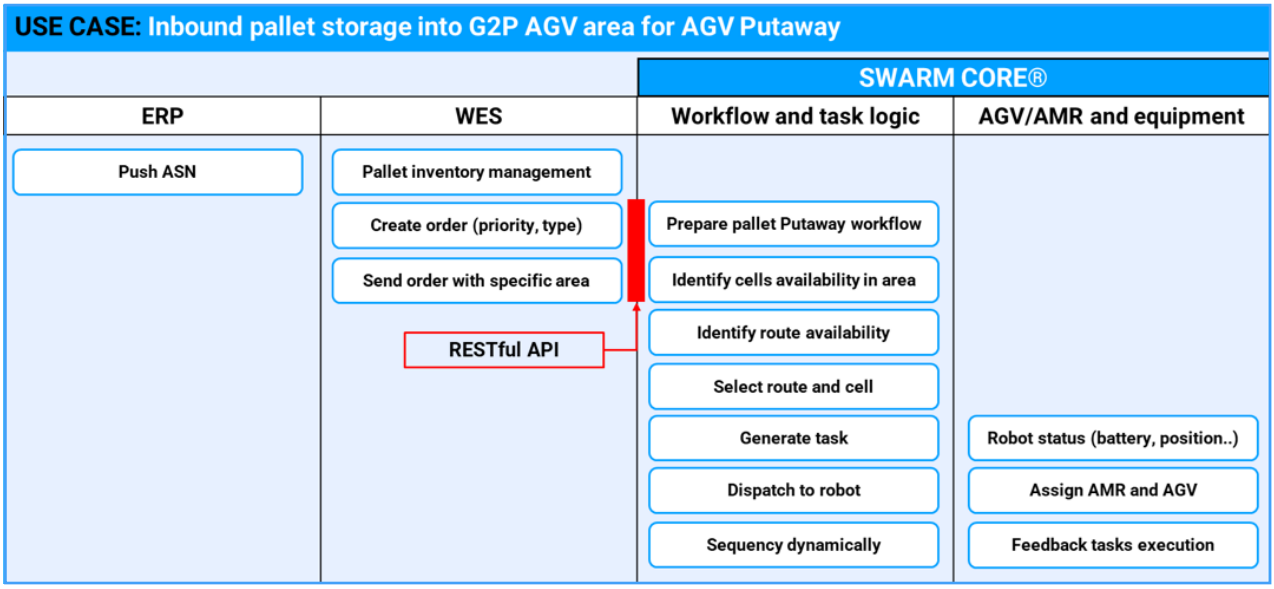
FARobot can provide documents and a demo-video on demand as the how-to tutorial.



Key benefits for system integrators

Focus on logic instead of protocols conversion

The Swarm API simplifies integration between extended applications and SWARM CORE® for intralogistics use cases, reducing manual integration efforts and custom code. This enables system integrators to focus on automation logic rather than protocols conversion. For example, SIs can customize tasks logic and add value on top of SWARM CORE® by letting the WMS choose specific racks, or by letting SWARM CORE® does so based on specified environmental conditions or workflow status. This optimizes onsite dynamic decision-making with minimum expense, helping SIs deploy SWARM CORE® faster and achieve performance effectively.



Example of integration between SWARM CORE® and a WMS using the Swarm API.

Scalability and Flexibility

The Swarm API facilitates workflow optimization by collecting relevant data for further analytics and improvement. This makes it an ideal solution for SIs who wish to grow and scale their automation projects over time without having to invest additional time in integrating other tools for different projects.

SWARM PROTOCOL

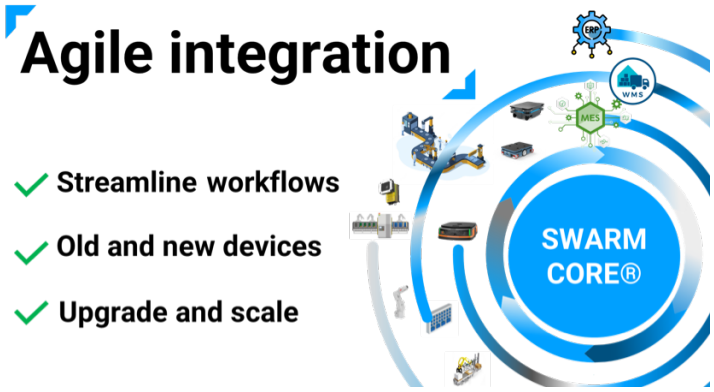
Connect, coordinate, and scale automation with one protocol

The Swarm Protocol is a DDS-based protocol developed by FARobot to revolutionize the way of data sharing in a more efficient and effective way.

Thanks to real-time data sharing and P2P device handshaking, the Swarm Protocol optimizes interoperability between mobile robots and equipment thereby solving many of the automation architecture challenges:

- It ensures that data is transmitted quickly and accurately, minimizing the risk of errors or delays.
- It brings a new level of safety, security, and reliability to system automation.
- ts QoS-based handling provides fail-safe and resilient workflows by dispatching the right robot to the right place at right time.

Today, the Swarm Protocol is carried out by FARobot's SWARM CORE® software platform to coordinate multi-brand robotics and IoT collaboration for route, traffic, and task planning and execution, The platform has already been successfully deployed in several sites, where it controls dozens of devices and robots on a 24/7 basis.



Why SWARM PROTOCOL is your go-to communication standard for various tasks?

One protocol adapts major industrial protocols

Swarm Protocol offers a level of flexibility and scalability that is unmatched in the industry – all major communication standards, interfaces, and protocols can be converted through customizable Swarm Wrapper and Swarm API. Whether you are working on a large or small-scale of factory or warehouse automation initiative, the Swarm Protocol can scale along.

One protocol defines complex automation workflows

Swarm Protocol can define complex automation workflows involving time-constrained handshakes and multi-robot collaboration. Moreover, it enables swarm knowledge sharing across industrial equipment and robots for task-robot capability matchmaking, traffic control, obstacle avoidance, and even error handling and task recovery.



Swarm SDK is recommended for SI to integrate various industrial protocols with lower development efforts.

MOBILE ROBOT WRAPPER

An extended application for SI to explore

FARobot cordially invite SIs and robot manufacturers to join our efforts in extending the coverage of SWARM TOOLS. This extension will help you sell more of your services and devices by leveraging a hybrid fleet that consists of multi-brand systems, robots, and equipment. By integrating the same design concept, the integration of robots can be defined by a hierarchy of functionality:

Flexible integration level options that fit in any hybrid fleet working needs

Full level

SWARM CORE® has direct control to the robot through a robot API or a native integration of FARobot's Swarm Protocol. This access allows full functionalities needed for robot navigation, workflow execution, and data collection from the robots.

Benefit: multi-brand robot deployment in one platform, better Overall Equipment Effectiveness (OEE).

Partial level

SWARM CORE® can operate and configure robots at multiple levels, ranging from comprehensive task programming and multi-brand robot management to task triggering of any robot or robot matchmaking for optimal task-workforce effectiveness.

Benefit: Reduce inconveniences and risks when deploying new systems to collaborate with existing ones, as well as the maintenance of traffic safety for multiple robots in situations where two fleets need to share spaces.

Monitor level

SWARM CORE® is able to monitor the 3rd party robot fleet information and display all relevant information in one UI.

Benefit: Easier maintenance and monitoring of entire sites running multiple fleets.

Control level	Full	Partial					Monitoring
		1	2	3	4	5	
Case	SWARM CORE® directly operates & configures robot SWARM CORE® creates navigation map	SWARM CORE® directly operates & configures robot SWARM CORE® manages navigation map	SWARM CORE® directly configures robot 3rd party robot manages navigation map	SWARM CORE® controls 3rd party robot's behavior 3rd party robot manages navigation map	SWARM CORE® assigns 3rd party robot's route & destination 3rd party robot manages navigation map	SWARM CORE® triggers 3rd party robot in its system	SWARM CORE® can only monitor robot status
Difficulty of integration							
Functionality	• Robot status & position • Task programming • Traffic control • Robot unit behavior (move/dock/initial pose) • Robot configuration • Map management • Sensor data	• Robot status & position • Task programming • Traffic control • Robot unit behavior (move/dock/initial pose) • Robot configuration • Map management	• Robot status & position • Task programming • Traffic control • Robot unit behavior (move/dock/initial pose) • Robot configuration	• Robot status & position • Task programming • Traffic control • Robot unit behavior (move/dock/initial pose)	• Robot status & position • Task programming • Traffic control	• Robot status & position • Task triggering	• Robot status & position
User's Benefit	• Multi-brand robot deployment in one platform • No robot integration effort	• Multi-brand robot management in 1 platform • Reduced robot integration effort	• Reduced fleet management effort	• Behavior level Optimization • Behavior level error handling • Reduced effort in multi-brand robot management	• Robot collaboration • Dynamic task dispatch & replanning	• Task-robotics workforce matchmaking	• Monitor hybrid fleet status in one platform