Magic Quadrant for Manufacturing Execution Systems

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MES solutions are a foundational building block of smart manufacturing strategies and digital business for manufacturers. MES technology is evolving and propelling the market in a new direction. Supply chain technology leaders should use this research to help select vendors and solutions.

Strategic Planning Assumption

By 2025, 60% of new manufacturing execution systems (MES) solutions will be assembled by manufacturers or implementation providers using composable technology.

Market Definition/Description

Gartner defines manufacturing execution systems (MES) as a specialist class of production-oriented software that manages, monitors and synchronizes the execution of real-time physical processes involved in transforming raw materials into intermediate and/or finished goods. These systems coordinate this execution of work orders with production scheduling and enterprise-level systems like ERP and product life cycle management (PLM). MES applications also provide feedback on process performance, and support component and material-level traceability, genealogy and integration with process history, where required.

These capabilities extend the product/process design release (PLM) and work order/batch order release (ERP) through completion of the manufacturing process for both process and discrete industries. Gartner's view of the MES market does not include production automation or operational technology (OT) software, such as supervisory control and data acquisition (SCADA), distributed control systems (DCSs) or programmable logic controllers (PLCs). It does not include Industrial Internet of Things (IIoT) platforms per se (see Magic Quadrant for Industrial IoT Platforms), unless the IIoT platform is part of the MES offering.

Core MES Functionality

Manufacturing execution systems have nine core functions:

- **Dispatching:** The ability to dispatch work based on global instructions from ERP or production scheduling systems, adapted to meet resource availability, schedule requirements and capacity.
- **Production management, execution and in-process quality monitoring:** Managing the production process from order release to work in process (WIP) to finished goods.
- **Manufacturing data management:** The capability of collecting and managing data manually from end users, at regular intervals from a data storage source (e.g., data historian), directly from equipment, or some combination thereof. This is data spanning domains of quality, process status, job/order status, regulatory compliance, labor collection and tracking/product genealogy, to name a few.
- **Operational data store:** An operational data store can be anything from a simple relational database for transaction-based operational data or integration capabilities to a data historian or IIoT platform for time series, streaming and transactional data.
- **Manufacturing-related quality management processes:** For regulated environments, where corrective and preventive action (CAPA) and nonconformance workflows are required to be inextricably linked to the production process.
- **Procedural enforcement:** Ensuring that all manufacturing process steps are performed in the correct order, at the right time, by the correct resource and in conformance with quality requirements.
- **Tracking and genealogy:** The ability to track by lot, batch, serial number or other unique identifier where each item is in the production process. And, as required per industry, the source and unique identification of the parts and materials that compose the item being tracked, as well as the equipment and personnel, in support of regulatory compliance, field service and product recall management.
- **Integrated analytics and reporting:** Tools and techniques for generating key performance indicators (KPI) results, performing advanced analytics and providing dashboard displays and datasets for performance monitoring and reporting.
- **Sophisticated integration capability:** Use of software development kits (SDKs), schemas and APIs to integrate:
  - Production equipment (process historians, robots, PLCs, SCADA systems, edge devices, data collection systems).
  - Enterprise systems (ERP, supply chain management [SCM] for materials management, inventory, order status, completions).

- Engineering/PLM (model-based planning with automated routing, work instruction and related data flowing to the MES environment, bill of materials [BOM]/recipe management and engineering change management).

Extended MES Functionality — Manufacturing Operations Management (MOM)

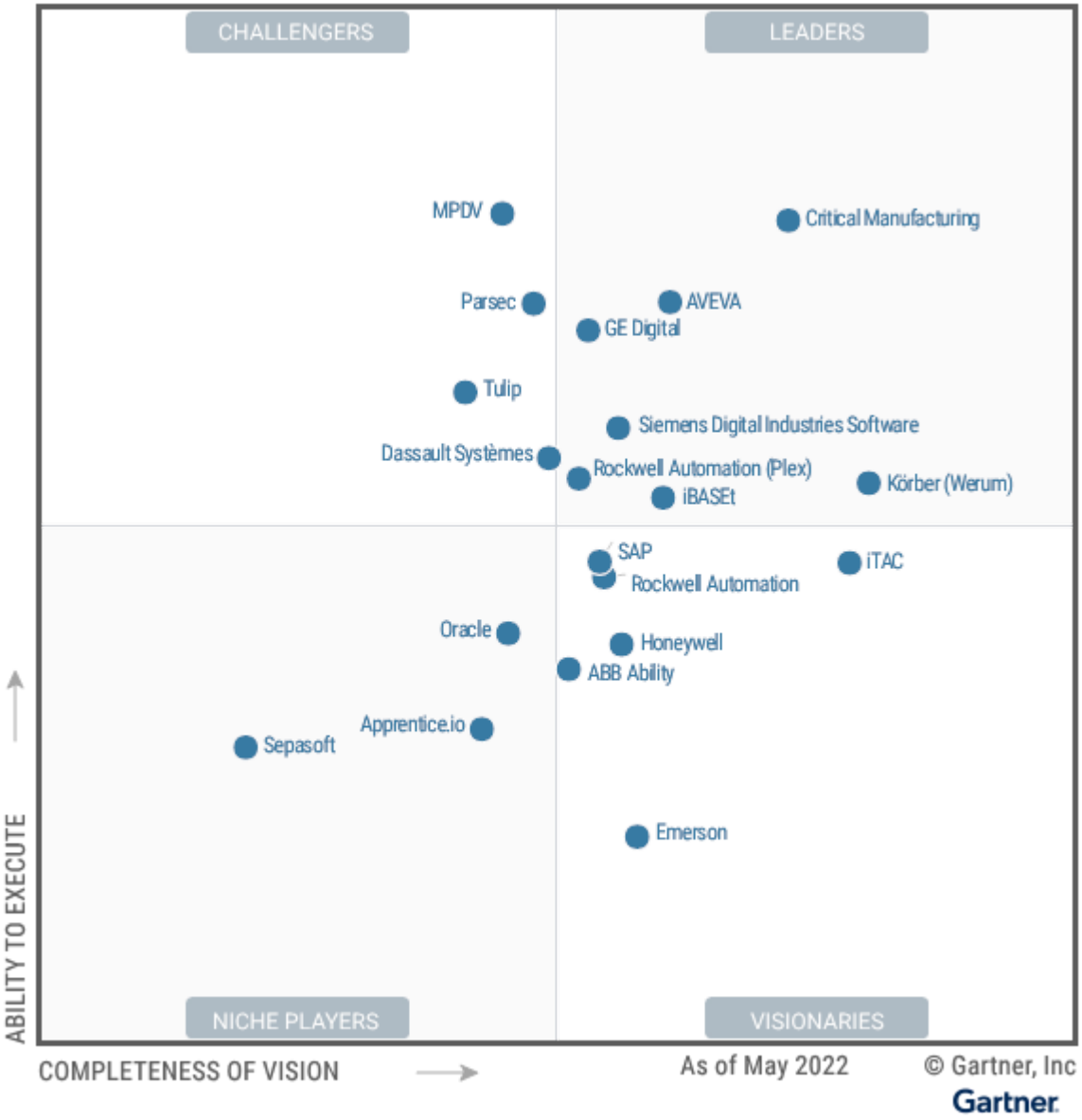
As the MES market has matured and expanded, additional capabilities have been added by MES vendors; these are typically referred to as manufacturing operations management (MOM) functions. This has led to some vendors referring to their solutions as MES/MOM, or simply MOM. The term "manufacturing operations management" is defined as Level 3 of the ANSI/ISA-95 Enterprise-Control System Integration standard. [1]

This extended functionality is defined in Note 1 at the end of this document. MOM functionality is not considered in the scoring in this Magic Quadrant.

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 (see Understand the Need for Supply Chain Execution and Manufacturing Operations Management Convergence). These capabilities will increasingly be provided through composable enterprise technology platforms, applications and processes (see Becoming Composable: A Gartner Trend Insight Report). In recognition of this trend, emphasis has been placed on vendors' vision and ability to execute recognition of the new paradigm of the composable enterprise.

Magic Quadrant

Figure 1: Magic Quadrant for Manufacturing Execution Systems



Source: Gartner (May 2022)

Vendor Strengths and Cautions

ABB Ability

ABB Ability is a Visionary in this Magic Quadrant. The ABB Ability Manufacturing Operations Management suite is a manufacturing operations and asset management suite. ABB's operations are geographically diversified, and more than two-thirds of its clients are manufacturers in the oil and gas, chemicals, paper, printing, minerals, and mining industries.

ABB has undertaken a multiyear drive to rationalize and modularize their ABB Ability MOM solution, adopting state-of-the-market technologies (microservices, cloud, edge, no-code). The five pillars of the ABB MOM solution are operational excellence, process performance, asset performance management, sustainability solutions and connected workers.

Strengths

- **Cloud, IoT, edge and sustainability:** As part of the larger ABB Ability platform, ABB capabilities in robotics, logistics and analytics from device (traditional automation and edge) to cloud can be leveraged by customers. ABB has also distinguished itself in adopting sustainability as a core part of its MOM solution, one of few vendors in this research to do so.

- **Vertical/industry strategy:** ABB Ability has increased its industry depth in core markets (pulp and paper, metals, mining). It has also increased industry breadth by leveraging capabilities in one industry and adapting them to other verticals. For example, proven core capabilities have been adapted for battery manufacturing and green hydrogen.

- **Product modularity:** The vision for a modular ABB Ability MOM solution targets all maturity levels of customer (or industry) implementations, from connected operations to autonomous operations.

Cautions

- **Integration to enterprise systems:** ABB is investing in REST APIs for integration, but customer IT departments currently rely on XML files for most integrations. Client inquiries and customer reviews report few out-of-the box integrations to ERP products, which could require additional engineering time during implementation of an enterprise/supply chain management offering.

- **Product enhancements:** ABB Ability has set lofty goals for modular solutions, cloud/edge, and improved user experience. This will be a multiyear effort, and year-over-year improvements are slower in coming compared to some of their competitors in this space. The underlying platform will roll out internally this year, the main components in 2023, and the entire stack will require additional time.

- **User experience**: We have seen no evidence in briefings, client interactions or other sources that there has been any significant advances in the user experience side of the ABB Ability MOM Suite, following the cautions presented in the last Magic Quadrant.

Apprentice.io

Apprentice.io is a Niche Player in this Magic Quadrant. Apprentice's platform serves the drug production life cycle in life sciences, from preclinical process development, through clinical testing, to commercial batches. It is applicable for next-generation therapeutics such as cell and gene therapy (C&GT). Its operations are solely in North America.

Apprentice.io entered the market with a cloud-native, augmented-reality (AR)-based training and collaboration platform called Tandem. The next iterations of Apprentice.io added "paper-on-glass" electronic batch record (EBR) capability, and, more recently, an expansion into MES capability. It has seen significant growth over the past two years, in part due to a unique offering in a growing market (cloud-native MES for biotechnology).

Strengths

- **Platform:** Apprentice.io is one of few built-for-purpose, cloud-native MES in the pharma-biotech space. It is also the only off-the-shelf MES offering that was designed with native augmented reality (AR) collaboration capability.
- **Product features:** The EBR capability is designed for both native creation of interactive instructions and conversion of static word documents into interactive instructions from within Microsoft Word via an Apprentice.io-developed extension.
- **User experience:** Vendor demonstrations show an intuitive, user-friendly interface for both the end-user community and administrators. This view has also been supported by customer references and in speaking with Gartner clients.

Cautions

- **Enterprise integration:** Apprentice.io has taken the approach of creating connectors for specific solutions. At the time of evaluation for this Magic Quadrant, an out-of-the-box connector for Veeva QMS, Ignition SCADA, and OPC UA is available, with integrations to SAP and DeltaV currently in development. Gartner clients and customer references have verified that, regardless of the availability of some APIs, integration is difficult and time-consuming.
- **Globalization:** Apprentice.io states it supports seven languages, but the implementation of these additional languages is limited to screens, not system prompts, or international date/monetary formats. It also lacks local support outside of North America.
- **Product readiness:** While Gartner clients and references state that Apprentice.io shows real promise, there are reports that some feature sets are not complete, and that there are additional functions or enhancements required before manufacturers will take the MES to full production.

AVEVA

AVEVA is a Leader in this Magic Quadrant. Its product that is reviewed in this research (AVEVA Manufacturing Execution System, formerly known as Wonderware MES) is mainly focused on process and batch manufacturing. Its operations are geographically diversified. More than two-thirds of its MES customers are in the process manufacturing industries.

AVEVA continues to develop a suite of model-driven MES capabilities. It has provided these capabilities to end-user clients and has white-labeled the capability with implementation templates as part of an OEM processing and packaging system. These same templates are also used by its model-driven MES implementation partners for customer implementations.

Strengths

- **Core technology:** AVEVA MES continues to be a device-agnostic open platform that provides for flexibility in connecting the MES layer to automation equipment, regardless of vendor. This flexibility includes system simulation and virtual commissioning of automation equipment, resulting in a process digital twin. It has continued to advance its manufacturing execution and analytics functionality via assimilation of the acquired OSIsoft assets

- **Vertical/industry strategy:** AVEVA MES has a strong position in the food and beverage industry, and is also found in consumer products. These two industries account for nearly half of its customer base.

- **Innovative partnerships:** AVEVA is advancing capabilities in supply chain collaboration through partnerships with PlanetTogether for advanced planning and scheduling, supply chain planning vendors, as well as reselling connected worker capability from Poka. It also recently announced a strategic relationship with Accenture's Industry X for smart manufacturing initiatives.

Cautions

- **Development operations:** The pace of innovation in the core product is slower than expected, especially related to availability of MES capability as a cloud-native solution. Cloud solutions are still mostly limited to analytics/reporting and dashboards.

- **Implementation:** The capability now offered in configurable implementation templates is currently available only to a subset of AVEVA implementation partners.

- **Product offering:** AVEVA's choice of growing capability through partnerships presents challenges in integration and configuration management. The impact continues to be felt in its customer base, where customer references continue to voice frustration regarding capabilities not yet fully integrated with different roadmaps and release cycles.

Critical Manufacturing

Critical Manufacturing is a Leader in this Magic Quadrant. The Critical Manufacturing MES is focused mainly on discrete manufacturing, with clients in the semiconductor, electronics, repetitive flow/batch and medical device industries. Critical Manufacturing's operations are geographically diverse across EMEA, North America and Asia/Pacific (APAC).

Critical Manufacturing is continuing to add global system integrators (SIs) to further expand its market presence. Its product roadmap, leveraging its unique data management capabilities, continues its expansion into extended MES, with features including new product introduction (NPI), material logistics and factory automation. It is focusing on simplifying deployments and upgrades in multiple environments, including Microsoft Azure.

Strengths

- **Innovation:** The Critical Manufacturing MES has strong data management, analytics and extended MES capability, supported by a sophisticated platform that manages both IoT and transactional MES data in the same data model.
- **Marketing execution:** As a smaller vendor, Critical Manufacturing is continuously expanding its partner and SI ecosystem. The number of certified resources has grown five times within one year.
- **Customer experience:** Critical Manufacturing continues to enjoy higher customer satisfaction scores than most vendors in this research.

Cautions

- **Geographic strategy:** Critical Manufacturing's geographic presence in North America is growing but still behind EMEA and APAC. Bringing added partners up to speed will take more time.
- **Product or service:** The implementation of a new product architecture was started on the data platform layer, but the application layer and the app store will take longer to complete. Already, customers don't find it easy to migrate to the latest version.
- **Innovation:** Critical Manufacturing has built a proprietary IIoT platform. The ongoing enhancement might be a challenge for this comparably smaller vendor's resources.

Dassault Systèmes

Dassault Systèmes is a Challenger in this Magic Quadrant. Its MES offerings are DELMIA Apriso, which is focused at larger enterprises, and DELMIAWorks, an ERP/MES combination focused at the small and midsize business (SMB) market. Both offerings are focused mainly on discrete and repetitive flow/batch manufacturing. Its operations are geographically diverse; however, the DELMIAWorks product client base is 90%+ North America-based. DELMIAWorks did not meet our inclusion criteria for global coverage and was not included in this research.

Dassault continues to invest in DELMIA Apriso MES and the infrastructure that supports it, including integration to the 3D Experience platform (examples: single sign-on [SSO], integrated engineering and scheduling, etc.).

Strengths

- **Marketing execution:** The Dassault DELMIA Apriso product enjoys strong name recognition and market acceptance. This is evidenced by its appearance in a good percentage of MES selection processes Gartner has assisted in and the relatively large number of "go-lives" reported to Gartner during our Magic Quadrant review.
- **Product or service:** The Dassault DELMIA Apriso product is well-regarded for its high level of configurability across discrete manufacturing and batch/repetitive flow manufacturing disciplines.

In addition to its configurability and new features, such as Operations Experience for the plant floor and plant supervisors, customers give Dassault high marks in customer support and service.

- **Marketing strategy:** Dassault Systèmes continues to leverage acquisitions and its 3D Experience platform to provide global manufacturers with MOM capability, including supply chain scheduling and warehouse management, and integration to its engineering solutions (computer-aided design/computer-aided manufacturing [CAD/CAM] and PLM).

Cautions

- **Innovation:** The DELMIA Apriso product must continue to evolve its architecture to keep pace with the newest technology trends, such as microservices-based architectures and cloud-native technologies. It has a vision and a plan for these technologies, and expects to complete this development in the next two years. However, MES vendors that have taken this journey required three to five years to achieve complete production-ready offerings that were truly microservices-based, cloud-native solutions.

- **Sales execution/pricing:** Gartner clients report that DELMIA Apriso's resource-based licensing model limits expansion and deployment in further facilities. Dassault has stated its new 3DEXPERIENCE Cloud roles will follow the standard 3DEXPERIENCE named user licensing model. However, DELMIA Apriso will continue with the current licensing model for on-premises or a cloud provider of the customers' choice.

- **Product strategy:** The strategy shared with Gartner included changes and enhancements to Process Builder (PB) and Global Process Manager (GPM), and an added data perspective (Factory Resource Intelligence). However, there were no additional prepackaged roles for the MES user experience (UX) — a strength in the last Magic Quadrant. In addition, development activities that would move DELMIA Apriso in the direction of a microservices-based, cloud-native application require leveraging technologies within the 3DEXPERIENCE platform.

Emerson

Emerson is a Visionary in this Magic Quadrant. Its Syncade MES product is focused on life science process manufacturing, specifically pharmaceuticals and biotechnology. Its operations are mostly focused in North America and EMEA, and its clients cover a wide range of pharmaceutical capability — from traditional large pharmaceutical enterprises to small vaccine and C&GT providers.

Emerson has a very ambitious MOM functionality roadmap. Its application set supplements the Syncade and DeltaV (DCS) combination with acquisitions in packaging (PACSystems), asset management and analytics (Plantweb Optics, Movicon), digital twin/simulation (Mimic), and scheduling (Bio-G). However, this analysis covers the Syncade MES only.

Strengths

- **M&A activity:** The merger between Emerson and AspenTech, initially limited to the OSI product line, does represent an opportunity for two experienced software corporations to collaborate on MES in the life science industry.
- **Market responsiveness/record:** Emerson has had successes in the vaccine and C&GT arenas during COVID-19, with accelerated implementations and faster time to value.
- **Offering (product) strategy:** Emerson has effectively used acquisitions (listed above) and partners to extend the reach and range of its total solution (for example, Fluxa's Process & Knowledge Management [PKM] software).

Cautions

- **Product suite:** Getting the most value from the Emerson life science solution requires a set of independent applications (Syncade, Plantweb Optics, Bio-G, ESI, Movicon, DeltaV Batch). Pharma/biotech/C&GT companies may require the entire solution set as Syncade alone may not be sufficient to meet their requirements.
- **Customer experience:** We saw no evidence of improvements to the user interface of the legacy platform since the previous Magic Quadrant publication. This has been validated in customer inquiry calls and customer reviews.
- **Implementation support:** Emerson scores continue to lag behind most other vendors in this research in implementation and training support, as verified by customer reviews.

GE Digital

GE Digital is a Leader in this Magic Quadrant. Its Proficy Smart Factory (MES) product supports process manufacturing, repetitive flow/batch manufacturing and discrete manufacturing. Its operations are geographically diversified as is its client base, although the client base is predominantly in the consumer products (consumer packaged goods [CPG]/food and beverage), chemical and automotive industries.

GE Digital's product includes enterprise system management with zero downtime upgrades, app store deployment, a common no-code configuration hub and configuration templates. It also launched Proficy Orchestration Hub, an application unifies product data from PLM, ERP and MES systems to standardize recipes and specifications across manufacturing plants.

Strengths

- **Innovation:** GE Digital was one of the first MES/automation vendors to embrace new microservices technologies to meld MES and IIoT capabilities. Its late fall 2021 release included cloud-native capabilities as it continues to leverage the new architecture.

- **Product improvements:** GE Digital is one of very few MES vendors to offer process manufacturing, batch/repetitive flow manufacturing, discrete manufacturing and mixed-mode manufacturing from a single application. Its vision has extended to supporting circularity and sustainability, starting with storing energy data in the MES, contextualized with other order data to help customers make better energy decisions based on actual performance.

- **Customer experience:** GE Digital has made marked improvements in its Ability to Execute — most notably, in its customer experience scores. This has also been noted in client inquiry calls, where clients have remarked that there has been a significant positive change in service and interactions with GE Digital.

Cautions

- **New technology platform:** While GE Digital has made enormous strides in the conversion of Proficy Smart Factory (MES) to microservices/containerized applications, this work is not complete, with the conversion of over 10 back-end Windows services expected for 2022. Clients have verified that microservices/containerization is predominantly found in the Operations Hub.

- **Business operations:** During the period of evaluation for this Magic Quadrant, GE announced its intention to break the corporation into three companies, healthcare, aviation and energy, with GE Digital becoming part of the new company along with GE Power and GE Renewables. This is expected to take place in 2024. There is always a possibility that the relative importance of manufacturing operations could change with the new company's focus on energy, from generation to consumption, and on decarbonization and sustainability goals.

- **New API proliferation:** Clients have reported concerns about the proliferation and robustness of the new simpler APIs.

Honeywell

Honeywell is a Visionary in this Magic Quadrant. The Honeywell Forge product is focused on continuous process and batch manufacturing. Its operations are global, and its clients tend to be in the process industries (oil and gas, chemicals, mining and metals, and pulp and paper).

Honeywell as a company has continued its reentry into life sciences with the acquisition of Performix, a Texas-based MES vendor that specializes in both pharmaceutical and specialty chemicals industries. Performix xMES was designed as a bolt-on to SAP ECC 6, but will be expanded to other environments as well. This solution was not included in this research, as the acquisition is very recent. Performix as a stand-alone company would not have met our inclusion criteria, and the life science capability is not part of the Honeywell Forge offerings.

Strengths

- **Industry focus:** More than 75% of the Honeywell Forge client base is in the oil/gas and chemical industries, supported by proprietary knowledge of manufacturing processes from Honeywell's own process technologies and manufacturing facilities.
- **Product delivery:** Honeywell Forge has specialized in-house consulting and delivery capability for advanced analytics and specialized implementation for petrochemical industries.
- **Industry expansion:** Honeywell Forge has added MES capability to support battery production (expected to have a 20% compound annual growth rate [CAGR]), capabilities to support sustainability and energy management in manufacturing, and its reentry into the pharmaceutical MES space mentioned above.

Cautions

- **Customer experience:** Honeywell has made progress on user interface improvements, but not across all product modules. For example, no-code/low-code capability is only available in its mobility apps.
- **Operations:** Some products are on the new Honeywell Forge multitenant cloud platform, built using Microsoft Azure; specifically analytics and visualization. However, replatforming all Honeywell Forge applications will be a multiyear journey and Honeywell Forge has not provided a timeline.
- **Customer support:** Honeywell acknowledged our caution on support from last year's Magic Quadrant, and has reported that it has ramped up customer support; but our interactions with customers have not shown evidence of much in the way of changes.

iBASEt

iBASEt is a Leader in this Magic Quadrant. Its Solumina product is focused on complex, discrete assembly in regulated industries. Its operations are mostly focused in North America, with about 15% in EMEA and less than 10% in APAC. Its clients are predominantly large aerospace and defense (A&D) manufacturers and their suppliers.

iBASEt's microservices-based iSeries launched successfully as a cloud solution via Amazon Web Services' (AWS's) Quick Start program. iBASEt has sold the iSeries product offering on the AWS platform for both SMBs and enterprise clients digitizing smaller sites. Recently announced partnerships with international implementation providers, and with ERP vendor IFS, should help accelerate iBASEt's international growth.

Strengths

- **Vertical/industry strategy:** iBASEt Solumina has a long, successful track record of providing MES functionality tailored for complex discrete assembly, and is targeted at aerospace, defense,

nuclear and other highly regulated industries in discrete manufacturing.

- **Offering (product) strategy:** Unlike most other vendor solutions in this space, iBASEt's aerospace and defense solutions for MES, supplier quality management and maintenance, repair and operations (MRO) were developed organically as part of a suite of capabilities, as opposed to being assembled from purchased applications/vendors.
- **Innovation:** While still incomplete, iBASEt's cloud-based iSeries has been successfully sold and implemented at several midmarket customers. This should be good news for midsize suppliers to the aerospace and defense industry that are looking for a cloud-based, A&D-specific MES.

Cautions

- **Technology progression:** The browser-based UI in iSeries is still being rolled out to some of the iBASEt applications; manufacturers should make sure they understand what areas of the suite are still using older UI technology. The same is true for progress toward low-code/no-code capability. Progress is being made, but the solution is not complete.
- **Global market presence:** iBASEt's customer base is predominantly in North America. Companies outside of this region need to ensure that local implementation and support resources are sufficient for their needs.
- **Customer upgrades:** Existing Solumina G-series customers may face an arduous task migrating to iSeries. As with all MES upgrades, significant customization in the current system may result in time-consuming and expensive conversion when attempting to migrate to iSeries from a G-series environment.

iTAC

iTAC is a Visionary in this Magic Quadrant. The iTAC.MOM.Suite is focused on high-volume, repetitive flow discrete manufacturing. Its clients tend to be in the automotive and electronics industries. iTAC Software can run on-premises or in the cloud, but Gartner estimates that more than 90% of its customers use its solution on-premises. Its customer base is geographically diverse; nearly half are located in EMEA.

Major recent enhancements include a deeper integration of a maintenance manager, interfaces to a data lake for better analytics and reporting, and some low-code options for UI development and business flows. The number of APIs has been significantly increased, making it easier to build enhancements yet allow for upgrades.

Strengths

- **Vertical/Industry strategy:** The integration between iTAC with its parent company, the Dürr-Group, has helped to build enhancements in UI and IIoT by bundling resources and coordinating

development efforts.

- **Geographic strategy:** iTAC has built out its customer care organization, extending its collaboration with partners in a more structured approach. iTAC has taken steps to expand its international presence (e.g., by the acquisition of Canada-based Cogiscan). A number of global rollouts and significant growth in North America are underway.
- **Innovation:** iTAC's architecture offers a workbench to build stand-alone plug-in modules with data integration, single sign-on and a common UI. This workbench is aligned with Gartner's composability vision and allows customers and partners to extend the solution and share extensions via a marketplace.

Cautions

- **Integration to business applications:** Enterprise integration is still based on older technologies, and iTAC has not shown a strong roadmap to improve this. A customer-by-customer approach is often needed.
- **Architecture innovation:** iTAC is working on the refresh of its solution's back end, with first versions not to be expected until the end of 2022. It will take longer to get to a fully composable architecture with more granular components.
- **Market responsiveness/record:** While some progress is visible, a big part of iTAC's customer base is still using older versions and, for whatever reason, is finding it difficult to move to the latest releases. Only a few premier customers have started to adopt the latest capabilities.

Körber (Werum)

Körber (formerly Werum IT Solutions) is a Leader in this Magic Quadrant. Its Werum PAS-X product is focused on the life science manufacturing vertical — predominantly pharmaceuticals and biotech. Körber's operations are geographically diversified, and its clients include a large portion of the top 100 pharmaceutical/biotech companies.

In 2020, Körber unified its entities, including Werum IT Solutions, under a single brand. Körber's pharma software product roadmap for life sciences continues to expand on current success in development of microservices and cloud-enabled EBR capability to other areas of the Werum PAS-X product.

Strengths

- **Vertical/industry strategy:** Körber's Business Area Pharma has a strong knowledge of the pharmaceutical business and a product that supports this business, including best-practice library templates for the different pharmaceutical business processes. It received high marks from

customer surveys, and Gartner inquiry for domain expertise in pharmaceutical processes and valuable consulting.

- **Innovation:** Körber has implemented application life cycle management (ALM) capability to its solution and has continued on the path to cloud-native solutions. Körber has also put additional emphasis on intelligence and analytics with its PAS-X Savvy offering.
- **Implementation and training:** It has also leveraged its internal expertise via implementation and training offerings, including MBR Studio Service, MBR Simulation and its Pharma Academy Software called PAS-X Learn, a digital solution for learning, development and upskilling.

Cautions

- **Market responsiveness/record**: The PAS-X UI has been changed to HTML5, but the front-end technology (running on the client) is in the process of changing from thick-client to web-based. The back-end technology (running on the server) is in the process of changing from monolithic to containerized architecture (cloud technology). Implementation options: Although Körber has addressed faster customer success with its "ready to run" (R2R) methodology, it reports that only 20% of its customers fit the R2R model. The remainder are better suited to the existing "ready, fit, build, run" (RFBR) deployment model.
- **Product dIfferentiation:** Körber's Business Area Pharma has an expansive product roadmap; however, its recent successes are predominantly in traditional pharma and biotechnology. Advanced therapeutic medicinal products (ATMP), including C&GT, are a growing market for Korber, but still a small portion of its business (less than 10% of new name customers in 2020).

MPDV

MPDV is a Challenger in this Magic Quadrant. Its HYDRA X MES product is broadly used in a variety of manufacturing disciplines across process, batch/repetitive flow and discrete industries. Its operations have been focused in EMEA, although MPDV's resources and customer numbers in North America are growing fast.

MPDV has completed its work on a web client and has released the result as Hydra X. Some MPDV partners go beyond individual implementations and have provided functionality extensions on the Manufacturing Integration Platform (MIP) marketplace. Hydra X supports both discrete and process flow manufacturing. It has built out its North American operations and is further enabling more partner resources for sales and implementation support.

Strengths

- **Product strategy:** MPDV is transforming its UI to a fully HTML5-based technology, which will allow users to adapt it more easily for their needs and will ease deployments to mobile devices.

- **Innovation:** MPDV is showing ongoing progress with its MIP marketplace, which is well-aligned to Gartner's composability vision. It is open, and companies such as Bosch Rexroth and thyssenkrupp are providing applications. The marketplace supports a commercial model, which allows partners to harvest their contributions.
- **Customer experience:** MPDV continues to have one of the highest customer experience scores of all vendors in this research. Customers highlighted the system's modular concept, the overall breadth of functionality and the quality of support.

Cautions

- **Innovation:** While the UI has been enhanced, the modernization of Hydra X is yet to be completed. Customers should check if the roadmap for cloud and no-code/low-code capabilities will solve their current and future needs.
- **Sales strategy:** One downside of MPDV's offering is the significant number of modules and components. Despite some recent simplifications, customers say they are still not happy with the complex license structure.
- **Industry strategy:** MPDV has started to build industry packages for electronics, food and beverages, and life sciences. However, Gartner has seen this more as exposing industry terminology and bundling, with less impact on actual vertical-specific functionality extensions.

Oracle

Oracle is a Niche Player in this Magic Quadrant. Its Oracle Fusion Cloud Manufacturing (OCM) is a public-cloud-based solution geared at various discrete, as well as repetitive, flow/batch manufacturing industries. Oracle's operations are geographically diversified, and its OCM clients tend to use OCM in conjunction with Oracle Fusion ERP. Gartner estimates that approximately 200 manufacturing companies are using some portion of OCM in production, with practically all of them also using the broader set of Oracle Fusion Cloud Applications.

OCM is updated every three months, with a focus on customer-driven enhancements for multiple industries, such as recently improved lot management for regulated industries, enhanced track and trace capabilities, and some focus on UI renovation.

Strengths

- **Vertical/industry strategy:** Oracle is one of a small subset of MES vendors in this Magic Quadrant that chose to create both discrete and process MES in the same data model. Oracle refers to this as mixed-mode manufacturing. It combines discrete, batch and continuous process capabilities that can be run in the same plant, and even in a single work center.

- **Geographic presence:** Oracle is building out its partner ecosystem for OCM. More than 2,000 consultants with 75+ partners have gone through a four-level certification program.
- **Product or service:** As a part of Oracle Fusion Cloud Applications, Oracle Fusion Cloud Manufacturing offers a similar UI, a joint data model and an integration with other products from Oracle's cloud portfolio.

Cautions

- **Product strategy:** While there is some progress in customer adoption for Oracle Fusion Cloud Manufacturing, Gartner did not see significant changes in Oracle's vision for core MES from previous years.
- **Enterprise application integration:** Oracle customers reported that Manufacturing Cloud has no prebuilt integrations to ERPs other than Oracle Fusion Cloud Applications, and not to Oracle's Applications Unlimited.
- **Customer experience:** The new Redwood UI has only been delivered for supply chain modules, so some UI complexity and responsiveness issues may be apparent with OCM. Companies evaluating OCM should make certain that it meets their usability requirements across the solution.

Parsec

Parsec is a Challenger in this Magic Quadrant. Its TrakSYS product is used across continuous process, repetitive flow/batch and discrete manufacturing. Its operations are geographically diversified, and nearly two-thirds of its customers are in food and beverage, pharmaceuticals or the CPG industry. It entered the MES market on the strength of its data collection, monitoring and reporting capabilities, but has continued to enhance the product line with additional features.

Parsec had a growth year in 2021, adding a significant number of new clients, and has grown significantly in Europe and Africa. It uses a strategy of performing enterprise implementations internally and third parties for smaller implementations.

Strengths

- **Business model:** Parsec has a new focus on managed (life cycle) services for Parsec TrakSYS customers. No decision yet on where the managed services group will be located, but 12 internal resources are currently assigned to the effort of setting up this organization.
- **Geographic strategy:** Although one of the smallest vendors in this Magic Quadrant, Parsec is one of only two vendors in this research that has at least 10% of its customers headquartered in each of the four global regions. It also has the second-largest percentage of clients in Latin America.
- **Customer experience:** Parsec has the highest percentage of customers with more than five plants in production and the lowest percentage of on-premises implementations, not including the cloud-

only vendors. This is due in part to its single-instance/multisite deployment capability.

Cautions

- **Product:** Architecture innovation is continuing; Gartner expected to see more progress in the adoption of newer technologies, including porting to .NET Core.
- **Resource availability:** Rapid growth for a fairly small organization that prefers to implement enterprise clients directly can result in resource issues, especially as Parsec advances into managed services.
- **Cloud deployment:** Parsec has shown innovation in single-instance multisite (SIMS) MES. SIMS technology is most often deployed in the cloud and has been the dominant mode for its large customers, but relatively few of its total customer implementations in 2020 and 2021 were cloud-based (less than 15%). We expected that the combination of SIMS and cloud would have been more prevalent.

Rockwell Automation

Rockwell Automation is a Visionary in this Magic Quadrant. Its FactoryTalk ProductionCentre product is focused mainly on enterprise customers with high-volume manufacturing, with specific application modules tailored to automotive, consumer products and pharmaceuticals. Rockwell's operations are geographically diversified, and its clients tend to be in discrete, hybrid or batch/repetitive flow process manufacturing.

It acquired Plex Systems in 2021, the eighth acquisition in the last three years, following Fiix (CMMS), Oylo (cybersecurity services), Kalypso (enterprise consulting), ASEM (industrial hardware/software), Avnet (IT/OT cybersecurity), Emulate3D (simulation) and MESTECH (MES consulting/system integration).

Strengths

- **Product portfolio:** The addition of Plex to the Rockwell portfolio provides manufacturers with a range of choices to meet their needs, from a customizable on-premises solution to a configurable, cloud option. This provides Rockwell on-premises MES clients who require rapid deployment and/or a high degree of feature alignment with an alternative.
- **Industry strategy:** Rockwell's focus on life science industries has resulted in strong growth in pharma accounts, which made up more than 50% of net new logos.
- **Product or service:** Gartner clients and customer reviewers rate Rockwell Automation's forward and backward product genealogy functionality as one of its best features, especially key for regulated industries.

Cautions

- **Marketing strategy:** Rockwell's technology roadmap is complex and has a lot of moving parts that have caused confusion with customers. Rockwell Automation continues to develop on multiple fronts, both with existing applications and new PTC-based offerings, and the addition of Plex Systems has made the strategy even more complicated.
- **Go-to-market strategy:** Rockwell has now bought into a completely different software model (multitenant cloud) and business (SaaS-based ERP/supply chain/MES). This broadens the software portfolio and pulls Rockwell into new segments. Whether Rockwell can pivot its software and sales strategy remains to be seen.
- **Customer experience:** Briefings on Rockwell's UI strategy indicate that Rockwell is lagging behind its competitors in modernizing the UI. For example, HTML5 is on the roadmap for completion in late 2022.

Rockwell Automation (Plex)

Plex is a Leader in this Magic Quadrant. In June 2021, Plex Systems was acquired by Rockwell Automation. The Plex Smart Manufacturing Platform is a multitenant cloud MES solution for discrete and batch/process manufacturers in automotive, industrial, and food and beverage. Its customers are predominantly in North America, with the rest in more than 30 countries supported by offices in Europe and Asia. Most of Plex Systems' customers are midsize businesses.

Enhancements include an option to deploy on Microsoft Azure, a deeper integration of the Kors acquisition for production monitoring and automation, and improvements for process manufacturing industries, such as IoT traceability and improved batch management. The first areas of collaboration with Rockwell are demand and supply planning, quality management and asset performance management.

Strengths

- **Product or service:** Plex is the vendor with the longest history of SaaS-based MES and ERP solutions in this Magic Quadrant. It has proven to be able to support hundreds of small and midsize customers with a reliable multitenant MES solution, and is further expanding into large enterprises and more international use cases.
- **Vertical/industry strategy:** The Rockwell brand should make Plex Systems more attractive to organizations with process and batch operations, where Plex alone would not have the same level of credibility with OT professionals.
- **International presence:** Plex has shown some more international wins. Its success will likely benefit further from Rockwell's visibility, global presence and partner network, but Gartner thinks that it will take significant time to reach necessary maturity levels.

Cautions

- **Customization:** The Plex multitenant architecture provides many configuration options, but by its multitenant SaaS nature, the code is identical across the customer base, all of which are using the same version. Clients with high customization requirements beyond the existing configuration parameters should consider other vendors with a more capable platform as a service (PaaS).
- **Vertical/industry strategy:** While customers acknowledge that the system can be tailored using prebuilt templates, they report that the process templates for detailed subindustry capabilities should be refined and developed further.
- **Product overlap:** The roadmap will have to address overlapping technology between Plex and Rockwell, such as the future of IIoT and Rockwell's investment in PTC ThingWorx (Innovation Suite versus Plex Asset Performance Management), process automation (FactoryTalk versus Kors Mach2). Plex customers should monitor these decisions, as they may have a negative impact for some.

SAP

SAP is a Visionary in this Magic Quadrant. The SAP Manufacturing Suite (Manufacturing Execution [ME], Manufacturing Integration and Intelligence [MII], and Plant Connectivity [PCo]) supports mostly discrete and hybrid manufacturing. The SAP Manufacturing Suite is used in all major geographies. The largest industry representation comes from high tech/electronics and general discrete manufacturing, and most deployments are on-premises and supported by SIs.

Key new capabilities include improved transfer of routings from ERP to MES, data translators to move specification data from PLM to MES for quality inspection and a deeper integration into Digital Manufacturing Insights (DMI) analytics. The work on UX enhancements is ongoing.

Strengths

- **Innovation:** In 2021, close to 20% of new wins for SAP Manufacturing Suite were on private cloud. This growing readiness of manufacturing companies to adopt deployment models closer to cloud bodes well for SAP's successor product, Digital Manufacturing Cloud (DMC).
- **Market understanding:** SAP Manufacturing Suite plays an essential role in SAP's broader Industrie 4.0 vision, together with a broad portfolio of other solutions, such as PLM, IBP and supply chain. SAP offers choices to companies that wish to leverage all the capabilities in the Digital Manufacturing portfolio beyond the SAP Manufacturing Suite, but they need to be ready for a mix of different deployment modes and resulting integrations.
- **Geographic strategy:** The SAP Manufacturing Suite is an organic part of SAP's overall business application portfolio. This strategy is in line with its customers' SAP-centric strategy, and is supported by SAP's global presence and partnerships with approximately 80 partners globally.

Cautions

- **Product strategy:** SAP Manufacturing Suite is a mature product. Its successor product, Digital Manufacturing Cloud, is growing in adoption and acceptance, but has not reached the maturity level of Manufacturing Suite. Companies using Manufacturing Suite should seek to understand the SAP MOM strategy for the Manufacturing Suite and Digital Manufacturing Cloud.

- **Product or service:** Customers and Gartner clients have reported issues with usability, navigation and visualization. Gartner has seen only minimal progress. As most investments are targeted at Digital Manufacturing Cloud, customers should not expect massive improvements coming soon, if at all, and should carefully assess its usability, navigation and visualization against their requirements.

- **Integration technology:** Gartner analysts receive questions about the transition from MII to newer integration technology but haven't seen a roadmap with clearly defined migration paths to build the necessary data and control flows, especially when non-SAP solutions are involved. Companies using these technologies need to investigate and understand SAP's integration strategy.

Sepasoft

Sepasoft is a Niche Player in this Magic Quadrant. It provides an MES capability built on top of the Ignition platform from Inductive Automation. It also markets several connectivity modules, including instrument interface, bar code scanner, business connector (generic ERP integration), interface for SAP and a web services capability to build company-specific integrations. Customers purchase modules for the MES and core Ignition functions that they need. Sepasoft relies on SI partners for most implementations.

Recent releases have added document management, batch processing and manufacturing procedures, support for Message Queuing Telemetry Transport (MQTT), artifacts which can be binary large object (BLOB) data required at the time of production, and a SaaS option for overall equipment effectiveness (OEE).

Strengths

- **Sales execution/pricing:** The Sepasoft per-server pricing model is rare in the MES space. Most competitors charge by user, resource or data tag, or have some sort of usage monitoring. Sepasoft charges per server, and the per-server cost and absence of user/resource/tag pricing gives Sepasoft a license cost advantage over most competitors.

- **Product customization:** Customers that want a system to fit their existing workflow and procedures will find Sepasoft to be an attractive solution; a combination of functionality and development tools (e.g., web services) that allows for customization. It is an effective assembly to order solution

- **Continuous process, batch manufacturing:** Manufacturers in continuous process, batch manufacturing and serialization will be attracted to the Sepasoft/Inductive stack because the OEE/downtime, recipe/changeover, batch processing and statistical process control (SPC) functions are key to these manufacturing styles.

Cautions

- **User experience**: The OEE cloud offering UI is lacking in features that would be expected in an enterprise MES; for example, HTML5. The screen builder is relatively simple, and the graphic elements (mainly data visualizations) are currently the only HTML components.
- **International presence:** Sepasoft only covers the U.S. and Canada directly, using global distributors and SIs for other regions. The UX for international customers presented to Gartner was incomplete and not well-prepared for global use. Example: The translation displayed a few fixed terms in another language; most of the other prompts were in English. There was no evidence of changes in numeric formatting for localization.
- **Enterprise readiness:** Standard implementation is server-specific, and less than 15% of customer deployments are in five sites or more. The Ignition platform is required and also tends to be plant-specific.

Siemens Digital Industries Software

Siemens Digital Industries Software is a Leader in this Magic Quadrant. Its Opcenter Execution products are broadly applied across multiple manufacturing disciplines. Nearly two-thirds of its clients tend to be in electronics/semiconductors, life sciences, food and beverage, and general discrete/repetitive flow/batch manufacturing industries. Its operations are geographically diversified.

Siemens continues to invest across the Opcenter portfolio in UX harmonization, cloud, data analytics, low-code/no-code extensions and closed-loop functionality. It is also continuing to simplify implementation and postimplementation support across the portfolio, including modular MOM with flexible deployment options.

Strengths

- **Offering (product) strategy:** Opcenter Execution provides MES capability across multiple discrete, process and hybrid industries, with extended MOM features, including advanced planning and scheduling, quality management, research, development and laboratory, and manufacturing intelligence. Vision includes a roadmap of containerization/modularization and the use of Mendix to build low-code extensions, plus a cloud-hosted multicompany architecture.
- **Customer experience:** Siemens users gave the user interface, system flexibility and system stability high marks in customer reviews. The Siemens Opcenter scored near the top in overall

customer experience, which measures both market performance and overall customer satisfaction.

- **G2M/vertical industry strategy:** Siemens continues to expand its vertical industry coverage with its Advantedge customer time-to-value success framework packages as industry-specific frameworks.

Cautions

- **Product or service:** The Opcenter MOM portfolio includes multiple MES offerings as well as separate scheduling, quality and R&D applications. Siemens strategy is to provide tailored MOM solutions per industry to reduce implementation and support complexity. As of this research, this strategy has been applied to solutions for semiconductor, electronics, medical device and diagnostics, and pharmaceuticals/biotech. All other industries are served by generic MES offerings for discrete manufacturing and process manufacturing.
- **Technical architecture:** Siemens is moving toward SIMS by using the workspaces concept originally developed for CAMSTAR v6, as well as cloud deployment. While it is ahead of some of its competitors, there are MES solutions that are already SIMS and cloud on the market today.
- **Sales execution/pricing:** Siemens has joined the ranks of vendors that are attempting to move existing clients from perpetual licensing to subscription-based licensing. Customers should review these proposals carefully, based on the expected life span of the MES versus the additive cost of the subscription.

Tulip

Tulip is a Challenger in this Magic Quadrant. Its platform is used to develop MES applications mainly in general discrete, chemicals and life science industries. Its operations are in North America and in EMEA, but a presence in China is being built. Its clients use the product in public cloud and hybrid environments.

In addition to community-driven enhancements throughout the platform, Tulip's investments are targeted toward device connectivity by adding further protocols for machine connectivity, more global and scalable enterprise multisite use, and better integration of vision detection into workflows. The platform is updated in nonregulated industries every two weeks, and in regulated industries once every three months.

Strengths

- **Customer experience:** Tulip's platform is used for app and integration development. Apps are role- and task-specific and can be built by Tulip customers, as well as Tulip partners, and can be shared using a central app library, in addition to existing apps and templates. This is well-aligned with Gartner's composability vision.

- **Innovation:** Tulip's no-code, cloud-based platform is an enabler for building or enhancing MES applications. The Tulip Library has grown in maturity, offering approximately 200 pieces of content, and the downloading/installing of apps is growing. New apps include weigh and dispense, new connectors to SAP S/4HANA and Oracle NetSuite.
- **Product or service:** Tulip has built mechanisms for automated application revision history, which is important for regulated industries. This has helped to complete major audits at a number of major pharmaceutical companies.

Cautions

- **Offering (product) strategy:** Tulip's Completeness of Vision rating reflects that creation and implementation of MES-specific processes often need additional effort by the customer or a Tulip partner. The library offers starting points, but the platform's flexibility requires governance and discipline to ensure application conformity and repeatable processes to ensure conformity in bigger deployments across multiple sites.
- **Geographic strategy:** Customers reported that Tulip's documentation and other material is available in English and only a few other languages, which isn't sufficient for most European or other international rollouts.
- **Market understanding:** Customers mention that while the solution provides innovative technology, it is often nearly as expensive as the solution it is replacing.

Vendors Added and Dropped

We review and adjust our inclusion criteria for Magic Quadrants as markets change. As a result of these adjustments, the mix of vendors in any Magic Quadrant may change over time. A vendor's appearance in a Magic Quadrant one year and not the next does not necessarily indicate that we have changed our opinion of that vendor. It may be a reflection of a change in the market and, therefore, changed evaluation criteria, or of a change of focus by that vendor.

Added

This Magic Quadrant saw the return of Sepasoft (2019), as well as the addition of Apprentice.

Dropped

There were no vendors dropped from this Magic Quadrant.

Inclusion and Exclusion Criteria

In 2021, we saw an increase in client inquiries and a shift in focus for MES. As in previous years, the inclusion criteria have been modified this year to adjust to market conditions and client interest. The modifications this year include a requirement of dedicated focus on MES as defined in the Market

Definition/Description section, changes in the criteria for growth and financial health, and in the definition of global coverage.

To be included in this Magic Quadrant, a vendor must have an enterprise MES solution that fundamentally supports all nine core MES capabilities:

- Dispatching
- Production management, execution and in-process quality monitoring
- Manufacturing data management
- Operational data store
- Manufacturing-related quality management processes
- Procedural enforcement
- Tracking and genealogy
- Integrated analytics and reporting
- Sophisticated integration capability

The vendor must also exhibit a vision for next-generation MES in at least moderately complex manufacturing environments. Vendors must meet the following criteria for inclusion:

- **Focus:** An MES solution with a clear and independent focus on MES that fully supports the MES functions defined above and in detail at the beginning of this document. The MES solution must support these defined functions out of the box, with or without customization.
- **Global:** The vendor must have more than 20% of MES customers headquartered outside its home geographic region (North America, Latin America, EMEA and Asia/Pacific).
- **Enterprise:** At least 10% of customers use the MES software in five or more sites.
- **Customer base:** At least 25 customers (names, not sites) are in production and actively using the MES software.
- **Growth/financial health:** Vendors must meet one of the following three scenarios for new customers, revenue growth and total revenue for their MES:

- **Scenario 1:**
  - At least 15 net new name (new logo) MES customers (not sites) during calendar year 2020.

- Annual recognized MES software, consulting, implementation service and maintenance revenue in calendar year 2020 equal to or greater than $5 million.
- Four-year CAGR of recognized MES software, consulting, implementation service and maintenance revenue for the period 2017 through 2020, equal to or greater than 15.4%.

- Scenario 2:
  - At least 10 net new name (new logo) MES customers (not sites) during calendar year 2020.
  - Annual recognized MES software, consulting, implementation service and maintenance revenue in calendar year 2020 equal to or greater than $50 million.
  - Four-year CAGR of recognized MES software, consulting, implementation service and maintenance revenue for the period 2017 through 2020 equal to or greater than 7.7%.

- Scenario 3:
  - At least five net new name (new logo) MES customers (not sites) during calendar year 2020.
  - Annual recognized MES software, consulting, implementation service and maintenance revenue in calendar year 2020 equal to or greater than $100 million.
  - Four-year CAGR of recognized MES software, consulting, implementation service and maintenance revenue for the period 2017 through 2020 greater than 0%.

Evaluation Criteria

Ability to Execute

Customer service, global reach and operations play strong roles in evaluating the ability of vendors to effectively serve their customers. Gartner finds that customers consider a vendor's ability to provide the services and support necessary to effectively implement the MES as critically important in their ability to achieve the goals of the implementation. Because MES impacts (and disrupts) production, the lifeblood of any manufacturer, the performance of the vendor (and its partners) in implementing the systems effectively is critical.

Product or Service: MES vendors' product breadth, depth and technology are highly rated components of their Ability to Execute. The MES market is unique in that different areas of functionality are more important in some vertical industries than others, but there are key functionalities that define MES and would be expected to be available across the industry landscape. We evaluate the MES products across a range of criteria, including functionality and technology (including the adoption of the latest available technology). We consider the depth and flexibility of

core capabilities, such as procedural enforcement, order execution, data collection, data visibility, quality, tracking, dispatching and reporting/analytics. We also consider the existing breadth of the application's extended MES (aka MOM) capabilities, such as detailed scheduling, definition (BOM/recipe/specification) management and resource management. Users with the most complex requirements and sophisticated operations are the most interested in a vendor's support for extended MES capabilities, which remains a differentiating factor across various systems. Less sophisticated or less complex users are most focused on core MES capabilities and might require less functional breadth. Thus, they could be supported by a wide variety of solutions. The adoption of device-agnostic UI technologies (e.g., HTML5) is expected, and, somewhat surprisingly, there are still vendors reviewed that cannot claim 100% compliance in this area. The same goes for cloud-native solutions and state-of-the-market technology platforms based on microservices architectures. While many claim to have adopted these capabilities, the depth and breadth of these capabilities vary widely. Finally, since MES has long been heavily customized, we place importance on the technical architectures of each MES. In particular, we note a solution's ability to adapt to change during the initial implementation as well as over the life of the investment. Therefore, product or service is weighted "high" in this research.

Overall Viability: The viability issue in the MES space, especially when considering the size of vendors covered in the Magic Quadrant, is different than it might be in other spaces. Almost all of the vendors covered in this research are offering MES solutions they acquired from somewhere else. The viability considerations in this market lean more toward the viability of a solution within the context of the parent company's market strategy rather than the viability of the company itself. Although viability is important, it should not overshadow product fit, vendor expertise, total cost of ownership (TCO), and service and support. We are often asked about the viability of the MES market; however, we cover this in other sections of this research. While important, overall viability is also considered in the inclusion criteria and is not viewed as one of the most important topics. It is weighted "low" in this research.

Sales Execution/Pricing: Most vendors in this Magic Quadrant continue to move to subscription-based license models, and the first signs of more comparable pricing become visible. Sales execution through direct sales or channels continues to be relevant, but it loses its differentiating nature in the MES market. Pricing in the MES market still varies across deals, depending on size and other specific circumstances of an individual initiative. The combination of subscriptions (which have a finite beginning and end) and MES (which has become a requirement for keeping a plant running long term) is perilous. Vendor lock-in is a preeminent threat. As subscriptions take hold, the ability of vendors to provide open and equitable arrangements for contract renewal becomes paramount. Because of the growing uniformity despite remaining differences in detail, sales execution/pricing is weighted "medium" in this research.

Market Responsiveness/Record: The MES market continues to evolve rapidly, and MES solutions must keep pace to remain relevant. This makes market responsiveness and track record meaningful.

We assess the historical and current performance of vendors to add to and enhance their MES solutions to keep up with the changing wants and needs of MES users. As such, we give market responsiveness/record a “medium” weighting.

Marketing Execution: Although marketing promotion is important, we focus more on a vendor’s product marketing and product management. We look at the product management team, processes and product roadmap to support ongoing innovation, track record of delivering on plans and ability of the vendor to respond to market forces. As such, we give marketing execution a “low” weighting.

Customer Experience: An MES vendor’s ability to use and exploit functionality to drive business value and provide a suitable customer experience is a critical element of a provider’s Ability to Execute. We consider a vendor’s track record with complex and sophisticated customers, but also its ability to effectively and efficiently service less demanding customers. Also critical is client satisfaction with a vendor’s products as well as services, how much manufacturing operations domain expertise and experience the vendor has, and how it can employ this to help customers fully exploit their MES investments. Although client satisfaction is always important, we also consider the nature of the relationship that vendors establish with customers, and whether the relationship is operational or strategic. The size and growth of a vendor’s client bases locally and internationally are also important because they demonstrate the vendor’s ability to identify and satisfy the needs of customers around the world. Vendor support, maintenance, business and technical consulting, implementation partnerships, and field operations are important parts of the MES selection process. As projects become more complex, a vendor’s ability to not only sell and implement a solution, but also help customers fully exploit their MES investments, is critical to long-term success. Thus, we give customer experience a “high” weighting.

Operations: Operational competence considers a vendor’s ability to meet its goals, obligations and commitments on an ongoing basis. There are marked differences in capabilities across vendors, as confirmed by customer references.Factors include the strategic value of MES to the vendor, as evidenced by the quality of the organizational structure, as well as skills, experience, programs, systems and other vehicles that enable an organization to operate effectively and efficiently. The vendor’s management structure, experience, skill and expertise play a role in a vendor’s ability to harmonize its vision, strategy, tactics and actions. We give operations a “low” weighting in this research.

Table 1: Ability to Execute Evaluation Criteria

Evaluation Criteria ↓	*Weighting* ↓
Product or Service	High

Evaluation Criteria ↓	Weighting ↓
Overall Viability	Low
Sales Execution/Pricing	Medium
Market Responsiveness/Record	Medium
Marketing Execution	Low
Customer Experience	High
Operations	Low

Source: Gartner (May 2022)

Completeness of Vision

Although the MES market is mature, it is undergoing considerable changes related to the technology, adaptability, usability, breadth of functionality and enhanced decision support capabilities. The changes embodied in these market shifts, driven by factors such as IIoT, composable enterprise and governmental vision (e.g., Industrie 4.0), will require considerable nimbleness and competency on the part of vendors. Therefore, in this Magic Quadrant, we place strong emphasis on a vendor's understanding of these market dynamics and its product strategies to support those offerings. Exhibiting and articulating a vision for where MES will be in the future, and exhibiting an innovative culture, remain distinguishing characteristics among vendors.

Market Understanding: A demonstrated knowledge, proficiency and differentiated vision of the current and future MES marketplace are critical considerations. Market understanding assesses the MES vendor's ability to understand MES buyers' wants and needs for the manufacturing modes they cover and translate them into products and services. Vendors that show the highest degree of vision listen to, anticipate and understand buyers' wants and needs, and can augment customer insight with their own MES visions. Vendors that simply respond to current market requirements without

anticipating future requirements will likely be unsuccessful over the long term. Marketing understanding is also considered in the inclusion criteria; consequently, we give market understanding a “medium” weighting.

Marketing Strategy and Sales Strategy: Until recently, marketing strategy and sales strategy have had modest impacts on the MES market, which had historically been dominated by specialist vendors focused on specific vertical industries. Today, marketing and sales strategies are becoming more important, particularly as enterprise vendors become MES providers. However, we consider vendors’ strategies for establishing their MES brand — and how they develop strategies and tactics for local and international expansion — to be of less importance than other factors. Therefore, we give these two criteria, marketing strategy and sales strategy, a “low” weighting.

Offering (Product) Strategy: This criterion is critical; it refers to an MES provider’s approach to product marketing, research and development, and solution delivery that emphasizes differentiation. We consider strategies for functionality, usability, technology, adaptability, delivery methodologies and feature sets as they map to current and future MES requirements, market trends and technology evolutions for the manufacturing modes they cover. In addition, we consider vendors’ strategies for supporting end-to-end processes that span functional areas such as order management, materials management, definition management and analytics. A vendor’s understanding of these market changes and its product strategies for successfully navigating these changes significantly influence its Completeness of Vision. Therefore, offering (product) strategy gets a “high” weighting.

Business Model: A vendor’s business model (i.e., the soundness and logic of its underlying business propositions) is a key indicator of its sustainability and how its overall strategies and tactics might affect its ongoing success in MES. For example, one vendor might focus on organic innovation, while another might concentrate on buying innovation through mergers and acquisitions. While the former might have a longer gestation period, it has potential product and technical advantages. The latter might allow a vendor to get to market faster but could cause longer-term product issues. We give business model a “medium” weighting.

Vertical/Industry Strategy: In MES, a vendor’s vertical/industry strategy is a key factor in how well the offering is aligned to specific industry requirements. Vertical/industry strategies are critical, so we give this criterion a “high” weighting. A vertical/industry strategy may be a vendor’s commitment to mastery of a few key vertical industries or relying on an ecosystem of partners to fill in the gaps between its solution and the industry-specific solution that the customer desires. Both are viable approaches, but the vendor must have a well-designed strategy to be successful in what has been a very fragmented market.

Innovation: Innovation is a critical differentiator. It is important for vendors to demonstrate the ability to support innovation by staying close to the most creative solutions or complicated problems in the market, to drive pioneering functionality. Innovation is a critically important factor in the MES industry, even though manufacturing production has been conservative in the adoption of new

technologies in the past. Innovation and thought leadership continue to play a strong role in this year's evaluations. Leading vendors continue to enhance core MES with more investment in extended MES. Gartner continues to evaluate innovations in these practices. However, this year, we are placing a strong influence on the technology side. Leaders are expected to embrace technology innovations that enable cloud, platform/infrastructure as a service, low-code/no-code application development and the composable enterprise. Leaders and Visionaries will be the vendors on the forefront of change, while others will lag in adoption, often for years. Consequently, we give innovation a "high" weighting.

Geographic Strategy: This research is focused on the global MES marketplace. Geographic strategy looks at technology providers' strategies for directing resources, skills and offerings to meet the specific needs of global manufacturing. At this stage in the evolution of the MES market, there is more interest in global enterprise-level solutions. We give geographic strategy a "medium" weighting.

Table 2: Completeness of Vision Evaluation Criteria

Evaluation Criteria ↓	*Weighting* ↓
Market Understanding	Medium
Marketing Strategy	Low
Sales Strategy	Low
Offering (Product) Strategy	High
Business Model	Medium
Vertical/Industry Strategy	High
Innovation	High
Geographic Strategy	Medium

Evaluation Criteria ↓	Weighting ↓

Source: Gartner (May 2022)

Quadrant Descriptions

Leaders

Leaders combine the uppermost characteristics of vision and thought leadership with a strong Ability to Execute. Leaders in the MES market are present in a high percentage of new MES deals, and they win a significant number of them. They have robust core MES and may offer some capabilities in extended MES areas. To be a Leader, a vendor doesn't necessarily need to have the absolute broadest or deepest MES application. Its offerings must meet most core MES requirements without significant modifications, and a substantial number of high-quality implementations must be available to validate this. Leaders must anticipate where customer demands, markets and technology are moving, and must have strategies to support these emerging requirements ahead of actual customer demand. Leading vendors should have coherent strategies to support supply chain convergence, and must invest in and have processes to exploit innovation; for example, composable enterprise. Leaders also have market momentum and strong client satisfaction — in the vendor's local markets as well as internationally. Client satisfaction starts with the initial sales engagement and continues through deployment and beyond. Leaders understand the importance of customer satisfaction and approach customer issues as trusted partners. Because Leaders are often well-established in leading-edge and complex user environments, they benefit from a user community that helps them remain in the forefront of emerging needs.

Key characteristics:

- Reasonably broad and deep MES offerings.
- Proven success in moderate- to high-complexity manufacturing environments.
- Support for enterprise MES implementations, including global availability of site-generated data.
- Participation in a high percentage of new deals.
- A strong and consistent track record.
- Consistent performance and vigorous client growth and retention.
- Enduring visibility in the marketplace from both sales and marketing perspectives.
- A proven ecosystem of partners.

- Global resources, capabilities and scale.

The 2022 Leaders quadrant includes a mix of enterprise and pure-play vendors (see Market Overview).

Challengers

While vendors in this quadrant provide solid and established MES solutions, they generally have one or more insufficiencies in offerings or go-to-market strategies when compared with Leaders. The critical characteristic of Challengers is that they have capable, proven and mature products, with numerous live customers. They also have consistent track records of successful implementations. Challengers' offerings often run some very large and complex facilities. These solutions are in use by a large number of individual enterprises, supporting multiple manufacturing operations locally and worldwide. These solutions are preferred by buyers that favor Ability to Execute over Completeness of Vision. Vendors can have practical visions for these solutions and, more generally, supply chain execution, but vision and thought leadership typically are not as complete as with vendors in the Leaders quadrant.

Key characteristics:

- A capable, proven and mature MES, with numerous live customers.
- A consistent track record of successful implementation.
- Often running some large and complex facilities.
- Offerings that are not as broad or deep as MES Leaders' offerings.
- A clear vision of the future of MES, although, relatively speaking, it is not as clear or complete as the Leaders' vision.

Visionaries

Visionaries must have a coherent, compelling and innovative strategy that seeks to deliver a robust and vibrant offering to the market. However, these offerings have some deficiencies in their Ability to Execute in areas such as viability, growth, global scale or operations. Visionaries are often thought leaders in one or more MES solution dimensions (e.g., analytics, model-based process development, vertical industry or deployment strategies), and they tend to be on the leading edge of some emerging concepts. At a minimum, solutions in the Visionaries quadrant fall into one of two broad categories. They can be vendors with established MES offerings that have yet to mature into leading positions in the market, or they can be innovative specialist vendors with unique and potentially disruptive views of where the market is going. These vendors can exhibit innovation in MES products, services, or go-to-market and deployment strategies, but lack innovation in other areas.

Key characteristics:

- A coherent, compelling and innovative strategy that seeks to deliver a robust and vibrant offering to the market.
- A thought leader in one or more MES solution dimensions that tends to be on the leading edge of emerging concepts.
- An undemonstrated ability to handle a broad range of complex user requirements.
- Execution gaps or deficiencies.
- Innovation in MES products and services, and in go-to-market, vertical or deployment strategies.

Niche Players

Although there might be an assumption that vendors in the other quadrants are better choices for new MES buyers, Niche Players are often just as good or sometimes better choices for prospective users. This is because they might focus on a geographic or vertical component of the market that is meaningful to particular users. However, this focus alone is not a compelling-enough differentiator for a vendor to ascend to a leadership position. It would also have to perform well in other dimensions. Although some vendors in the Niche Players quadrant often have solid MES solutions for a specific industry or geography, they are not as broad as the MES solutions in other quadrants.

Key characteristics:

- Focuses primarily on a geography or vertical market (although this is not a sole determining factor).
- Is not a generally differentiated offering, although it can have some unique capabilities.
- Is not a broad MES capability.
- Has market momentum and product or company viability that may be in question.
- Has growth strategies, either geographic or in other markets, that may be lacking.

Context

The MES market is highly fragmented by vertical industry, technology, manufacturing processes/style and application functionality, which makes choosing a vendor difficult.

Vendors with leading market shares continue to extend the functional footprint of their MES offerings farther into extended MES (MOM) via internal development and acquisition. Newcomers tend to

provide more organically developed solutions built on state-of-the-art platforms, but may not offer broad functionality.

Given the market's fragmentation when selecting an MES vendor, it is important to consider:

- **Scope** — Business or process opportunity prompting this selection and whether it requires full MES, extended MOM or possibly a subset of that functionality that may be available in specialized applications not identified as MES or MOM.
- **Industry** — Demonstrable understanding of your industry and modes of manufacturing (backed up by multiple independent customer references).
- **Integration** — Integration maturity of the platform and experience in integration with all of the related business and production systems (ERP, planning and scheduling, warehouse management system [WMS], quality management system [QMS], PLM, production equipment).
- **SLA** — SLAs and quality-of-service requirements.
- **Security** — Security and regulatory compliance needs.
- **Geography** — The geographic location of the support centers.
- **Architecture** — The ability to deploy the MES platform as a solution in a mode that suits your enterprise architecture (single-instance/multisite, public cloud, private cloud, corporate data centers or on-premises).
- **Cost** — The availability and cost of MES skills from the provider and external service providers.
- **TCO** — The long-term cost expectations and available budget.
- **Outlook** — The short- and long-term product roadmap.

Gartner recommends starting the selection process after developing a thorough understanding of your requirements and priorities. Be pragmatic and tactical, and evaluate domain-specific solutions, where appropriate, for quick wins.

Market Overview

The MES market is served by two groups of vendors:

- Enterprise software vendors that provide a wide range of MES/MOM capabilities and additional functionality serving multiple industries: ERP vendors (examples: Oracle, Plex Systems, SAP); PLM vendors (examples: Dassault Systèmes, Siemens Digital Industries Software); Automation vendors (examples: ABB Ability, AVEVA, Emerson, GE Digital, Honeywell, Rockwell [FactoryTalk])

- Pure-play vendors providing MES or MES/MOM capability/enablers only: Apprentice.io, Critical Manufacturing, iBASEt, iTAC, Korber Werum, MPDV, Parsec, Sepasoft and Tulip.

There is a fundamental technological shift taking place in the MES market, driven by evolving new technologies that challenge the MES status quo and driven by vendors with the agility and talent to accelerate the adoption of those technologies. We see these trends in the market:

- Vendors are increasing their adoption of PaaS architectures and low-code/no-code app development; some are succeeding in the MES market, often to the detriment of the enterprise vendors that have recently dominated this space.

- The COVID-19 pandemic has pushed manufacturers to embrace the agility of cloud-native, availability-anywhere systems. We see that vendors that have embraced these capabilities, and are developing these organically, have a significant head start on others that have embraced application growth by acquisition.

- IIoT and edge capabilities continue to evolve. As these solutions mature and end-user manufacturers generate new, scalable use cases beyond simply monitoring equipment condition, the distinction between IIoT applications and traditional MES applications will continue to blur.

Continuing from the trends above, we see an acceleration of the transformation of traditional application architectures into composable applications. The complete reference architecture is described in Use Gartner's Reference Model to Deliver Intelligent Composable Business Applications. Composable MES applications are characterized by adopting principles and technologies, such as:

- Built out of modular and autonomous packaged business capabilities (PBCs). PBCs have to be granular enough so that they can support individual requirements; major modules like track and trace or quality management do not offer the desired flexibility. PBCs can be sourced externally from a vendor or built internally. A marketplace delivers the infrastructure to discover and procure PBCs as needed. The marketplace should offer mechanisms for commercialization; for instance, to pay the original contributor of a PBC for its efforts.

- Equipped with a set of stable APIs that can be exposed to different users according to their respective roles. The user interface has to be isolated from the PBC's code and data layer; the UI will be provided by the application that consumes the PBC and exposes it to the user.

- Leveraged as an application composition platform to support more complex business processes that use multiple PBCs. The composition platform will provide tools to define the sequence in which individual PBCs are invoked and to design a common user interface.

- Data self-contained within the PBC, to let it operate autonomously in different contexts. Data is shared through an open data fabric, which also consolidates data of multiple applications for integrated analytics, AI/ML and reference access.

An architecture like this has allowed some vendors in this Magic Quadrant to offer their clients:

- A low-code/no-code environment that lets citizen developers and business users build personalized capabilities catered to their individual needs, with less cost and risk associated with traditional customization.
- An apps marketplace for partners and customers to offer prebuilt extensions, dashboards, additional capabilities and more.
- An HTML5-based, user-centric and role-specific UX that can be personalized and expanded by the user with no involvement of IT or professional developers.

However, it should be noted that simply having this architecture and these features does not mean a vendor is providing an off-the-shelf MES solution. Significant discipline, governance and domain expertise are required to turn these components into a production-worthy, scalable MES.

Incorporating these architecture principles is simpler for vendors with a newly built MES solution. In general, it is fair to assume that the longer an MES system has been in the market, the more effort that is needed to fundamentally rearchitect it. For instance, it is fairly easy to surround an entire existing solution with a layer of APIs and interfaces to allow for easier integration with other applications. However, it is much more difficult to modularize the solution and break it into components that can then be reassembled and enhanced according to a customer's needs.

One area where this becomes immediately visible is UI: "simply porting an existing UI to HTML5 doesn't do the job," as one customer reference pointed out. A complete redesign is needed, resulting in a user-centric UI that is catered to different roles and can be altered by end users. Some vendors with more mature systems have started this transformation, but it will take most of them years to finalize it (see How to Implement Composable Technology With PBCs).

This transformation, once completed, will provide more flexibility and allow for more agility in the deployment, use and enhancement of these solutions. This flexibility and agility have proven to be among the main drivers of resilience that was so visibly important during the COVID-19 crisis.

These trends, disruptors and events have had an impact on the Magic Quadrant results, and we suspect these changes will continue in future publications of this Magic Quadrant.

Finally, when considering the supply chain (plan, source, make, deliver) and supply chain maturity, there is a growing desire to break down the barriers between MOM (make) and the rest of the supply

chain. The breaking down of barriers occurs from both a process and a technology direction. As the MES market continues to evolve and change, the ability to remove these artificial barriers will be a key consideration in vendor choice.

Evidence

This research is based on information gathered from the following sources:

- Peer Insights reviews from 385 MES customers.
- Online surveys and/or vendor briefings from 30 MES vendors.
- More than 1,500 inquiries and interviews on MES in 2020 and 2021.

[1] ANSI/ISA-95.00.03-2013 Enterprise-Control System Integration — Part 3: Activity Models of Manufacturing Operations Management, International Society of Automation (ISA).

Note 1: Extended MES Functionality — Manufacturing Operations Management (MOM)

As the manufacturing execution systems (MES) market has matured and expanded, additional capabilities have been added by MES vendors; these are typically referred to as manufacturing operations management (MOM) functions. This has led to some vendors referring to their solutions as MES/MOM, or simply MOM. The term “manufacturing operations management” is defined as Level 3 of the ANSI/ISA-95 Enterprise-Control System Integration standard. [1]

Extended MES/MOM functionality includes:

- **Resource management:** This can include management of all resources required for manufacture, including:
  - Equipment (computerized maintenance management systems [CMMSs]/enterprise asset management [EAM]).
  - Labor (labor management, certification/training management).
  - Materials (inventory management, warehouse management).
- **Manufacturing process management/model-based manufacturing:**
  - BOM/recipe management.
  - Process planning/work instructions.
  - Model-based manufacturing (for products and processes).

- **Analytics:**
  - A suite of development and runtime software tools that monitors, alerts and supports interactive decision making by providing data and analytics about current conditions.
- **Quality management:**
  - Manages quality policies and standard operating procedures (SOPs). This may include, but is not limited to, customer requirements, quality documents, ISO requirements, manufacturing capabilities, robust design, auditing procedures and protocols, nonconformance/risk management activities, testing criteria, and industry-specific regulations (for example, U.S. Food and Drug Administration [FDA] or Federal Acquisition Regulation [FAR] requirements).
- **Planning/scheduling:**
  - Detailed production scheduling.
  - Supply chain scheduling (e.g., suppliers, contract manufacturers, remanufacturers).

Evaluation Criteria Definitions

Ability to Execute

Product/Service: Core goods and services offered by the vendor for the defined market. This includes current product/service capabilities, quality, feature sets, skills and so on, whether offered natively or through OEM agreements/partnerships as defined in the market definition and detailed in the subcriteria.

Overall Viability: Viability includes an assessment of the overall organization's financial health, the financial and practical success of the business unit, and the likelihood that the individual business unit will continue investing in the product, will continue offering the product and will advance the state of the art within the organization's portfolio of products.

Sales Execution/Pricing: The vendor's capabilities in all presales activities and the structure that supports them. This includes deal management, pricing and negotiation, presales support, and the overall effectiveness of the sales channel.

Market Responsiveness/Record: Ability to respond, change direction, be flexible and achieve competitive success as opportunities develop, competitors act, customer needs evolve and market dynamics change. This criterion also considers the vendor's history of responsiveness.

Marketing Execution: The clarity, quality, creativity and efficacy of programs designed to deliver the organization's message to influence the market, promote the brand and business, increase

awareness of the products, and establish a positive identification with the product/brand and organization in the minds of buyers. This "mind share" can be driven by a combination of publicity, promotional initiatives, thought leadership, word of mouth and sales activities.

Customer Experience: Relationships, products and services/programs that enable clients to be successful with the products evaluated. Specifically, this includes the ways customers receive technical support or account support. This can also include ancillary tools, customer support programs (and the quality thereof), availability of user groups, service-level agreements and so on.

Operations: The ability of the organization to meet its goals and commitments. Factors include the quality of the organizational structure, including skills, experiences, programs, systems and other vehicles that enable the organization to operate effectively and efficiently on an ongoing basis.

Completeness of Vision

Market Understanding: Ability of the vendor to understand buyers' wants and needs and to translate those into products and services. Vendors that show the highest degree of vision listen to and understand buyers' wants and needs, and can shape or enhance those with their added vision.

Marketing Strategy: A clear, differentiated set of messages consistently communicated throughout the organization and externalized through the website, advertising, customer programs and positioning statements.

Sales Strategy: The strategy for selling products that uses the appropriate network of direct and indirect sales, marketing, service, and communication affiliates that extend the scope and depth of market reach, skills, expertise, technologies, services and the customer base.

Offering (Product) Strategy: The vendor's approach to product development and delivery that emphasizes differentiation, functionality, methodology and feature sets as they map to current and future requirements.

Business Model: The soundness and logic of the vendor's underlying business proposition.

Vertical/Industry Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of individual market segments, including vertical markets.

Innovation: Direct, related, complementary and synergistic layouts of resources, expertise or capital for investment, consolidation, defensive or pre-emptive purposes.

Geographic Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of geographies outside the "home" or native geography, either directly or through partners, channels and subsidiaries as appropriate for that geography and market.