SymphonyAI
INDUSTRIAL

WHITE PAPER

Data intelligence

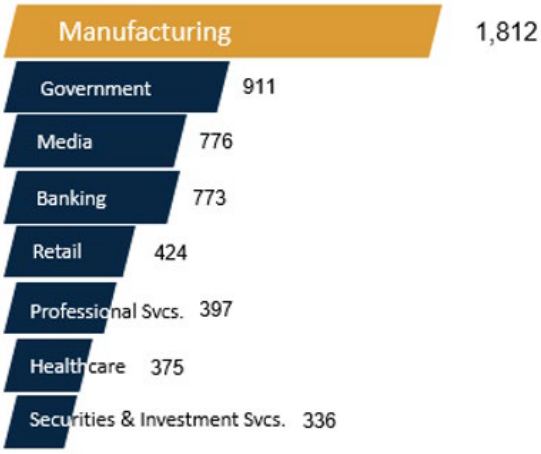
Avoid digital exhaust—put your data on the balance sheet.

Introduction

IIoT and Industry 4.0 initiatives have expanded at a staggering pace, attaching more sensors, connecting equipment, generating terabytes of data every day. And more than any other business segment, manufacturing creates the largest amount of data and therefore has the greatest opportunity to capitalize on the full value of their data. Organizations across every industry have long realized that the pace of change is quickening and have adapted through digital transformation, but the pandemic has acted as a digital accelerant like none seen before, especially for manufacturers. Yet while the volume of available data has grown exponentially in recent years, most companies are capturing only a fraction of the potential value in terms of revenue and profit gains. The challenge for manufacturers is to harness this data and not let it go up the smoke stack as digital exhaust.

In short order, manufacturing leaders have had to respond to rapid change by ensuring employee safety and business continuity, moving toward recovery, and reimagining each facet of their organization and supply chain to create a path forward. This has brought a new focus on how well systems across the enterprise are connected and helping to solve the challenges of massive data lakes by combining IIOT, production systems, equipment integration and data platform elements for processing, and analytics. Companies that have the agility to identify and capture the right data coming from their operations are accelerating into a future of true data intelligence and are reaping the benefits of digital transformation.

Taken together, these trends unlock the ability to respond and adapt today, build resilience, and leverage data intelligence to be competitive and win market share. But, perhaps the most promising trend is artificial intelligence/machine learning (AI/ML). AI/ML help unlock the value of big data and helps align technology innovation and focus an organization's unique capabilities to make a step change in productivity, quality, and efficiency. When executed strategically, making data accessible for AI/ML initiatives enables an organization to improve operations, transforming processes, payments and business models, customer and supply chain interactions.



Source: Morgan Stanley, "Engineering the 21st Century Digital Factory"
Figure 1

Figure 1: Torrents of data

Manufacturing collects 2,000 petabytes of potentially valuable data each year, yet discards all but 1% of it.

Digital disruption and the AI/ML opportunity

Rapid technological advances in digitization and data and analytics have been reshaping the business landscape, supercharging performance, and enabling the emergence of new business innovations and new forms of competition. At the same time, the technology itself continues to evolve, bringing new waves of advances in robotics, analytics, and AI/ML. Data scientists are constantly searching for newer techniques and methodologies that can unlock the value of data and distill this data further to identify operational insights that could transform productivity and provide business differentiation.

Many manufacturers struggle to switch from legacy data systems to a more nimble and flexible architecture that can get the most out of big data and analytics. They may also need to digitize their operations more fully in order to capture more data from their customer interactions, supply chains, equipment, and internal processes. Business leaders need to build new digital capabilities without worrying about the underlying infrastructure, thus placing stringent demands on their IT organization. In order for AI/ML initiatives to succeed, data from across the enterprise has to be readily available—not stuck in siloes or unreadable legacy systems and protocols.

The SymphonyAI Industrial Digital Manufacturing Platform helps relieve pressure on IT by giving the business the tools to bring together disparate operational data, and workflows to work together as a single entity while also being able to scale independently to address the IT issues in the data center. SymphonyAI Industrial Digital Manufacturing combines a fully scalable infrastructure with centralized management to accelerate the journey to smart manufacturing and digital supply chain with technology that thinks and acts differently.

Big data and the three V's

"Right now, each system primarily creates its own data; each system manages its own data environment."

— VP Operations, Fortune 500 Manufacturer

Capturing, storing and generating value from big data raises a number of technical and conceptual challenges that go beyond the capabilities of most manufacturers. To get a handle on the issues involved, industry analyst Doug Laney articulated the now-mainstream definition of big data as the Three V's:[1]

Volume

Volume is big data's greatest challenge as well as its greatest opportunity. Centralized solutions like ERPs with relational databases are increasingly not capable of handling such tasks. Most enterprise IT systems are not scalable to big data proportions. To manage, store and process this overflow of data, a technique called "data scaling" has become necessary for many organizations dealing with exploding datasets. Data lakes and Hadoop have eased this challenge.

Velocity

Big data velocity also raises a number of challenges. For a start, the rate at which data is flowing into most organizations is increasing beyond the capacity of their IT systems to store and process. In addition, users increasingly want streaming data to be delivered to them in real time, and often on mobile devices close to the action. RFID tags, video streaming, location tracking, augmented reality and many other applications now rely on large quantities of such high velocity data streams, and for many manufacturers with distributed operations delivering the right data to the right people takes hours or days, if it happens at all.

Variety

The third "V" in big data is its variety, with the types of data that many organizations are called on to process becoming increasingly diverse and dense. Gone are the days when data centers only had to process documents, financial transactions, stock records, and personnel files. Today, unstructured data like CAD files, audio, video, 3D models, complex simulations and location data are all being piled into corporate data siloes. The fact that many of these data sources are almost entirely unstructured, and hence not easy to categorize, let alone process, with traditional computing techniques. All of this means that big data is in reality messy data, with a great deal of effort required in complex pre-processing and data cleansing before any meaningful analysis can be carried out.

References

[1] A model first developed by Gartner's Doug Laney.

Digital exhaust: enterprise-wide data management —"your machines are talking, are you listening?"

Consider the example of an oil rig miles off the coast. It's very expensive to transfer the 2 terabytes per day of data being captured by the more than 250 monitoring and control systems. So, in reality only 1% of the data is sent to the main office, losing most of the fidelity and analytical insights.

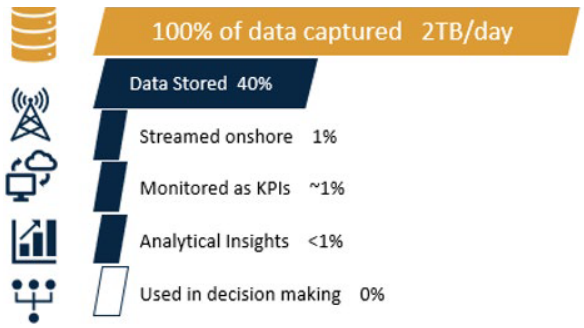
Despite having very sophisticated equipment, this oil and gas company had little choice but to ignore or excrete very large quantities of potentially very valuable information. Sensors and IT systems are simply not up to the job of scanning and interpreting the vast oceans of data in which they swim. As a consequence, most of the data that surrounds organizations today is ignored. A large proportion of the data that they gather is then not processed, with a significant quantity of useful information passing straight through them as digital exhaust.

The global datasphere

More than 59 Zettabytes (ZB)[2] of data will be created, captured, copied and consumed this year according to IDC's Global Datasphere report.[3] In fact, IDC says that the pandemic has caused an abrupt increase as more employees work remotely. Some of IDC's key findings include the following:

- **The amount of data** created over the next three years will be more than the data created over the past 30 years, and the world will create more than three times the data over the next five years than it did in the previous five.
- **Productivity data** is the fastest growing category of data creation with a **40% CAGR** for the 2019–2024 forecast period.
- **Sensors** are being embedded into anything and everything and throwing off data that can help contextualize and deliver greater insights. A new trend has developed around **soft sensors**—AI models that make inferences based on input from a variety of sensors and time series data. This data along with increasing amounts of metadata is growing aggressively and soon will surpass all other data types.

Offshore oil rig example

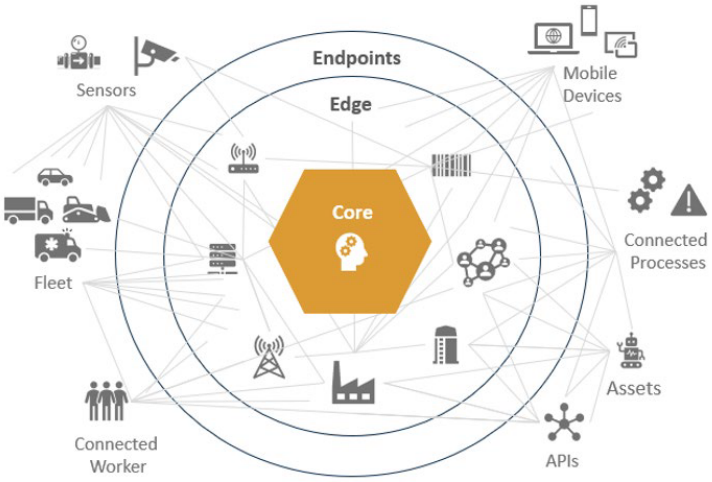


References

[2] Refresher: A Zettabyte is 1,000 Exabytes; an Exabyte is 1,000 Petabytes; a Petabyte is 1,000 Terabytes, and so on. It's a lot—a quick online search shows that 5 Exabytes represents all the words ever written by humankind.

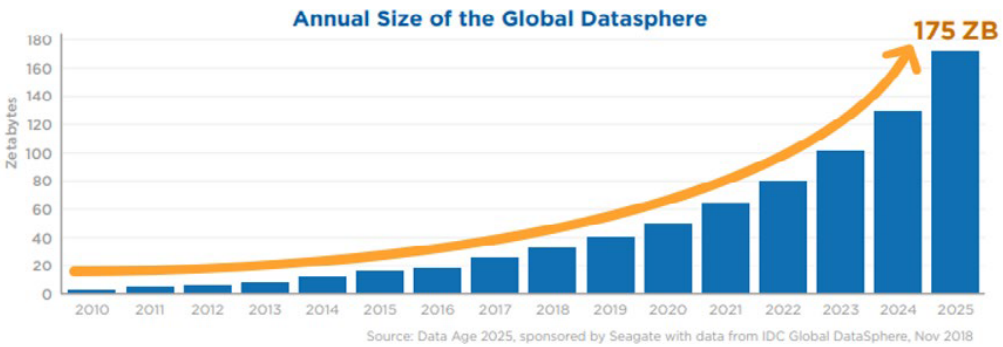
[3] Worldwide Global DataSphere Forecast, 2020–2024: The COVID-19 Data Bump and the Future of Data Growth (idc.com)

Data propogation from endpoints to core and back



IDC predicts that the global Datasphere will grow from **33 Zettabytes** in 2018 to **175 Zettabytes** by 2025

Figure 1 – Annual Size of the Global Datasphere



References

[4] The IDC report, Worldwide Global DataSphere Forecast, 2020–2024: The COVID-19 Data Bump and the Future of Data Growth (Doc #US44797920)

How do you identify and capture the data?

It's not smart if it's not connected—build scalable and flexible data pipelines.

It is vital to connect the entire value chain. In many cases, the most important assets in the value chain aren't connected because their legacy machines that make it difficult to retrofit. This challenge is exacerbated by plant and equipment that is remote and hard to reach (e.g. an oil rig in the middle of North Sea).

Meaningful data will vary based on the vertical and the types of products being manufactured. Here are some common areas to digitize to ensure get the right data is being gathered and made available to the people who can act on it:

- Assets, including infrastructure, connected machines, data, and data platforms, etc.,
- Operations, including processes, payments and business models, customer and supply chain interactions,
- The workforce, including worker use of digital tools, digitally-skilled workers, new digital jobs, and roles.
  In measuring each of these various aspects of digitization.

Metadata and data governance

Capture all runtime meta data about a product, processes and workflows, (e.g. process steps, timestamp, operators involved, actions taken, process branch, machine states, parametric data, quality results, data lineage, auditing, and data anonymization or masking) and develop a corporate data governance model to support the following across the enterprise:

- Gain real-time visibility with apps that collect data from the people, machines, and sensors throughout your operations. Visualize your data on dashboards to inform decision making and drive continuous improvement.
- Preserve the data thread of the production run for automated decision making and real time updates to ERP and other decision support systems.
- Store critical information in Historian for deeper analysis by engineers and data scientists for continuous improvement and creating next generation solutions.
- Enables real time data stream processing, AI and machine learning with contextualized data and standard plugins.

Contextualize

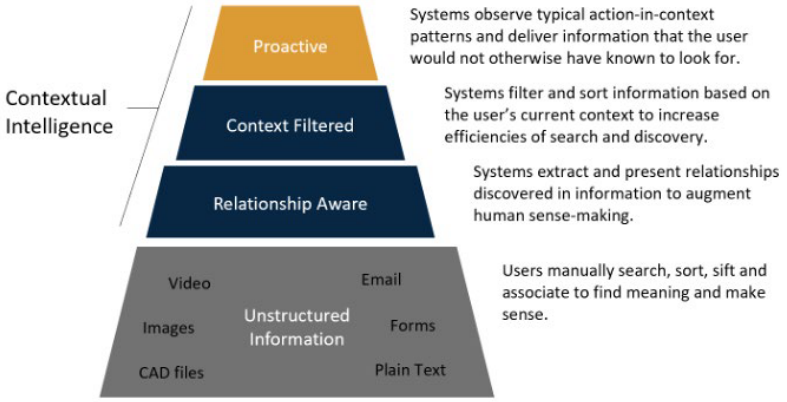
Automate event detection with real-time stream processing to spot trends across operations and trigger corrective action. Contextualized and historized data provides engineers, analysts, and data scientists real-time access to data to spot trends across the operation and institutionalize corrective action.

But, it's not just operational data that needs context. Supply chain and customer data are driving opportunities and challenges for data and analytics leaders. Gartner analyst Melissa Davis writes that "customer-centric, contextualized experiences based on the customer journey are becoming the competitive differentiator for the future of customer experience, requiring organizations to leverage new types of analysis and data sources."[5]

References
[5.] Gartner "Shape the Future of Customer Experience With Customer Analytics," ID G00386859

Levels of Contextual Intelligence

(The figure right shows the levels of contextual intelligence according to Xerox PARC researcher Bo Begole.)



Source: Bo Begole, PhD, Ubiquitous Computing, Palo Alto Research Center

Make the data talk to us: Empower your plant managers with the tools to tell you which data is important.

How to use your data to empower your workforce: With some exceptions like predictive maintenance, few manufacturing firms have marshaled the amounts of data and analytical talent to aggressively apply analytics and AI to key processes.

Empowering your people with the right tools and processes can unleash transformational change. Many of the insights on how to improve performance come from the people running the machines, doing the work.

For example, an innovative plant operator at a large agricultural products company was able to optimize truck receiving and processing. Using connected scanners, scales, humidity sensors, this operator was able to reduce processing time by one minute. When the company rolled out this process across all their plants, that one minute was multiplied by thousands of trucks per day across dozens of plants resulting in millions of dollars in savings per year.

Orchestration

Manufacturers must support the orchestration of information, machine controls, analytics, and people, to ensure that the different components of the industrial big data world interoperate effectively.

For example, a machine-level analytics that detect and respond locally to an operational anomaly must also be able to trigger other analyses and actions (e.g., rescheduling production runs or moving spare parts) across the network in order to avoid ripple effects throughout the system. This requires the ability to self-tune and adapt as data, processes, and business models change.

Quality

When put to good use, AI/ML can drastically improve product quality, especially in discrete manufacturing industries. There are two ways in which AI/ML can do this. First and foremost, finding anomalies in products and their packaging. Through a deep examination of the manufactured products, companies can stop defective products from ever reaching the market. In fact, the following case study is about an improvement from 50% to 90% in defect detection when compared with human inspections.

And then there's the possible enhancement of the quality of the manufacturing process. Through AI/ML applications, businesses can analyze the availability and performance of all the equipment used in the manufacturing process. This allows for predictive maintenance, which estimates the best time to attend to specific equipment to extend its life and avoid costly downtime.

Seagate success story

Seagate Technology, a $10B manufacturer of data storage and management solutions, is a prominent counterexample to the challenges outlined above. It has massive amounts of sensor data in its factories and has been using that data extensively over the last five years to ensure and improve the quality and efficiency of its manufacturing processes.

Seagate is using machine vision for microscopic inspection of silicon wafers throughout the manufacturing process. Based on deep learning algorithms, these ADC (Auto Defect Classification) models were first deployed in late 2017, and since then the scale and power of image detection has grown extensively across Seagate's wafer factories in the US and Northern Ireland, realizing multi-million dollar savings in inspection labor and scrap prevention. Visual inspection accuracy was at 50% several years ago, but **now exceeds 90%**.[6] Automated defect detection and classification systems are now institutionalized in the Seagate wafer factories as a strategic asset.

More recently, the company has actively focused on exploiting value out of the terabytes of sensor data coming out of their high precision tools. As a result, they now have several automated fault detection solutions making wafer and tool decisions in the manufacturing line. In addition to the operationalization of the fault detection systems, they also boast an impressive portfolio of AI augmented detectors that are autonomously monitoring and controlling critical processes in the factories.

SymphonyAI Industrial Digital Manufacturing—delivering on the promise

The SymphonyAI Industrial Digital Manufacturing Platform provides an intuitive low-code, point-and-click platform which empowers business leaders in engineering and operations to easily create smart manufacturing solutions, digitize processes, automate work and replicate high value solutions across global factories. We store data when a process starts and ends, and we store data as it changes and as the product goes through the manufacturing process enabling deeper insights and better decision making.

Digital thread

Digital thread captures all runtime meta data about a product, processes, and activities, (e.g. process steps, timestamp, operators involved, actions taken, process branch, machine states, parametric data, quality results) and contextualizes and transforms raw data into complex data model and useful information in real time. The digital thread preserves the data of the production run for automated decision making and real time updates to ERP and other decision support systems.

The integration of contextual data in the digital thread has been particularly empowering for the data team within Seagate, who would otherwise have to build the necessary pipelines to connect the highly complex streams of data that their manufacturing processes generate. The digital thread enables connected, holistic views of events which can be modeled by powerful AI algorithms.

Additionally, one of the unexpected benefits was extending the life of assets and equipment. Seagate was able to avoid new capital outlays by predicting and isolating equipment that is out of calibration and better plan for needed maintenance. With these new performance insights, acquiring new capital equipment can be delayed are avoided altogether.

References
[6] Tom Davenport, "Pushing the Frontiers of Manufacturing AI At Seagate", Forbes, January 27, 2021

SEAGATE

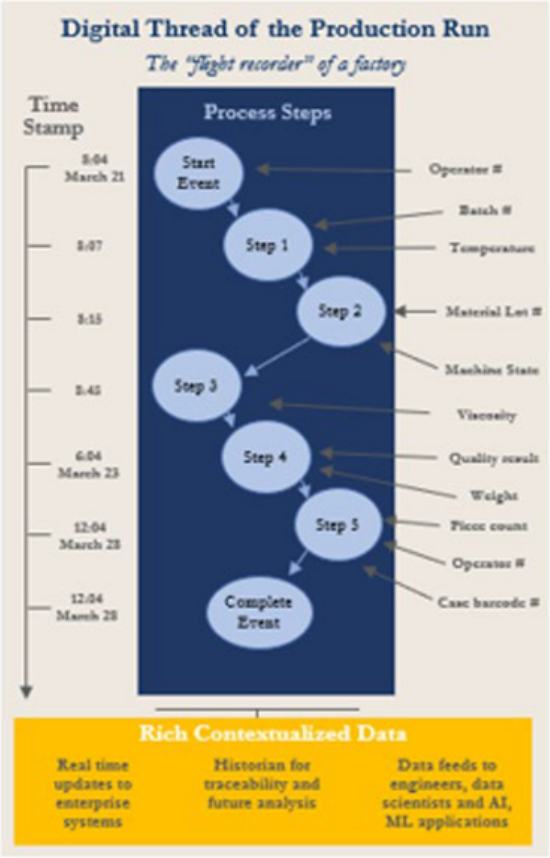
The results

Seagate's strong focus on digital transformation has enabled improved operating performance, accountability and speed of decision making. It has increased the effectiveness of enterprise systems with timely and accurate visibility into the manufacturing processes and key input and output variables.

As a result of this deep-learning approach, Seagate is realizing multi-million-dollar savings from cost and operational efficiencies gained from capital avoidance, scrap avoidance and labor reallocation. Its factory-wide initiative to monitor every process variable has resulted in autonomous monitoring algorithms running continuously in the background to monitor an entirely new set of key process variables. This higher granularity and dramatic increase in data make it impossible for operators to monitor. This deep learning system of algorithms providing supporting evidence for other factory control systems. Together with SymphonyAI Industrial Digital Manufacturing, Seagate can harness terabytes of data for virtual metrology and process control.

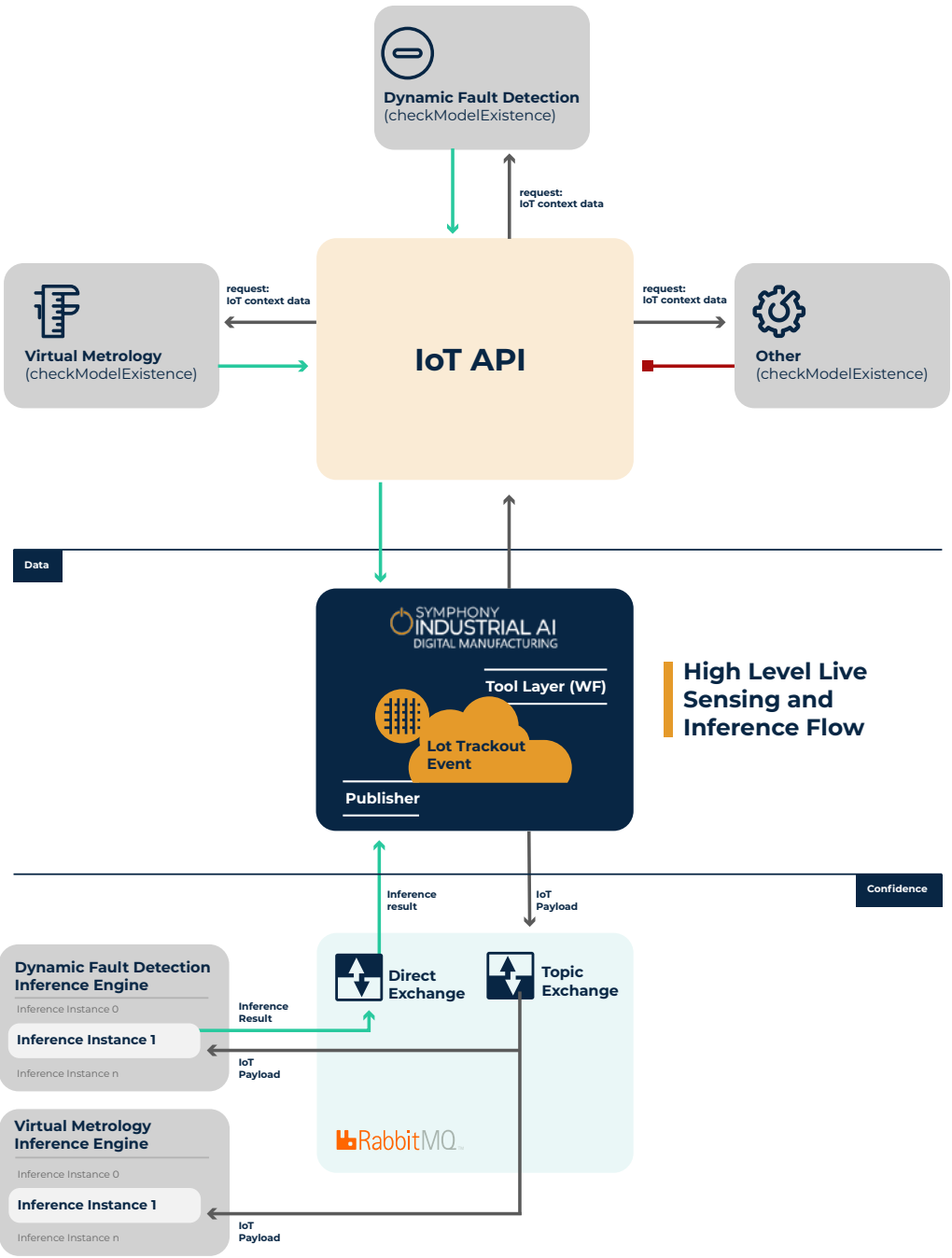
"I believe in creating a culture where systems drive operational excellence. The collaboration with SymphonyAI Industrial Digital Manufacturing has helped us capture data critical to the development of cutting edge solutions that know how to harness data for value."

—Sthitie Bom, Senior Director – Factory Controls, Anaytics, and Reporting at Seagate



Digital thread captures all runtime meta data and contextualizes and transforms raw data into complex data model and useful information in real time.

SEAGATE


Dynamic Fault Detection
(checkModelExistence)
request:
IoT context data
request:
IoT context data
Virtual Metrology
(checkModelExistence)
request:
IoT context data
IoT API
Other
(checkModelExistence)
Data
SYMPHONY
INDUSTRIAL AI
DIGITAL MANUFACTURING
Tool Layer (WF)
Lot Trackout
Event
Publisher
High Level Live
Sensing and
Inference Flow
Confidence
Inference
result
IoT
Payload
Dynamic Fault Detection
Inference Engine
Inference Instance 0
Inference Instance 1
Inference Instance n
Inference
Result
IoT
Payload
Direct
Exchange
Topic
Exchange
RabbitMQ
Virtual Metrology
Inference Engine
Inference Instance 0
Inference Instance 1
Inference Instance n
IoT
Payload

What's next?

For manufacturers, the opportunities are clear. Leaders should embrace the transformation and performance opportunities already available to them (and their competitors) from data, analytics, and digitization, as well as the rapidly evolving opportunities in AI/ML. To harness these benefits, business leaders will not only have to invest in technology, but also in transforming their organizations. Specific approaches will vary by business; however, several new mindsets will be critical:

- Testing, experimenting, learning, and scaling fast:

Beyond book knowledge, business leaders will need to amass practical knowledge from devoting resources to experiments applying technologies to real problems, and then scaling those that show promise.

- Reimagining business models and business processes:

To make full use of the power of AI/ML, and other digital technologies will require a thorough reimagining of processes, with priorities for which processes to transform and in what order. Similarly, leaders will need to reimagine how current business models could be transformed and how new business models could be created based on these capabilities.

- Digital assets and capabilities as the "new balance sheet":

These assets and capabilities, both hard and soft, are increasingly becoming a competitive differentiator and platforms for innovation and disruption. Each business regardless of industry and sector will likely need to assess how distinctive its digital assets and capabilities are vs. those of competitors.

- A new focus on human capital, including integrating workers and machines:

Companies are likely to face gaps in skills they need in a more technology-enabled workplace, and would benefit from playing a more active role in education and training. Humans and machines will need to work together much more closely.

An organization's digital exhaust is becoming its most valuable asset—and its value is only going to grow. If companies want to gain a competitive advantage, embrace this new field of competence now and get a big head start.

About SymphonyAI Industrial Digital Manufacturing

Long before Industry 4.0 and IIoT, SymphonyAI Industrial Digital Manufacturing was innovating capabilities that today drive this one-of-a-kind technology.

The recent advancements in cloud technologies, storage capabilities, processor speed combined with the decrease in sensor costs, have created a perfect storm for customers to maximize SymphonyAI Industrial Digital Manufacturing's powerful platform.

Innovation and industry leadership are the launch pad for continuous improvement and the journey toward lights-out manufacturing. We are proud to work with professional associations dedicated to driving standards, improving business results, and communicating best practices to global manufacturing.