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The Dawn of Digital Industries

MindSphere Enables New Digital Transformations

A Frost & Sullivan White Paper

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INTRODUCTION

The Internet of Things (IoT) is an important topic in the industrial milieu as many manufacturers are progressively trying to determine the value that could be gleaned from this upward technology swing. Over the years, the topic has moved from interesting to imperative. This change in significance is due to the renewed focus on manufacturing by global economies, resulting in national policy programs such as Platform Industrie 4.0, Industrial Internet Consortium (IIC), and Made in China 2025. However, the Industrial Internet of Things (IIoT) is still evolving as a concept as manufacturers continue to navigate ambiguous circumstances, including the converging information and communication technology (ICT) and operational technology (OT) landscapes, the increasing importance of open and heterogeneous platforms, and evolving business models.

CONVERGING ICT-OT ENVIRONMENTS

Traditionally, ICT and OT have been viewed as two separate environments within manufacturing. As digitalization continues to pervade the industrial space, the lines between the two environments are blurring. What manufacturers must realize is that the two environments are extremely different in terms of their characteristics and what they can each bring to the context of digital platforms. For instance, a digital platform provider from a traditional ICT background might often fall short in identifying the finer details of an industrial space. The provider may not understand the industrial area from an OT viewpoint. Worse, these ICT providers may be viewed as outsiders to the manufacturing world.

On the other hand, traditional OT players (at least the established ones) already have a strong industrial base and are on the verge of discovering newer roles and opportunities with their digital capabilities. As a result, these OT players are emerging as strong contenders to the ICT giants in the digital platforms market. The convergence of the two environments is opening up new opportunities that could benefit manufacturing businesses in optimizing efficiencies, costs, and productivity. The following exhibit illustrates some of the benefits that could be derived from the converging ICT-OT environments.

Exhibit 1: Benefits of the ICT-OT Convergence

ICT	IIoT	OT
COMPONENTS OF ICT		COMPONENTS OF OT
• Networks • Software & hardware • Web-based deployments • Gateways and other communication technologies • Big data • Data security • Tracking & analytics • Artificial intelligence • Cloud	**Benefits from the ICT-OT convergence** Connected factories Inventory management Analytics Predictive maintenance Visualization Plant safety & security Quality control Logistics & supply chain optimization New business models	• Embedded computing • Machinery • SCADA, HMI, PLC • Plant equipment • Monitoring & control systems • Remote industrial hardware & software • Plant safety • Operations • Processes • Supply chain • Logistics

Source: Frost & Sullivan

This convergence between the ICT and OT environments is not just a merging of the constituting elements and technologies. It is also the convergence of different ways of thinking that have emerged as a result of working separately and with completely different sets of technologies, vendors, and systems.

RISING IMPORTANCE OF OPENNESS AND HETEROGENEITY IN DIGITAL PLATFORMS

To facilitate a smooth deployment of digital platforms, manufacturers should develop platform capabilities that can handle large volumes of heterogeneous and constantly evolving industrial assets and devices. The main reasons behind such high levels of heterogeneity in manufacturing include an ever-expanding product portfolio—product variants and categories and several product upgrades and versions. The length and depth of manufacturing cutting across several industry verticals such as oil and gas, automotive, aerospace, and industrial machinery further add to existing complexities in the adoption of digitalization. Furthermore, there is a constant need to innovate, scale, and hasten the process while keeping in mind the cost, globalization, complexity, and competition in this emerging space.

Therefore, it is important that digital platforms demonstrate an end-to-end IoT ecosystem designed with reusable infrastructure and open industry standards. This is necessary to facilitate smoother flow of information across different departments and levels of businesses so that applications and data do not remain locked in silos. Closed ecosystems limit the value of digitalization due to poor information sharing and inefficient collaboration.

An open platform ecosystem is an interdependent group of stakeholders that includes enterprises, devices, competitors, technology enablers, developers, regulators, and others who share digital platforms for mutual benefit. Some of the key benefits of an open platform ecosystem include standardization of protocols and regulatory frameworks, security, interoperability, and free access to open data. Such open ecosystems are also enablers of innovation. They route demand from end users to technology providers and developers, and, in the process, give them a proper direction to develop innovative products or services.

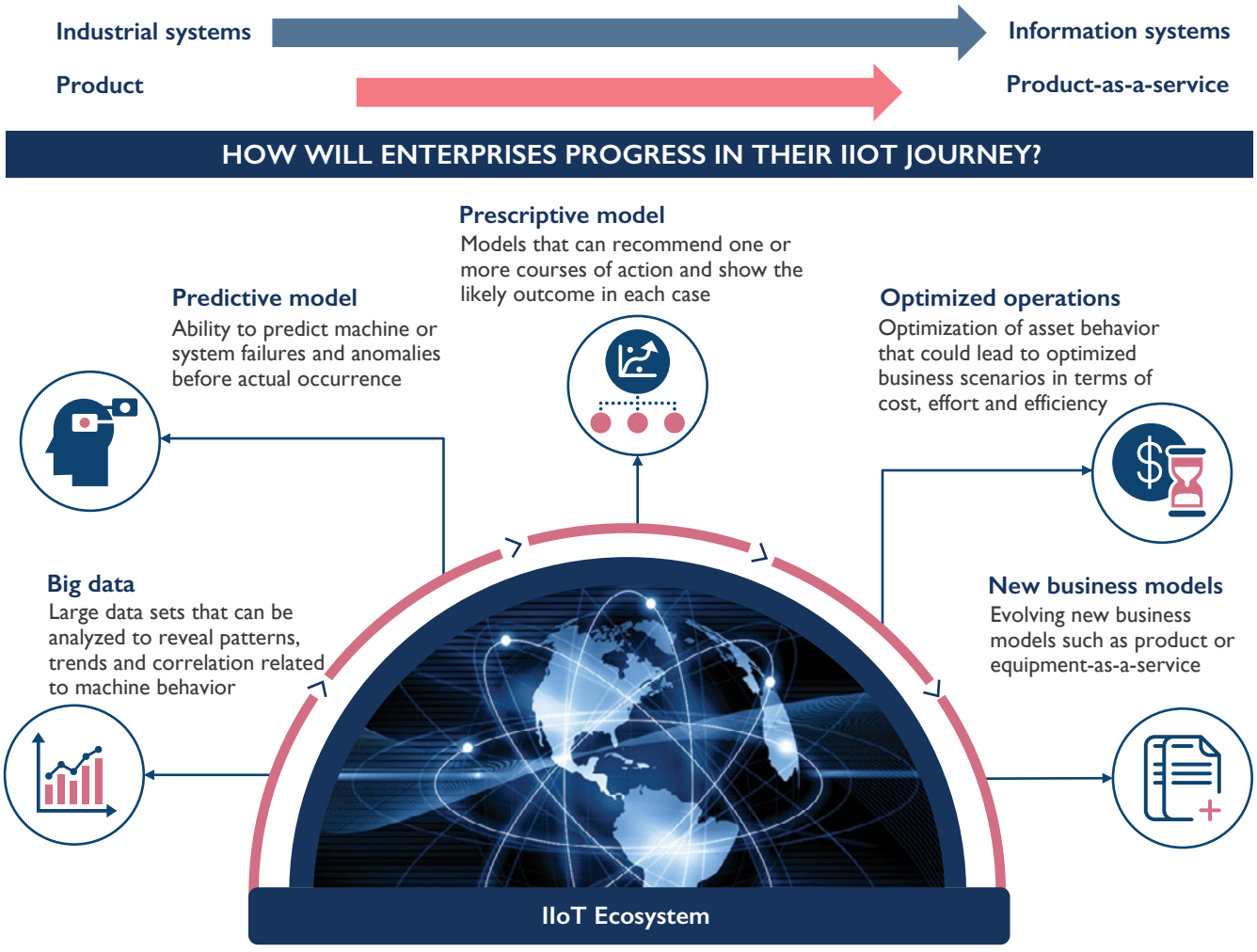
Manufacturing industry has hardly scratched the surface of the countless benefits that can be achieved with digitalization; yet it is clear that a well-defined and strong digital strategy will go a long way in helping manufacturers realize these potential benefits, including the conception of newer business models.

EVOLVING BUSINESS MODELS

Conventionally, manufacturing has focused only on selling hardware, and business profitability was squarely tied to product quality. But with changing consumer preferences, this hardware-centric approach started to make room for software and value that could be derived via services. Several decades ago, Rolls-Royce revolutionized traditional business models in manufacturing by offering engines on a pay-per-use basis. This led to the birth of the newer product-as-a-service model as other manufacturers began to rethink business strategies and pursue a similar approach.

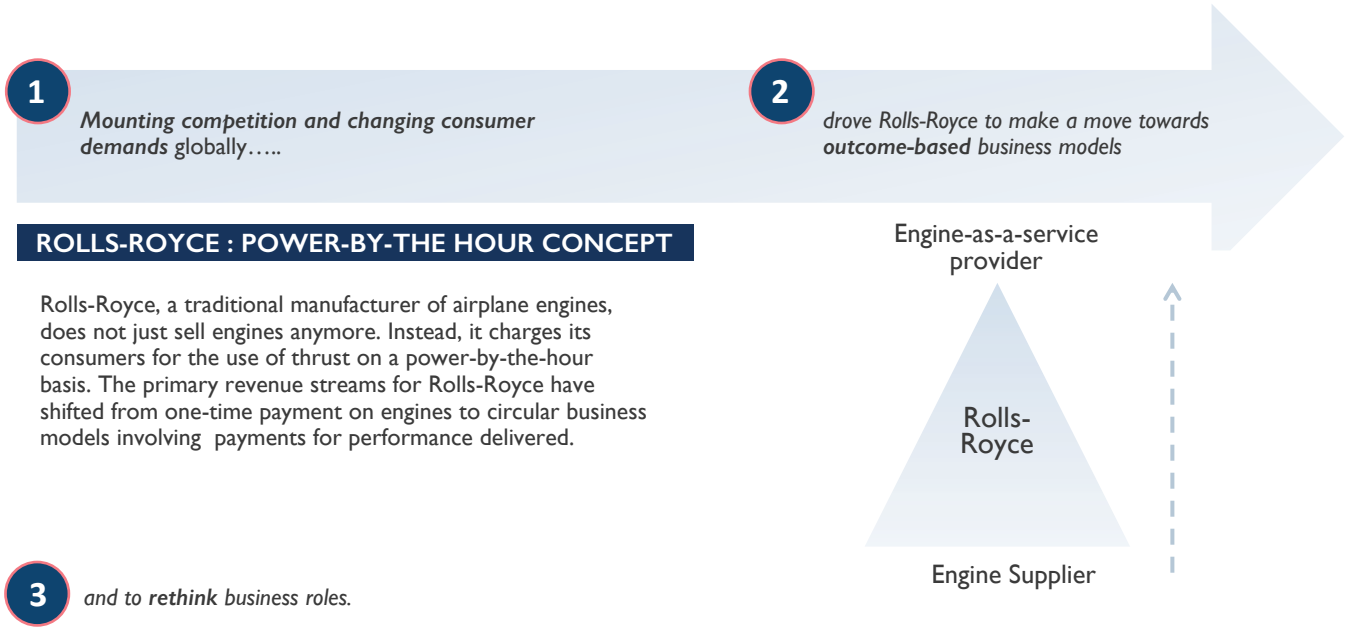
Today, these models have become much more sophisticated with advancements in technology. Opportunities are immense from the significant quantum of operational data that is churned out of industries. Digital platforms play a critical role in shaping newer business models to gather, store, analyze, and manage data. These platforms will be the foundation for any modern digital factory of the future. Digitalization has given these manufacturers the power to take a huge leap from merely supplying a product to delivering a service along with the product. The following exhibit gives an overview of some of the business model changes that manufacturing organizations are likely to undergo with the power of digitalization.

Exhibit 2: Evolving Business Models in Manufacturing



Source: Frost & Sullivan

Use Case: Rolls-Royce Power by the Hour[1]



Source: Rolls-Royce, Frost & Sullivan

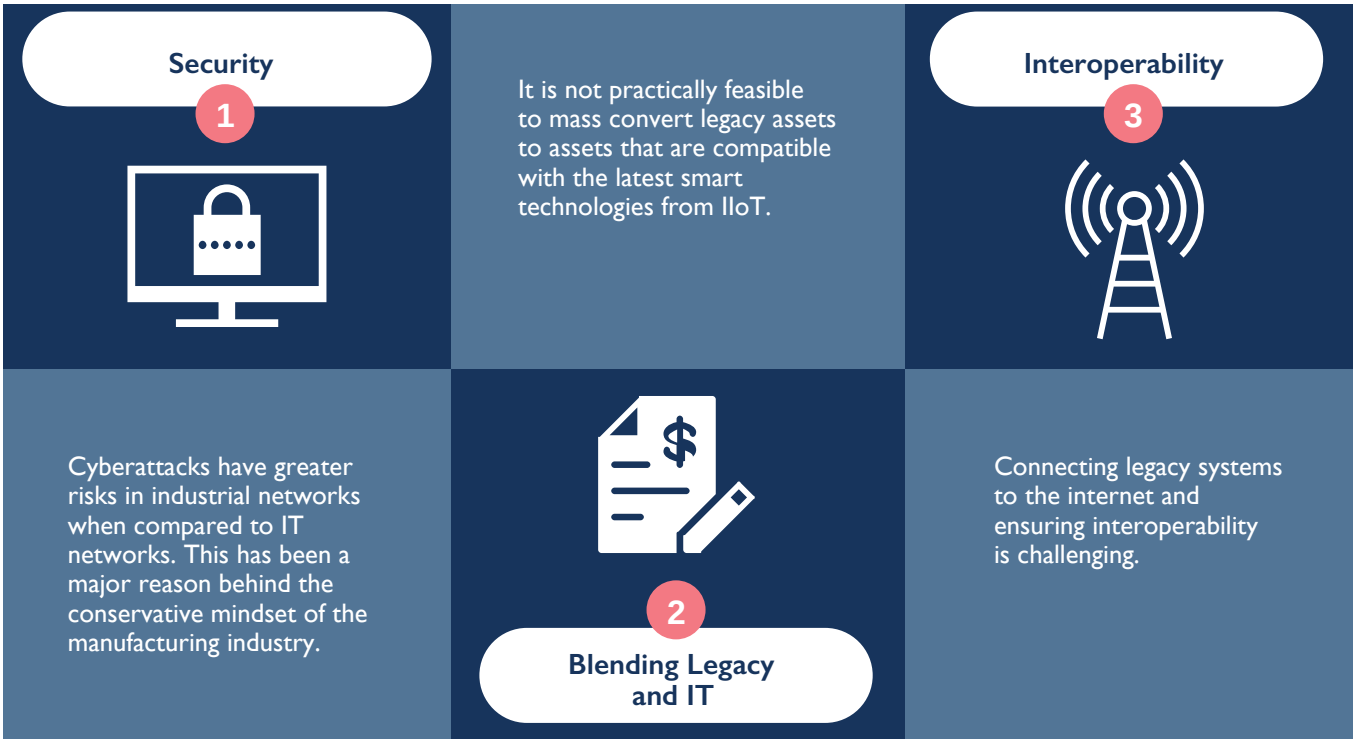
However, the digital platforms market is crowded and involves established and emerging platform providers. Therefore, evaluating platforms can be a challenging exercise. On the one hand, technology giants from the ICT world such as IBM, Microsoft, and SAP are trying to make inroads into the manufacturing world. On the other hand, traditional industrial giants such as General Electric (GE), Siemens, and Bosch are working to transform into digital firms that offer solutions to the industry. Moreover, there is an increasing trend of industrial enterprises trying to develop indigenous cloud platforms to deliver greater value to customers. This surge in digital platforms is creating a choice overload for the end user, who understands the need to make a digital investment but is drowning in the options of a highly complex marketplace.

CHALLENGES BEHIND ADOPTION OF DIGITAL PLATFORMS

Digitalization will create several opportunities for industrial systems and the people and processes involved. Despite the numerous benefits that digital platforms offer to the industrial world, some challenges can decelerate their proliferation. Manufacturers must address these challenges to reap the complete benefits of connected manufacturing.

1. https://www.rolls-royce.com/media/press-releases-archive/yr-2012/121030-the-hour.aspx

Exhibit 3: Challenges behind Adoption of Digital Platforms



Source: Frost & Sullivan

Digital platforms are designed to control critical infrastructure, but in this case, they are responsible for more than just IT networks. Shutting off industrial systems or operating in silos is no longer considered a good approach. In fact, an increasing number of manufacturers are beginning to understand the tremendous value that can be derived from digital implementations. As businesses turn to global expansions, connectivity and digitalization will be hard to ignore. Finally, to expand and upgrade existing functionalities of digitalization and compete and survive in the increasingly crowded digital platforms market, platforms will need to be built on open and flexible hardware, software, and networks. In addition, further challenges, such as competition, price pressure, and commoditization, will need to be handled.

If manufacturers already face some of these business challenges and don't have the time or resources to chart out their operational architecture, they can look at some of the carefully analyzed open platform ecosystem partners to execute a project on pilot mode before getting into the full platform approach.

THE DAWN OF DIGITAL INDUSTRIES

Digital transformation in the industrial environment is no longer an item to be ticked off on the wish list of organizations; it is a business imperative. Despite the challenges mentioned above, industrial organizations are prioritizing digitalization to connect their vertical operations as well as their horizontal supply chains. Digitalization is transforming how manufacturers are creating and delivering products and services, regardless of the type of industry. In the factories of the future, the most valued manufacturing organizations will be the ones that can homogenize digital capabilities with their industrial environment.

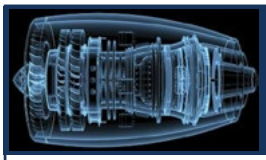
CURRENT STATE OF DIGITALIZATION IN MANUFACTURING

Some of the key industries leading the way in digitalization include aerospace and automotive manufacturing. Many large organizations across different industry sectors are shifting toward digitalization to optimize factory operations and automate

maintenance to ultimately raise the quality standards of their products and processes. Smart machines are constantly sending out performance and other relevant data to help manufacturers anticipate demand, schedule maintenance, and create better products. These are machines that come embedded with intelligence to help solve complex problems without human intervention. Many of these industrial organizations are starting to leverage one or more of the emerging technologies that fall under the purview of digital enterprises. These include technologies such as cognitive intelligence, additive manufacturing, and robotics. Others are exploring opportunities in developing new business models such as subscription-based pricing, licensing, profit sharing, and outcome-based pricing. This digital transformation is viewed as a boon for all the contenders in the industrial environment.

For instance, a leading aircraft manufacturing company is using digitalization to weave together its extremely complex supply chain. Aircraft manufacturing typically follows a cell-based manufacturing approach in which all components of the aircraft are required to flow into the point of aircraft assembly. While some components are developed in-house, most are sourced from multiple vendors located across the world. Therefore, without a proper tracking mechanism, the business of aircraft manufacturing gets extremely complicated and tough to manage. Cloud-based smart tools allow all stakeholders in this complex value chain to collaborate faster and with greater accuracy. Additionally, this transparent approach to information sharing helps manufacturers bring down the cost and effort required to fix any errors. Aircraft manufacturers, such as Boeing, have already shifted toward digitalization, reducing time-to-market by more than 50%[2].

Use Case: Digitalizing Aerospace Manufacturing—Key Benefits[3]

	Key Objective	Benefits
 **Design & engineering**	To provide the basic foundation towards building a flawless aircraft	Minimize • Weight & volume • Lifecycle cost Maximize • Performance • Strategic reuse
 **Manufacturing**	To efficiently coordinate, direct, and oversee the production of aircraft on the factory floor	• Planning & optimization • Quality monitoring • Asset optimization
 **Supply chain**	To create value by forming a competitive infrastructure using logistics working on demand by measuring performance	• Supply chain • Optimization, efficiency • Visibility
 **Aftermarket**	To offer on-time inspection, repair, alteration, and the supply of aircraft spare parts	• Aircraft health monitoring • Last mile connectivity

Digitalization penetration and adoption analysis across aircraft value chain

Low penetration **Nascent** stage	**High** penetration **Adoption** stage	**High** penetration **Adoption** stage	**High** penetration **Nascent** stage

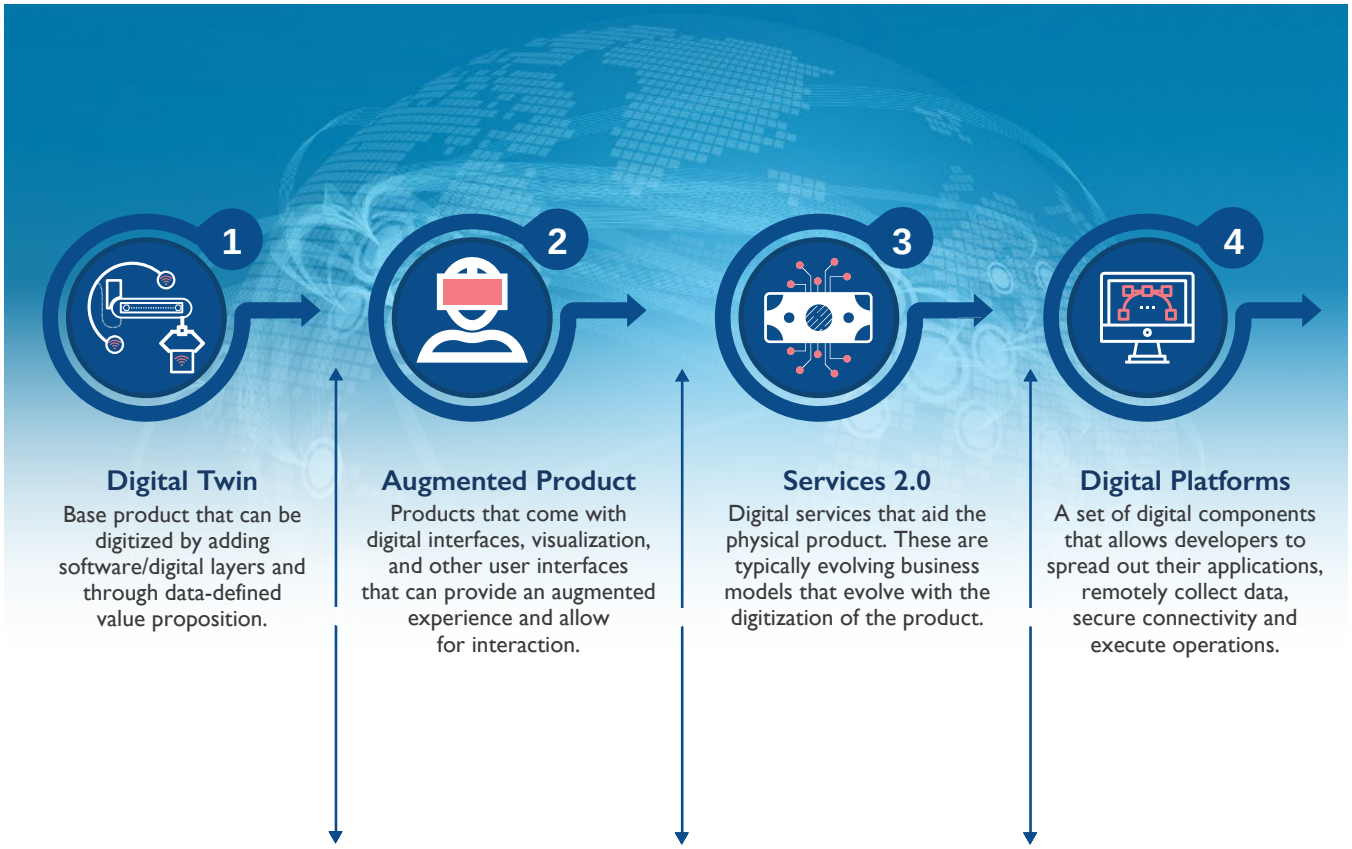
Source: Frost & Sullivan

2. http://www.frost.com/k218
3. http://www.frost.com/k218

APPROACH TO DIGITALIZATION

The rising complexities in manufacturing demand business solutions that can extend across vertical and horizontal levels within organizations. As far as industrial solutions are concerned, suppliers can offer their solutions in four layers: the digital twin, augmented product, value-added services, and a more extensive platform ecosystem. Several leading industrial firms that have traditionally sold hardware components are now increasingly foraying in the software and services side, so much so that these firms now see value in being positioned among the top software enterprises.

Exhibit 4: The Big Shift to Digital Platforms



Source: Frost & Sullivan

Small- to mid-sized enterprises that are beginning to evolve their digitalization strategy can follow the partnerships and collaborations route. Aligning their digitalization strategies with bigger platform providers allows them to stay in the market game without having to burn a hole in their pockets. True headway in performance can happen only when these smaller firms can align their role within the future digital platform ecosystem consisting of technology partners, suppliers, and customers.

Despite the complexities involved in evaluating and rolling out digital platforms, the manufacturing industry understands that implementing these platforms is critical for delivering impactful business outcomes. A comprehensive understanding of

the platforms can be helpful in decision-making. Some of the key questions that manufacturers should keep in mind while assessing the digital platforms include:

1. Will the platform support a data-driven business model?
2. Is the platform capable of supporting the full life cycle of operation for devices and data?
3. Does the platform provider have comprehensive knowledge and the requisite domain experience?
4. Will the platform connect to all assets seamlessly?
5. Where does the platform stand in terms of facilitating openness?

Getting answers to some of these questions can help manufacturers gain clarity in deciding what will work best for their line of business.

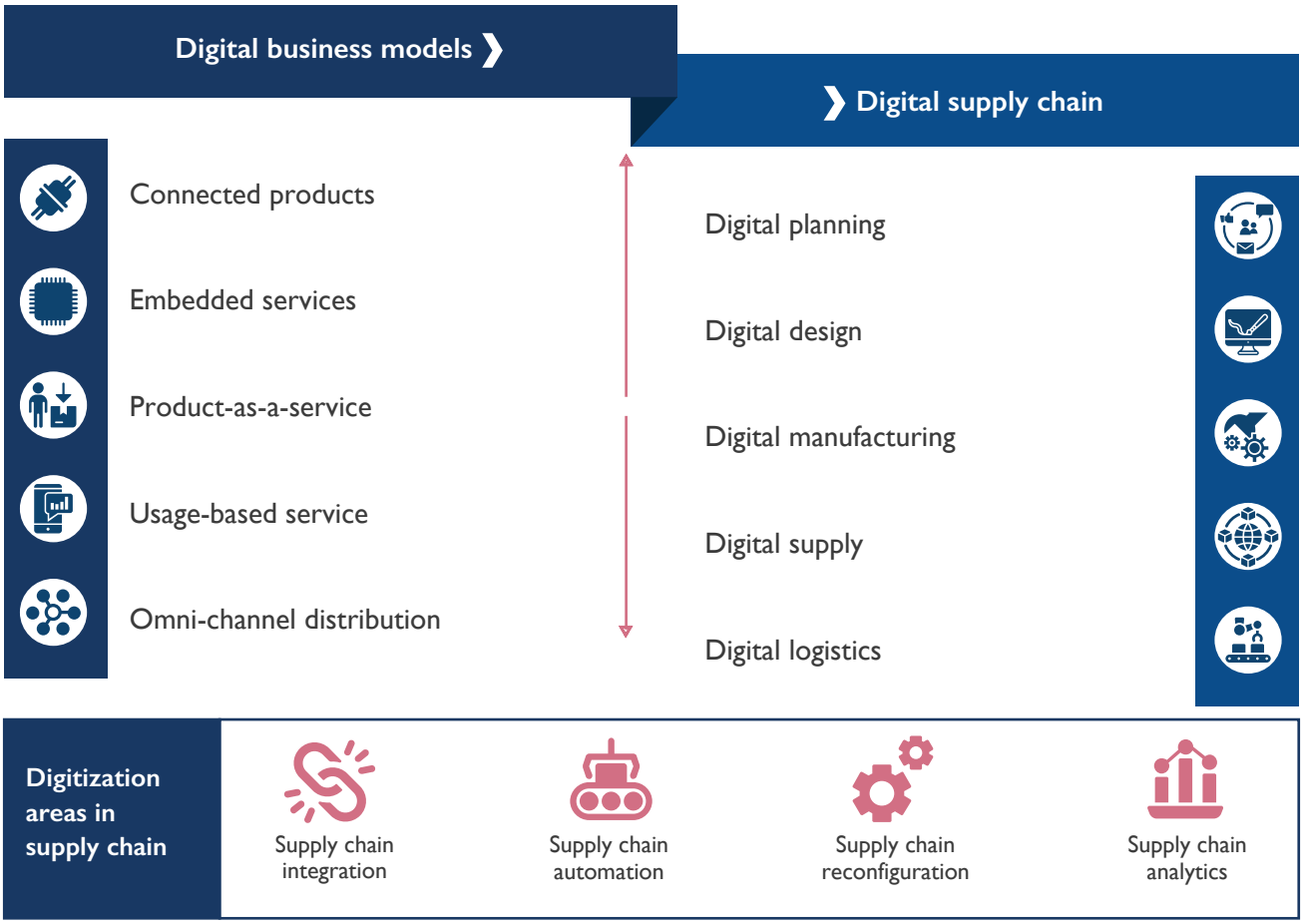
The rapidly changing face of manufacturing driven by globalization, competition, and dynamic consumer demands is pressuring the manufacturing community to improve productivity, decrease costs, and reduce time-to-market. The various government-led initiatives and frameworks can help manufacturing businesses streamline their advancement of digitalization in manufacturing. However, aligning these ideals with the complexities of a manufacturing supply chain is no easy task. Nevertheless, as this consensus on digitalization covers more ground, platform adoption is bound to accelerate.

The emerging importance of digitalization can no longer be overstated. The digital wave has approached manufacturing in a non-linear fashion, but at an exponential pace. As industrial firms continue to collaborate and invest in digital technologies, the ones at the forefront are beginning to move beyond pilot implementations. The speed at which some firms have begun to invest in this new paradigm is bound to surprise many others. Manufacturers that exhibit digital reticence run the risk of being left behind. As the concept of digital factories transforms from being important to critical in the future of manufacturing, the following trends will be in the forefront:

1. End-to-End Digitalization

There will be total integration of ICT with the OT as digitalization begins to happen vertically across every business function and hierarchy, as well as penetrate horizontally, connecting all stakeholders in the entire manufacturing value chain, including suppliers, partners, distributors, and customers. From traditionally just inspecting machines, manufacturers today are taking a closer look at the data generated by these machines. This change comes from realizing the value that could be derived from the machine data. However, manufacturers often face a difficult call in deciding what to do with the vast amount and types of data. All of the data that gets churned out of industrial machines is of no use if it cannot be converted to deliver meaningful insights. Thus, one of the key areas where digitalization will have an important role is in creating a virtual model or digital twin of not just the product, but also the production process and performance of the product. This, in turn, can be instrumental in generating high-level insights that can help in managing complexities related to product and process supply chains and can significantly assist in enabling well-informed business decisions. Using the digital twin, manufacturers can keep several parameters in check across the entire length of the manufacturing value chain, from planning and design to production, supply, and logistics. The information gathered through a digital twin can be used to perform both predictive and adaptive maintenance, and will be instrumental in understanding the dynamic needs of the end customer. The following exhibit indicates the different areas of the manufacturing supply chain where digitalization can be applied, resulting in newer potential for revenues.

Exhibit 5: Digitalization Areas in a Global Manufacturing Supply Chain



Source: Frost & Sullivan

2. From Product Selling to Value Selling

There will be a shift from the traditional definition of product and services as an increasing number of products will come embedded with capabilities that will help manufacturers make informed business decisions based on product and environment behavior. For example, cars are evolving into products that can self-diagnose potential issues and be repaired via software upgrades instead of by traditional mechanics. Industrial machines will also evolve to track their performance and deliver insights that could be useful for manufacturers.

3. Innovating Business Models

Digital connectivity will enable industrial manufacturers to become more directly responsive to customers and their needs. Accordingly, newer business models such as usage-based pricing will emerge. These newer business models will allow manufacturers to accurately forecast supply, demand, and revenues with greater accuracy. Industries such as aerospace and defense are already offering services on a subscription and consumption basis. For example, a Swedish air compressors

manufacturer is changing its business model from selling air compressing equipment to delivering compressed air as a service. In this model, customers are billed only for the compressed air that is consumed. Smart systems can precisely monitor the flow of compressed air and deliver the amount of air that the customer requires. This is a win-win situation because it leads to less waste, lower costs, and increased efficiency.

The early bird catches the worm. So did early adopters of internet technologies such as Google, Microsoft, and Amazon. Similarly, now that we are on the cusp of a fourth industrial revolution, the first movers to digital enterprises will enjoy a great advantage. GE, Siemens, and Bosch have already strengthened their positions in the market. Interesting revenue models that stem out of smart digital concepts will help even the smaller enterprises derive immense benefits from digitization. Despite a burgeoning marketplace with one platform being added every quarter, many of these platforms are either narrow in their application or come with an innate "lock-in" principle. Once committed to a platform, it will be extremely difficult for customers to switch to any other solution at a later stage. This is an unhealthy approach that is unlikely to yield critical mass adoption. Therefore, a more flexible approach, such as what GE, Siemens, and Bosch are taking, is more desirable.

PREPARING FOR THE FACTORIES OF THE FUTURE

With slow adoption of technologies, use cases, and standardization in the market, implementing digitalization in the true sense can be a slow process for many manufacturers. The path toward industrial digitalization is an evolutionary process, and the speed of this evolution is at different levels for different organizations and different industrial sectors. It is not going to hit the industry all at once.

Meanwhile, industrial organizations need to take necessary steps toward building factories of the future to ensure sustainable competitiveness. Making a move toward digitalization will allow manufacturers to not just increase productivity and improve efficiencies, but also set a base for future business models, thus preparing the manufacturing industry to gain an edge over the competition. Irrespective of where industrial firms are in their digital journey, digitalization is no longer an option, but rather an inevitable necessity that will determine market sustainability in the future.

THE WORLD OF MINDSPHERE

Manufacturers looking to adopt digitalization face multiple challenges. Chief among these include securely connecting a diverse asset base and deriving real-time insights that will improve efficiencies across the value chain. Speed and scale, in this regard, are decisive factors that determine effectiveness.

Just like security, data integration and harmonization from a diverse asset base will continue to pose a roadblock for vendors and end users. Frost & Sullivan foresees that a resolution to this challenge is inevitable as the digital path is a one-way street.

In the past 12 to 18 months, a number of new platforms have been introduced, creating a new market of industrial digital platforms (IIoT platforms). At this juncture, this nascent space has an interesting mix of vendors from OT and ICT that

compete, co-opt, and cooperate with each other. Such a wide, expansive trend of cooperation between various vendors is unparalleled in industrial history.

This nascent market not only includes vendors that provide end-to-end IoT solutions but also includes vendors that provide customized solutions for various manufacturing functions.

VOICE OF THE INDUSTRY #1: IN SPITE OF IN-HOUSE IOT PLATFORM CAPABILITIES, EISENMANN[4] ADOPTS MINDSPHERE TO EXTEND CAPABILITIES ACROSS MUTIPLE PLANTS, LOCATIONS, AND CUSTOMERS

What was Eisenmann looking for?

A platform that -

- Could support multi-plant, multiple customers
- Is fairly independent of all structures
- Can run across different industry verticals for various customers

Top reasons why Eisenmann chose Siemens MindSphere

1. Lower investment costs
2. High competition
3. Eisenmann's products made use of components from Siemens, which paved way for a much closer collaboration.
4. Trust in the Siemens brand

Source: Eisenmann, Frost & Sullivan

In the backdrop of such an eclectic mix of platform providers, it is essential to note that this also creates a cloud of uncertainty among end users now beset with several platforms from which to choose. An Industry 4.0 architect of an automotive supplier in Europe commented that to digitalize its existing factories, it would need to develop an indigenous digital platform that can integrate various vendor platforms. Thus, a large platform market does not necessarily result in efficient utility for the manufacturer. What the industry needs is a platform that brings an ecosystem and is open for collaboration with other suppliers.

According to Frost & Sullivan analysis, among the various industrial digital platforms currently in the marketplace, the MindSphere platform stands out from the rest. Furthermore, as we currently stand at an inflection point in the industry, with increased awareness and heightened interests in digitalization, the need of the hour is proofs-of-concept that can inspire digital converts in manufacturing. In this regard, the Siemens MindSphere ecosystem forms an interesting case in point.

4. http://www.eisenmann.com/en/media/press/press-releases/2018/2018_01_24_Mindsphere_Eisenmann_en.html; Customer discussions at Hannover Messe

VOICE OF THE INDUSTRY #2: RITTAL[5] TRUSTS SIEMENS MINDSPHERE FOR OPTIMIZED CLIMATE CONTROL INDUSTRY SOLUTIONS

What was Rittal looking for?

- Platform-ready applications and features
- Security and trust from platform vendor

Top reasons why Rittal decided to be part of MindSphere World

1. Rittal believes that Siemens MindSphere is optimized for the climate control industry. MindSphere is already offering ready support to the industry in the form of a cabinet that is complete with features like PLC that is already present on MindSphere-ready devices.

2. Because devices are already MindSphere ready, all that Rittal's customers are expected to do is to let the gateway open for data to be available for visualization in under a few minutes.

3. The cloud-based open IoT OS from Siemens enables companies like Rittal to develop their own IIoT applications.

4. The Siemens MindSphere platform is scalable, and can capture and analyze huge quantums of data, leading to smart energy data management and resource optimization.

5. It also allows Rittal management to harness the power of analytics to predict when repairs and maintenance are required.

Source: Rittal, Frost & Sullivan

Recently, Siemens, along with 19 other industrial enterprises, founded the "MindSphere World," a global, open IoT ecosystem based on Siemens MindSphere. The main objective behind this ecosystem is to support and guide participating firms in developing IoT applications with MindSphere. This collaborative effort is likely to establish new synergies between companies as they enter into a symbiotic relationship. Through MindSphere's open platform architecture, manufacturers can integrate heterogeneous machines and systems and build applications that are independent to the manufacturer. This collaboration will also result in the establishment of common standards that can be beneficial to every player in the ecosystem.

Rittal, for example, is one of the founding members of the MindSphere World. As a global manufacturer and provider of solutions for industrial enclosures, power distribution, and climate control products, the company has achieved recent noteworthy advancements in the field of climate control that are much more energy efficient and capable of communicating. The company is currently using MindSphere in its "cooling as a service" app and its networked "Blue e+" cooling units. As a result of this integration, Rittal can perform data-based predictive maintenance and repair that has further helped the company realize benefits such as reduced costs and increased uptime.

5. https://www.rittal.com/com-en/content/en/unternehmen/presse/pressemeldungen/pressemeldung_detail_64448.jsp; Customer discussions at Hannover Messe

VOICE OF THE INDUSTRY #3: HAM-LET[6] DELIVERS INDUSTRY 4.0 INNOVATION WITH SIEMENS MINDSPHERE

What was Ham-Let looking for?

- To connect its industrial products to the cloud
- To increase reliability, reduce costs, minimize physical space for valve rigs
- Open new possibilities that were previously too expensive to implement

Top reasons why Ham-Let chose Siemens MindSphere

1. Using Siemens MindSphere, Ham-Let was able to provide its customers with more than just a valve that could open and close. Powered by Siemens MindSphere, Ham-let was able to provide its customers with valves that can sense what passes through them, along with various other environmental conditions such as temperature, pressure, vibration, humidity, etc., using a combination of smart IoT technologies such as cloud, AI, and edge computing.

2. By choosing MindSphere, Ham-Let was able to develop valves that could effectively manage devices, perform analytics, and enable visualization.

3. With MindSphere, Ham-Let was able to build a comprehensive industrial solution that can perform valve and gateway device management right from the cloud. It can also display useful historical data and other parameters related to valves.

Source: Ham-Let, Frost & Sullivan

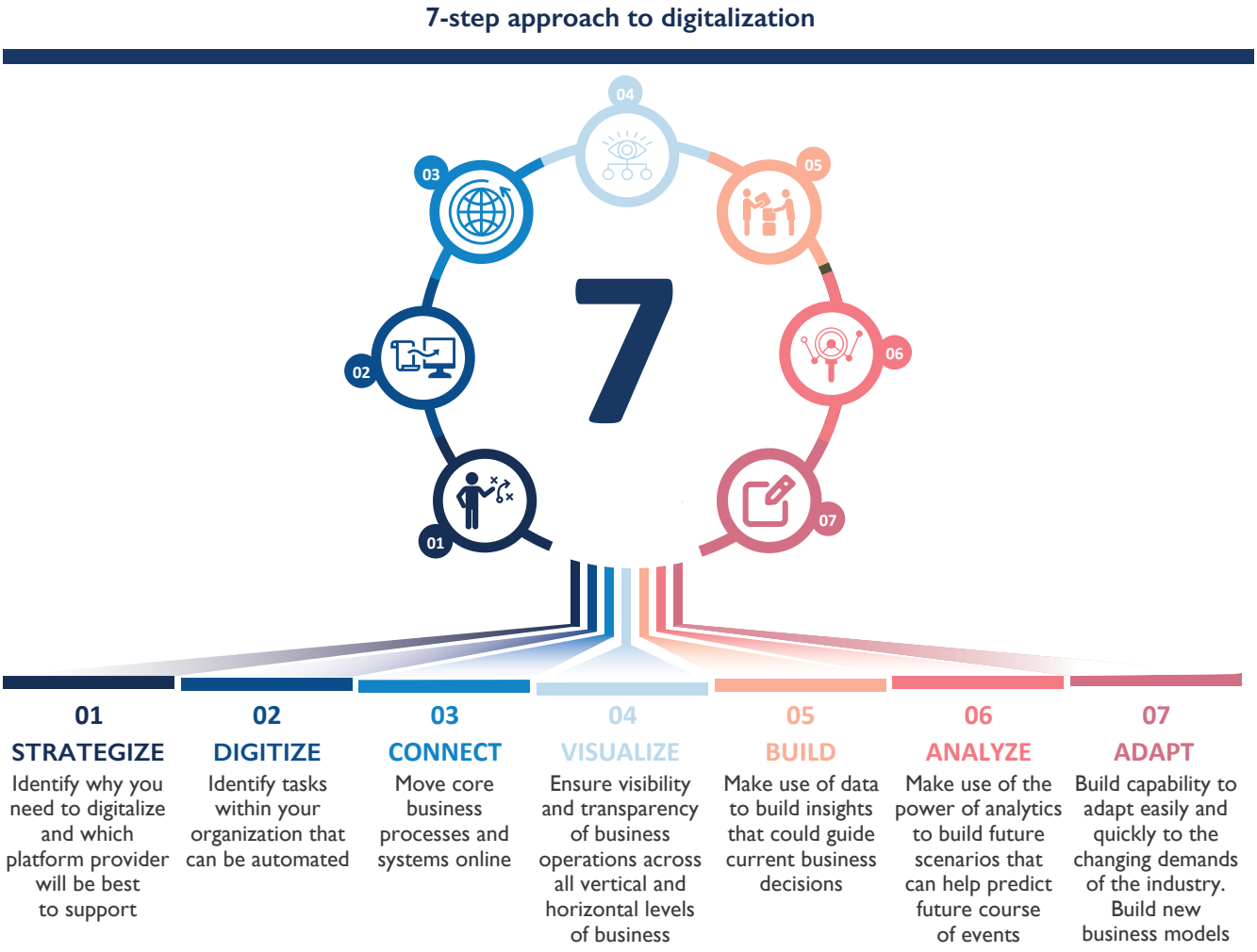
As indicated earlier, the presence of multiple platforms does not guarantee value. Although this is an important milestone in the digital journey, suppliers need to realize that manufacturers will not be keen to pay for multiple platforms. It is our strong belief that the digital platform market will eventually witness heavy consolidation, resulting in two or three major participants.

CONCLUSION

Different manufacturers can be at different points in their journey toward digitalization. There are clearly no one-size-fits-all approaches when it comes to adoption of digitalization. Therefore, regardless of where a manufacturer is, it should aim at following an approach that combines its objectives, requirements, and constraints. Choosing a digital platform should start with a good understanding of business requirements. Enterprises should keep in mind the problems that they would like to solve and shortlist likely solutions and use cases. The following exhibit provides rough guidelines to keep in mind before embarking on a journey toward digitalization.

6. https://www.plm.automation.siemens.com/en/about_us/newsroom/press/press_release.cfm?Component=260834&ComponentTemplate=822; Customer discussions at Hannover Messe

Exhibit 6: Digital Platforms



Source: Frost & Sullivan

To summarize, the digital platforms market is still at a nascent stage of industry-wide adoption. Despite the many options to choose from, considerable research should be performed to identify a partner that is not just large and has proven use cases, but can also be trusted to stay in for the long run.

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