EBOOK

Extend Your MES. Not Your Complexity.

Amplify the power of your MES with platform-native apps.

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Critical manufacturing
an ASMPT company

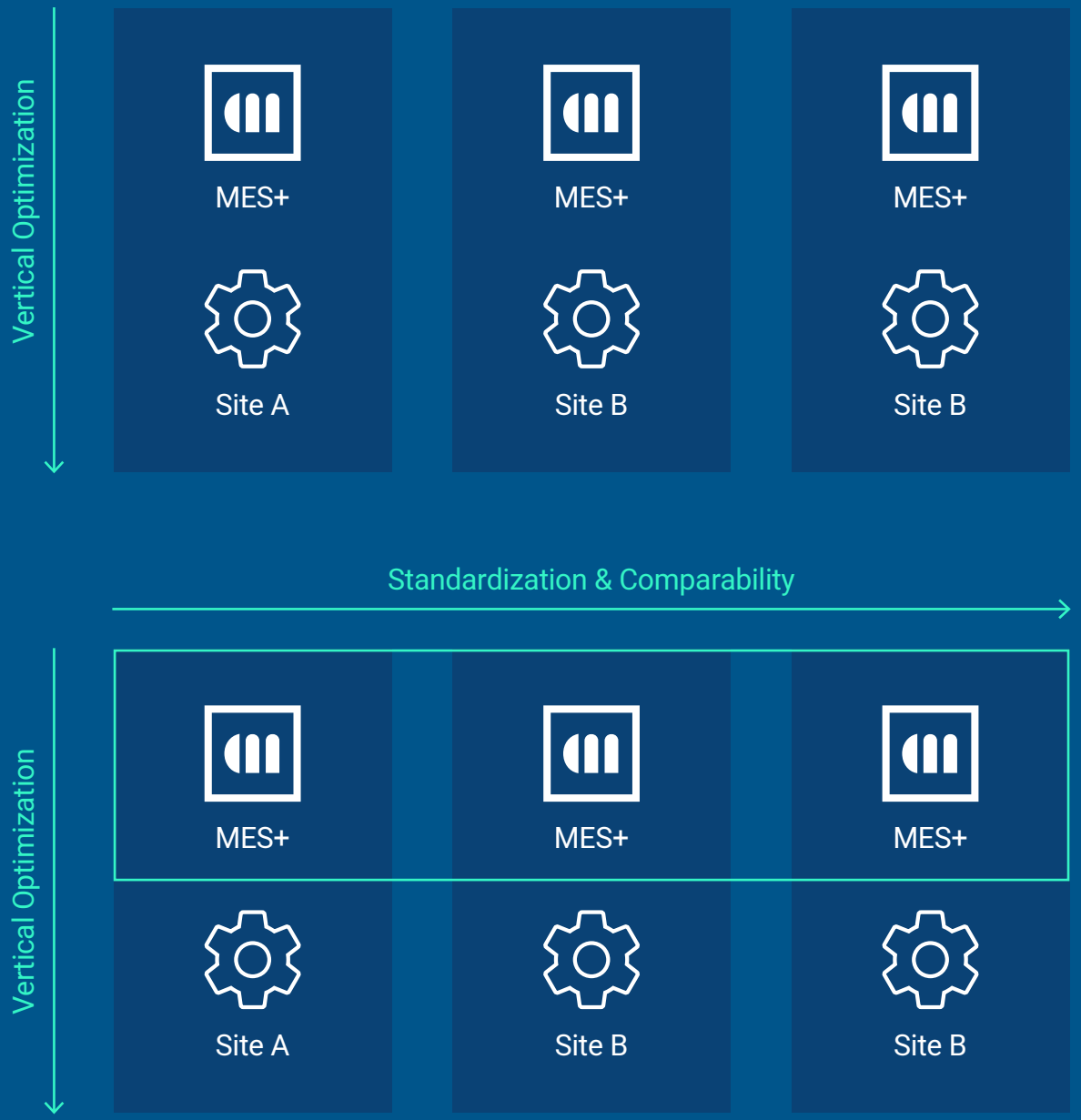
The MES is the center of manufacturing operations.

Responsible for **controlling everything** that happens inside the shop floor and for interacting with other systems, ERPs (Enterprise Resource Planning Systems), PLMs (Product Lifecycle Management Systems) or QMS (Quality Management Systems).

There is a tendency in the MES that is hard to avoid, the tendency to optimize vertically. This is not necessarily a bad thing. An MES implementation that only exists for a specific site over time, even without the use, in excess, of customization, to optimize for specific needs and use cases. MES allows the users to continuously tweak their systems to improve and expand their efficiency and productivity. **This is great for that site, but in a global world this may become a problem.**

In a multisite scenario the goal is not just to make factories more efficient, but also understand how factories work, and how each factory is addressing their issues. Vertical optimization is no longer the only goal; systems need to also be horizontally aligned.

Different factories across the world must produce standardized data and comparable reports. Implementation projects are no longer focused on a site, but on how they **can leverage multi-site strategies to produce better and more standardized solutions**. Of course, this elevates the complexity of implementing an MES system, particularly one without the proper toolset.

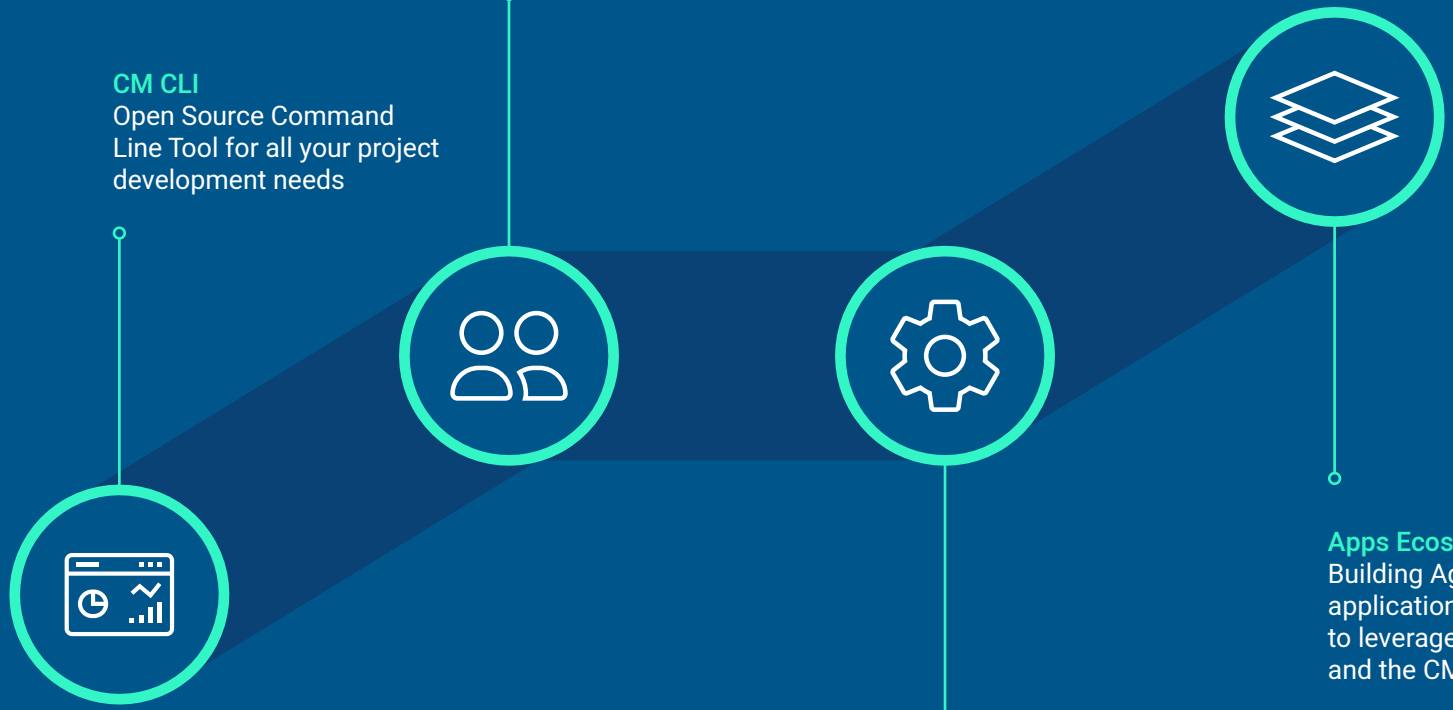


Implementation Suite

Traditional implementations with SDKs and manual deployments, if they were ever viable, they surely are not, when dealing with multi-site, multi-team scenarios. There is a need for a much more robust toolset.

Collaboration Hub
Platform for MES Project Management, Development and DevOps

CM CLI
Open Source Command Line Tool for all your project development needs



Apps Ecosystem
Building Agnostic applications that are able to leverage all the MES data and the CM MES Platform

DevOps Center
Portal for MES Deployments

Critical Manufacturing CLI

Critical Manufacturing (CM) CLI is an **open-source command line interface**. It provides all the tooling required to create new MES projects, new MES Apps and to build and package all MES customization.

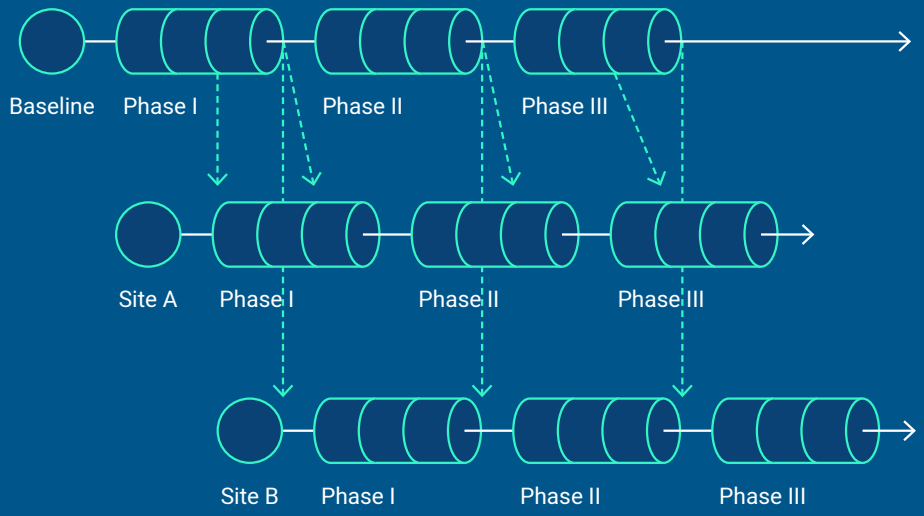
It has a rich knowledge base and documentation and has the full transparency of being an open-source project accessible to all. It allows users to be able to open issues and add their own contributions, helping create an MES developer community.

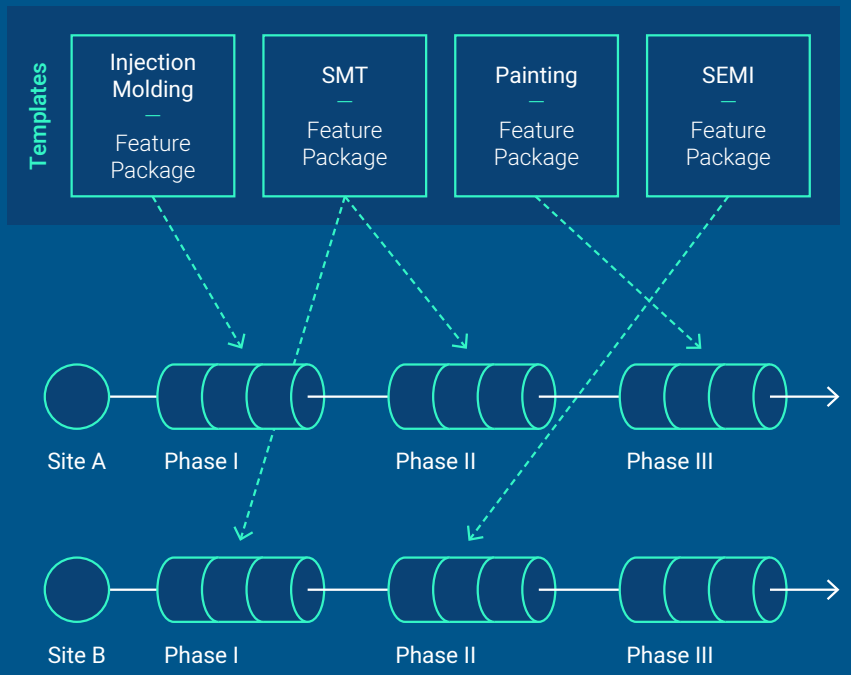
Solutions like CM's CLI are absolutely critical for modern MES implementations, they are a key element in solving package versioning and managing complex dependencies.

Each package delivered for each module of the system is versioned, transparent and trackable. This is a necessary condition, so the teams always know what they developed, tested and validated.

It allows for new and interesting ways to develop.

The emergence of **global baseline packages**, with sets of features that are deployed across all sites or even feature packages that can be imported on demand, are all fundamental aspects of handling large and complex projects. All of them are versioned and deterministic, where you know exactly what was done and who did it for each package that is installed in your systems, even when that package was not originally made by your direct project team.





Collaboration Hub

Even systems like the CM CLI are just a small piece of the puzzle. We require deeper integration across multiple teams and across roles. The people that are handling the requirements and the people that are implementing them must no longer be siloed. The use of common repositories of task backlog, project implementation and code, allow for a level of **transparency and visibility** fundamental in being able to organize ever more complex projects.

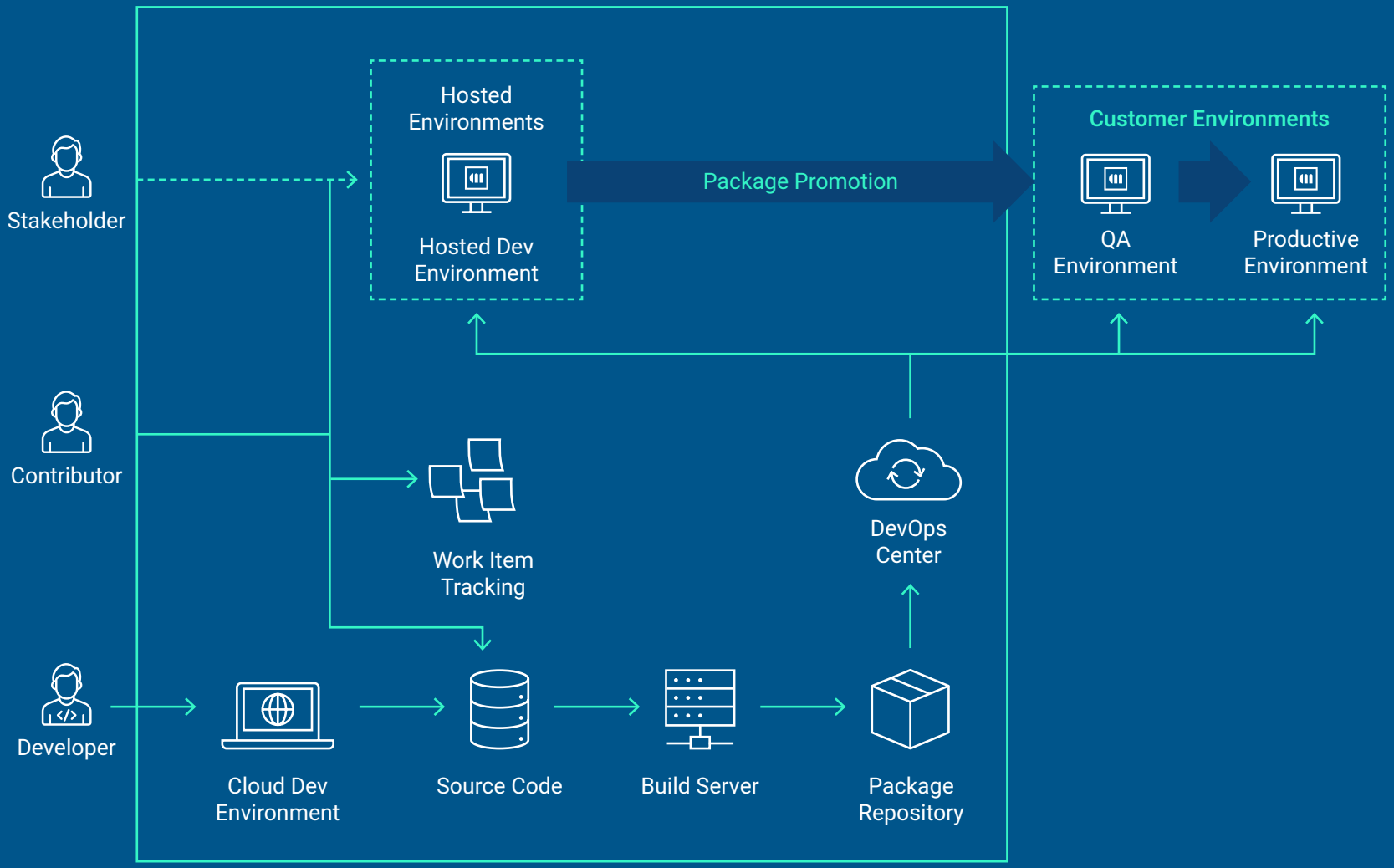
Collaboration Hub closes that gap, allowing all stakeholders, from customers to partners to Critical Manufacturing developers, **all share the same workspace**. From task backlog to code development, running tests and deploying packages. We move from a delivery of a black box to a collaborative ecosystem between all the stakeholders of the implementation. All the stakeholders use the same system and have the same visibility on the work being done and planned for. Enabling a new paradigm where there is no abrupt transition between active project development and project handoff. The customer is continuously the owner of the project in all its facets, from the beginning into the future.

It has a role centric approach, depending on their needs.

A **reader** can see the status of the project, consulting reports, dashboards, completion state and access an MES system with the latest delivered customization.

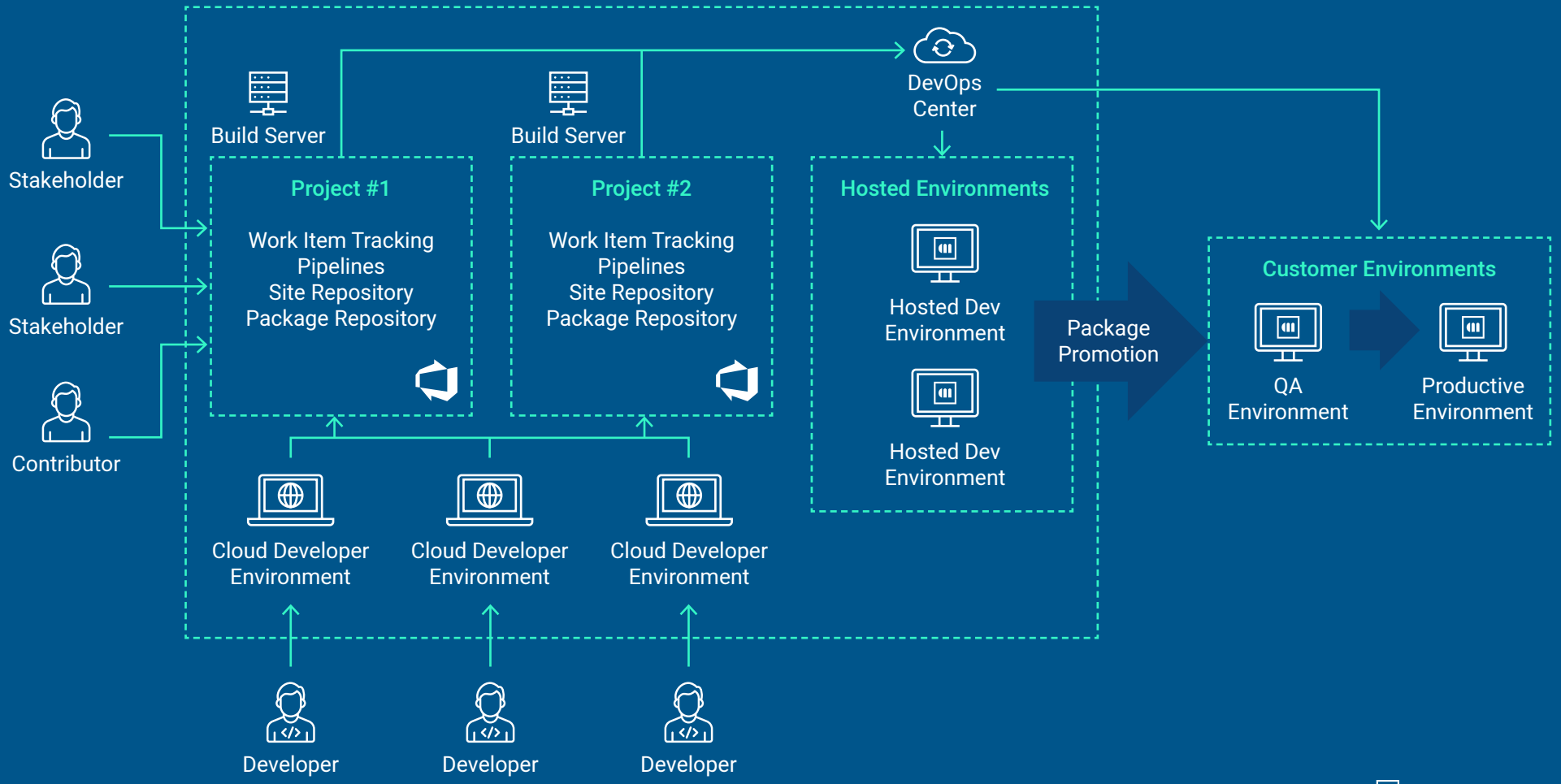
A **stakeholder** actively manages the backlog, creating tasks and assigning work. It can see all the source code and interact with the MES Environments.

A **contributor** can create tasks and complete work. He interacts with the source code, being able to do all the activities of an MES project development. He can also have a DevBox, a remote system where he can perform all his day-to-day development. He can deploy the MES environments and promote MES Customization packages to release candidates.


Hosted Environments
Hosted Dev Environment
Package Promotion
Customer Environments
QA Environment
Productive Environment
Stakeholder
Contributor
Work Item Tracking
DevOps Center
Developer
Cloud Dev Environment
Source Code
Build Server
Package Repository

Collaboration Hub out of the box comes with **all the needed DevOps experience**. It provides the ability to spin up MES environments based on the latest customization pushed to your code, run suites of tests and generate comprehensible reports, create guardrails for the code being generated and an approval process for code deployment and acceptance.

With DevBox development cloud environments, you can **quickly scale and on-board** your developers. They come provisioned with all that is needed to start developing and creating value for your projects. Now all your developers have the same developer experience and machines that are all equally provisioned. From his DevBox, the developer can contribute to multiple MES projects.

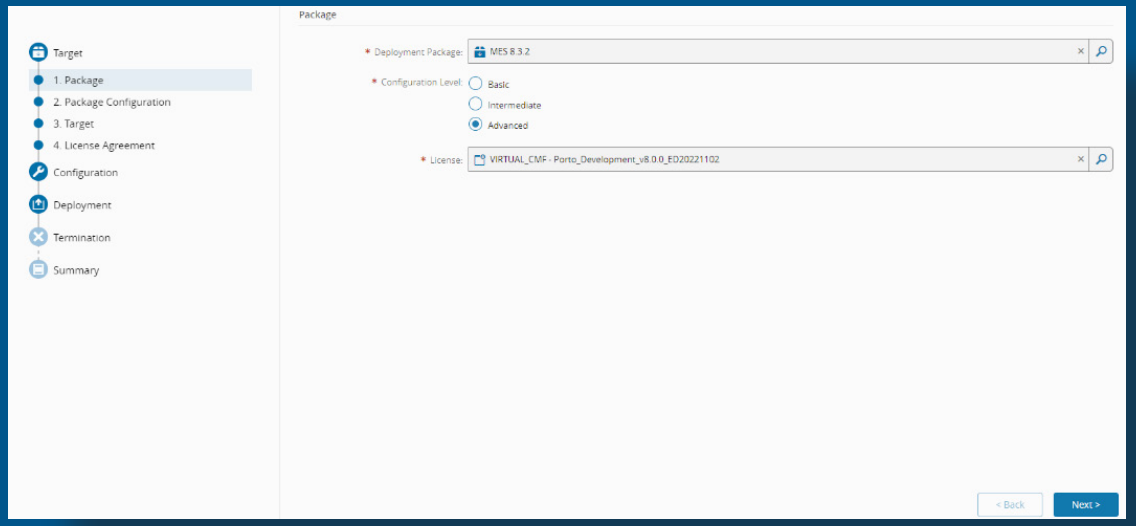


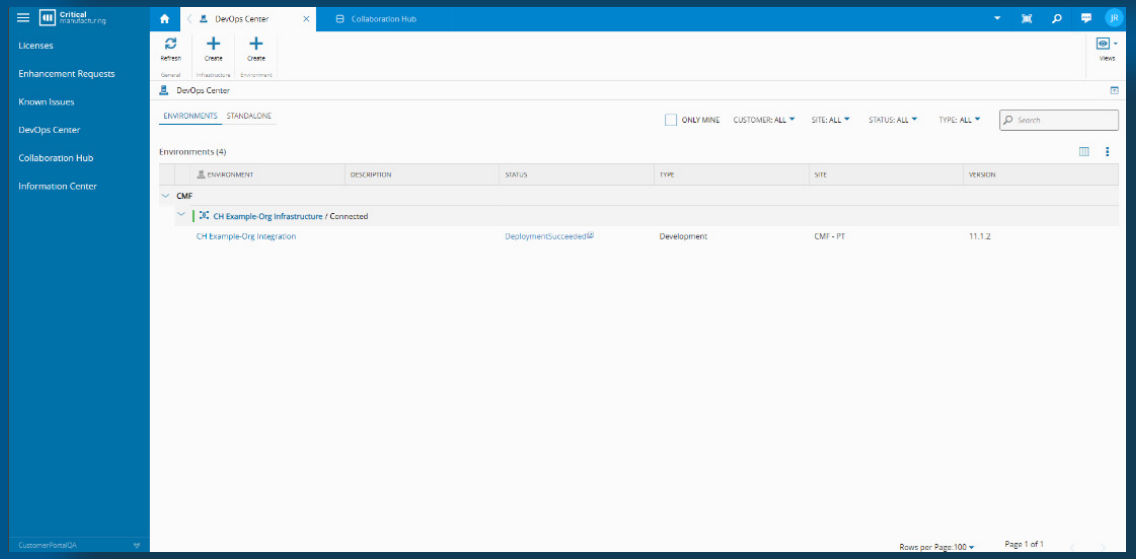
DevOps Center

Deployment is also a key part of handling MES implementations. While it may be possible to survive clunky deployments for one system, when you start scaling with multiple systems, that illusion quickly falls apart.

A robust deployment solution able to deploy your latest MES solution **across different environments in different geographies** is absolutely critical to avoid deployment chaos and mismanagement. A one stop shop, **centralized portal** that allows a qualified installer to run the **MES deployment**, with whatever additional packages he wishes, in a button press, is a must have. Without this the customer is forced to have ever bigger IT teams, focused on menial tasks and coordinating across the world, instead of focusing on bigger issues, like security and infrastructure.

The user is not only able to deploy remotely he is also able to constantly monitor the state of his environment. Having **live feedback**. He is also able to trigger new installations, from updates of the CM MES to deploys of new customization packages, all directly from the portal.



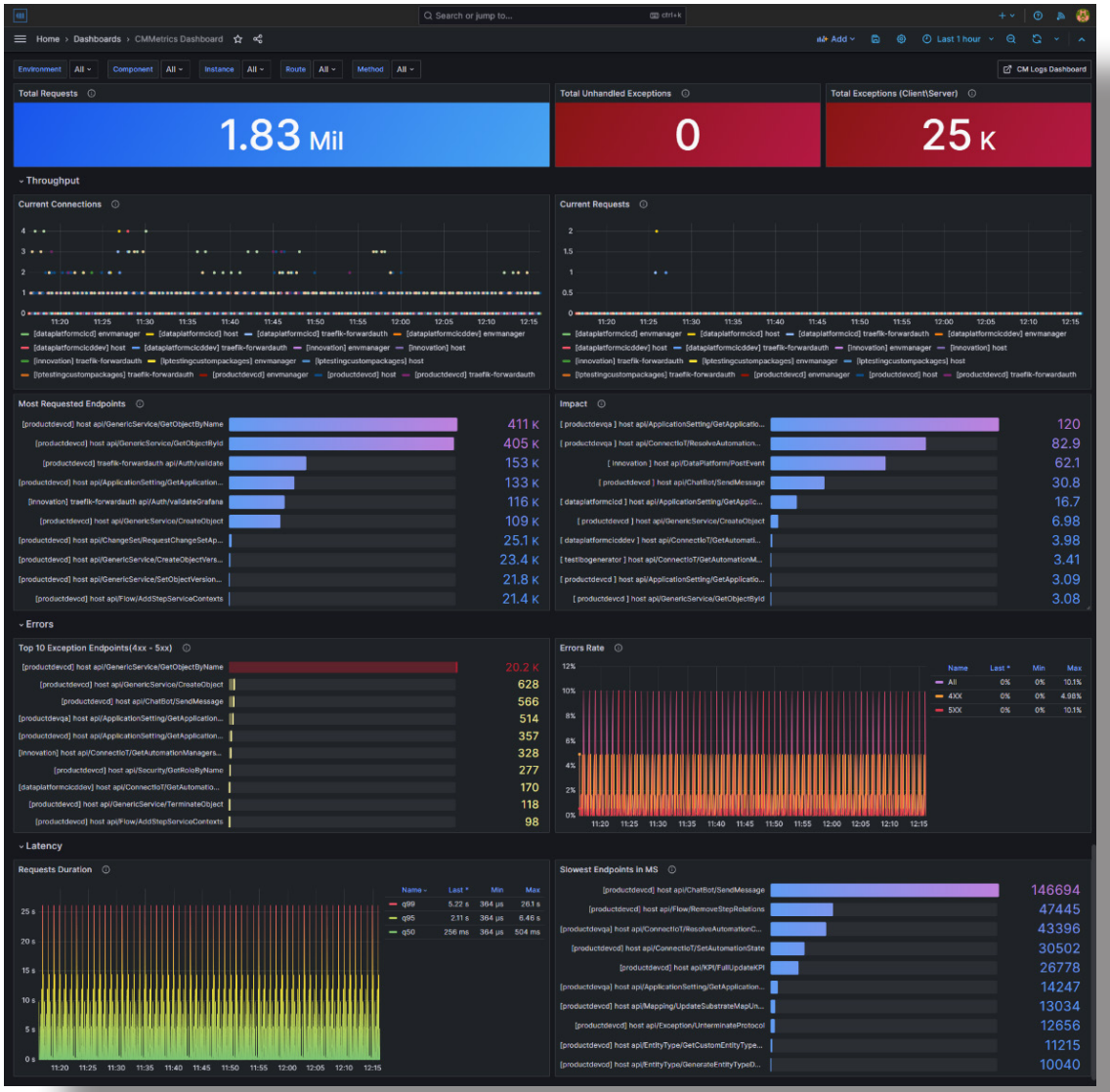


Observability

In modern distributed systems, maintaining visibility across diverse components and data streams is critical. The Observability service addresses this challenge by offering interactive dashboards that visualize real-time data from multiple sources, empowering teams to make data-driven operational decisions with speed and precision. At the heart of the platform lies a unified telemetry pipeline that ensures consistent, structured, and streamlined data flow across environments. This centralization eliminates data silos, providing a single source of truth for metrics, logs, and traces—regardless of their origin.

Users can explore live telemetry streams with interactive navigation and time-based controls.

This real-time access enables engineers to instantly assess system health, track performance trends, and identify emerging anomalies before they escalate into incidents.



The platform supports fine-grained filtering by environment, component, instance, method, and even free-text queries. These capabilities allow users to quickly isolate relevant data, compare behaviors across deployments, and perform deep diagnostics on specific functions or transactions.

By correlating error rates, latency metrics, response times, and trace durations, the platform delivers holistic performance insights. Engineers can pinpoint bottlenecks, analyze root causes, and evaluate the impact of code changes or infrastructure updates—all within a single analytical view.

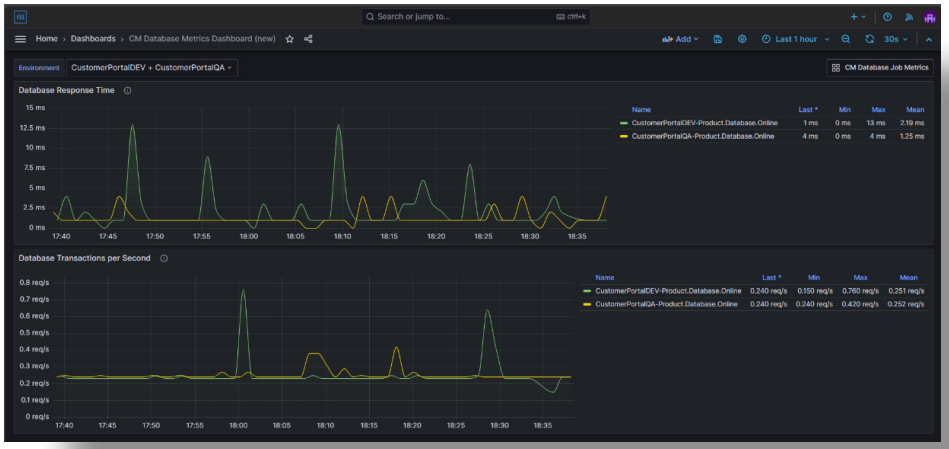
The integrated logging system captures rich contextual information, including log levels, timestamps, and associated traces. It highlights critical errors and performance warnings while maintaining a detailed historical record that supports trend analysis and compliance needs.

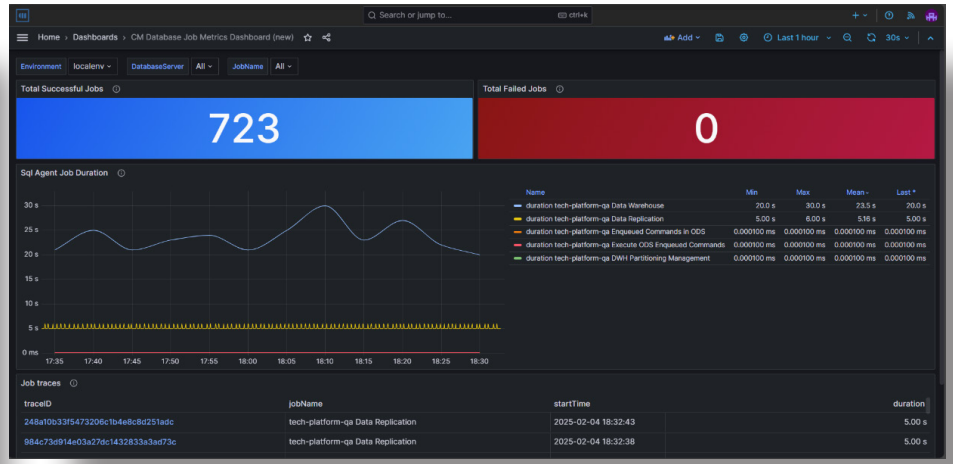
It also supports logging for on-edge applications like Connect IoT. Allowing for a centralized view of remote logging.

Beyond system metrics, the platform provides visibility into user interactions and session dynamics, bridging the gap between technical performance and user experience. This insight enables teams to understand how backend performance directly influences user satisfaction and product engagement.

Key views on your database, making it easier to spot database degradation of response time, number of transactions per second and bringing visibility to your database jobs.

Together, these capabilities empower organizations to monitor, diagnose, and optimize their digital ecosystems with unprecedented clarity. The Observability service transforms raw telemetry into actionable intelligence—ensuring reliability, enhancing performance, and fostering a culture of proactive operations in an increasingly complex software landscape.





Apps

Apps are in many ways the missing link for true agnostic implementations.

They are the prime example for implementations that scale horizontally across sites, generating value both vertically for each site and horizontally with the ability to aggregate data across sites.

Apps are standalone software packages that are not made to run in an MES environment, but on top of. They are not like customization, that is not just dependent on your system but a part of your system. They are able to consume data and perform actions in the MES without being part of the MES. They run in completely different stacks, with their specific components.

Apps can be as broad or as narrow as the user wishes. Tackling very specific domain use cases, or more broad needs of the shop floor. Apps are accessible through the MES or in their own application web portal.

The big advantage of apps is their first-class support for MES integration and all that comes out-of-the-box with the MES app framework. Authentication, security, roles, backend, frontend, UI components, all of this is available so you can create your app.

They leverage the same tooling and structure of a normal implementation project, but are intrinsically different, having their own deployment and data model. With the use of **EDP (Enterprise Data Platform) the CDM (Canonical Data Model) is now available from version 9.1 of the MES**.

They allow for a totally different outlook on how to address customization that is multi-site.
Apps can be generally thought of as split into three fundamental types:

- **Analytics**
- **Execution**
- **Automation**

Let’s take a look at what each of these apps is tailored for.

Automation Apps

Automation apps are probably one of the easiest to leverage across different sites. They are apps that serve as **interfaces between the MES and third-party systems**.

The MES is continuously producing Canonical Data Model (CDM) events for each relevant MES operation that occurs. Typically, interactions with third party systems have a few touch points for importing data into the MES and are then data consumers of MES operations. They match exactly with this need to consume real-time data from the shop floor.

For example, each time an MES Material Defect or a Material Loss is reported there is a new CDM event that is emitted. It is common across an organization to have the same or similar QMS. We can have an application that is available to all our sites that ingests CDM events for defects and losses. These events provide all the ISA95 context (like Resource, Area, Facility, Site) plus information regarding that operation, like material and product. We can then create a generic integration with the third-party QMS. As the QMS is similar across sites, our application can be deployed in all our sites with a button press, without impacting the MES system.

Analogously, for ERP systems, even though there are a few instances of mass data import, the ERP is much more interested in information regarding consumption of raw material, losses and confirmations of production orders and of material produced. All this information is provided via CDM. It also leverages the fact that most organizations try to be standard regarding their cost reporting across sites. This way it may require some flexibility to work in all sites, but it can all be handled on the app level.

This model is **ideal for separation of concerns**; your implementation project no longer has to deploy a set of customization packages into an MES system for these integrations. It doesn't need to be concerned with compatibility and versioning across sites, or even the hassle of deploying code that will not be used in that site. Having to have complex feature flag systems, to check when a particular feature should or not be active on Site A or Site B. The Site can simply choose to install the app or not.

With an app, we can just deploy it, consume the CDM events and interface with the third-party system.

Execution Apps

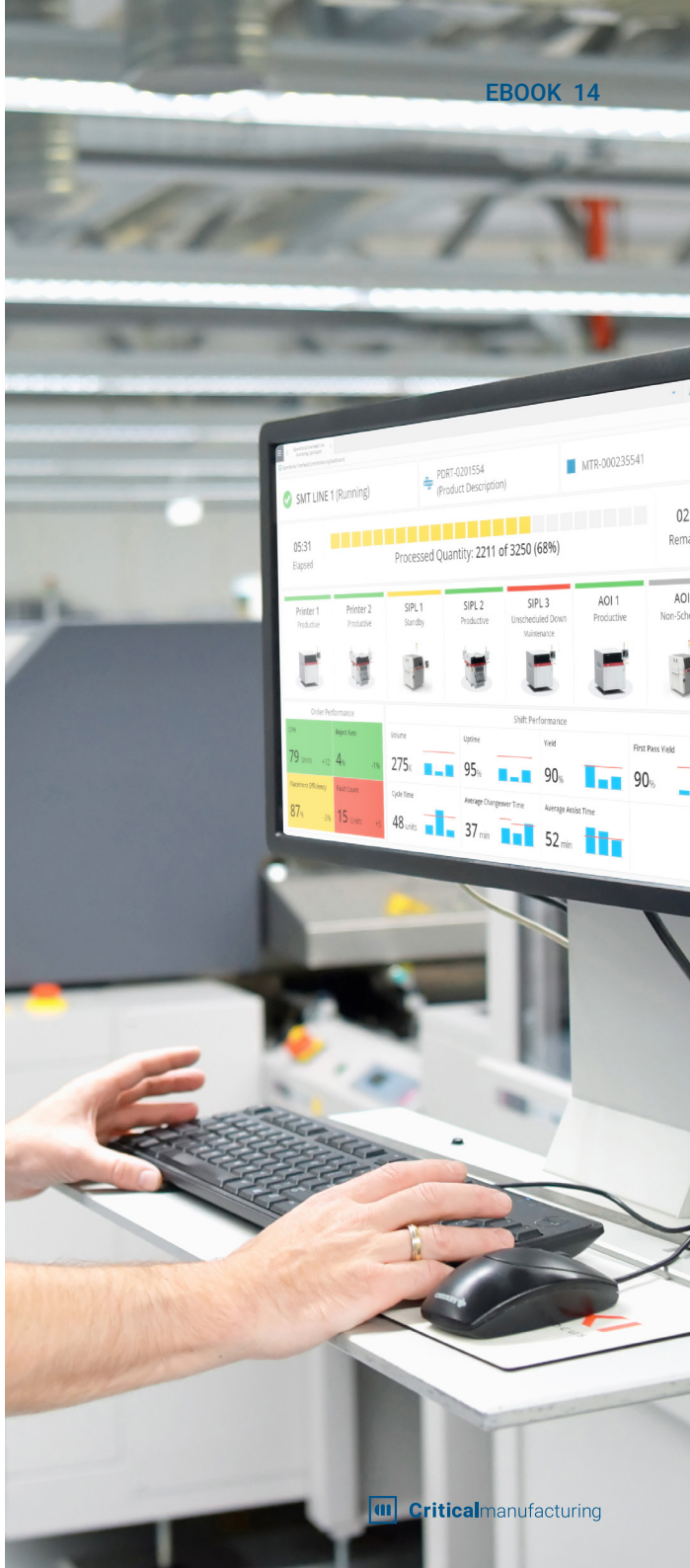
Execution apps are apps that are able to retrieve information and **perform transactional actions in the MES**. They allow for full on feature sets of solutions that interact with the MES without being tightly coupled with a particular MES model or configuration.

These apps can consume CDM events but also perform requests to the MES system. These types of apps can work as entirely separate applications with their own set of logic and scope and behave like third-party systems, with the added bonus of having **first class support for MES interaction**. These types of apps may have a broader scope, so they are harder to pinpoint to very specific examples, but you can imagine using the CM app framework to build a ticketing or certification platform, that would interact with the MES to extract users and roles and then synchronize certifications, schedules and key information about the users.

We can even think of apps focused on machine data, collecting all the data points that a machine is producing. It can then create data visualizations, search for hidden patterns and make machine learning predictions. With these predictions we can do preemptive actions in the MES system, from a simple MES notification to the proper user role, to opening a Quality Protocol for an MES material or scheduling a preventive maintenance on a Resource.

Another example can be alarm handling and collection. Most alarms don't directly affect the process and do not require action in the MES. But an app that collects all the machine alarms and then is able to perform interactions with the MES and QMS, can be helpful in truly understanding what is happening in the shop floor.

A lot of use cases can already be handled by the MES out-of-the-box solution, but sometimes it's helpful to have the possibility to address this in specific applications tailored to your use case, without burdening the MES.



Analytics Apps

These are a prime example where the App module can shine. The MES is a premier structured data producing application, with CDM open for third party applications, **the pool of data grows even larger**.

Apps that offer particular data aggregation and data visualization are very interesting targets for apps.

By ingesting CDM data and the ability to query cubes, apps can bring a whole different insight. They can be focused on very specific use cases that make the difference across all your sites.

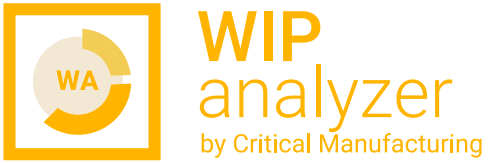
We can build applications tailored to our particular use cases, from understanding machine data, process variations or flow monitoring. They can be designed around a specific shop floor process.

An app focused on monitoring and controlling a clean room can leverage sensor data gathered with CM Connect IoT and control the state of a clean room, with dedicated dashboards, reports and notification systems.

We can think of a plastic mold lifecycle tracking application. We can correlate the immense data produced by an injection molding machine. Where we have detailed information about the shots per cavity, temperature and pressure. Then we can correlate that with all the maintenances done to the mold and we can better extrapolate the current quality of the mold. Our app can then track if any rework is needed and what is the impact of the deterioration of the mold in our processes.

We can even have **tailored applications, focused on process flows**. Like a root cause analyses flow. We can have an app with detailed reports and dashboards to better allow quality and process experts to quickly track down the origin of an issue. Some of these apps can be built generically, but others are very tightly coupled with use cases and features required for particular business domains.

Critical Manufacturing has released a steady stream of new and innovative apps in this domain.



CM Analytics Apps

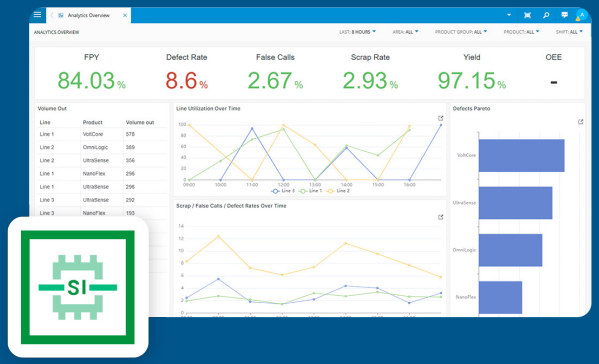
Resource Monitor built to provide manufacturers with a centralized, data-driven approach to tracking machine status and performance across all operational levels—from entire sites to individual machines.

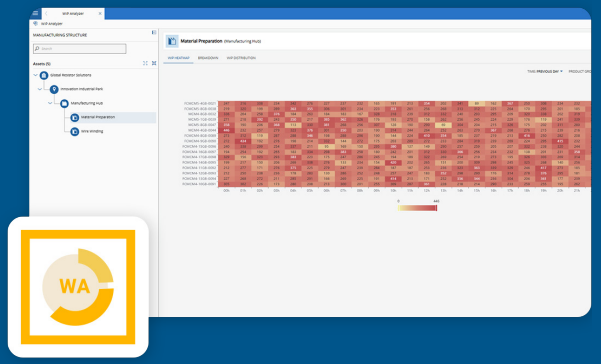
Smart Inspect focused on the SMT (Surface Mount Technology) process, designed to enhance the efficiency and quality of SMT manufacturing by providing deep insights into machine performance and defect rates

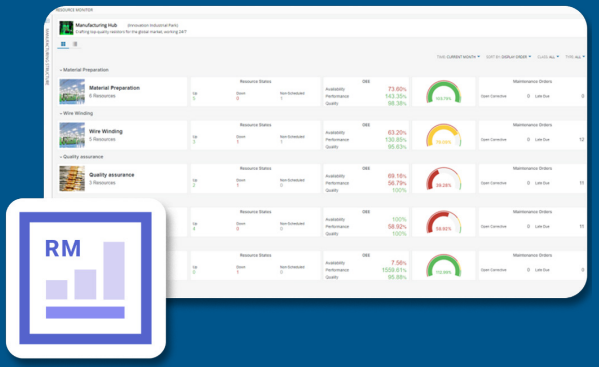
WIP Analyzer, looking at managing work-in-progress (WIP) as a key task for production engineers. Keeping WIP balanced helps meet customer demand while providing a buffer against disruptions. Since WIP changes constantly throughout the day, it can become difficult to track the various fluctuations that occur.

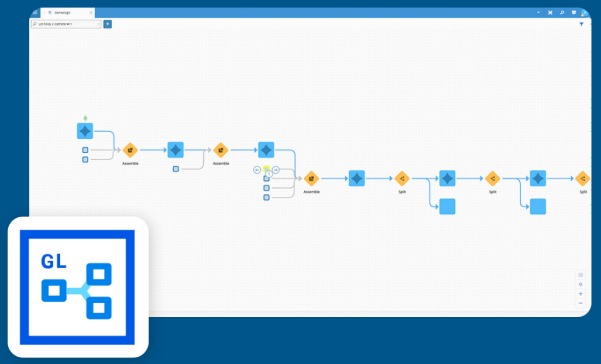
WIP Analyzer helps track material movement on the shop floor. It provides current WIP data, visualizations, and metrics to monitor changes over time, manage material levels, and identify temporary capacity issues.

Genealogic is an application aimed to quickly home in on any potential root cause when there are complex traceability chains. It aims to handle scenarios when there are genealogy operations, with multiple history chains of different lots having to be analyzed at once.









Conclusion: Apps as a Tool for Innovation

Apps are part of the definitive **ecosystem** of an MES of the future.

Now we have a multi-layered approach to new functionalities. Having the possibility to build and expand the feature set in a layer that maximizes value and impact. We will have our site requirements, our out-of-the-box MES system plus, then on top we can have our app ecosystem.

With democratization of structured data producing applications, enabled by CDM. We can now build a constellation of applications that consume data from the MES and other sources and bring different insights and value propositions. Now we have a common framework for building tools, leveraging the existing MES APP platform. To build an app the developer doesn't need to be concerned with routing, security or a development framework, he just uses what CM already provides out of the box. He will use similar tooling to what he is already used to working with CM CLI framework and have out of the box scaffolding to bootstrap his app building.

Apps allow for **a deep mindset change**, where we are no longer centered in only delivering MES features for our projects. We can now create easy to deploy and implement solutions complementary to the MES. This also solves a common long-term risk in the shop floor with unstructured applications being created to service real needs. With apps, those needs can be solved, keeping a centralized and common approach to the solution. If Site A team creates an application to solve their particular need, they can make that solution available for Site B and C with similar issues to also deploy it on their site, without a direct impact on their running MES system.

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About the author
João Roque is a leading voice in automation and connectivity at Critical Manufacturing, driving strategic initiatives that bridge MES and machine integration. With a strong focus on R&D and consulting, he plays a key role in shaping MES solutions while also serving as a public advocate for Critical Manufacturing's technology. João is responsible for showcasing the company's MES capabilities through real-world use cases, helping customers and partners understand the value of automation and connectivity in manufacturing.

About Critical Manufacturing
Critical Manufacturing a subsidiary of ASMPT and recognized leader in the Gartner® Magic Quadrant™, provides the most modern Industrial Operations Platform. With MES at the core, we bring together execution connectivity, automation, analytics, and trusted AI, to improve performance in real-time. Critical Manufacturing helps manufacturers build the connected, intelligent factories of the future, where people and AI collaborate seamlessly.

For more information, visit www.criticalmanufacturing.com.