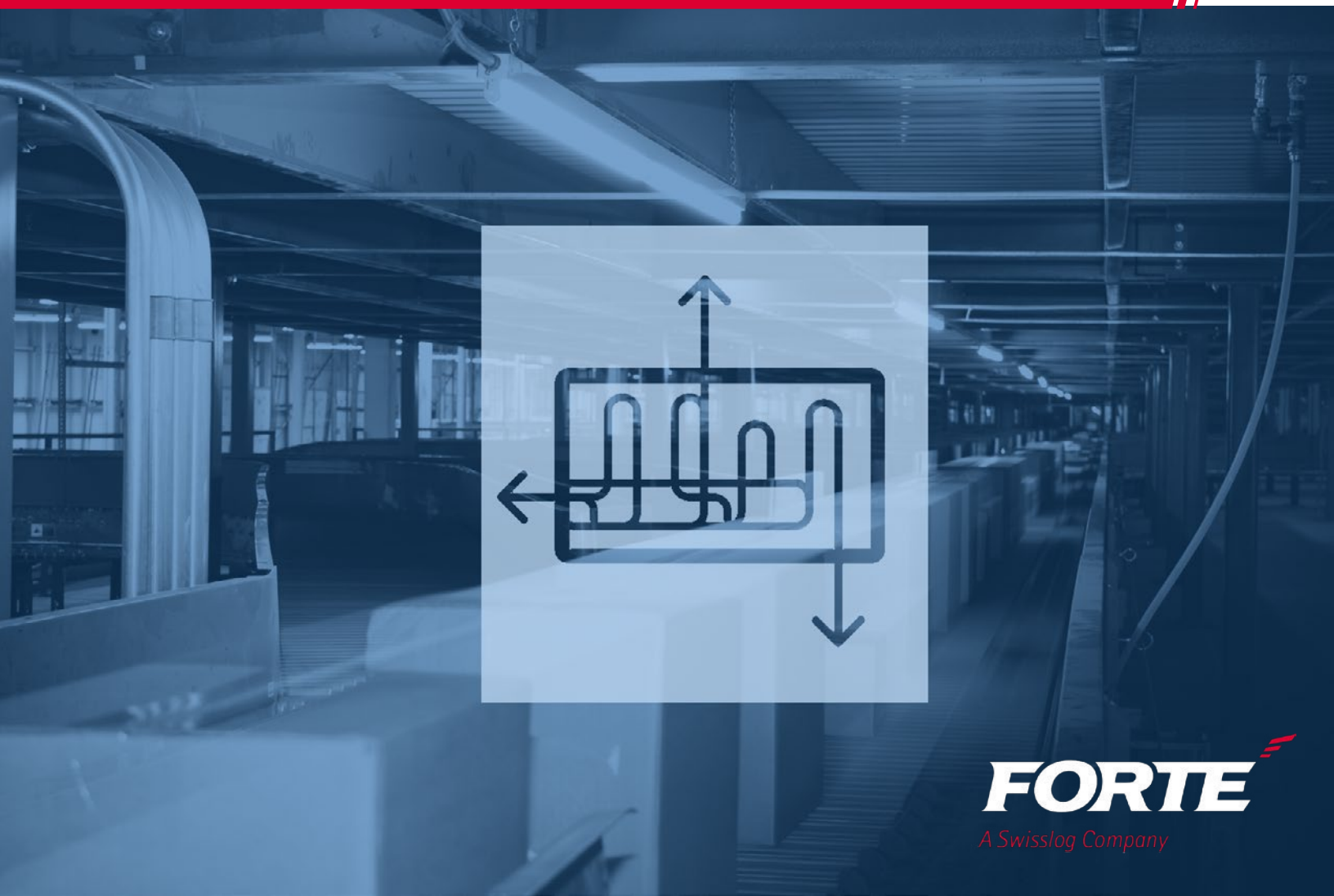
WHITE PAPER

Agents Power Adaptive, New Approach to Warehouse Execution Software



FORTE
A Swisslog Company

Maybe your company has experienced the crash of a computer server that controls warehouse operations. It's not fun, especially right before the busy year-end holidays.

At the height of seasonal sales, a large retailer offering furniture, kitchenware and home essentials lost a server, shutting down one of its distribution centers in the United States. A warehouse manager phoned the company's software vendor — a call with more than a little seasonal urgency behind it. The manager expected to hear that the resolution would require hours to set up a new computer server, reinstall the warehouse control system and then redeploy the settings. Instead, the software vendor copied the application agents and configurations onto a second server and restored the distribution center's system within five minutes.

This was no holiday miracle. It was a direct benefit of FORTE's adaptive architecture, the FORTE Agent Framework.

The retailer's warehouse execution system, built on the Agent Framework platform, has individual features that interface, control, monitor, optimize and report on activities in the distribution center. This discrete approach to functionality requires fewer IT resources and typically can be deployed and configured cost-effectively. Importantly, the agent-based approach to software does not require changes to existing software code base that runs a company's business applications, including enterprise resource planning (ERP) and warehouse management systems (WMS).

The Agent Framework approach to warehouse execution systems is arriving at a time when warehouse operators face dramatic increases in the velocity and volume of orders.

Many companies are adding automation, especially flexible goods-to-person systems that can be modified to support ever-changing fulfillment needs.

Across all industries, including businesses selling directly to consumers and those selling to other businesses, there's a new reality. Buyers' behavior has changed from large orders delivered to a few purchasers, to small orders delivered to many purchasers. In response, distribution center managers must rethink their strategies to fulfill orders from growing numbers of SKUs and more, smaller orders for products and parts. Many companies are adding automation, especially flexible goods-to-person systems that can be modified to support ever-changing fulfillment needs.

Greater order volume and velocity and more options make today's distribution centers incredibly complex. The need to optimize operations to meet customer demand is larger than ever. As a result, warehouse execution is emerging as a new class of software.

Agents Fine-tune Warehouse Controls

Warehouse execution systems bridge gaps between fully featured warehouse management systems and warehouse control systems. WMS has long handled business transactions such as receiving, putting away goods, picking, packing and shipping orders. WCS developed as middleware to communicate between the WMS and the programmable logic controllers (PLCs) directing material handling equipment, such as conveyors and sorters.

WMS software vendors traditionally offer a full range of functionality that the vendor or customer can turn off or on to meet operational requirements. The underlying programming code for all functions is integrated and must be maintained — whether or not the customer uses it.

Contrast that design with the newest approach to warehouse execution systems built upon an Agent Framework whose programming code addresses specific functions instead of a wide range of activities.

Agents operate autonomously to control one function, such as managing orders, optimizing order waves or releases, routing cartons, communicating with a PLC, monitoring conveyor status or the location of cartons.

Agents consume information about orders, inventory, tasks and material handling transactions and use them to optimize processing of the fulfillment operation. Agents then create instructions for personnel and automated equipment that moves orders through a distribution center. Agents operate autonomously to control one function, such as managing orders, optimizing order waves or releases, routing cartons, communicating with a PLC, monitoring conveyor status or the location of cartons. They can be added, removed or enhanced without the need to revise the programming code of other agents or for other systems, allowing for changing operational needs at a low risk.

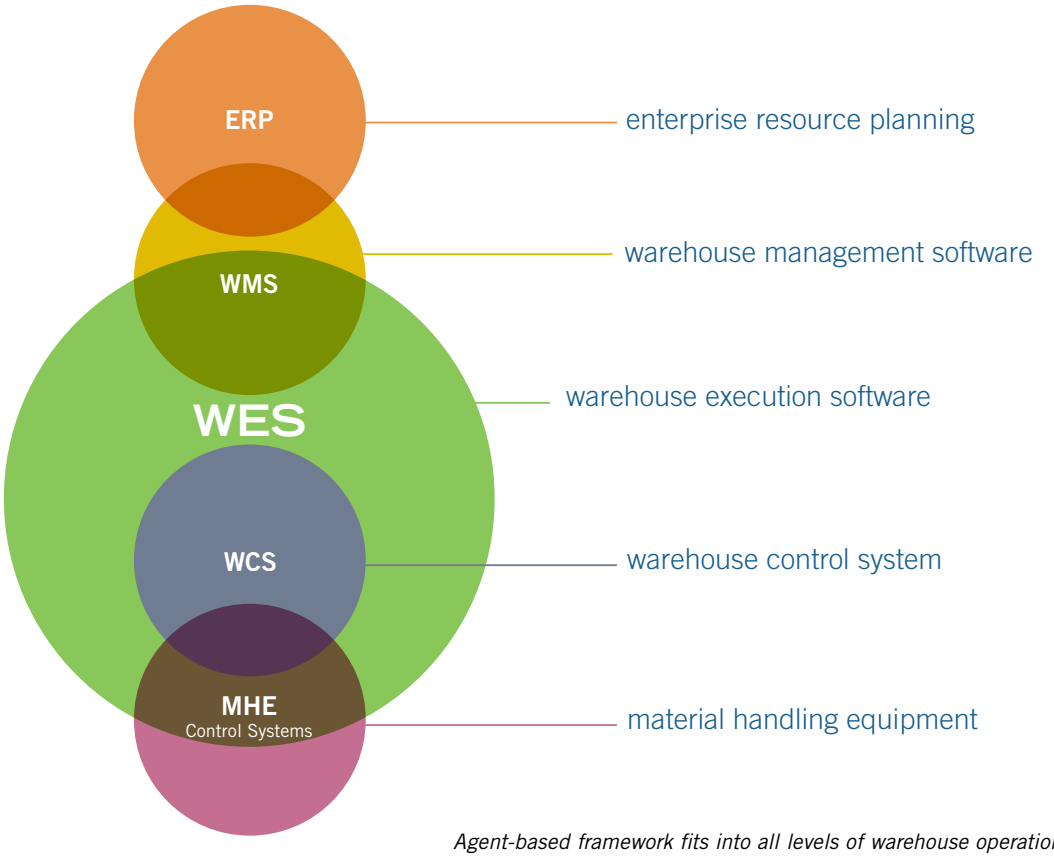
Only agents needed to meet the actual operational functionality requirements are configured and deployed. This results in less risk, cost and complexity while allowing for a cleaner path to expansion and enhancement.

Choose Carefully: Software Design Can Be More Important than Functionality

Today a wide range of warehouse software is available for companies of all sizes and distribution center needs. Choosing which system best supports your company's strategies can be daunting, so it's important to consider that the platform of distribution center technology may be more significant than the functionality itself. That's true especially for mid-sized companies in fast-growing sectors that need to quickly modify how their distribution centers operate in response to the continually changing marketplace.

It's warehouse execution software (WES) that slips in between the warehouse management software to coordinate inventory, orders and high-level activities and the warehouse control software needed to operate conveyor and sortation equipment. As powerful as WES can be, not all versions can support the quick changes and precise solutions sought by those fast growers and any warehouse operator heavily dependent on automation.

Today's most innovative approach to WES is built with an Agent Framework, which really is a software architecture and development environment. FORTE's Agent Framework enables the focus to be placed on rapid functionality development, integration with all kinds of warehouse management software and with PLCs and automated equipment in the distribution center. Agents can use all languages for communication among the devices and systems in a DC.



Agent-based framework fits into all levels of warehouse operations

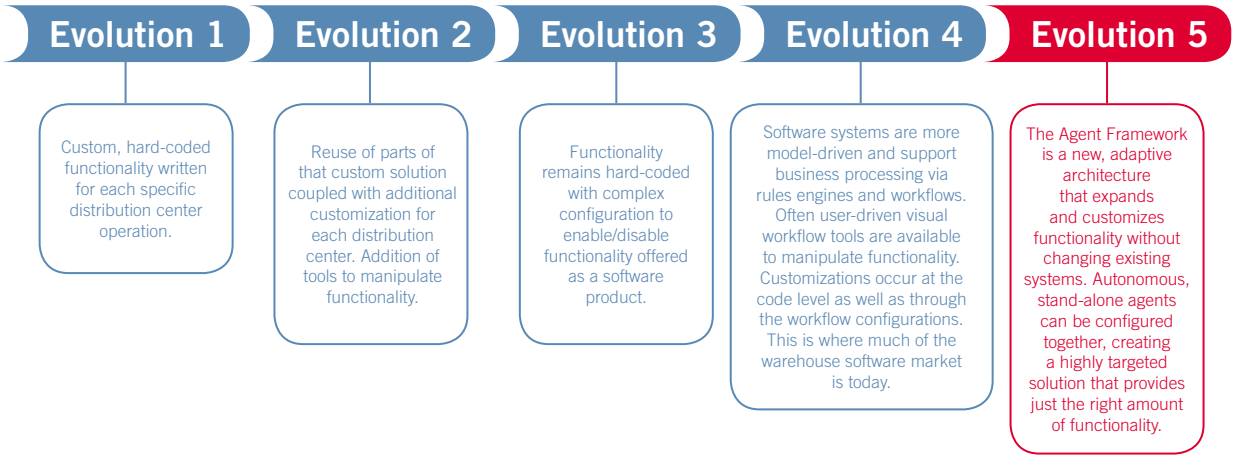
Evolution of Architecture in Warehouse Software

Warehouse management software first appeared more than 30 years ago as highly customized solutions to help companies and each of their distribution centers make business decisions about shipping and receiving. Large enterprise resource planning systems evolved with warehouse management tools and functions to support fulfillment strategies when companies sold primarily to other businesses and shipped large quantities infrequently.

Companies today must fulfill more frequent, small orders, increasingly purchased by individual customers. The new class of warehouse execution software takes customization deep into the control of warehouse automation. When built with an Agent Framework, WES becomes extremely cost-effective and highly efficient.

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History of Distribution Software Architectures



Business Case: Agent Framework Saves Money

Businesses can save significant costs with warehouse execution software based on an Agent Framework because its specific functions are deployed in ways that do not affect existing systems.

Agents are not hard-coded modules baked into the software as found in other more traditional warehouse software in which functions can be turned on or off. An agent is specific to a singular piece of functionality or feature. Only the agents required to meet the operation's needs are purchased and deployed. This reduces the complexity of the deployment and reduces the amount of testing both in the original deployment as well as in enhancements and additions of functionality to the system. This means less cost and risk.

A warehouse execution system built with an Agent Framework does not duplicate top-tier warehouse management systems that come with full functionality. Most small to mid-sized businesses do not need all of the features built into enterprise WMS, yet they must purchase and maintain the entire package whether or not they use all the features. Any customization requires expensive updating every time a new version of the WMS software is released.

Agent-based software, on the other hand, provides the ability to create new functionality with lower costs compared to traditional warehouse management systems. This gives businesses options to add distribution center technology but manage their IT spend as they grow. The agents also are developed independent of their framework's core technology, which makes it possible for each agent to be updated on its own schedule. The approach taken by other warehouse management systems requires the entire software package to be updated when bugs are fixed and functionality is added.

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"Small to mid-sized businesses do not want to change the way they do business. With a big, monolithic WMS system, change is going to be imposed on them. Compare that to warehouse execution software that has adaptive architecture. When you build on an Agent Framework, the software does only what the business wants," said Michael Howes, who pioneered the Agent Framework concept as vice president of software engineering and services for FORTE.

Benefits of Agent Framework

In many ways, warehouse software is converging as companies adopt higher levels of automation in their distribution center operations.

A warehouse execution system extends business logic down into more of the automation layer, especially at companies involved in omni-channel fulfillment. These systems are combining their WCS-level control with upstream business decision-making capabilities to better manage product flow through the distribution center. When paired with the unique capabilities of an Agent Framework, warehouse execution systems provide companies with these seven benefits:

- ***Access to real-time information with broad visibility***
- ***Optimal automation functionality, efficiency and productivity***
- ***Maximum agility to respond to marketplace***
- ***Ways to avoid over-investment in a traditional warehouse management system***
- ***Elimination of costly warehouse management system customization***
- ***Low total cost of ownership***
- ***Allows the fulfillment software to grow/change as the business needs change, more agile approach to warehouse fulfillment functionality***

Agent-based warehouse execution software can fully replace a warehouse management system and also can add additional specific functionality to an existing warehouse management system. Moreover, agents can be a less-expensive alternative because their configurations are right-sized for each business. Paying for and deploying only the functionality needed can drive out costs and risk while allowing for a more scalable and changeable feature set. An agent-based system reduces the investment required for IT hardware while providing paths to scale up on existing servers or by adding servers. Most of these agent-based systems require a small footprint that can be as small as one server for the applications, a second server for the database and a third server to back up everything.

Among the ways this approach reduces costs: Agents that control a specific warehouse function are developed to be easily configured for each installation instead of customized for just one company's application. In the case of the

FORTE approach, its Agent Framework is mature, well tested and widely deployed. Literally hundreds of agents are available to monitor, control and report on the full range of distribution center activities.

IT costs also can be better managed because of the way an Agent Framework provides standards-based communication between and among warehouse systems and control devices. Agents by design are not tied to any one method of communication. Instead, they have "endpoints" that enable an agent's discrete functionality to be developed, configured to a business need and deployed regardless of the devices and languages used elsewhere in the distribution center. Out of the box, agents can talk to the existing systems.

Warehouse managers, supply chain executives and chief technology officers are not likely to move as fast with traditional WMS and WCS software because of the expense and time required to rewrite, test and deploy all the integrated code.

Perhaps most important is how agents reduce complexity. By design, agents used in warehouse execution systems are autonomous. While they interact with and supplement warehouse management and control systems, the underlying code for agents stands apart from existing software. In practice this means warehouse operators can quickly add and remove agents to expand or take away functionality as business needs change. Warehouse managers, supply chain executives and chief technology officers are not likely to move as fast with traditional WMS and WCS software because of the expense and time required to rewrite, test and deploy all the integrated code.

With Agents, Businesses Take More Control of Warehousing

The agent-based approach to warehouse execution systems greatly reduces the risk of disrupting fulfillment operations when software changes are made. That's because each agent in a warehouse execution system can work with existing systems and the PLCs controlling machinery and islands of automation while remaining autonomous.

Such an approach enables businesses to be nimbler than ever. That's been the experience of a large U.S. manufacturer of hunting and fishing products. While FORTE was on site to update software built with an Agent Framework, the customer requested additional functionality. Within 45 minutes, all of the scheduled changes plus a new agent were configured, tested and deployed. The manufacturer's distribution center (DC) had to shut down for only two minutes during the software installation.

"The business benefit is that they [the manufacturer] were able to get things updated and the new functionality they needed in less than an hour with minimal disruption to the DC. I've never seen an enterprise WMS that's capable of that," Howes said.

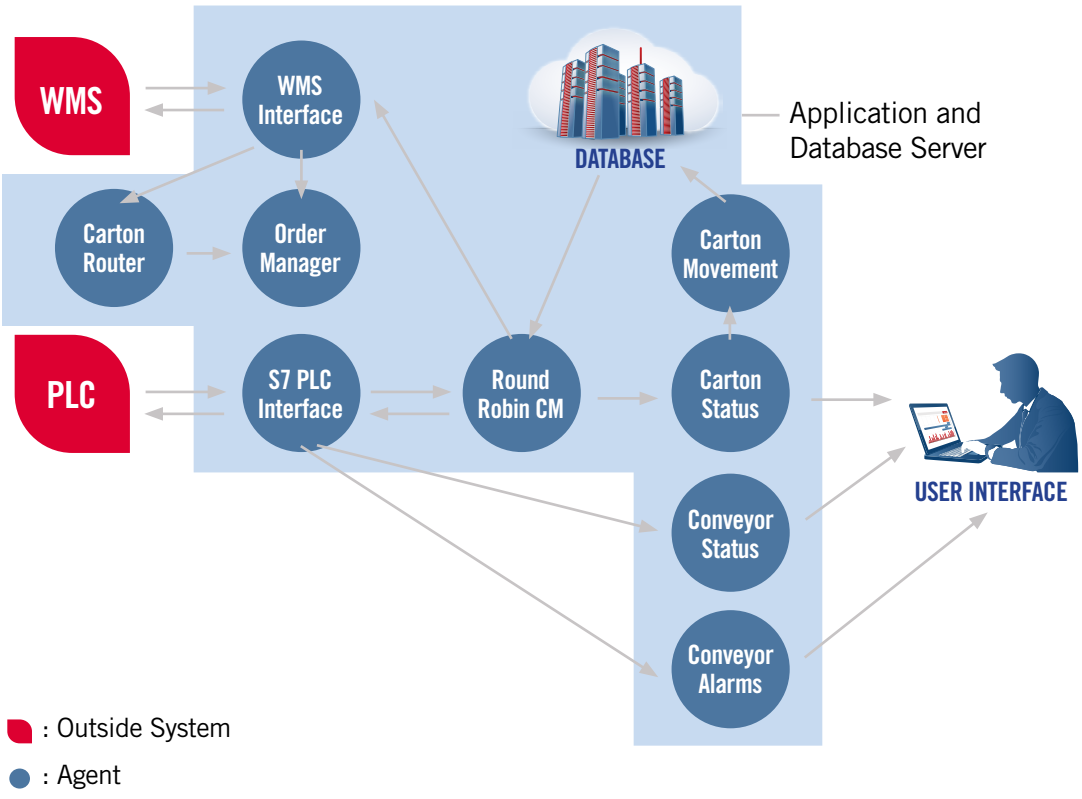
When Should You Use Agents?

Warehouse execution systems built around an Agent Framework are agile, affordable and best suited for companies considering these scenarios:

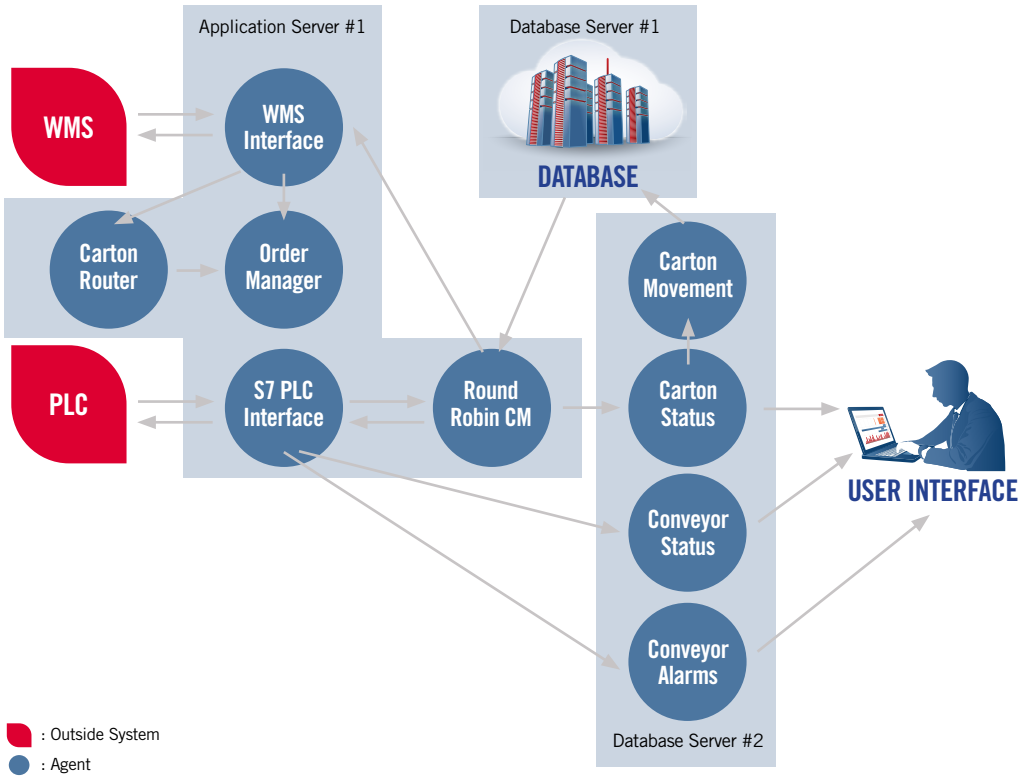
- Constructing a greenfield distribution center construction
- Retrofitting an existing building
- Adding specific functionality to an existing warehouse management system without replacing the entire system
- Expanding warehouse management system functions without incurring the expense and complexity of top-tier, full-featured WMS
- Adding material handling or fulfillment automation to an existing manual warehouse

Agent Deployment Examples

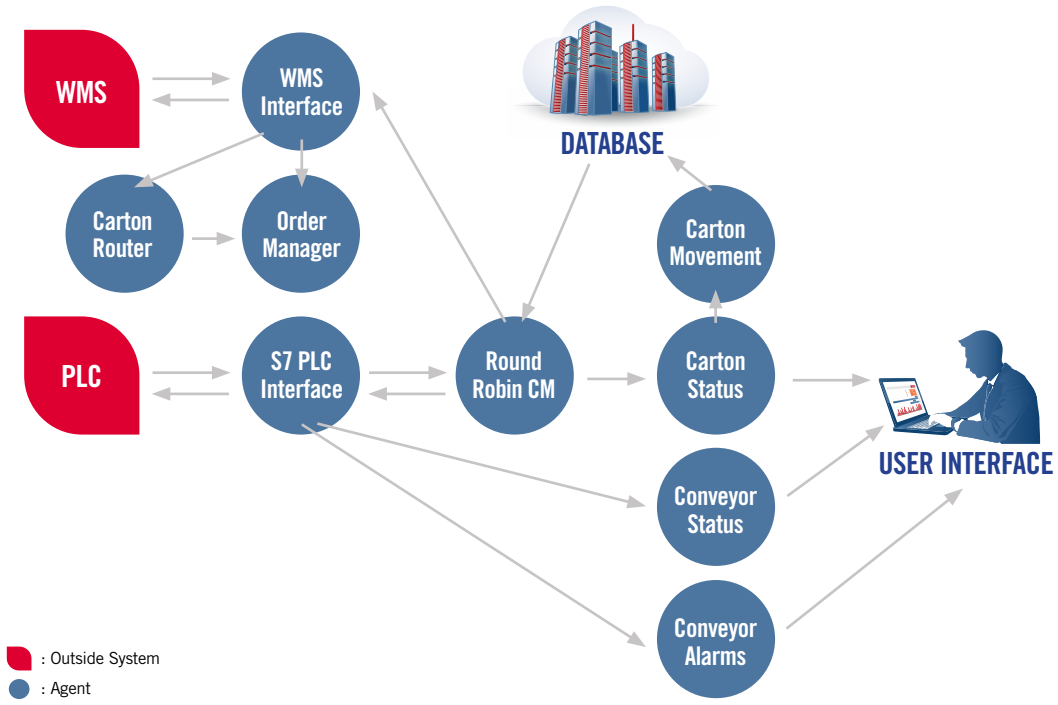
1. **Here's an agent-based solution with agents communicating between a warehouse management system and a programmable logic controller all running on a single application server. The arrows are endpoints that represent configured communication links that orchestrate each agent's functionality.**



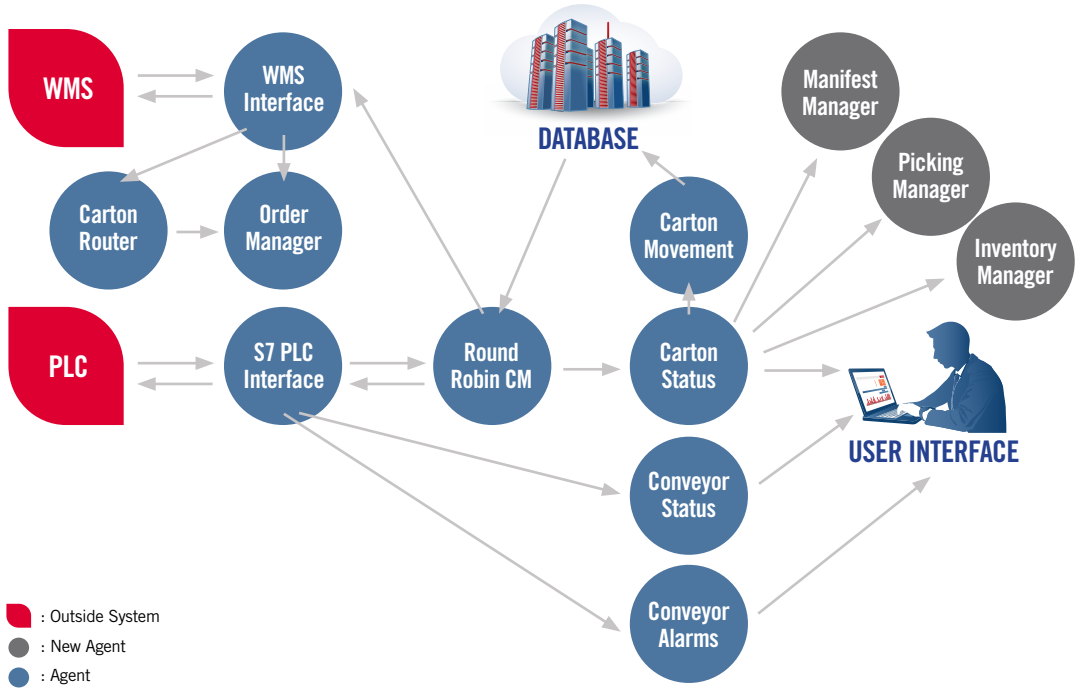
2. Here are the same agents shown in the first example. The only change is where they are deployed. Also shown is how the communication endpoints change to match the new location of the agents.



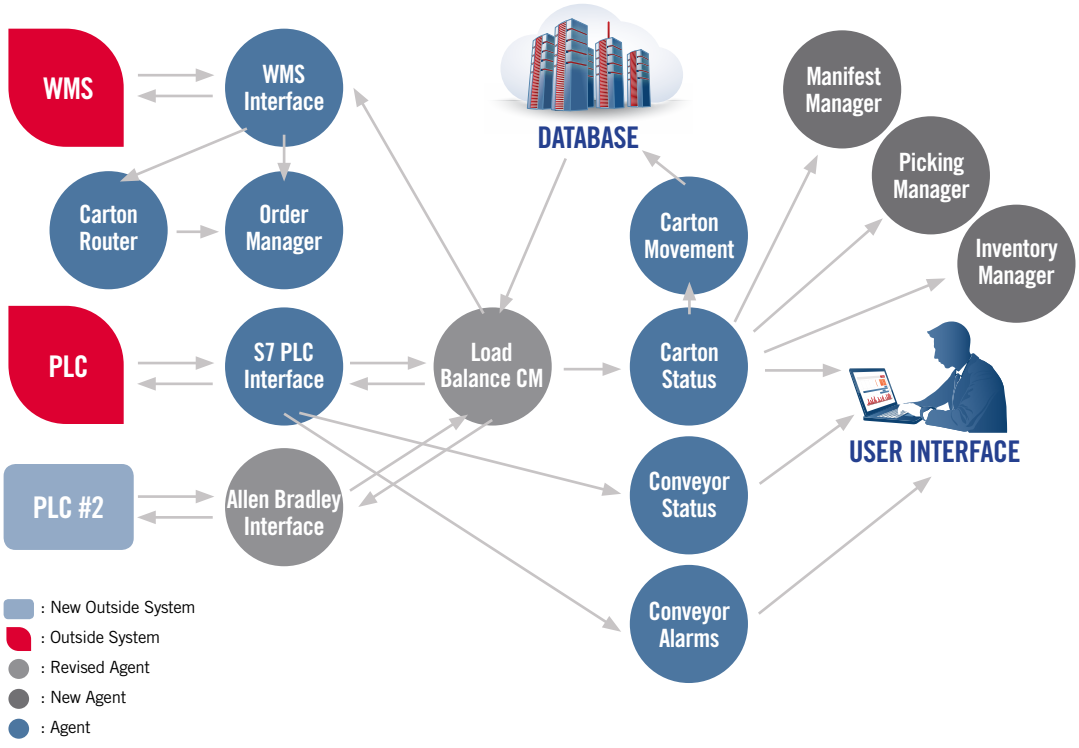
3. Agents add functionality to an existing warehouse management system and a database server:



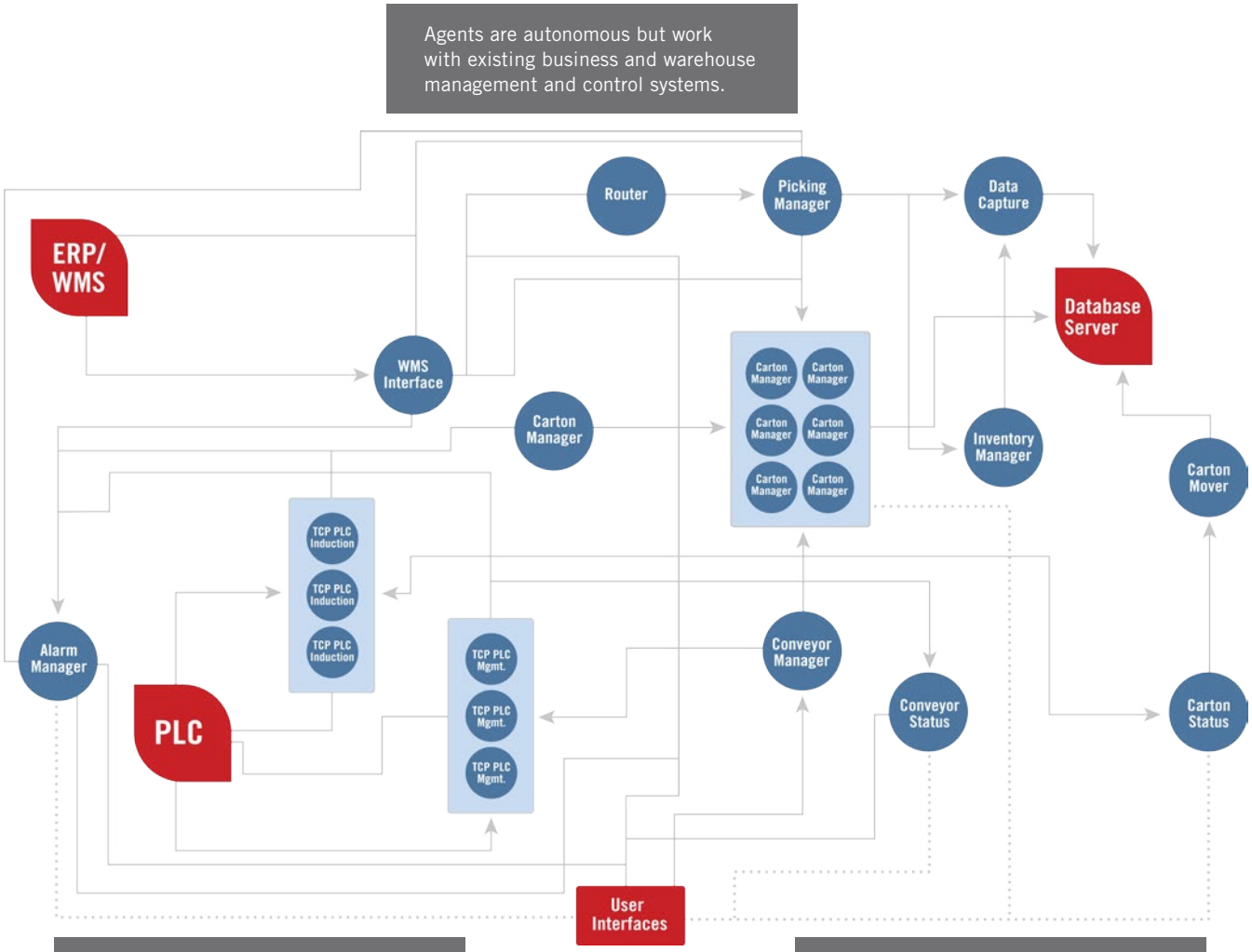
4. How the original agents are deployed remains unchanged. Additional endpoints are added from an existing agent to newly added agents. Using the Agent Framework, functionality can be quickly added with low risk and low cost.



5. Functionality has been added with new agents to support new system components such as the programmable logic controller (PLC) shown here. Existing processes can be enhanced by replacing an agent to meet a new operational need.



Typical Warehouse Installation: Where Agents Fit into Existing Workflow



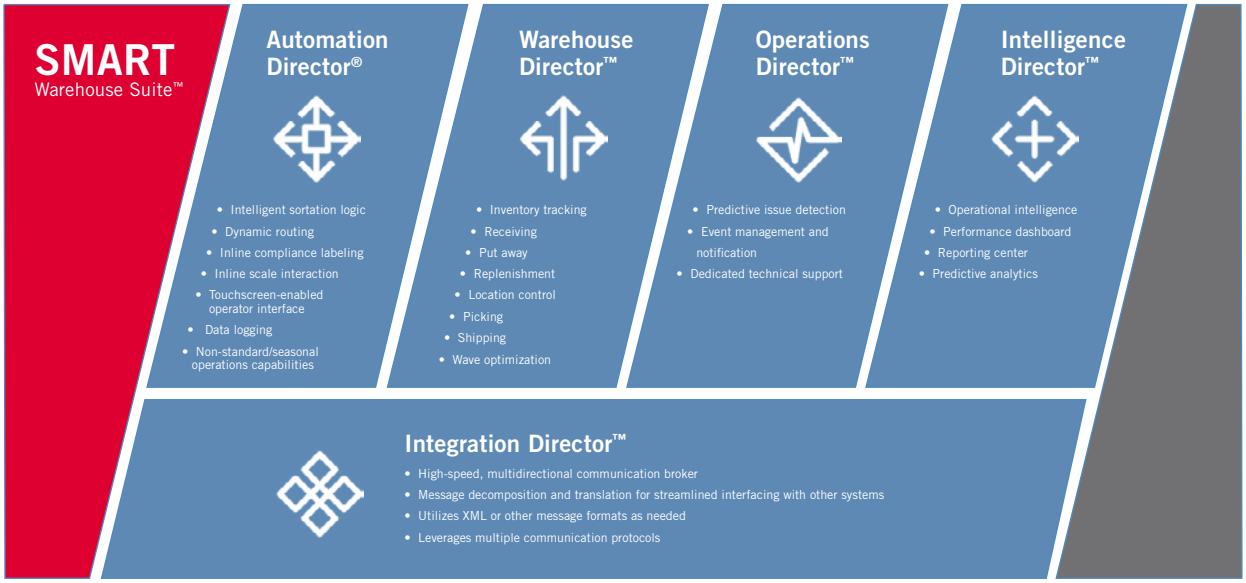
New Distribution Challenges Need New Warehouse Execution Systems

The operational challenges faced in distribution centers today require a new breed of warehouse software. They demand a flexible and versatile system that serves as a critical bridge between people and automation — between legacy systems and new hardware.

Standing at the forefront of this evolution and building on an unmatched knowledge of warehouse operations, FORTE has developed the FORTE Smart Warehouse Suite™ of warehouse execution software. In automated warehouse environments, the Smart Warehouse Suite has proven itself a cost-effective means to extend the functionality of legacy systems or augment warehouse management system functionality.

Introducing the FORTE Smart Warehouse Suite™

The Smart Warehouse Suite is the industry's most advanced warehouse execution system software. Highly robust and adaptable, this best-in-class software enables DC managers to focus on improving performance through fine-tuning functionality while optimizing material handling equipment systems. It comes with five modules:



You Need an Expert Partner

Distribution center managers and their companies can rely on a trusted partner to assist with a thorough review of warehouse management and automation systems and offer expert advice about ways to improve fulfillment operations. Inside the four walls of a distribution center, FORTE can help DC managers optimize the flow of products as well as monitor and control the locations of cartons and equipment.

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Why FORTE

Single-Source Accountability

Whether we're helping you develop a strategic plan, design and build a distribution facility, or optimize a distribution operation through performance metrics and analytics, FORTE provides a true single point of contact responsible for the complete performance of your distribution network. No finger pointing. No fragmentation of responsibility. No multiple suppliers for technical support. You have performance goals, and it's our job to make sure they're met on an ongoing basis.

Total Objectivity

We don't manufacture equipment. We don't develop warehouse management software. We don't have commercial arrangements with any suppliers for expected volumes of business. We're simply interested in delivering the most efficient distribution solutions at the lowest total cost. Our client-side service approach means our only allegiance is to our customers. So with every engagement, you know we'll choose the most appropriate level and blend of technologies integrated into an effective operational system.

Expertise

Our team is deeply rooted in the hands-on implementation of distribution center design and warehouse automation. FORTE's engineers and technicians integrate today's best practices in supply chain management and distribution center operations while developing next-generation technologies. As a result, our solutions employ the best combination of practical advice, data-driven analysis and technology-enabled systems. With FORTE, you get:

- More accountability than a consultant
- More experience than a systems integrator
- More objectivity than a manufacturer