# Always On, Active Analytics and AI for Superior Performance in Digitally Powered Enterprises

Digital transformations *always* focus on enhancing organizations' performance in some measurable way. Improvements at the task level include gains such as increasing the quality of a manufacturing process or improving safety for people and materials when robots are involved. Larger organizations' performance can also be enhanced by using digitally powered processes with a broader scope, such as in a group of similar factories or at the level of an entire business unit or whole company.

Naturally, improvements at each of these levels focus on requirements relevant to that level. To prove their value, new tools and capabilities must produce clear benefits in their areas of focus. For example, improvements in quality made possible using digital cameras at a specific location in a production line must focus on determinants of quality at the precise step where they are employed. Evaluations must be made **then and there** on dimensions of quality that matter for that product. It is an implicitly granular objective.

Similarly, focusing at the right level matters when evaluating the **performance of a whole operating site**, such as a factory, a warehouse or a seaport. We need inputs from a number of different systems including computerized numerical control systems (CNCs), stationary and autonomous mobile robots (AMRs), automated guided vehicles (AGVs), digital camera and computer vision systems, drones of many types, gantries, conveyor systems, and others. Each of these has its own device or fleet-level management system that guides its operation. When we widen the lens to analyze the site's overall performance, **a compound set** of metrics is required.

At other levels, such as **a whole business unit, product line or entire organization**, analyses must aggregate inputs even further from a number of different sources and merge them into a view of results at that higher level of operation.

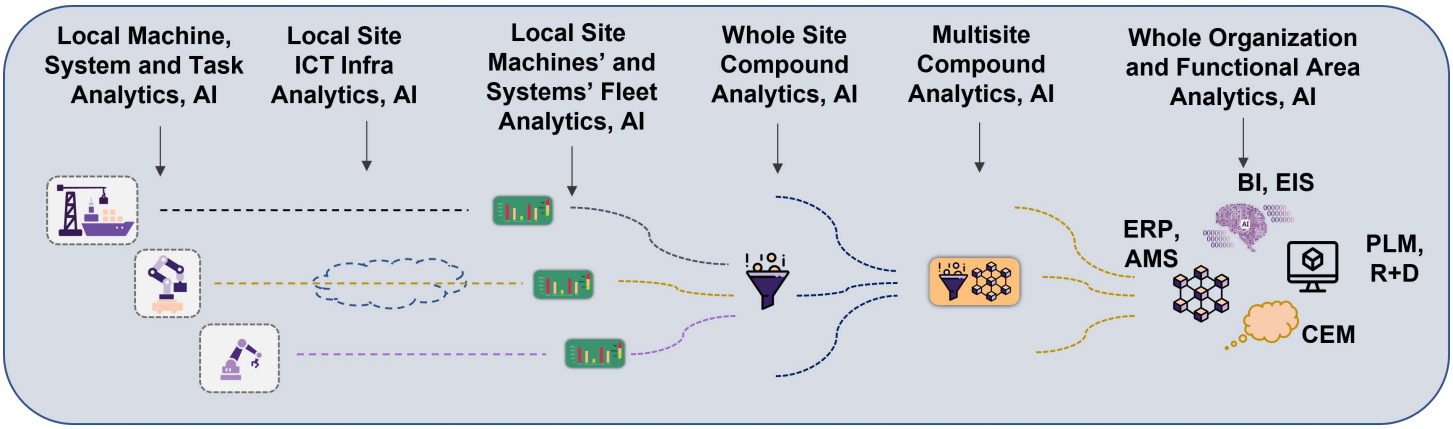


Figure 1. Today's Relatively Fragmented and Disparate Analytics and AI Solutions Focused on Optimizations in Individual Functions and Tasks

Clearly, there is a range of processes and systems running at **different levels** that have their own focus on helping teams achieve their goals. Each makes a meaningful contribution to improvements in its own area. This creates progress, even if it is in relatively isolated pockets. Understanding this blend of progress and fragmentation (to date) along with two other highly relevant factors (described below), inspires the vision of a more thoroughly integrated model of digitally powered operations with a prospect for generating even greater, more sustainable sets of benefits.

The first additional factor is the deep seeded commitment in many leadership teams to bringing differentiated, valuable offerings to target market segments on an ongoing basis and doing so with a firm grasp of how to foster innovation, responsiveness, coordinated execution, and commitment to demonstrably beneficial results. Harvesting a more *unified* set of analytics on a responsive, ongoing basis would contribute directly to that goal.

A second factor of equal importance is the proof of benefits we have from early implementations of digital enhancements in many domains and the readiness of the most important technologies enabling them to be implemented.

All of which brings us to the essential question:

*If a key goal of investing in digital transformations is to achieve continuous optimization in companies' performance, can the contribution made by each solution to a local goal be* ***amplified*** *by integrating it into an always-on, fully connected digital pipeline of analytics and AI functions focused on helping organizations apply stronger, deeper insights to their tasks and achieve superior results more continuously at every level? Can we achieve better overall net results?*

A yes answer in the long run is supported by observing that the technological capabilities for doing so are arriving at a stage where creating such a pipeline can be practically considered, versus being relegated simply to the domain of science fiction.

Although the vision is compelling, today, we need to acknowledge it realistically as a goal worth working toward by steadily adding the capabilities to empower it. Enhancements at every layer, from individual tasks to broader company operation, will be essential to achieving it.

The unique element that will ultimately deliver the results is an **active analytics and AI pipeline** working to achieve best outcomes **at every level**. Such pipelines will support optimization in individual end systems and functions. They will support synthesized analysis of performance among heterogeneous elements **in a whole operating site** (such as a factory, a warehouse or a seaport). They will support optimizations across **groups of similar sites** (such as factories, warehouses, seaports) against KPIs established for them (throughput, cost, revenue, safety, etc.). They will support analyses of whole organizational performance including profitability of entire product lines or the effectiveness of particular approaches to operation in one or more of the company's regions. Each would have an impact on the company's overall KPIs including profit and loss (P+L), net promoter score (NPS), and others.

In each of these cases the **speed** at which analyses could be performed, the **confidence** teams could have in the actions they are taking, and the **flexibility** organizations could have in pursuing best possible outcomes are improved by analytics and AI being always on, available to all groups (as appropriate to their roles), and enriched by applying a wider and more holistic set of inputs to each task at hand.

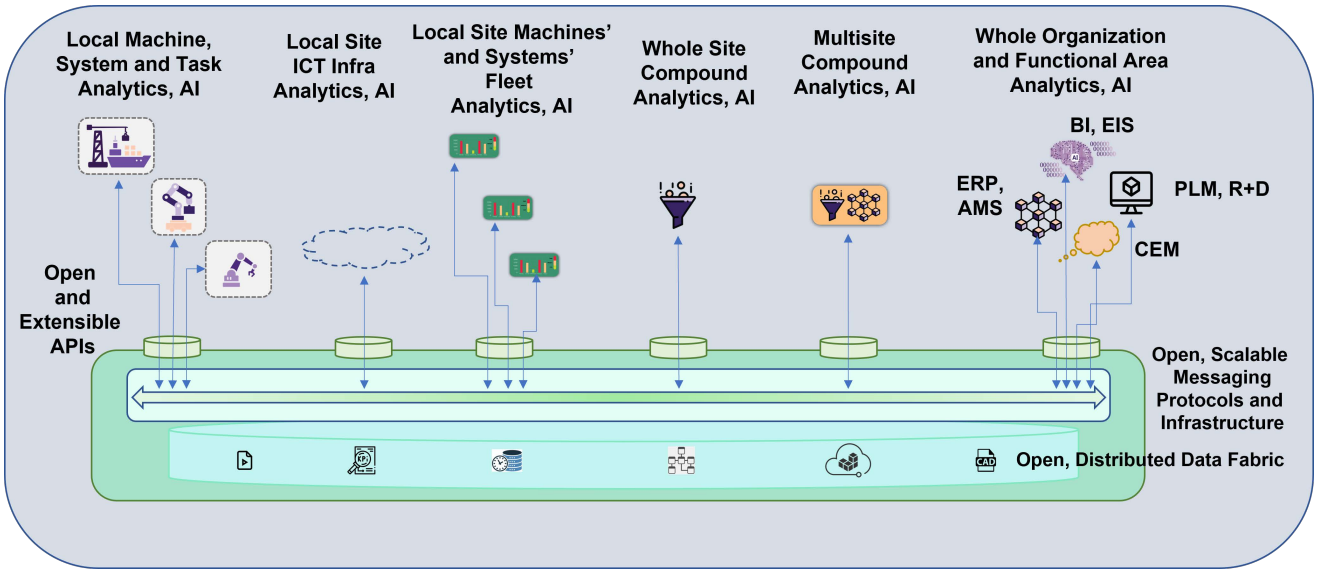


Figure 2. Model of an Always On, Fully Connected Analytics and AI Pipeline Supporting Continuous Optimization at Every Level

Figure 2 shows a vision of such an always on, fully connected pipeline of analytics and AI across an entire organization's footprint. Where local analytics and AI functions in Figure 1 were shown working in a relatively fragmented, isolated manner relative to each other, here each analytics and AI function is linked via data models and APIs into a distributed, elastic, highly available pipeline of digital tools and assets available to teams at every level.

Progress in multiple areas of technology will contribute to achieving this goal over time. For example, if enhancements to **microprocessors** used in end systems continue on the trajectory they are currently on (of significantly increased performance in progressively smaller footprints at acceptably low overall cost) they will continue to expand the scope of their contribution. They will improve motion control, computer vision, real time AI in process control, and other functions. They will connect their end systems more efficiently into the active analytics and AI pipeline we are describing.

Enhancements to local **network infrastructures** will be important. Improvements to wireless and wired networks will contribute in their own ways. 4G and 5G cellular networks will be deployed in combination with **WiFi** and **IP/Ethernet** according to each organization's requirements. Advanced functionality such as **Ultra Reliable Low Latency Communications (URLLC)** and T**ime-Sensitive Networking (TSN)** will be introduced into selected scenarios as implementations are brought to market and will help their adopters achieve new levels of performance[1].

Of equal importance are evolutions in **data models and communication protocols** to support interoperability between systems. Open data models such as **OPC UA**[2] in the manufacturing sector will help streamline factory operations in the future. At layers above IP, adopting open and standardized messaging protocols such as **Message Queuing Telemetry Transport (MQTT)** and **Advanced Message Queuing Protocol (AMQP)** and messaging platforms such as **Kafka buses** will link end systems and applications together flexibly and efficiently in fully connected pipelines[3].

At each level, systems in this pipeline will benefit from ready access **to robust storage and computing** functionality that will process, maintain, and share diverse sets of information required to support optimizations. Developments in two categories will make great contributions to enabling this.

[1] URLLC and TSN are each included in cellular wireless network specifications for 5G as of 3GPP Release 17 (approved in June, 2022), and TSN is also incorporated into fixed network standards via specifications from IEEE's 802.1 Working Group.

[2] Open Platform Communications – Unified Architecture (OPC-UA) is an open data model for industry 4.0 developed and published by the OPC Foundation, https://opcfoundation.org/about/opc-technologies/opc-ua/.

[3] Message Queuing Telemetry Transport (MQTT) is an open, standardized, lightweight telemetry protocol for IoT developed and maintained by OASIS, https://mqtt.org/. Advanced Message Queuing Protocol (AMQP) is an open messaging protocol for use between applications, also maintained by OASIS, https://www.amqp.org/about/what.

First is the growing number of **hybrid, multi-cloud computing infrastructures** that firms can take advantage of to support a wide range of functions, including analytics. Depending on the circumstances, an organization could deploy new functions quickly to a particular cloud and link them into its analytics and AI pipeline, accelerating the time to achieving its goals.

Second and equally important is what we refer to as a **unified data fabric (UDF)**, sometimes referred to as a data lake house, a hybrid data fabric or simply a data fabric (depending on supplier and implementation)[4].

UDFs support the storage and availability of diverse types of data, including **structured** (as in relational data bases) and **unstructured** (as in video, audio, graphic, text, and web application files). UDFs have a number of properties that make them extremely valuable in active analytics pipelines:

- They are extensible, distributed and elastic, and can be deployed concurrently across distributed edge and private, central, and large public cloud environments.
- They support a mix of latency, availability, and capacity requirements for accessing and managing data and analytic models, from real-time streaming and transaction processing, to rolling batch processing schedules, time series data bases, and archiving.
- Most importantly they allow a mix of applications, including AI and analytics, to work with the varying types of data in a consistently governed, managed, and elastic mode.

At the highest level there are tools and applications that help leadership teams analyze performance at the **business unit, functional area or whole organizational level** and consider options available to support forward planning. Analyses include looking at the pace of revenue generation for product lines, analyzing the efficiency of manufacturing against KPIs, and examining potential returns of targeting various customer groups in a variety of regions in the plans. Of necessity, tools at this level need to work with **summarized data and metrics** to support decision making on overall operations and plans. Types of applications used include enterprise resource planning, asset management, product line management, computer aided design, customer experience management, executive information systems, and business intelligence dashboards.



[4] Databricks, HPE, and IBM are suppliers of data fabric solutions, using each of these three additional names for their offerings, respectively.

Each has a role in evaluating the performance and direction of the organization against its KPIs. Each is a recipient of information from the pipeline and a contributor of outputs into it to support continuous optimization in many areas across the organization.

While developments in each of these areas will be an important contributor to progress, achieving sustained and superior results will be amplified even more by applying consistently expanding capabilities in **analytics and artificial intelligence** to improve operations at every level, focusing on continuous optimization.

For example, **neural networks** of multiple types (deep learning, convolutional, others) can be designed into operations at many levels. They accelerate the availability of insights in their areas of focus, and can work in conjunction with **inferencing and recommender systems** to evaluate opportunities for improving operations. **Digital twins** can be used to analyze the performance of their physical counterparts with a focus on improving results. Various **modeling and analysis tools** that help improve product designs and evaluate opportunities in alternative business plans can be applied at other levels.

Taken as a group all of these developments will move the opportunity to benefit from digital transformations to a higher level than we have been able to achieve to date. They will make it possible for each organization to combine its own digital enhancements into its own fully connected, always on pipeline of analytics and AI. From our work on technology and architectural transformations in related sectors, and the impact they have had on outcomes for their adopters, we expect the implementation of such always on, fully connected pipelines in combined OT/IT operations to be a critical ingredient in achieving superior results on an ongoing basis in adopters' digital transformations.

We will pay close attention to innovations in each of these areas as developments progress. We will evaluate new designs in end system categories that will contribute to achieving this vision (in AMR, AGV, drone, and computer vision offerings). Similarly, we will explore evolutions in ICT infrastructures that contribute to achieving the results (in microprocessor, network, cloud computing, and storage implementations). When applications focused on sector operations (such as MES, ERP, and PLM solutions in manufacturing) are enhanced to include functions that contribute to continuous optimization we will examine the benefits they are creating. As developments in analytics and artificial intelligence progress, we will explore the innovations and their contributions. At the highest level we will research the impact that always on, fully connected analytics and AI pipelines are able to have on enhancing the results for whole business units and corporations. In this way we will analyze whether the benefits we anticipate will result from always on, fully connected analytics and AI are being achieved.

**About the Author**

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