Smart Manufacturing Solutions: Build or Buy?

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Executive Summary

Terabytes of data are collected each day in a typical fab. Smart manufacturing platforms that leverage this big data can bring compelling throughput, quality, and productivity advantages to a manufacturing organization. But should sucha solution be built or bought?

Before embarking on an in-house project, manufacturers should consider:

1. Do they have or can they build a development/datascience team that has manufacturing domain expertise?
2. Does the team have the validation skills required for mission-critical workflows? Can they provide ongoing training and support?
3. What happens if key personnel leave the project?

Manufacturers must understand that they are taking on the burden of technical debt and must be committed to ever-growing investments in order to keep their system on the cutting edge.

On the other hand, it can be difficult to adapt a third-party solution to meet their specific manufacturing requirements. NI's open, enterprise-grade smart manufacturing platform offers the best of both worlds: it benefits from deep manufacturing and data science expertise to provide a holistic view of the entire product lifecycle across the global supply chain while working in synergy with data platforms and solutions that the manufacturer already has in place.

Smart manufacturing platforms that leverage this big data can bring compelling throughput, quality, and productivity advantages to a manufacturing organization.

Introduction

Enterprise smart manufacturing platforms have become an important part of the manufacturing ecosystem, especially in domains such as semiconductors and electronics.

McKinsey & Company estimates, for example, that the quantity of process, product, and machine data collected on a daily basis in a typical fab quickly exceeds terabytes. If you add to this in-line and end-of-line inspection as well as metrology data, the volume of data generated in a fab expands exponentially with each new node dimension. Smart manufacturing platforms make this data actionable through state-of-the- art technologies such as advanced analytics, machine learning, and artificial intelligence.

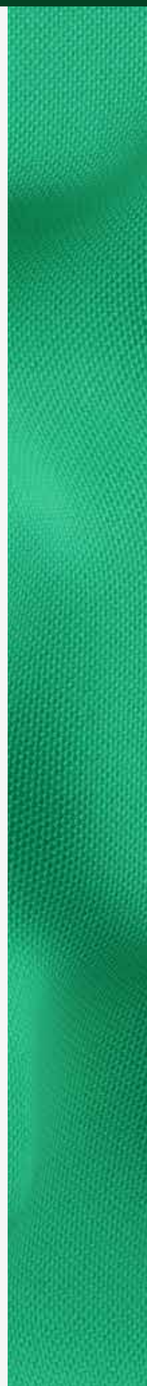
Smart manufacturing platforms leverage big data to bring compelling advantages to a manufacturing organization.

- DATA FROM SMART SENSORS ON THE PRODUCTION FLOOR ARE USED TO MINIMIZE DOWNTIME THROUGH EFFECTIVE MAINTENANCE SCHEDULES AND PREDICTING MALFUNCTIONS.
- CLOSE MONITORING AND INTEGRATION OF SUPPLY CHAIN AND LOGISTICS DATA ENCOURAGES PRECISE INVENTORY CONTROL AND MINIMAL WASTAGE.
- BREAKING DOWN PRODUCTION AND QUALITY DATA SILOS LEADS TO INSIGHTS THAT ENHANCE PRODUCT AND PROCESS QUALITY.

Together, these capabilities give the manufacturer a strong competitive edge, delivering highly customized products in a timely manner while containing production costs.

However, manufacturing processes vary widely across different verticals and organizations. Thus, there can be a temptation to build a proprietary smart manufacturing system that is fully tailored to the organization's unique requirements. At first glance, the arguments for building your own solution may seem compelling, and the availability of modular, open-source software components for data collection, storage, analytics, and visualization can make a home-grown solution seem like a viable option.

Breaking down production and quality data silos leads to insights that enhance product and process quality.



Manufacturing processes vary widely across different verticals and organizations. Thus, there can be a temptation to build a proprietary smart manufacturing system that is fully tailored to the organization's unique requirements.

Yet there are numerous risks involved in building any enterprise software system in-house vs. buying a third-party solution. The devil is in the details—and in the long-term cost of building, maintaining, and supporting the solution.

EXPERIENCE: It is unlikely that an enterprise's in-house development team would have anywhere near the person-years of domain experience that a third-party solution vendor would have.

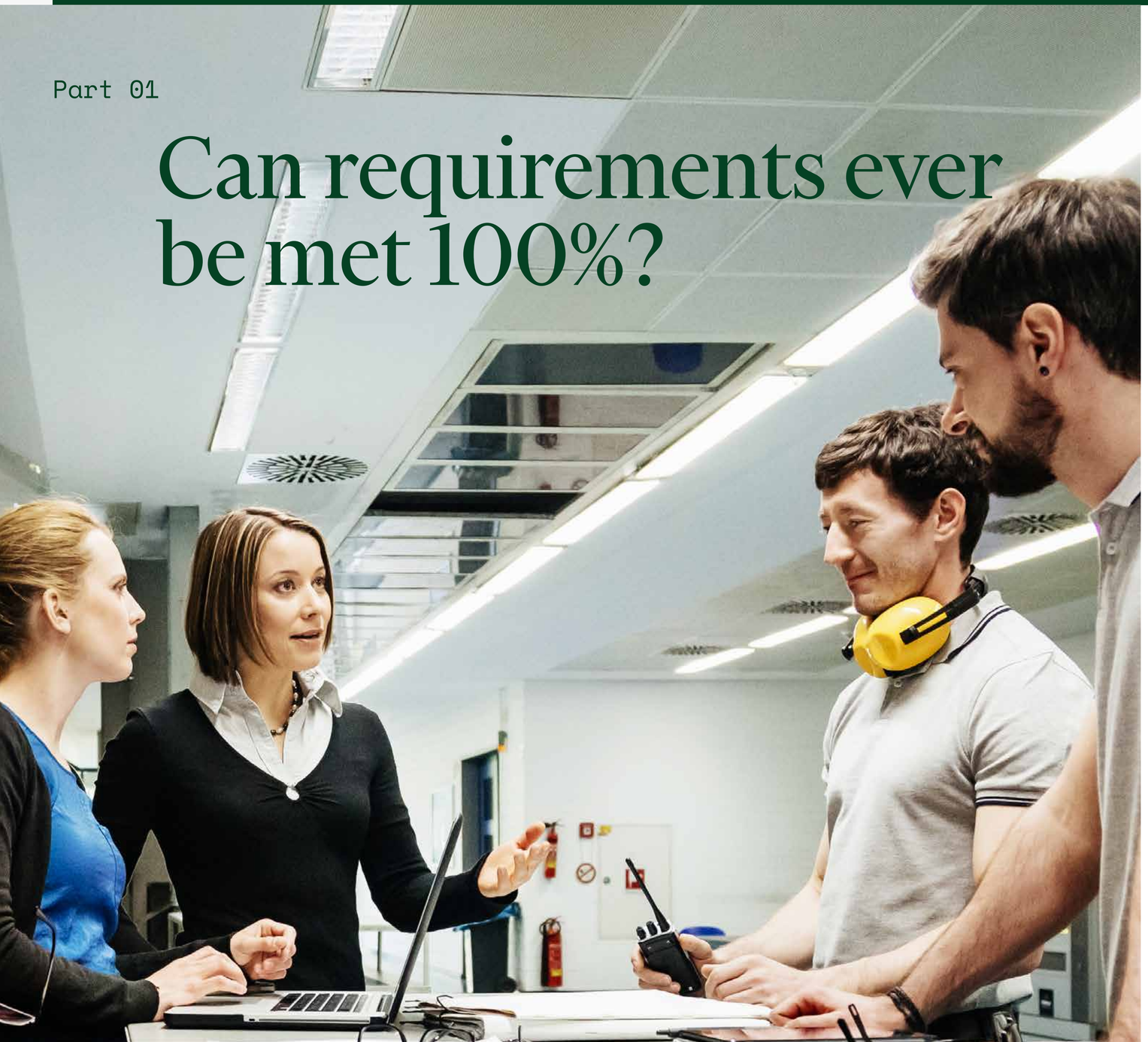
SCOPE: A development project of that scope would take a long time to deliver—far longer than the timeline for implementing an off-the-shelf solution.

COSTS: Building in-house means that there is only one customer to absorb the development and maintenance costs vs. the vendors who spread these costs and risks across numerous installations. For all these reasons, it is rare to hear of an organization that builds, for example, its own ERP or CRM system.

In this eBook, we examine the challenges of developing and maintaining a bespoke smart manufacturing system using generic platforms. We also present the advantages of investing in a ready-made system such as NI, which has the added benefits of being open and flexible.

Part 01

Can requirements ever be met 100%?



There are those who would argue that building a smart manufacturing system in-house is the only route that allows the organization to meet all of its requirements. Whether building or buying, gaining a clear understanding of both business and technology requirements for a smart manufacturing platform is critical. Requirements that are missed at this stage due to inadequate, high-level analyses can later cause implementation delays and budget overruns.

Missing requirements can have a significant impact on the expected ROI and can even doom the project to failure.

Done properly, gathering requirements for an enterprise software platform is a long and laborious process. Specifying requirements for an ERP system, for example, can take 6-24 months, as inputs are gathered from all relevant users (both hands-on and management) and from external sources that have been through a similar decision-making process. The relevant business processes must be carefully analyzed, and all desired features need to be translated back into their relevant requirements.

A thorough requirements gathering process will generate literally hundreds of requirements. Thus, whether building or buying, the requirements must be carefully prioritized in order to stay within the bounds of reasonable timelines and budgets, destroying the myth that building a smart manufacturing platform in-house will result in 100% fulfillment of requirements.

Whether building or buying, the requirements must be carefully prioritized in order to stay within the bounds of reasonable timelines

Part 02

The right team for the job

Another important consideration when deciding whether to build or buy an enterprise manufacturing solution is whether the organization has the in-house resources to get the job done. Even if there is a strong in-house software development/data science team, there can be significant challenges in building and maintaining a proprietary smart manufacturing platform.

Deep understanding of organization's manufacturing processes

First, it should not be taken for granted that the development/data science team has a broad, deep, and hands-on understanding of the organization's manufacturing processes.

In many cases, it will be necessary for them to climb a steep learning curve that takes time and draws on the resources of the organization's production and quality teams. Their domain expertise must reach a high enough level that they can understand what manufacturing data is truly of high value for their particular organization and how that data can best be retrieved from their machines.

Despite all such efforts invested, the learning process may not reach the level of expertise required to optimize the requirements-gathering and software-specification phases discussed in the **previous chapter.**

CHALLENGES OF BUILDING AND MAINTAINING A PROPRIETARY SMART MANUFACTURING SYSTEM

- Manufacturing domain expertise
- Adopting AI, ML algorithms to manufacturing
- Smoothly deploying a mission-critical system
- Ongoing training and support
- Constant updating to meet new, changing requirements
- Long-term team commitment and continuity

Smart manufacturing domain expertise

Second, smart manufacturing is an entire world unto its own. It has its own special take on big data mining and analysis, machine learning, and artificial intelligence. It is not enough to have mastered the algorithms; they must be implemented in a way that supports the best practices that have evolved, and continue to evolve, in the smart manufacturing domain.

The solution's workflows must effectively integrate with the enterprise's supply chain, quality, production, and logistics systems. It must ensure that all the data is arriving on time and must alert when there are issues.

The solution must provide the right information at the right time to the right users, which may also include partners and vendors who are external to the organization. In short, it requires a breadth of vision that comes only with hands-on experience.

When forming an infrastructure for big data, a partner who comprehends and acknowledges your specific industry and manufacturing requirements should be considered. Currently, analytics solutions are generic and not exclusively applied to each industry, which does not cater to the particular needs of your company. Operating with an analytics application explicitly designed for automotive, semiconductor, and electronics manufacturing will surely yield better results than generic platforms. Here's why.

When forming an infrastructure for big data, a partner who comprehends and acknowledges your specific industry and manufacturing requirements should be considered.

Expose your organization's knowledge

Assimilating relevant suitable analytic platforms will expose your organization to endless amounts of accumulated knowledge extracted from industry peers, which induces rapid effects and shorter time for ROI. Custom smart manufacturing solutions constructed to recover from your industry-specific challenges will turn the analyzed data into real business value.

Be aware of how to embed and leverage extensive domain-specific applications, methodologies, and algorithms into the platform. By connecting the machine lines and systems in every facility, accurate data on all sides of the spectrum—from edge to central—will be collected.

With high performance, any complex type of manufacturing data will be ingested, contextualized, and operated by machine learning, enabling real-time impact on processes and linking insights to existing data sources. While supporting a multi-tiered, hot- warm-cold data retention policy, your company can balance long-term data availability with total cost of ownership.

Accelerate innovation

Accelerating innovation throughout your digitalization journey is one of the prime benefits of collaborating with an industry-focused application versus a generic analytics application.

Your business will hold a steady position on the path to becoming data-savvy by using your discoveries to maximize the return on your investment in big data technologies. A data-driven organization will provide dominant intuition towards predictive business opportunities through progressive analytics and directed visualizations in the manufacturing process. The standard customizable connectors enable affiliation to virtually any data source that reveals flexible data schemas and personalized analytic flows and facilitates a smooth integration with other systems.

All in all, industry-focused analytics will allow for data scientists to focus on building cutting-edge models by issuing an end-to-end deployment platform that automates the entire lifecycle for them.

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Validate mission-critical workflows

Third, the organization's manufacturing solution is mission-critical. Each workflow and process has to be validated before the platform goes into operation. Once again, does the in-house team have the skills and experience to manage the software implementation and operation validation process?

In addition, after the solution has been deployed, the production chain will continue to evolve. Does the team have the resources and expertise to bring in new data and modify old connections in order to keep the solution fully aligned with changing processes and with new insights gained?

Training and support resources

When purchasing or licensing a third-party solution, the vendor will have a clear contractual obligation to train and support the customer's different types of end-users throughout its lifecycle. Yet another consideration in the build/buy decision, therefore, is whether the organization has the right in-house resources to train and support users on an ongoing basis.

Continuity?

By the same token, an organization should not undertake building its own smart manufacturing solution if it does not believe that core members of its internal development team are in it for the long haul. Without strong continuity in the development/data science team, maintaining and upgrading the solution over time will be very difficult, if not impossible.

The bottom line is that building an enterprise smart manufacturing solution in-house requires a substantial and long-term commitment of resources. Would it not make more sense to allocate those resources to projects and activities that are core to the manufacturing organization's main line of business, while leveraging the domain expertise and managed services of a third-party smart manufacturing solution vendor with a proven track record?

Building an enterprise smart manufacturing solution in-house requires a substantial and long-term commitment of resources.

PART 03

Take on the burden of technical debt

The cost of paying back technical debt must be taken into account as part of the total cost of ownership when deciding whether to build or buy an enterprise manufacturing platform.

It is not unusual for a development team to incur technical debt, i.e., pushing to the future additional development work that is necessary to achieve the optimum solution. Technical debt is also about the effort that will inevitably be required to maintain and upgrade code as technologies and architectures morph or become obsolete.

Technical debt can be incurred up-front and intentionally, with the team deliberately deciding to implement a less-than-optimal design in order to quickly deliver product to the market.

Technical debt can also arise inadvertently over time as systems and requirements evolve. The original design may have been good, but new functionality or new methods now have to be incorporated. Yet a third type of technical debt is “bit rot”: a component or system becomes unbearably complex due to many incremental changes, often carried out by people who do not fully understand the original design.

Whether incurred deliberately or inadvertently, technical debt, like financial debt, eventually needs to be paid back, with interest. This involves ongoing and continuous refactoring to upgrade the design and the code, incorporate new features, and accommodate emerging software development technologies and architectures.

If managed properly, closing a technical debt incurs a heavy and ongoing cost of bug fixes, refactoring, and so on. The rule of thumb is that this effort should be budgeted at ~15% of the initial application cost annually. If not managed properly, the platform will become increasingly complex and cumbersome, with a high risk of slower delivery times, loss of performance quality, and difficulty in responding to new requirements.

In short, the costs of paying back technical debt must be taken into account as part of the total cost of ownership when deciding whether to build or buy an enterprise manufacturing platform.

PART 04:

Stay on the cutting edge

As the pace of change accelerates even further, keeping in-house manufacturing systems at the cutting edge will require ever-growing investments in specialized personnel and other resources.

Industry 4.0, a.k.a. the 4th Industrial Revolution, uses advanced artificial intelligence, machine learning, intelligent sensors, and data analytics technologies to automate and digitize the manufacturing process.

Industry 4.0, with its promise of smart, adaptive products and processes, has already transformed many manufacturing sectors such as automotive, semiconductor, and electronics. Dominated by global giants such as Amazon, Google, HP, Samsung, IBM, Siemens, Microsoft, and more, the Industry 4.0 market is expected to be worth $214 billion by 2023.

Smart manufacturing platforms are at the heart of Industry 4.0. As the pace of change accelerates even further, keeping in-house manufacturing systems on the cutting edge will require ever-growing investments in specialized personnel and other resources.

When considering whether to build or buy, a manufacturing organization must ask itself crucial questions. Will investing in a proprietary smart manufacturing solution provide the organization with a strong competitive advantage over time? Or will it constantly be playing an expensive game of catch-up as technology stacks and system architectures are transformed?

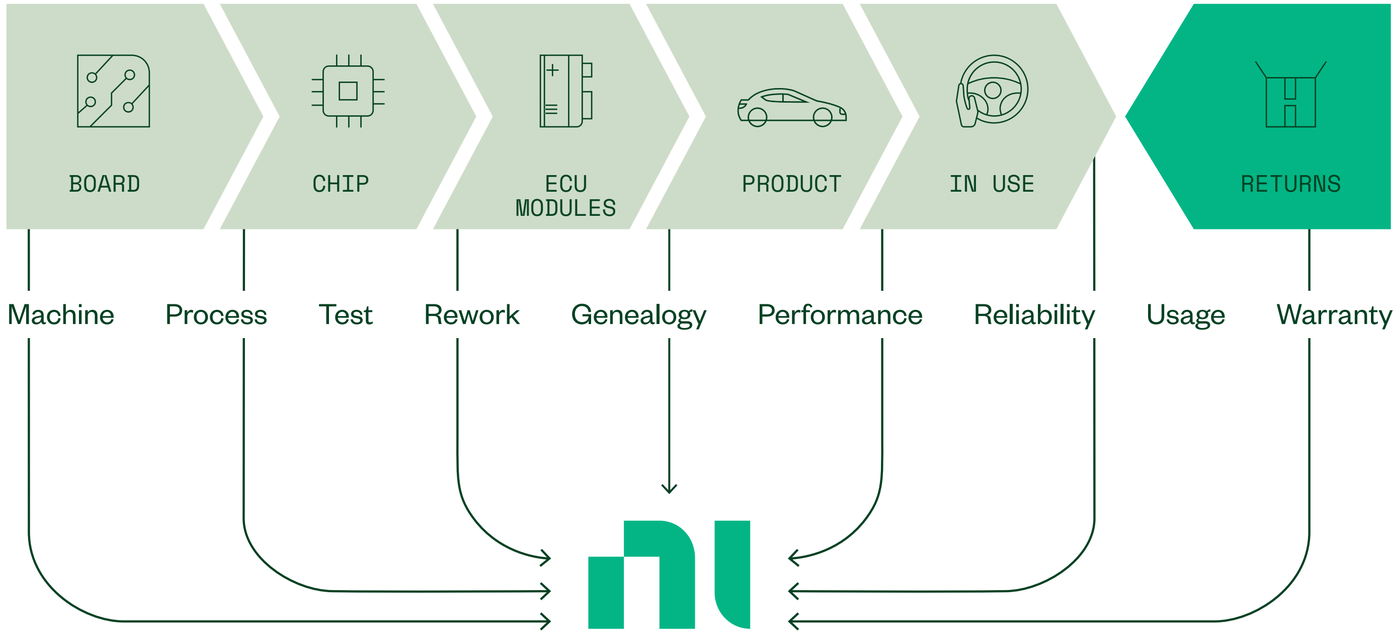
PART 05:

The best of both worlds

Semiconductor brand owners and their suppliers to measurably improve performance, quality, and yield. NI goes beyond traditional process analytics, providing a holistic view of products that covers the entire product lifecycle and spans the global supply chain.

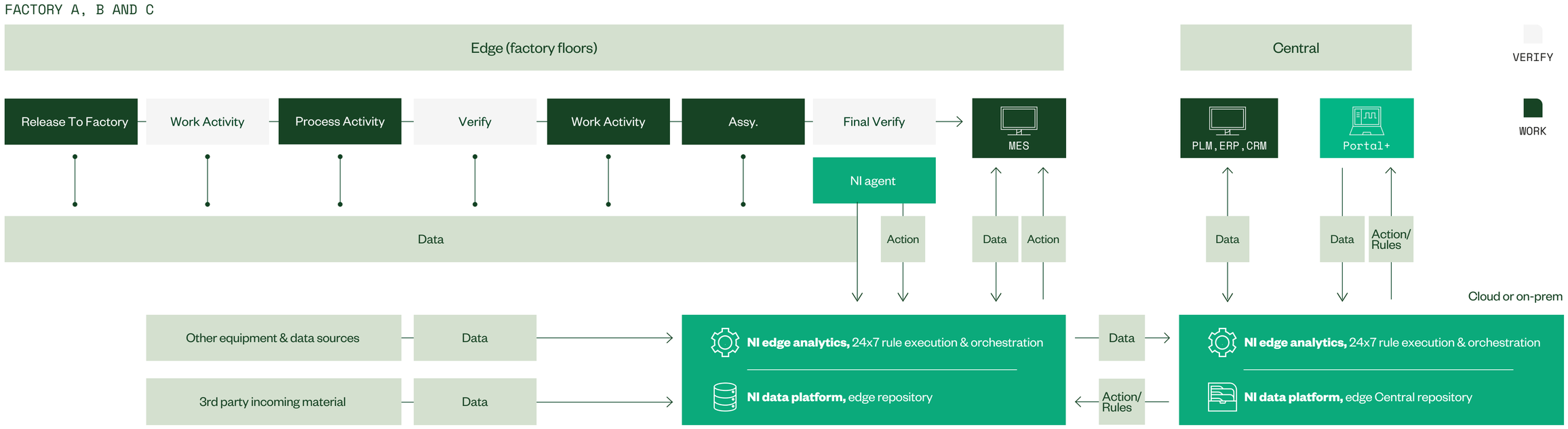
NI breaks down silos and tightly integrates with other critical enterprise systems such as MES (Manufacturing Execution Systems), ERP (Enterprise Resource Planning), PLM (Product Lifecycle Management); and SCM (Supply Chain Management). This complete, end-to-end view of the product drives a superior end-user experience that differentiates NI customers within highly competitive markets.

NI understands that no single manufacturing system—no matter how cutting-edge or comprehensive—can fully meet the unique needs of each of its customers. In the end, companies will combine components and platforms from multiple suppliers. For that reason, NI has opened its solutions to work in synergy with other data platforms and solutions that are already in place.



NI goes beyond traditional process analytics, providing a holistic view of products that covers the entire product lifecycle and spans global supply chain.

For example, if a company has standardized on a data-lake architecture, NI solutions can store their data in that data lake, leverage other data already available in the data lake, and provide data and insights to other applications running on the data lake.



High-level Architecture: Connecting End-to-End Central to Distributed Edges

The NI team of support professionals and its partners helps each customer plan, implement, integrate, monitor, and operate its NI manufacturing intelligence platform in the most effective way, customized to its own specific infrastructures and modes of operation.

During and after deployment, NI trains end-users and IT support teams to make sure that the manufacturing organization achieve the maximum ROI from the platform. NI also ensures that its customers will always benefit from the latest in Industry 4.0 capabilities, without having to worry about domain expertise, best practices, or technical debt.

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