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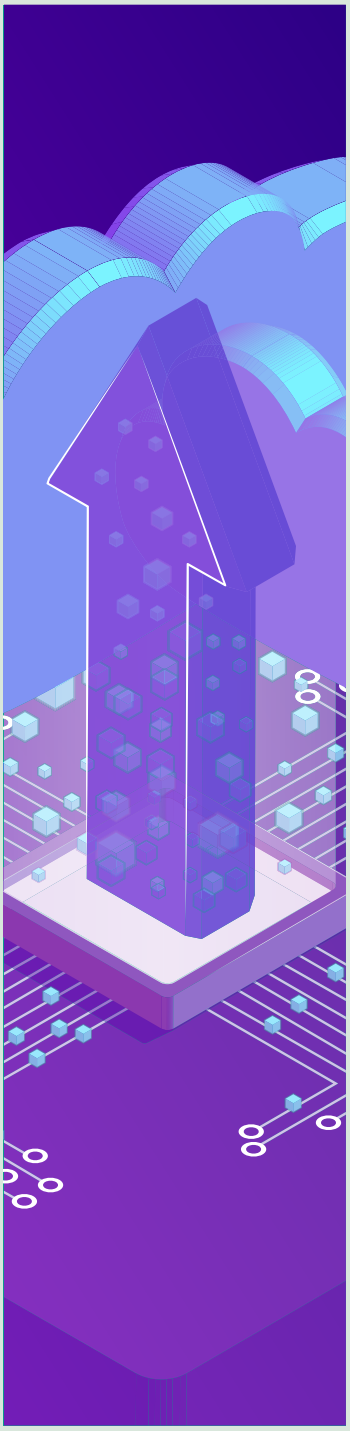

DIGITAL TRANSFORMATION INITIATIVE: CLOUDIFICATION OF MES

Abstract

With the advancement of cloud native applications and the thrust for a cloud-first approach, almost every organization is seeking transformation of their applications and systems. While the applications on the top of the stack of ISA-95 are rapidly undergoing infrastructure reorientation and are cloudified through SaaS/ PaaS solutions, there has been a strong and reasonable resistance towards application migration to the cloud, especially those hosted on the production floor and belonging to the lower part of the ISA-95 stack (primarily Level 2 applications). Organizations are not considering moving their plant applications to the cloud. Instead, they prefer to interface with cloud apps through Edge.

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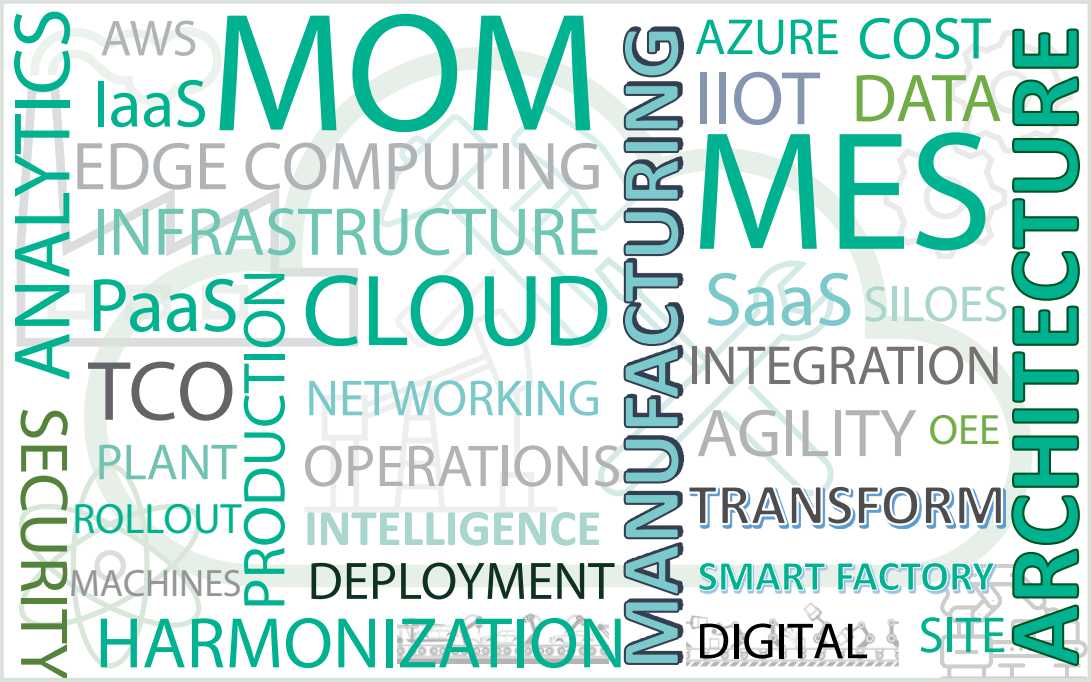


Figure 1 : Word Cloud – Cloudification of MES

Cloudification of MES shall aid in

PREFACE

This journal focuses on the positioning and management of MES-MOM, which forms the basis of Level 3 applications. MES is a component of MOM that supports the complete stream of manufacturing processes from production execution, quality management, logistics and materials, covering the 4Ms – Man, Material, Machine and Methods of Manufacturing. MOM is the larger ecosystem that ensures strategic optimization and insights into the manufacturing processes, emphasizing production, quality, maintenance, and inventory and seeking overall advancements of KPIs, thus facilitating OEE improvements.

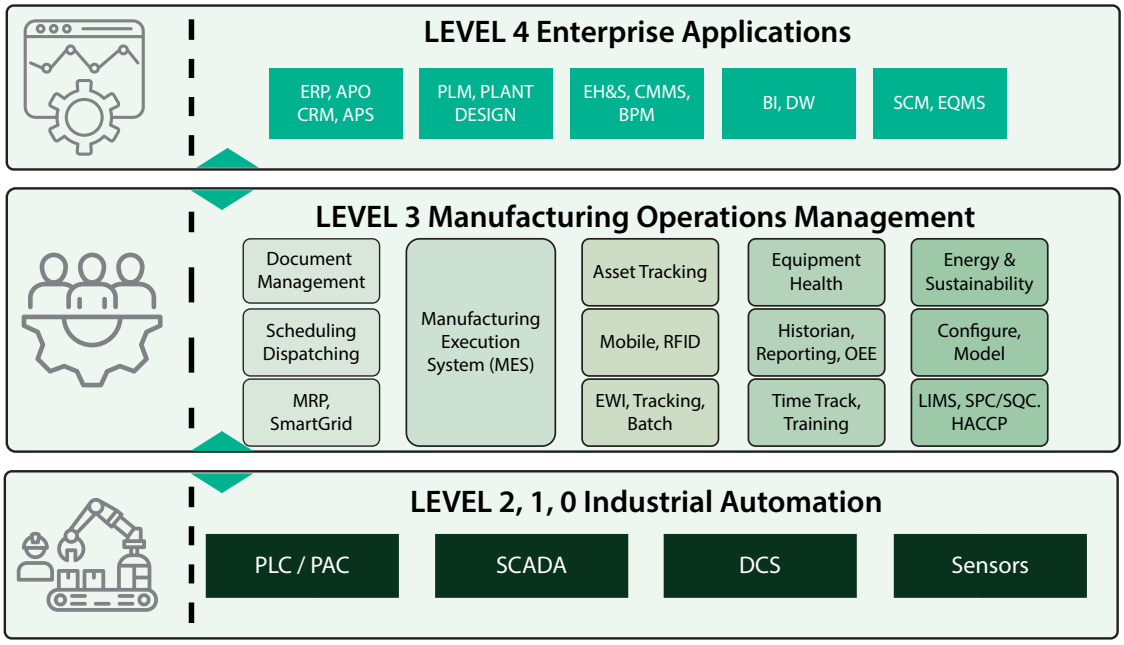


Figure 2 : MOM Application in ISA-95 Model

Hence, MES-MOM is integral in executing the manufacturing processes and driving the SCM operations rapidly. While the MES-MOM is primarily responsible for collecting data from southbound systems, including plant applications related to production, quality, warehouse, inventory and HSE, amongst others, there is equal responsibility on the northbound Level-4 systems like ERP and PLM for Production Orders, Quality Results, Backflush and other data updates. MES–MOM has traditionally been set on-premises closer to plant applications for a seamless experience and to eliminate business disruptions.

As businesses look forward to being cloud-first and navigating their next steps, they must move MES – MOM systems to cloud. Maintaining MES systems on-premises for large enterprises requires enormous investment, cost of ownership and infrastructure maintenance. As cloud democratizes and harmonizes data, applications and interfaces across the enterprise, it is reasonable for businesses to want the move.

Organizations have had a mixed response to migrating MES to cloud since the onset. To achieve application harmonization and savings on OPEX, IT teams have explored various options to place MES on cloud, either as an IaaS or PaaS model. Such a move aims to meet their cloud-first strategy and infrastructure consolidation. On the contrary, the business and plant IT are resistant to change anything related to the manufacturing processes and applications. They see it as an uncomfortable migration with concerns about the application's performance and availability when the servers are physically moved out of the plant network. MES-MOM must be a highly available application, and downtimes, even in minutes, have a substantial cascading impact on the supply chain. In addition, culturally, site personnel prefer the pleasant application support experience from the physical plant IT team over the virtual support setup in a cloud world.

As a large chunk of enterprise data across the organization is securely and cheaply maintained on cloud applications, many manufacturers are willing to go the extra mile and seek answers to the question – **How do we balance the sentiments on the shop floor with the advantages cloud-based technologies offer?**

Manufacturing organization heads are now mulling options to move MES to the cloud infrastructure. Though adoption has been slow, it is expected to make rapid inroads over the next two to three years. Cloudification of MES is a crucial prerequisite for digital transformation and Smart Factory initiatives. Over the past few years, there have been seamless and successful migrations across various organizations without any aftereffects on business.

Intended Audience

This paper series aims to provide a sneak view of the benefits and challenges of MES cloudification. It calls out industry use cases and will assist decision-making, eliminating concerns and confusion about migrating MES to cloud infrastructure.

01

Head of manufacturing Enterprise

It clarifies the benefits and challenges of migrating MES to cloud infrastructure. It helps with decision-making, effective digital transformation planning, and raising awareness on the cloudification of MES. It also helps address some of the concerns often raised by the business about this approach.

02

Head of IT (Digital Officer), Enterprise

The document further strengthens the push for portfolio rationalization, IT systems standardization and infrastructure centralization on cloud networks. It helps justify and strategize the migration of MES to the cloud.

03

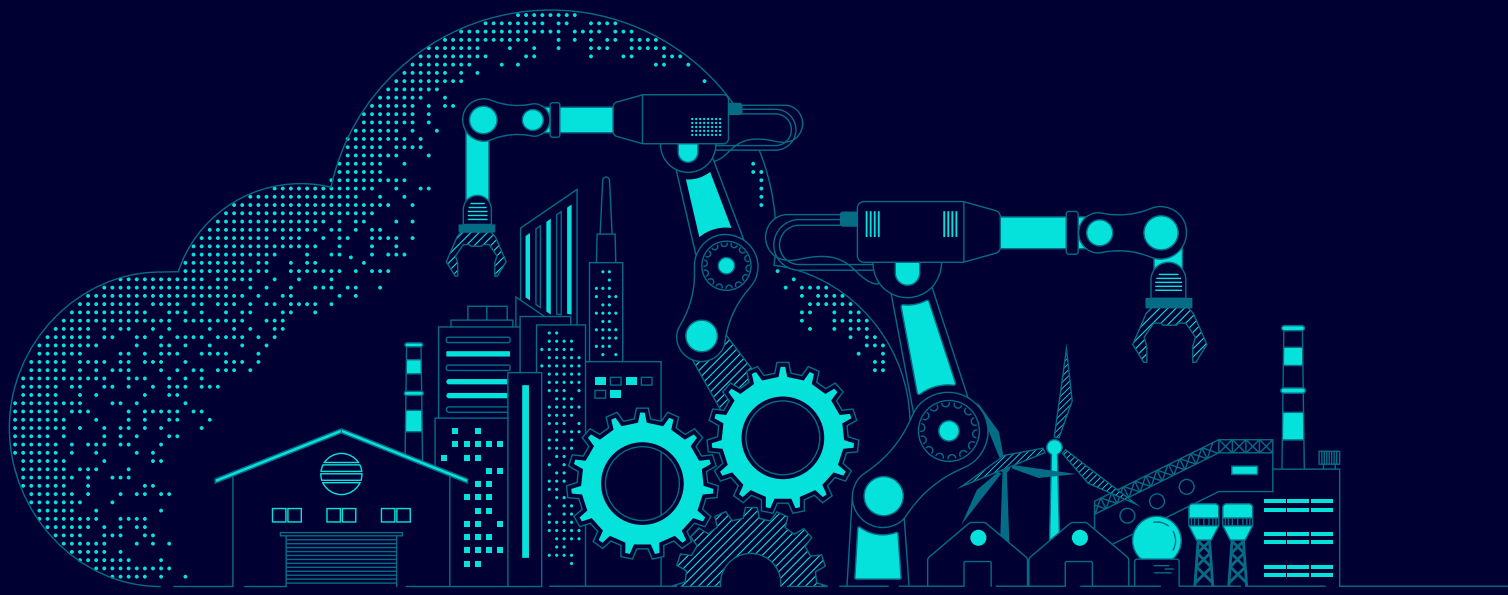
Site Manager / Site IT

This paper helps the Site Manager and Site IT team understand the overall data flow architecture and advantages of MES on cloud and bust the myths around performance issues, availability, data loss, data security, accessibility, etc.

04

Cloud Infrastructure IT Services Team

It provides a high-level overview for the IT team/Cloud Infrastructure services team on the nuances of the MES migration and typical challenges involved, which can help them establish best practices and build a migration checklist.



What are the challenges …

The on-premises MES focuses on seamless point-to-point integration and control over the system to deliver a specialized user experience committed to business requirements. The necessary infrastructure for MES is placed in a plant location, which provides improved control over equipment and essential data security.

While there is a consistent demand to migrate to cloud-based MES, concerns are expressed, too, especially from the business fraternity. Some factors that influence the narrative to stay on premise include: -

1. **Volumes of Operational Data**—Manufacturers are skeptical about storing large amounts of operational data in the cloud, which could eventually increase the Opex costs for data storage and maintenance.
2. **Integration with On**-Premises Control System Framework - There is a common perception that the integration between level 2 systems and a cloud-based MES may not be seamless and lead to data loss. As information is generated rapidly, data transfer velocity (both inbound and outbound) is questionable and substantially impacts the outcomes.
3. **Data Security** - Some manufacturers hesitate to host sensitive production data on cloud owing to security concerns. They seek more assurance on the security and confidentiality of manufacturing data on cloud with role-based restricted access.
4. **Continuous Availability**—Because the application is hosted in an environment external to the plant ecosystem, there are apprehensions about its high availability. Questions on Internet connectivity, application accessibility, slowness experienced at the client end on the shop floor, etc., have posed a threat to adopting cloud-based MES.
5. **Dependency on Cloud Provider** - As a cloud-based MES depends on the provider's server and infrastructure, any issues leading to connectivity slowness or infrastructure downtime can eventually impact the availability and performance of the MES.
6. **Tailoring the MES**—Cloud-based MES may offer limited customization compared to on-premise systems, which can challenge manufacturers who want to build bespoke applications for manufacturing execution.
7. **Response time for Application Maintenance**—In case of any issue with server responsiveness or networks, the on-ground plant IT team is more geared to tackle and provide instant support for on-premise MES. In contrast, it is difficult to get immediate intervention for cloud-based MES.
8. **Real-time, Time Series nature of data** -The data must be processed in real-time. The data volume is massive if it is a time series acquired with a frequency of <1s.
9. **Not just Data Security, but the Security of OT is also at Risk**- As the data from OT is acquired and sent to the cloud, OT systems are vulnerable to cyberattacks, and integration with MES on cloud poses a risk to these systems.

Most of the above concerns are resolved with an effective and resilient cloud systems setup and an Edge computing framework such as a hybrid Edge clubbed with a cloud approach. The Edge handles real-time processing and secure closed-loop automation, while cloud handles large chunks of data, dashboards, reports and global operations visibility. The need of the hour is to effectively drive mindset change, educate on cloud services and offerings and change the perception of manufacturers.

Key Factors that influence Cloudification of MES Applications

Cloud adoption is driving the key trends underpinning the future factory. Many enterprises are willing to migrate MES to cloud as the benefits outweigh the cost and risk associated with adoption. In combination with relatively new technologies like artificial intelligence (AI) and digital twins, the cloud is set to become an indispensable tool for improving manufacturing operations. Some key factors that influence the cloudification of MES include: -

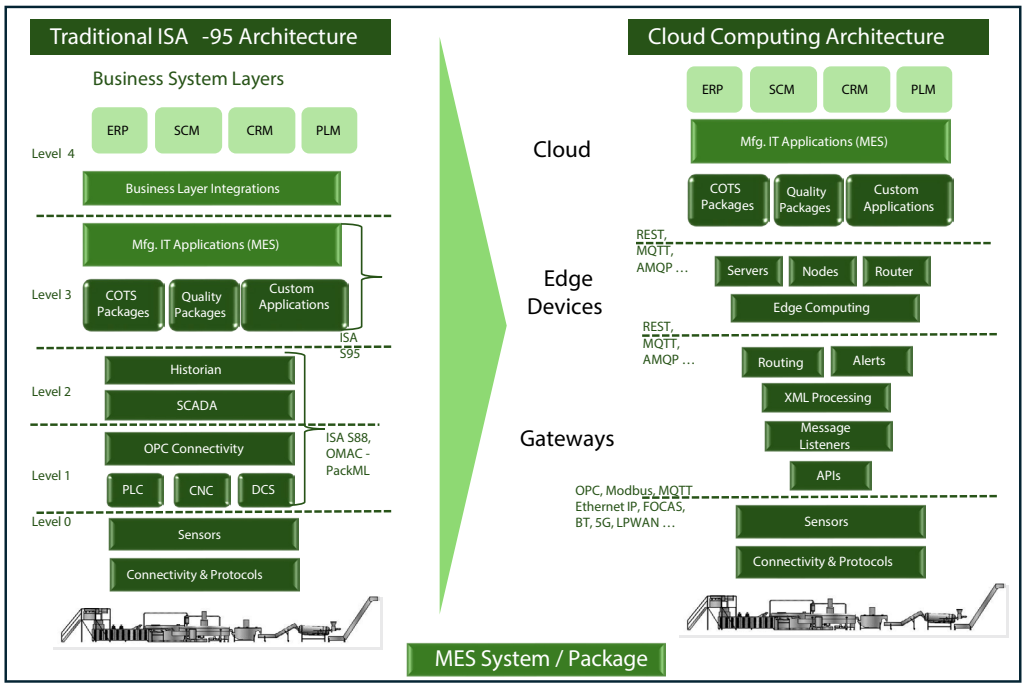
- **Convergence with IIoT Platform**—The MES and IoT platforms will coexist and be integrated to provide an ecosystem that is scalable vertically with new use cases and horizontally across production lines and plants. The ability to handle IIoT data leveraging the latest offerings from MES-MOM applications is just one of the many ways MES platform functionalities and IoT platform functionalities converge in manufacturing. As these applications overlap, end-users now have multiple options for reaping the best out of manufacturing.
- **Increased integration with AI Tools** – With powerful computational offerings from cloud, manufacturing applications (particularly MES) increasingly integrate machine learning and AI-based tools that go beyond simple OEE and SPC calculations to digital and innovative use cases. The MES-MOM suite is reorganizing itself to drive model-oriented manufacturing workflows, which are topped up with AI-based manufacturing modules to differentiate themselves. Modules such as Predictive Quality, Predictive Production Operations, and Predictive Asset Maintenance are unique value propositions from MES-MOM applications.
- **Increasing integration of Digital Twin capabilities** - Leveraging the fast scalability and massive storage of the cloud, manufacturing applications (particularly MES and IoT platforms) are increasingly integrating model-based digital representations of factories for process optimization, simulation, what-if/scenario analysis, and other use cases. Though Digital Twin is primarily data-driven at this point, we foresee a real twin being established that brings the physical and data models together and is imbibed into the Twin element. MES-MOM in the new avatar anchors a digital twin of operations to simulate changes such as new shifts, maintenance downtime, asset performance management or availability.
- **Ease of Cloud Infrastructure Setup, Operations and Maintenance**—Because the provider owns the infrastructure, manufacturers do not have to deal with infrastructure setup, day-to-day operations and maintenance. Additionally, upgrades to the infrastructure and boosting resources on demand can be efficiently managed with just a few clicks.
- **Savings through the OPEX nature of cloud infrastructure**—On-premise self-managed infrastructure requires significant upfront investments (CAPEX nature of spend) and can be detrimental based on the manufacturer's strategies for MES applications. Cloud infrastructure driven through a subscription-based model will add to the Opex but eliminate the huge initial capital investment and is preferred for applications like MES.
- **Resource Optimization with multi-plant MES on Cloud** – As cloud-based MES offers setting up multiple sites on a single application instance, it provides a reliable and cost-effective alternative to having site-specific MES infrastructure on-premises in a similar case. The overall cost of ownership, application maintenance and enhancements are reduced drastically with cloud-based MES.

Journey from Traditional MES to Cloud-based MES

The traditional ISA-95 Architecture leverages MES at level 3, and it integrates the shop floor applications and systems with the business systems, thus enabling the passage of manufacturing data into business layers. It is primarily a domain-driven architecture and an abstract model to define domain responsibilities and boundaries. The MES applications usually reside on-premise – within the plant network or a data center and are accessed virtually by the shop floor personnel for factory operations. it follows a distributed architecture model, thereby increasing the cost of ownership.

Figure 3: Traditional ISA-95 Architecture to Cloud Computing Architecture

On the contrary, MES on cloud computing architecture is hosted on a private or public cloud and is centrally accessible to all sites and shopfloor personnel. It is supported well through Edge Computing, which ensures data pre-processing and reliability. Protocols such as MQTT and AMQP for communication across the layers augment the seamless and rapid flow of data packages, thus providing real-time access to shopfloor events on the MES platform.



What are the options for setting up a Cloud-based MES …

MES on cloud enables agile, resilient, and highly autonomous manufacturing and quality systems by embedding Industrial IoT and intelligence into manufacturing operations and supply chain processes, thus driving digital business transformation for discrete and process industries.

Most existing and legacy MES support migration to cloud are set up on an **IaaS Cloud model** without changes to the underlying architecture. This is a 'lift & shift' model and supports the enterprise initiative of application consolidation on cloud. The manufacturers must manage initiatives for MES, such as application enhancements, application version upgrades and patch updates. The benefits are limited to bringing applications together on the cloud infrastructure, thus saving on infrastructure and hosting costs.

Importantly, vendor products like DS Apriso and Siemens OpCenter do not provide cloud-native architecture. They utilize IAAS—Infrastructure as a Service —where virtual machines are used to deploy MES. Vendors have not designed their products with microservices or containerized architecture to deploy the MES on cloud at a highly flexible scale.

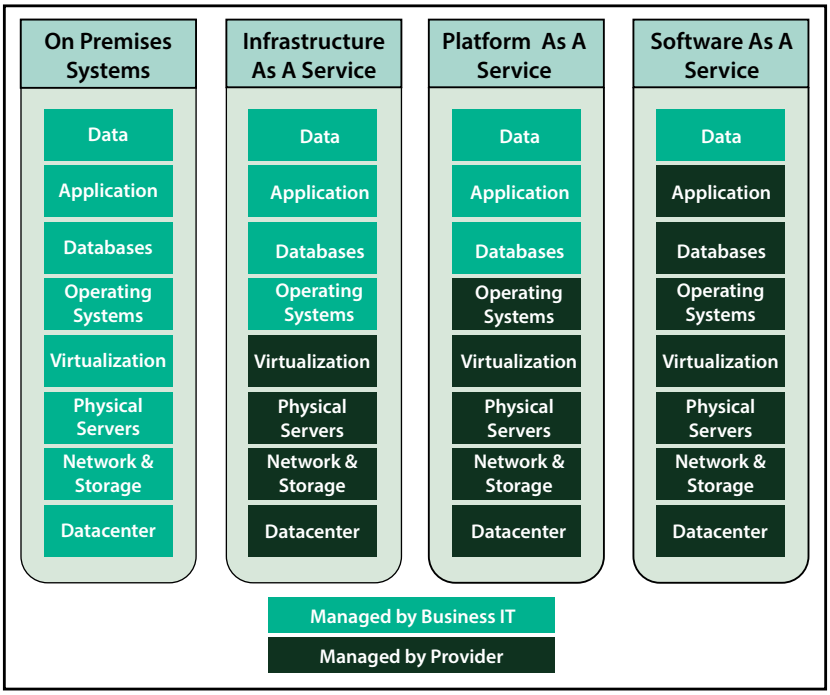


Figure 4: Cloud Deployment Models

The PaaS cloud model is also not much different. It provides additional coverage regarding the operating system, whereas we still require following the 'lift & shift' model for MES. The only advantage over the IaaS model is that the provider will manage the underlying OS's maintenance, upgrades and upkeep.

The true essence of the cloudification of MES lies with the **SaaS cloud model**, where the application is a native cloud application managed by the provider. A SaaS MES combines many possibilities with connected modules, digitally orchestrating sustainable manufacturing, resulting in lower costs for finished products, increased margins, and higher returns on assets. It helps break down manufacturing silos through a single data model and a well-connected and integrated manufacturing process. Powered by AI and advanced analytics framework on cloud, it enables utilizing business and operational data points to analyze the root cause of inefficiencies and predict failures in real-time. Cloud-based digital MES helps to automate processes and resources, improving manufacturing efficiency, quality and productivity.

Some SaaS MES provided off-the-shelf include SAP DM, Tulip MES, Plex Systems, Critical Manufacturing, iBaseT Solumina, and AVEVA Wonderware MES.

Companies have a long way to go before adopting cloud MES systems. While SaaS MES applications are set to revolutionize and reverse the trend by 2030, we find limited adoption now. With current trends, almost 60% of industries still rely on on-premise MES systems. However, there is an increasing push for the SaaS MES platform on a private cloud. Industries are navigating to a sensor-driven smart production with IIoT as the driver and are embracing SaaS-based MES platforms, though the RoI has yet to be established for some of them. Manufacturers need to be educated on the process and business ROI from the transformation rather than using reasons related to technical obligations, cost of ownership, reduced maintenance hassles, etc.

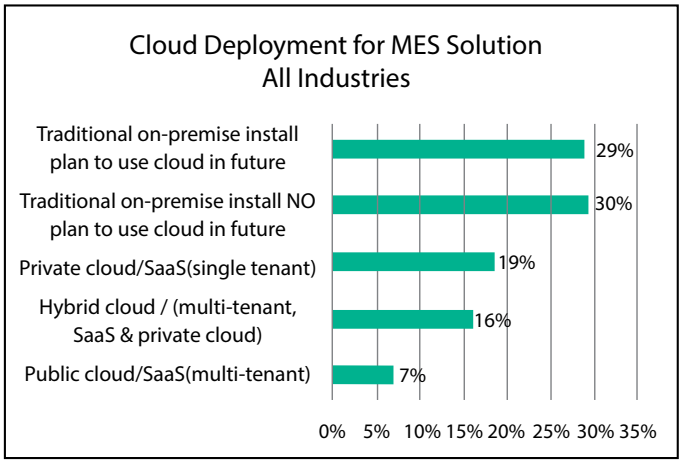


Figure 5: Industrial Adoption towards Cloud Deployment Models[1]

Studies and analyses have suggested that best-in-class and large-scale manufacturing enterprises continuously invest in cloudification of MES and drive continuous improvements in a closed-loop process. Table 1 captures the sentiments towards cloudification of MES platforms based on the size and position of enterprises.

Cloud Model	Best-in-Class	Average	Laggards
Traditional on-premises install (Plan to use cloud in future)	25%	35%	20%
Traditional on-premises install (no plan to use cloud)	5%	20%	55%
Private Cloud/SaaS (single tenant)	20%	5%	5%
Hybrid cloud / SaaS (multi-tenant & Private cloud)	30%	20%	5%
Public Cloud / SaaS (multi-tenant)	20%	20%	15%

Table 1: How Enterprises are adopting MES Clouds

Reference Architecture for MES on Cloud (SaaS Model)

The I4.0 ecosystem provides several opportunities to shape next-gen systems for smart businesses. MES on cloud shall lay down the factory of the future, integrating micro-services-driven MOM (Manufacturing Operations Management) applications synchronized with IIoT platforms for effective transaction management, process controls, data collection, etc. It is powered with predictive and prescriptive analytics available through various cloud apps for setting up an intelligent enterprise. The seamless integration from the shop floor to enterprise systems helps to democratize manufacturing data and bring transparency to operations and processes.

The horizontal communication between various modules at the MES level facilitates unparalleled knowledge sharing between Man, Materials, Machines and Methods (the 4Ms of MES).

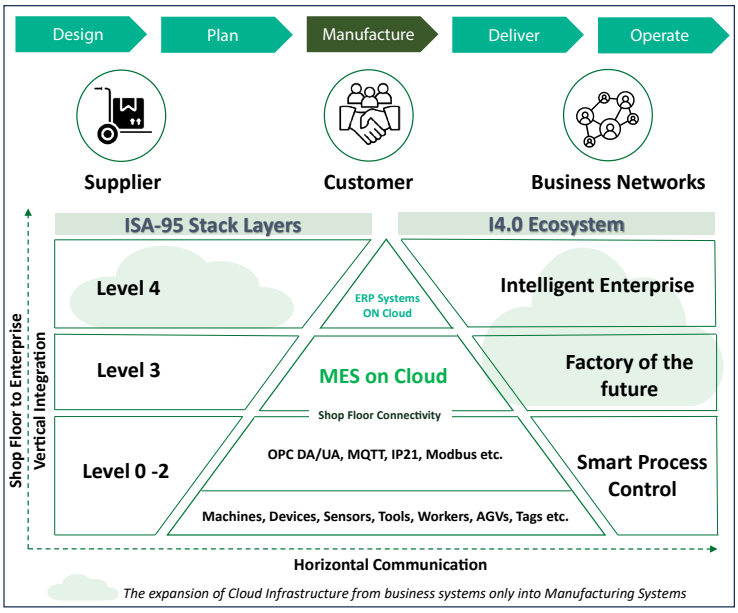


Figure 6: Logical Architecture: The I4.0 Ecosystem of MES on Cloud

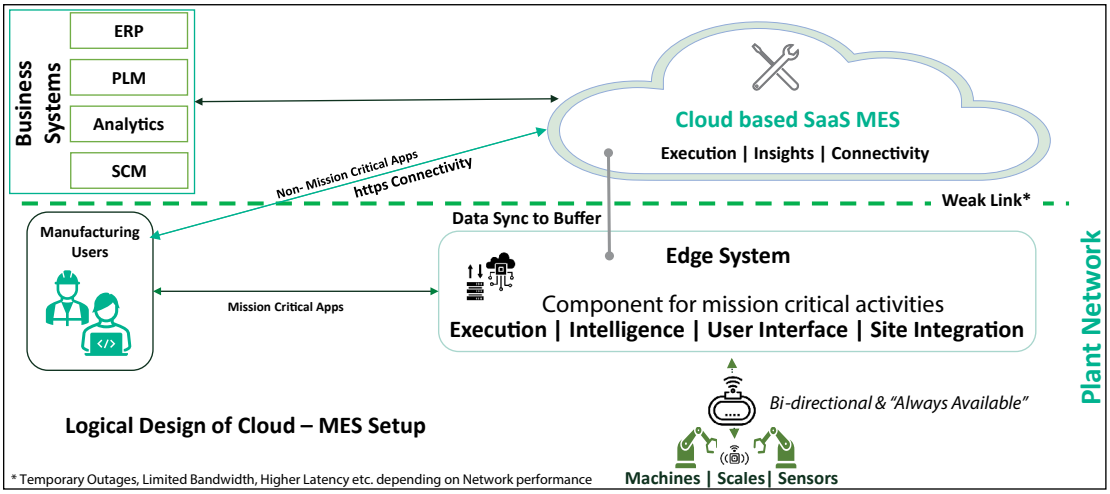


Figure 7: Reference Architecture for Cloud – MES Setup

Figure 7 depicts the reference architecture of a typical cloud-based MES application. While there will be nuances between MES (cloud-based SaaS) from various providers based on the product base architecture and its potential, the overall data flow architecture will be similar in most cases.

The Edge system provides adequate storage and data processing capabilities to bridge gaps arising from connectivity/network/availability and be a definitive option ensuring no data loss and zero impact on operations. The continuous data sync between cloud MES and Edge system keeps both platforms in sync for mission-critical activities such as process execution, manufacturing data and real-time intelligence information on assets and resources from the shop floor. The store-and-forward approach through MES Edge provides a reliable way for implementing an in-memory cache for MES on cloud. It ensures the delivery of shop floor data to cloud MES and stored efficiently in MES Edge. Furthermore, other vital benefits from MES Edge include:

- Data loss prevention: Data is removed from the system only when the write to the database has been executed successfully.
- Guaranteed ordering: Data is forwarded in the same order it arrived, even if a database connection is unavailable.
- Enhanced performance: The store-and-forward system can optimize writes and prevent the originating systems from blocking. This means the system is less likely to lose data samples during a slowdown.

The business systems on cloud shall stay connected to the cloud MES, bring together the critical analytics paramount to the business, and provide an integrated view of enterprise and production systems on a page.

A key architecture consideration is offline operations. The architecture should support MES functions even during connectivity and network issues to the cloud. Production and production operations should not stop when MES is in the cloud.

The deployment model on cloud can follow a single-site or multi-site deployment model. Manufacturing aspires for increased decentralization as production plants become "virtual production entities" managed on MES applications. Requiring a highly flexible way to handle vertical and horizontal integration, each virtual production entity will contain an increasing number of smart sensors, actuators or equipment generating a continuous stream of data. This data is required to control flows and quality and be used for automated analytical purposes. It seems inevitable that the MES used in such smart industries will "live in the cloud."

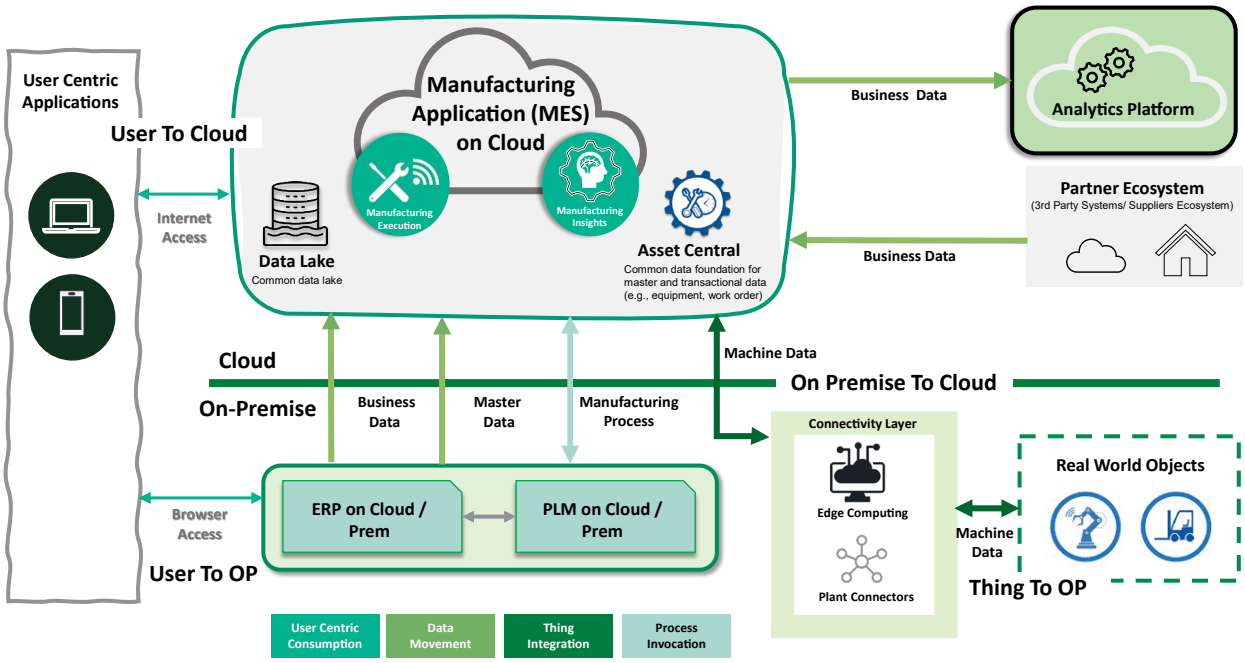


Figure 8: MES Ecosystem on the Cloud – Single Site Deployment Model

As we know, there are significant differences in the manufacturing ecosystem, even within an enterprise. The differences can be related to processes, machines, operations, line setup, or special instructions and can vary from material to material and from one production line to another within the same site. The following architecture (Figure 9 encapsulates the differences and can best serve the needs of individual locations while providing common KPIs for analyzing location manufacturing performance and health.

While ERP, along with PLM, can be the single source of planning and master data for all shop floor processing, the plants may use their individual Data Concentrator PLCs and Edge Device combination or may share the architecture based on region (or it may use a Web Application Server for collecting data across sites before pushing to MES on the Cloud). However, all sites may have to use some Plant Connector APIs, such as OPC servers, for data collection. All data rolls up to common KPIs using the MES Manufacturing Insights (Reporting app) with a common Data Lake on the cloud. Data can be available to other cloud-based analytics platforms for enhanced/advanced analytics.

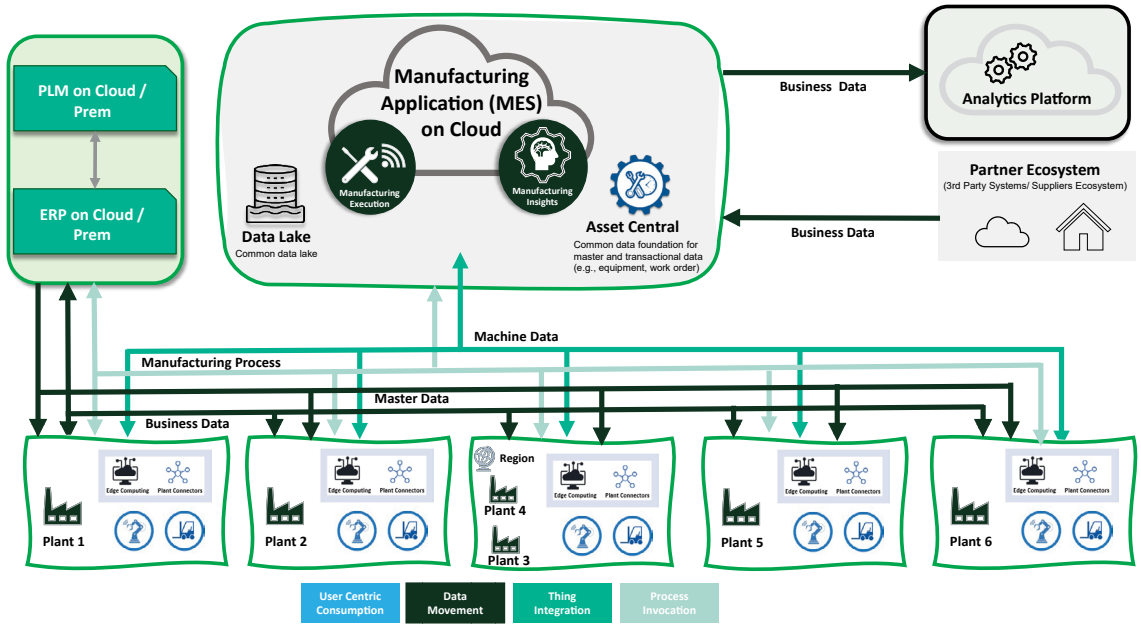


Figure 9 : Multi-Site Deployment model for MES on Cloud

Advantages with Cloud-based MES

Cloud-based MES drives greater agility and flexibility at the helm of lower control than on-premise MES. It utilizes third-party cloud computing services to provide the necessary resources for MES, allowing manufacturers to focus on their core competencies and rely on the service provider for MES maintenance.

Some key benefits that cloud-based MES offer compared with on-premise MES are:

1. Cost of Ownership—Cloud-based MES eliminates the cost of procuring and maintaining hardware and software related to MES. Additionally, there is greater flexibility in reducing computing resource use based on usage.
2. Scalability - Cloud-based MES provides a scalable, faster, and swift configuration framework that helps the speedy rollout of applications across sites in the ecosystem, enabling rapid deployment.
3. Accessibility—Real-time operational data can be accessed anytime, connecting departments and improving communication. Ease of access also leads to greater utilization of MES and employee compliance.
4. Mixed Mode Manufacturing—Businesses can be more agile in supporting the right mix, respond quickly to evolving markets and customer demands, and be resilient to disruptions in the supply chain with better predictability.
5. Enhanced Customer Experience – Cloud-based MES streamlines operations, maximizes production, and, most importantly, helps exceed customer expectations through real-time decision-making across multiple facilities, shortened time to market, improved quality, reduced operational costs, and increased customer confidence and market share.
6. Decision Making—Real-time data ingestion into MES on cloud enables real-time decision-making augmented through advanced analytics and intelligent recommendations.
7. Flexibility in Operations - MES on cloud provides the unique advantage of being accessed from everywhere, providing greater flexibility in ways of working.
8. Periodic Updates - The service provider is responsible for keeping systems, infrastructure, and applications (in the case of SaaS) current. Manufacturers do not need to spend time and investments updating their systems and applications to the latest versions.

9. Smart Integration—IoT gateways enable edge computing and Edge-Cloud integration, and services provide smart integrations, hence driving the sensors-to-insights manufacturing model.
10. Business Systems Collaboration – MES on Cloud enables clean and native integrations with business systems like PLM, MES, ERP, and CPQ through cloud-native integration methods and adapters.

In addition, it also provides the extended benefits through: –

1. Unraveling hidden opportunities to Boost Operational Efficiency - MES data on cloud is provided a meaningful base through advanced analytics, transforming it to actionable insights and uncovering improvement ideas and limitless potential on the floor, thus gaining operational efficiency and competitive advantage.
2. Gain Agility and Improved Performance—Production operations can be handled more swiftly by storing operational data on cloud instead of dealing with vast amounts in local storage. With MES upgrades leveraging containerized architecture, application downtime is almost eliminated, and better ROIs emerge with new features.
3. Intelligent Insights across the Hierarchy - MES on the cloud provides innovative ways to combine and access data remotely and track end-to-end manufacturing from enterprise to shop floor, thus enabling fast and best decision-making. The digitized MES technology harnesses invisible data and provides role-based value-added information.
4. Reduce Local Data Storage Costs - Storing years of operational data is usually a compliance requirement for most manufacturers, but on-site server costs quickly add up. It is cheaper and affordable for manufacturers to keep the required subset of their operational information on cloud, thus reducing the need for on-premise data storage.

Synopsis of Cloud-based MES over traditional MES – A practitioner's view …

As elaborated above, cloud-based MES platforms have promoted an all-inclusive manufacturing application software, with MES being the backbone in recent years. These packages have encompassed features and functions offering Manufacturing Operations Management (MOM) to enterprises. While the features and functions vary between packages and are mostly specific to the line of business (domains), we have presented the key values delivered by cloud-based MES platforms over traditional MES.

- **Integrated Golden Triangle Framework** – MES, ERP and PLM make up the holy trinity of manufacturing. MES on cloud embraces a built-in integration framework for seamless exchange between MES, ERP and PLM systems. It drives a pan-enterprise digital integration, thus simplifying the supply chain process.
- **AI-enabled Chatbots** –MES on cloud provides features leveraging AI, bringing together process optimization, quality assurance and asset capitalization. Chatbots have been popular with blue-collar personnel, enabling them to execute manufacturing processes smarter and at lightning speed.
- **Extensive Reporting Booth**—With an in-built analytics engine and automatic reporting environment, it provides a self-service composition framework to build reports spontaneously churning through a massive set of underlying connected data. Additionally, it gives a well-oiled reporting framework powered by AI that brings together predictive and prescriptive analysis.
- **Digital Fabric Offering** – Combining multiple digital threads to ensure a true cross-silo and multi-enterprise data flow by stitching together the digital threads to a digital fabric. This is important for industries with complex products and systems that aid in synchronizing and unifying multiple digital models (Digital Twins).
- **Connect IOT**—These packages combine a wide range of drivers and integration adapters for seamless IoT connectivity. Devices and sensors on the floor handle Edge processing, leveraging connectivity networks such as Bluetooth, Wi-Fi, Zigbee and LoRaWAN.
- **Continuous Evolution and Enhancements**—Being competitive, cloud-based MES platforms rapidly expand their offerings and introduce new features and beneficial functions to enterprises every quarter or so. While most features add value to the application experience, they are also rolled out specifically to industries.

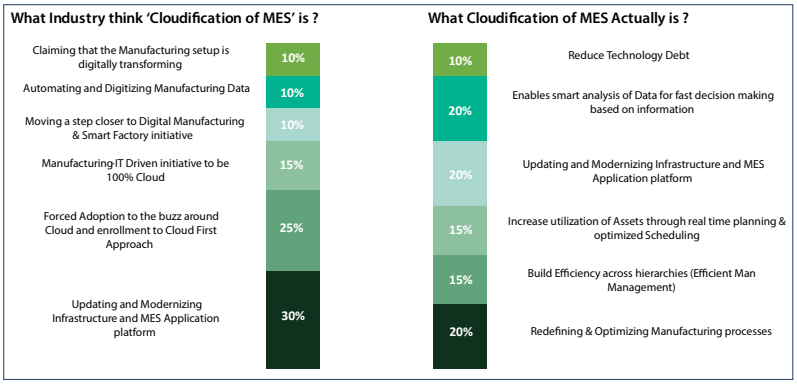
Understanding Industry Sentiments towards Cloudification of MES …

An all-inclusive MES system is an absolute necessity, and the industry is keenly watching trends as the competitive products seem to move from an on-premise MES application to a cloud-based MOM platform enhanced with IIoT features powered by AI frameworks.

Gartner (based on 2019 MES Magic Quadrant report) states, "By 2024, 50% of MES solutions will include IIoT platforms synchronized with microservices-based manufacturing operations management (MOM) apps, providing near-real-time transaction management, control, data collection, and analytics." Complementing it, Gartner (based on 2023 MES Magic Quadrant report) recently quotes ""The next phase in the evolution of MES will be the convergence of technologies (processes) that support end-to-end supply chain planning and execution functions. These capabilities will increasingly be provided through composable enterprise technology platforms, applications and processes."

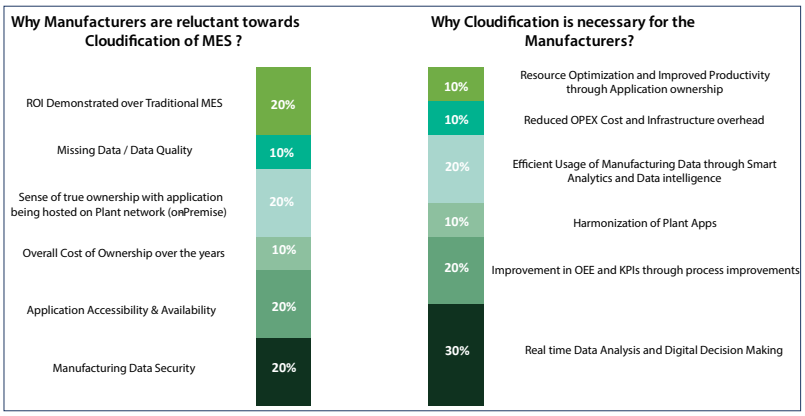
Our analysis and interactions with various manufacturers show that as many as 70% of MES users prefer cloud over on-premise. While just over 15% have migrated to Cloud MES (SaaS), the rest plan to "lift and shift" MES applications soon.

Furthermore, our surveys across industry segments (across roles and capacities) have demystified their sentiments on cloudification of MES: -



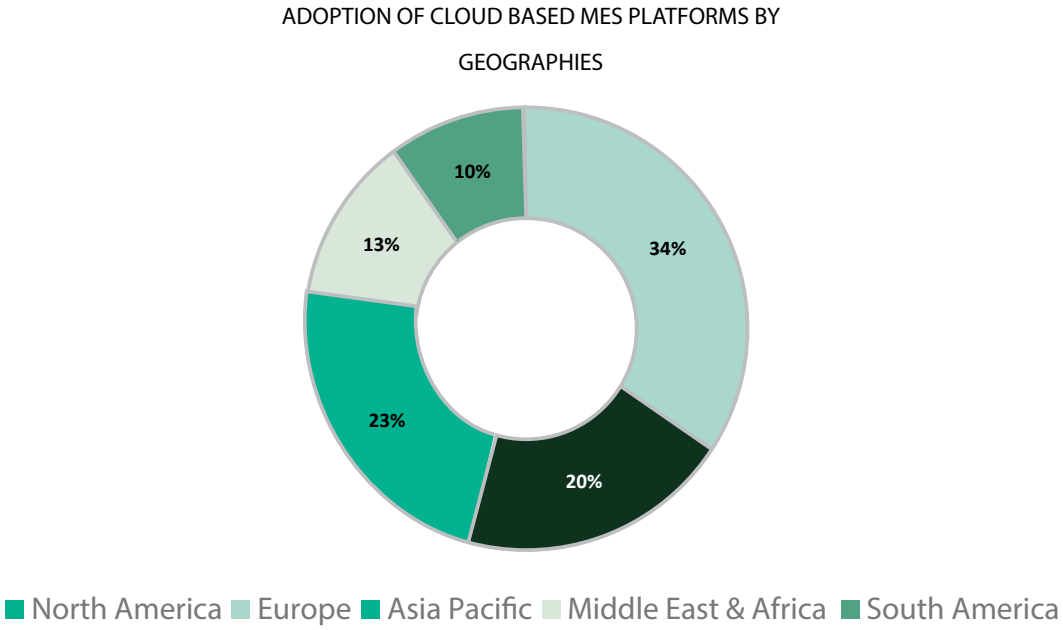
Graph 1: Industry Sentiments Towards Cloudification of MES

Additionally, we tried to understand the manufacturer's reluctance to embrace cloudification of MES by capturing the key reasons and their perceptions towards it. In the process, we also educated them on the significance of this transformational approach.



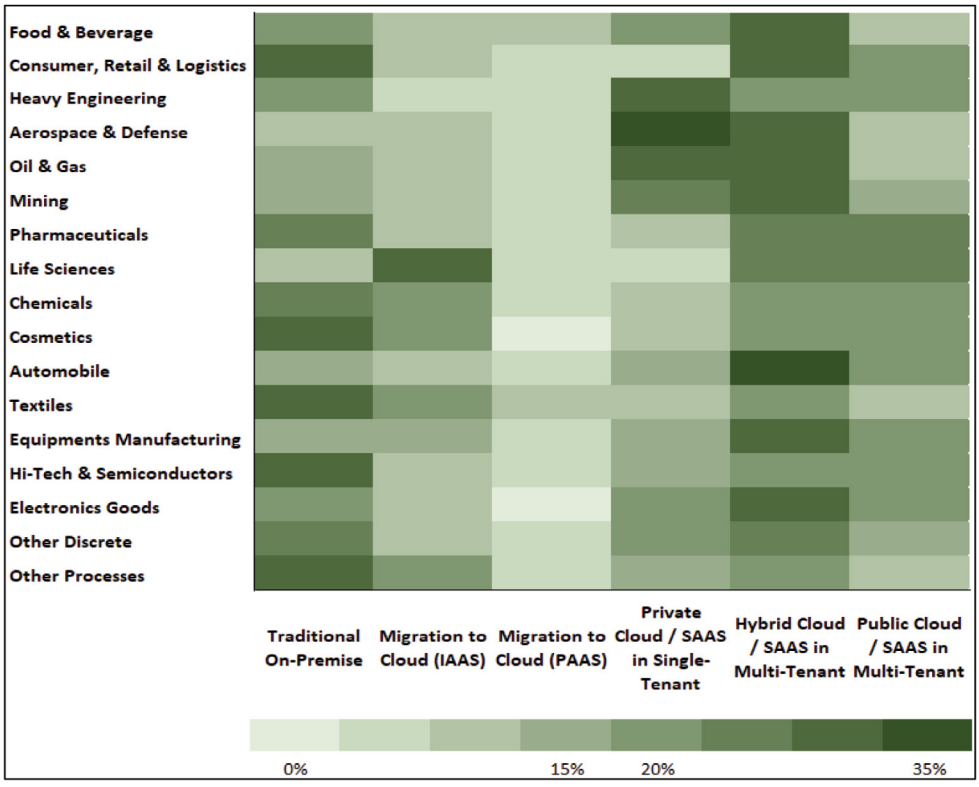
Graph 2: Importance of Cloudification of MES for Manufacturers

Additionally, we discovered a surge in North American manufacturers migrating towards cloud-hosted MES solutions—Rockwell's recent acquisition of Plex points to this trend. Europe and the APAC region are increasingly interested in migrating MES to the cloud. At the same time, traditionally labor-intensive markets may transition significantly later.



Graph 3: Cloudification of MES by Geographies

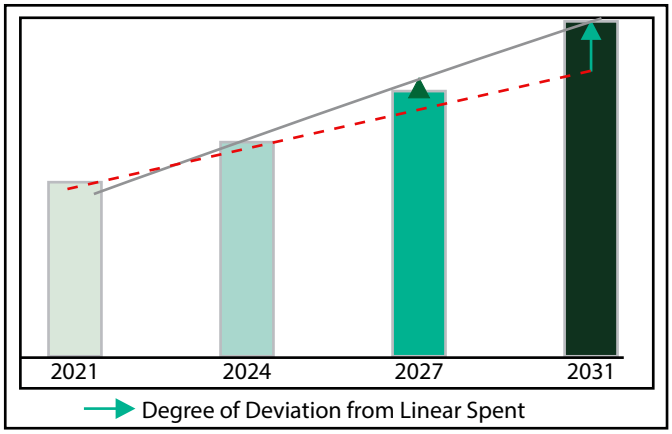
While there has been a migration from traditional on-premise MES setup to cloud-based MES, we saw that most industry segments intend to move towards SaaS MES in a hybrid cloud setup. Currently, the urge towards cloudification of MES systems is more prominent in discrete industries, and the trend has steadily captured all segments over time.



Map 1: Cloudification of MES by Industry Segments

Transitioning from an on-premise MES model to a cloud-based MES (SaaS MES product) has started slowly. Multiple factors, including geographies, IIoT adoption, IT-OT Convergence, ROI evaluation and socio-economic factors, primarily drive this.

However, based on the analysis, we expect a surge post-2024, when it is predicted to grow above the linear trend. A key reason is the growth forecast for the APAC region, where MES adoption is nascent and has tremendous potential. This is proportional to IIoT adoption and the smart movement to Industry 4.0 across segments and enterprises.



Graph 4: Cloud MES Market Growth Predictions

Migrating to Cloud: Be cautious of Factory feelings …

MES is not just an application; it connects the shop floor personnel with systems that they are emotional and possessive about. Business operations are always a priority. As manufacturers decide to migrate their MES systems from traditional on-premise to cloud, they must be aware of the critical success factors for the migration journey. Each attribute needs to be handled and demonstrated carefully for successful adoption and to help eliminate concerns and wipe out rumors.

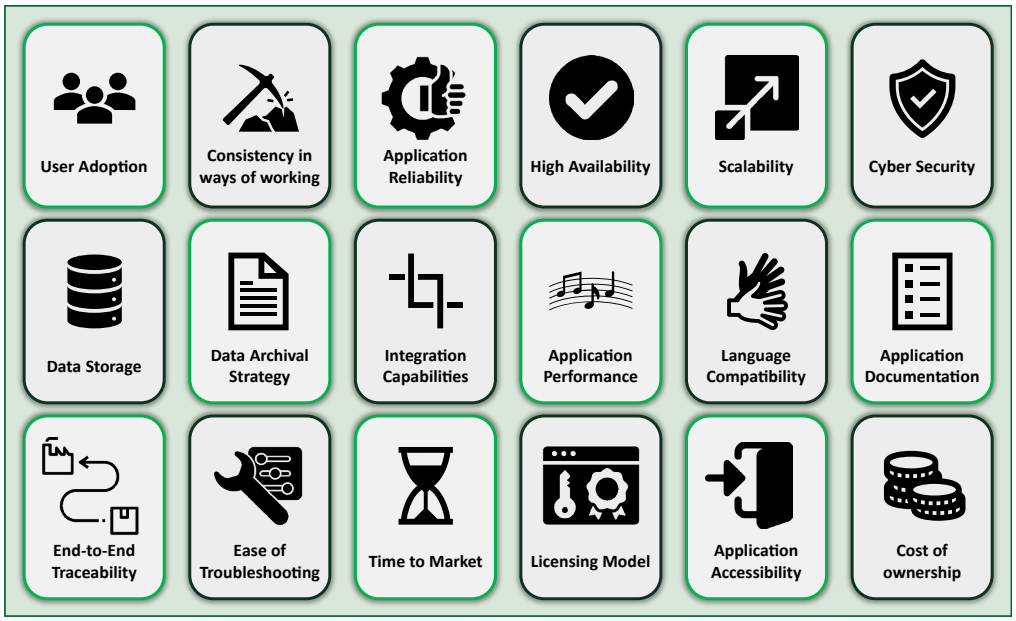


Figure 10: Cloudification of MES - Managing Factory sentiments.

Migrating to Cloud: How do we enable floor adoption …

Shop floor adoption is a necessary metric to determine the success of MES transformation programs. As a business-critical application, launching it across resources with confidence is essential. On the flip side, poor adoption and resentment lead to the identification of an alternative option, even restoring the previous application within weeks. These are the fundamental guiding principles that can help ensure floor adoption: -

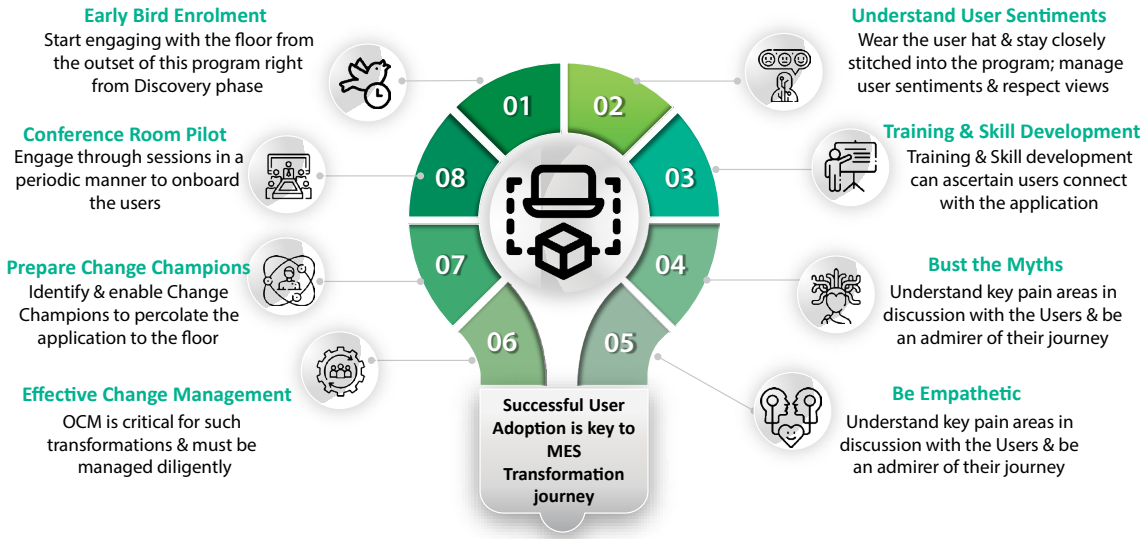
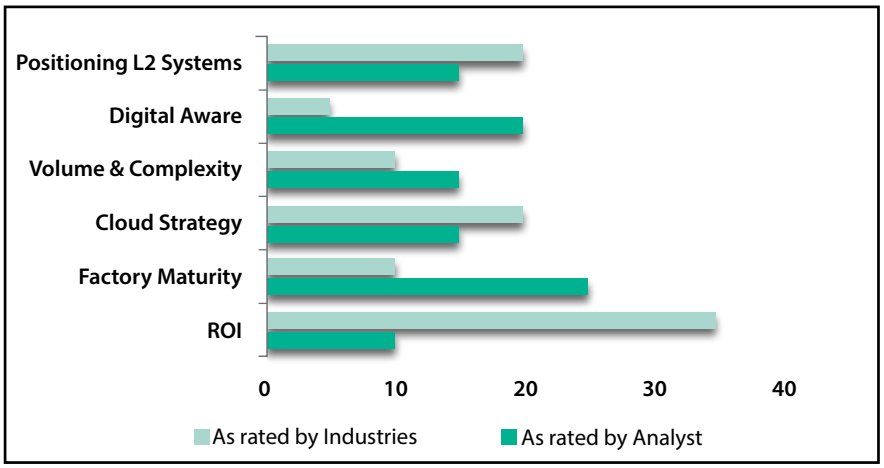


Figure 11: Cloudification of MES – Enabling Floor Adoption

Key Decision-Making Levers: A Strategic Step for Manufacturers

For industries already engaged with on-premise MES product setup (centralized or decentralized), migrating to a cloud-based MES-MOM product is strategic and requires decision-making. This step involves considering various factors and risks. Importantly, they must present a business case to senior leadership to pave the way. Some key levers to be taken into consideration while deciding on this transformative strategy include: -

- **Factory Maturity**—Leveraging Acatech[2]'s Industry 4.0 Maturity index, one can assess an enterprise's maturity level and make a data-driven decision on cloudifying MES. When combined with digitalization guided by Smart Factory initiatives, cloudification can yield significant benefits.
- **Overall Cloud Strategy**—The adopted cloud strategy across the ecosystem and IT landscape must be considered when deciding on MES's cloudification. The migration must echo the organization's 'cloud-first' objective.
- **Volume & Complexity** – The volumes and complexity of manufacturing processes usually dictate the customization and hosting of a bespoke MES application. In such cases, it is important to evaluate the features, functions and offerings of the cloud MES application to make a fruitful decision.
- **Digital Awareness** – MES on cloud brings numerous additional functions covering MOM aspects. Before the move, manufacturers must ensure that the business and a large section of factory personnel are digitally aware and willing to participate in this massive transformation journey.
- **Positioning of Peripheral OT (L2) systems**—Since MES involves a lot of interaction with L2 systems, it is imperative to understand the flexibilities offered by these applications in terms of integration and data exchange with MES systems. While several options are available for seamless integration, this must be factored in for informed decision-making.
- **ROI**—ROI is an important factor in effective strategy and planning. While considerable investment is made in product licensing, migration, support and so on, presenting a business case on ROI in tactical and strategic terms is essential. For budget-constrained industries, ROI has always been a factor to rely on.



Graph 5: Cloudification of MES - Key decision-making levers.

Use cases¥

European Vehicle Products Manufacturer & NVH Expert

As we grasp the benefits of setting up an MES system on cloud (leveraging SaaS MES), there has been a significant benefit for manufacturers with the implementation of such platforms with other digital initiatives. The following cases depict the advantages of the setup of a cloud-based MES system in factories: -

A manufacturer sought to standardize their global manufacturing operations across multiple (>50) European sites and used a cloud-based MES product. After successfully implementing the pilot site on MES, they rolled out the solution using a golden template approach across other sites. Digitalizing prototype production processes with a cloud-based ERP platform ensured a smoother transformation and a holistic digital manufacturing state. Key features included paperless production, maximum digitization, continuous traceability from raw materials to parts and attaining sustainability goals (CO2 savings with 100% green energy).

European Consumer Products – Food Processing

A food processing giant envisioned their journey for digital manufacturing to reduce TCO and increase the efficiency of operations. A series of transformational steps, including the cloudification of the MES-MOM platform, helped them to realize the digital strategy. An end-to-end integration between processes for asset utilization and continuous monitoring helped reduce downtimes. The cloud-based MES system helped to build a paperless shop floor and enhanced operator guidance through digital work instructions.

¥ These cases are prepared based on customer surveys and not implemented by Infosys.

Conclusion

Harnessing the power of digital transformation in manufacturing under the Industry 4.0 umbrella has been the norm worldwide despite their spends, size and revenues. With the core objective of cloud-first, cloudification of MES is a key step and paves the way for cloudification of the entire MOM ecosystem (Level 3 systems). Most MES platforms in the market are transforming themselves to deliver SaaS packages that inherit traits of the IoT ecology.

Successful and proper implementation of cloud MES delivers attractive returns across a wide range of segments, leading to more empowered decision-making, new opportunities for process optimizations, upskilling and cross-functional collaboration, eventually navigating your next. level.

Benefits	Range
Infrastructure Cost ↓	20-25%
OEE ↑	4-8%
Asset Uptime ↑	15-20%
Cost of Quality ↑	10-15%
Forecasting Accuracy ↑	20-30%

Table 2: Value Potential with Cloudification of MES

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References

1. What Is the MES Technology Doing for the Next Generation?
2. https://www.acatech.de/wp-content/uploads/2018/03/acatech_STUDIE_Maturity_Index_eng_WEB.pdf