



Predix: The Industrial Internet Platform



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Predix and the Industrial Internet

Investment in the Industrial Internet of Things (IIoT) is expected to top \$60 trillion during the next 15 years.¹ And by 2020, over 50 billion assets will connect to the Internet.²

The amount of industrial data generated will be significant in terms of volume, velocity, and variety. In fact, industrial data is growing twice as quickly as any other sector. Yet today, less than 3% of that data is tagged and used in a meaningful fashion.³ In order to extract insight from the data and gain a competitive advantage, every industrial company will need to become a software company to thrive.

But harnessing that data ‘potential’ from scratch isn’t easy. Datasets can be fragmented and even siloed such that they can’t be used elsewhere. Operational Technology (OT) and Information Technology (IT) often operate separately, leading to duplication as the roles these functions play in organizations converge. Diverse practices lead to performance variability as many of the best practices are used in some but not all parts of an organization. And, even though there are islands of excellence that meet various Key Performance Indicators (KPIs), opportunities may be missed if those KPIs are not standardized across the business.

Consider how your business’s decision makers may be struggling to answer questions such as these:

- *How do I allocate budgets strategically?*
- *Is my facility performing optimally?*
- *Are our current security policies putting us at risk?*

Guessing at the answers — or being reactive instead of proactive in answering them — undermines a

For example: In aviation, one flight produces 1TB of data: In healthcare, data growth is projected at 50x over today’s volume by 2020

company’s ability to be competitive in its market, and even risks brand reputation as productivity is lost, unplanned downtime is not mitigated, and market opportunities are missed.

Tapping into the power of a software platform can help companies get the answers they need when they need them to plan ahead and optimize performance. Industrial companies need a software platform that:

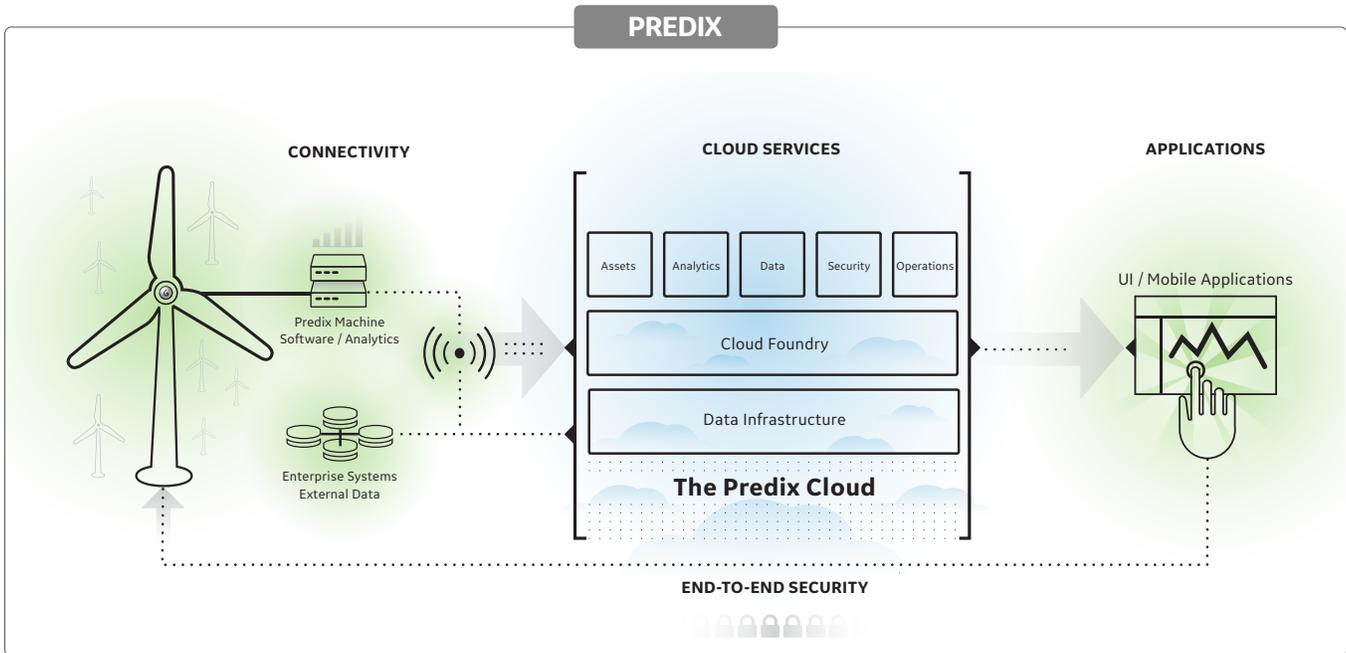
- is machine-centric.
- supports heterogeneous data acquisition, storage, management, integration, and access.
- provides advanced predictive analytics.
- guides personnel with intuitive user experiences.
- is delivered securely in the cloud.

That’s why GE created Predix — the Industrial Internet platform. Businesses can create innovative apps on Predix that turn real-time operational data into actionable insights. Predix equips them with

1 GE estimates: <https://www.ge.com/digital/press-releases/GE-Announces-Predix-Cloud-Worlds-First-Cloud-Service-Built-Industrial-Data-Analytics>

2 IDC report: December 2012 - THE DIGITAL UNIVERSE IN 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East - <https://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf>

3 Cisco report: The Internet of Things. How the Next Evolution of the Internet Is Changing Everything - http://www.cisco.com/web/about/ac79/docs/innov/loT_IBSG_0411FINAL.pdf



everything they need to rapidly build, securely deploy, and effectively operate industrial apps, putting them in charge of their IIoT journey.

GE has the industrial know-how to help companies transform themselves because it has had to transform itself. GE is actively deploying Predix across its own business, IT, and manufacturing operations. GE also plans to work with many of its customers to use Predix to secure and monitor the approximately \$1 trillion GE industrial assets deployed worldwide.

Why solve the problem with a cloud platform?

Why a platform? A platform offers a standardized way to enable an entire business to quickly take advantage of operational and business innovations. By using a platform that is designed around a reusable building block approach, developers can:

- build apps quickly.
- leverage work elsewhere.
- reduce sources of error.
- develop and share best practices.
- lower risk of cost and time overruns.
- future-proof their initial investments.

Independent third parties can also build apps and services on the platform, allowing businesses to extend capabilities easily by tapping the industrial ecosystem.

Why in the cloud? The cloud model allows businesses to take advantage of key capabilities including:

- economics of a centrally managed and shared infrastructure in a pay-as-you-go subscription model.
- scale to meet different business and application workloads by easily adjusting capacity on-demand.
- assets can be connected across the entire business so data can be captured.
- analytics can be developed and run to deliver insights at all levels of the organization.

A common cloud architecture also enables improved system governance, standardized security vulnerability assessments, and release management control and consistency

Why move today? There is no time like the present to decrease unplanned downtime, increase productivity, and minimize missed opportunities. By getting started with an industrial cloud platform today, businesses address an immediate need, knowing that an extensible architecture is there to help them grow to meet future requirements.

Delivering outcomes that matter

Predix empowers organizations to develop, deploy, and operate industrial apps in the cloud by securely connecting machines and data to people — driving outcomes ranging from the reduction of unplanned downtime to improved asset output and operational efficiency.

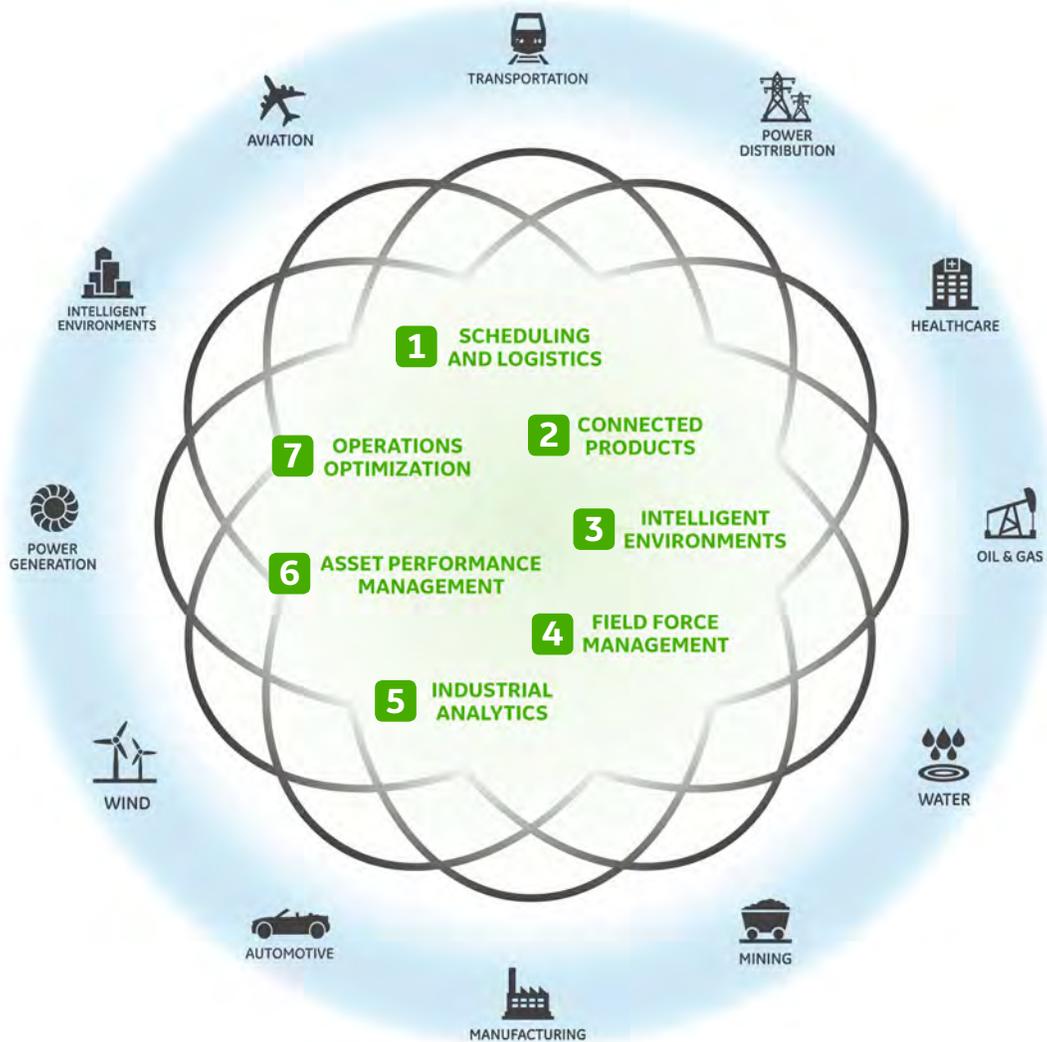
By combining cutting-edge IT with leading-edge OT, Predix brings world-class software innovation to your assets and operations, while integrating within your organization's existing IT systems. The result? Mobile staff, field operators, plant managers, business analysts, and data scientists can visualize data in the right context, build their own data models, answer key questions, and deliver on business outcomes. Predix is the only platform designed to:

- **address the key challenges that prevent growth and market competitiveness.**
- **capture and analyze the velocity, volume, variety, and complexity of industrial data.**
- **meet the demanding needs for industrial grade, end-to-end cyber, informational, and operational security.**
- **innovate faster by eliminating the barriers to entry to develop industrial apps for new business outcomes.**
- **take advantage of an industry-wide ecosystem of partners to extend capabilities through integrated software, hardware, and services.**

Mobile staff, field operators, plant managers, business analysts, and data scientists can visualize data in the right context, build their own data models, answer key questions, and deliver on business outcomes.

Supporting common industry needs

GE has invested in building capabilities that can meet common needs across many different industries.



- 1 Scheduling & Logistics**
 Increase asset utilization with predictive analytics, improving performance and efficiency that can result in lower repair costs.
- 2 Connected Products**
 Replace the current “break-fix” model with a “predict-and-prevent” services approach by making machines software-defined.
- 3 Intelligent Environments**
 Use LED solutions and sensors in cities and buildings to collect and analyze data and enhance everyone’s experience.
- 4 Field Force Management**
 Give workers the machine data, expertise and processes they need, to make repairs and upgrades more effective.
- 5 Industrial Analytics**
 Monitor asset health to identify problems then use predictive and prescriptive analytics to boost productivity.
- 6 Asset Performance Management**
 Achieve new levels of performance, reliability, and availability throughout the life cycle of all assets.
- 7 Operations Optimization**
 Use key insights on an enterprise-wide scale to resolve operational issues, drive productivity, and increase efficiencies.

A cloud infrastructure that runs industrial workloads

Public cloud infrastructure doesn't support the unique and demanding requirements of industry. For example, these clouds are developed to support IT data (such as ERP or CRM). Industrial data exists as multi-terabyte structured streams sampled continuously, resulting in unprecedented volumes of data (one plane flight, for example, can generate 1 TB of data). Also, how the cloud provider handles security incidents — especially the reporting and subsequent management and root causing — may impact operations.

As a leader in the industrial world, GE built a cloud that meets the needs industrial companies have for scale, security, and regulatory compliance. Predix cloud can handle vast amounts of Industrial Internet information, while also managing customer SLAs, security, support, governance, compliance, and export controls.

Gated industrial community

Predix is based on a multi-tenant “gated community” model to ensure that tenants of the cloud belong to the industrial ecosystem. This reduces the risk of bad actors entering the community, and enables GE to account for stringent regulatory requirements in ways that IT-focused public clouds cannot. Support for various data governance, federation, and privacy needs are included, as well as stringent security requirements, such as perimeter security, data security, access control, and data visibility.

Built on Cloud Foundry

Predix is built on Pivotal's Cloud Foundry, an open source Platform-as-a-Service (PaaS). By using Cloud Foundry's unique microservices architecture, its support for existing languages and programming tools, together with its modern development and operations (DevOps) environment, app developers can quickly build, test, deploy, and, perhaps most importantly, scale applications in hours or days instead of weeks or months. Developers also gain access to the Cloud Foundry ecosystem and an ever-growing library of services that are continually being contributed by industry.

Security is embedded at every level of the cloud stack.

GE-managed cloud

GE will make Predix available to customers in the Americas, Europe, Africa, Middle East, and Asia. Data center locations are to be selected based on provider diversity, network peering, technology capabilities, regional data privacy considerations, customer needs, and security considerations. All locations will be ISO27002/01, SSAE16 SOC 2 compliant and operate at either Tier III (Concurrently Maintainable) or Tier IV (Fault Tolerance) levels, based on the Uptime Institute Standards.

Capacity on-demand

Predix uses software-defined infrastructure (SDI) as an abstraction layer above the hardware, allowing services to evolve over time, with minimal disruption to the applications. This SDI is especially useful when an application dictates that a change to the underlying hardware configuration is needed to ensure that demand is met. The provisioning management and pooling of resources can be done at a granular level, allowing for optimal resource allocation, and ultimately driving costs down and value up.

Enhanced security controls

Security is embedded at every level of the cloud stack. This specialized approach offers industrial-grade security, as every layer is monitored and scanned for vulnerabilities. Capabilities include encryption, key management, incident response services, logging, network-level security, support for end-to-end chain of custody reporting for code and data, and 24/7 security and network operations centers. See Appendix A for additional security details.

Services that support the variety, velocity, and volume of industrial data

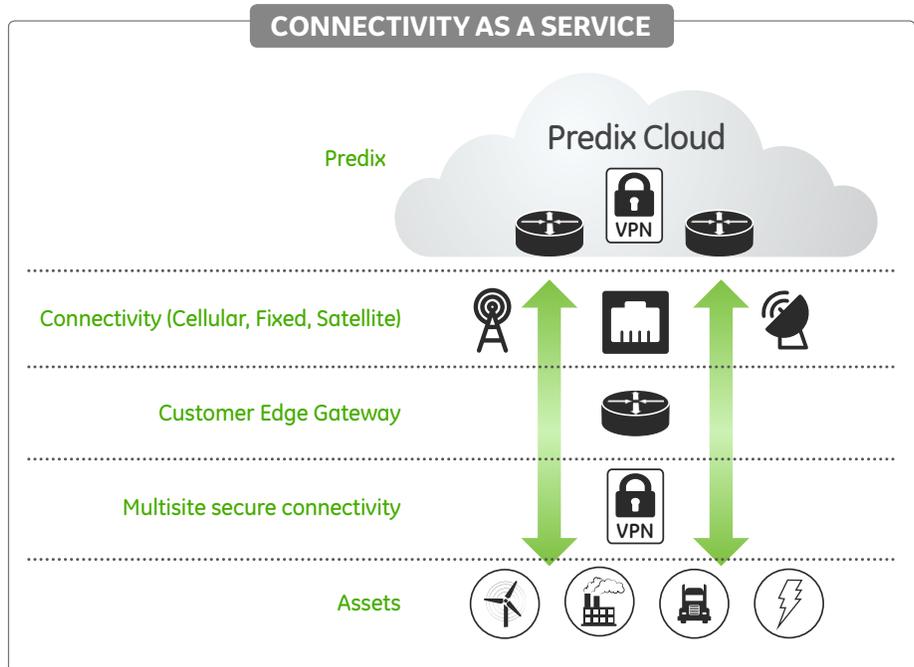
A truly global industrial platform needs to consume and analyze massive volumes of data by connecting to a wide variety of machines, sensors, control systems, data sources, and devices. Predix can securely connect with machines—old and new, GE and non-GE—on a very large scale. Once connected, data is captured, stored, analyzed, and made available to the right people at the right time to enable the right decisions.

Connecting GE and non-GE assets

CONNECTIVITY AS A SERVICE

The design and initial deployment of connectivity services can typically take 6-12 months. Predix connectivity services can provide same-day activation and provisioning. Combined with continual proactive monitoring support, troubleshooting, and automatic business alerts, these services deliver a managed, secure, end-to-end connectivity solution from the edge of a customer's network to the Predix cloud. These services are available today through several partners, and are offered worldwide, providing:

- physical connectivity globally via cellular, fixed or satellite networks through partnerships with Tier-1 CSPs (IP QoS, Policing, Metering, ACL, NAT).
- secure virtual private network (VPN) between the edge assets and Predix cloud, ensuring data privacy and asset protection.
- ability to manage and control the edge assets by providing remote access via VNC, RDP, SSH, and HTTP.



- end-to-end monitoring and notifications about the connectivity between Predix cloud and edge assets.
- one-stop-shop billing and reporting for all connectivity and IP services.
- a self-management portal.

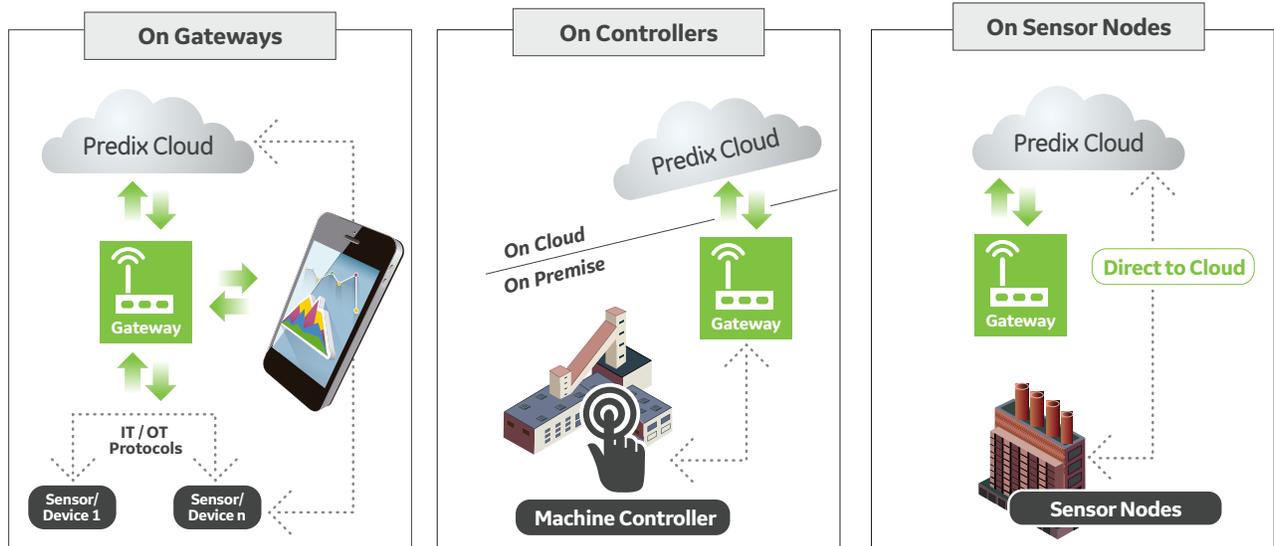
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PREDIX MACHINE

Predix machine is part of the “edge” software for Predix. Its primary responsibility is to provide secure, bi-directional connectivity to industrial assets (GE or non-GE), while also enabling applications (analytical and operational services) at the edge. The latter is particularly important to delivering near-real-time processing in controlled environments. Predix machine can make any equipment or device a more intelligent “software-

defined machine,” enabling a new generation of smarter, more connected products.

Predix machine also provides security, authentication, and governance services for endpoint devices. This allows security profiles to be audited and managed centrally across devices, ensuring that assets are connected, controlled, and managed in a safe and secure manner, and that critical data is protected.



The gateway acts as a smart conduit between the cloud and the machines - providing connectivity to assets via a variety of IT or OT protocols.

By using existing controllers, industrial and commercial assets that previously operated stand-alone can be connected to the cloud for data collection and analytics.

Leveraging low cost intelligent sensors deployed on or near the assets allows data to be transmitted directly or through a gateway to Predix.

Modeling assets

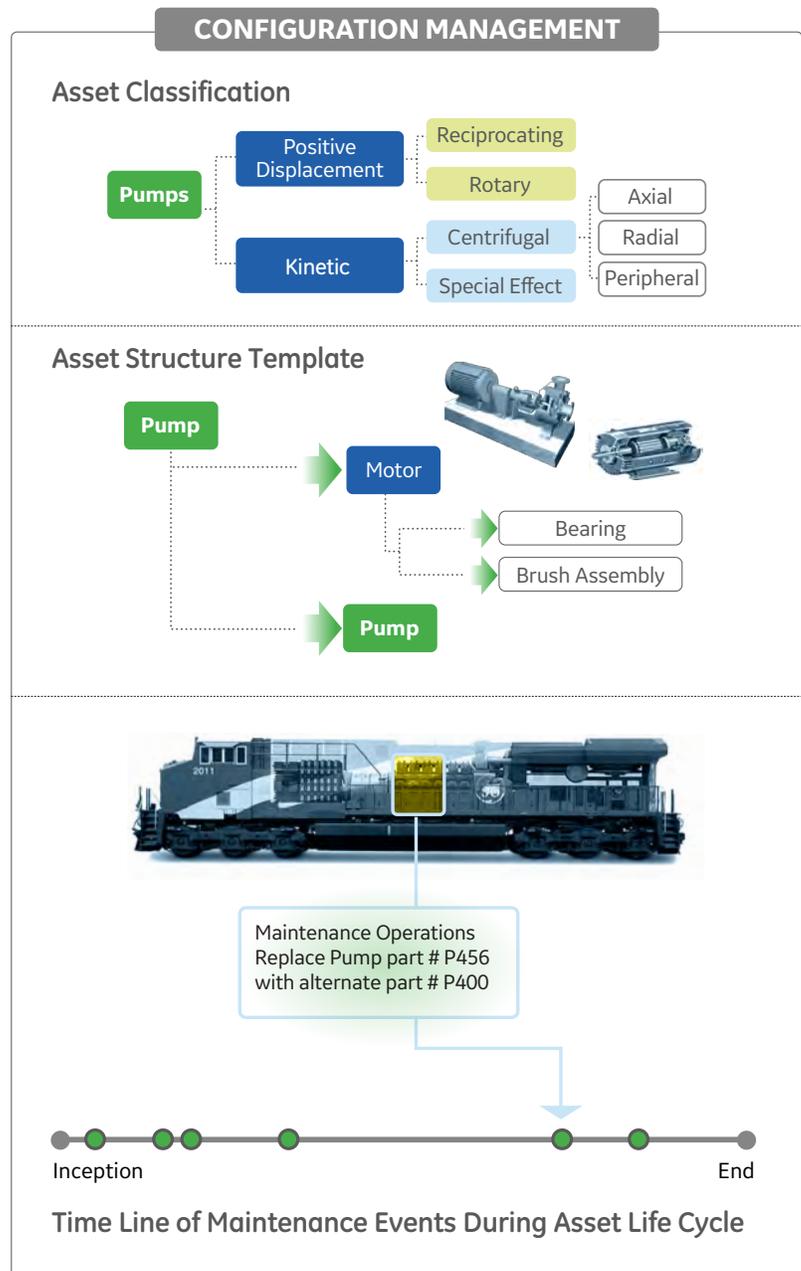
The Predix asset service enables developers to create, store, and manage asset models that define asset properties, as well as hierarchical relationships (parent, child, peer, etc.) between assets and other modeling elements. Asset models typically employ common elements. For example, classifications support different ways to identify and search for assets, which can provide a richer view of how the assets live within the business and who needs access. Templates can be used to create the structures that define the components that make up a complex asset.

One example use case is for **configuration management**. An application developer can create an asset model that describes the logical component structure of all locomotives in a fleet, and then create instances of that model to represent each individual locomotive. As a locomotive's configuration changes over its lifespan, the changes are recorded in the system. This history then allows for a snapshot of that locomotive's state (operating, retired, etc.) at a particular date and time. It also allows for displaying timelines of change events that have occurred to the asset over its lifespan.

Finally, Predix has an open asset model, which allows developers to create custom modeling objects that meet their own unique domain needs — for example, to support non-GE assets.

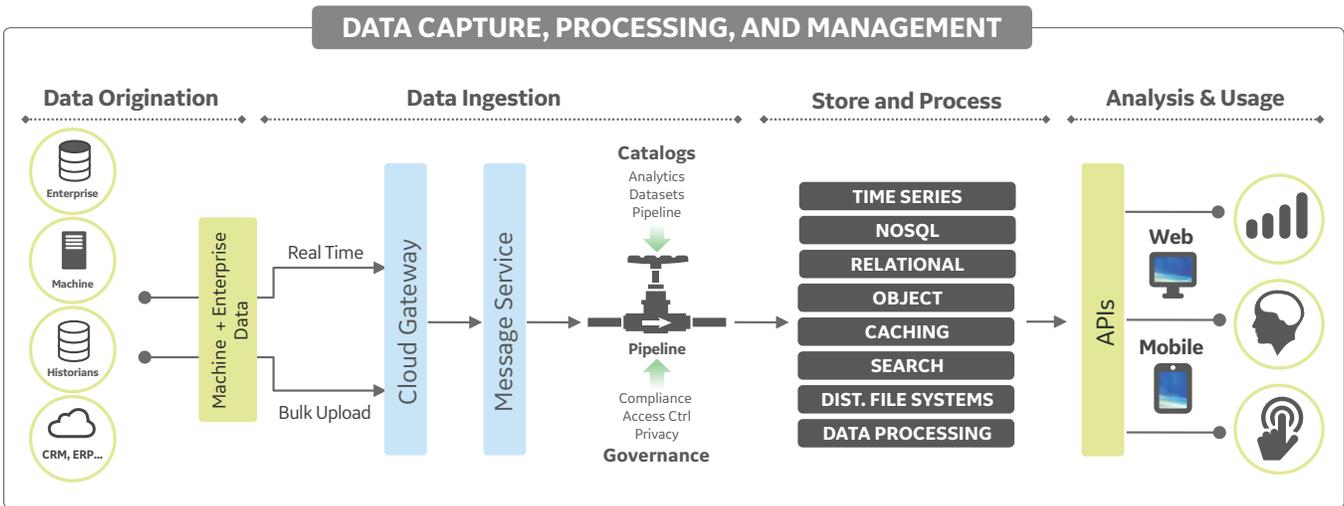
Data capture, processing, and management

Predix data services provide rapid access to data and timely analytics while minimizing storage and compute costs. It offers a secure, multi-tenancy model that includes network-level data isolation and encrypted key-management capabilities. It also



supports the ability to plug in analytic engines and languages to interact and process the data. There are four key components:

1. **Connection to the source:** Connections are established with GE and non-GE machine sensors, controllers, gateways, enterprise databases, historians, flat files, and cloud-based applications.
2. **Data ingestion:** Data is ingested from the source in real time, and by bulk upload.

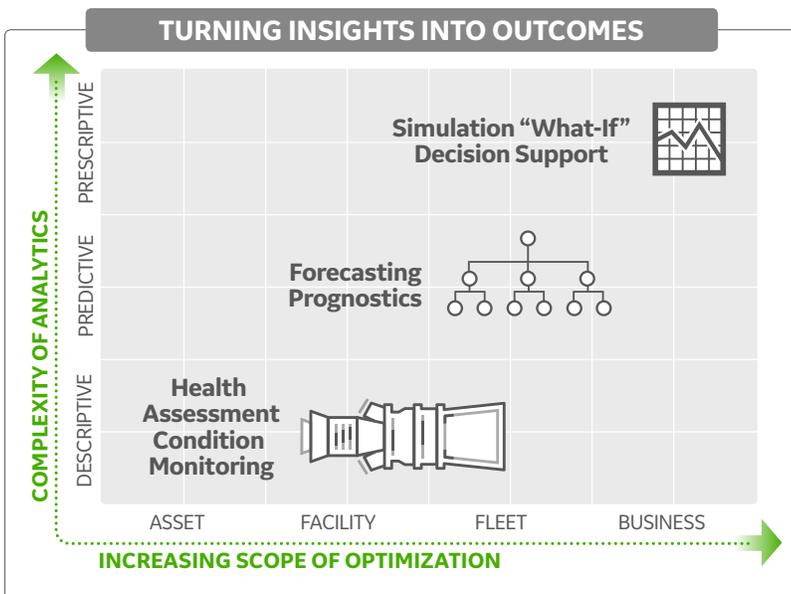


Workflow tools allow the user to identify specific sources and to create default data flows for all—or specific—data sets and data types, including unstructured, semi-structured, and structured. These tools speed the design, testing, and generation of code, making it easier to manage and monitor simple, one-time projects to complex, ongoing data synchronization projects.

3. **Pipeline processing:** The ingestion pipeline can efficiently ingest massive amounts of data from millions of assets. However, data can be messy, arrive in different formats, and come from multiple sources, all of which make running predictive analytics difficult. Pipeline processing allows the data to be converted to the correct format so that

predictive analysis and data modeling can be done in real time. The pipeline policy framework provides governance and cataloging services, allowing users to perform data cleansing, increase data quality, data enrichment (for example, merging with location or weather data), data tagging, and real-time data processing.

4. **Data management:** Data needs to be stored in the appropriate data store, whether it be time series for machine sensor data, Binary Large Object (BLOB) (for example, MRI images), or an RDBMS. This allows use of the data for both operational and analytical purposes. It also provides data blending capabilities, where users can deploy tools to extract value from these data sources to find patterns and process complex events (i.e., look for a combination of certain types of events to create a higher level business event).



Turn insights into outcomes with analytics

Companies that leverage analytics can become more data driven. A business can take its advanced analyses and express them as analytics. Predix offers a scalable, reusable framework for industrial analytics, enabling businesses to analyze data, create insights, and build targeted analyses that impact business outcomes. Analytic services abstract the intellectual property of a business’s advanced analyses to reusable analytics and orchestra-

tions (workflows) that define analytic sequences. Effective analytic functions can be cataloged, shared, and reused across different business solutions, saving time and extending the investment elsewhere in the business. Deploying analytics in the cloud also ensures that analytics are dynamically scaled across the business.

Operational analytics at the edge ensure the efficient operation of assets, but those analytics can be improved over time based on historical analysis.

Predix performs two types of data analyses: operational and historical.

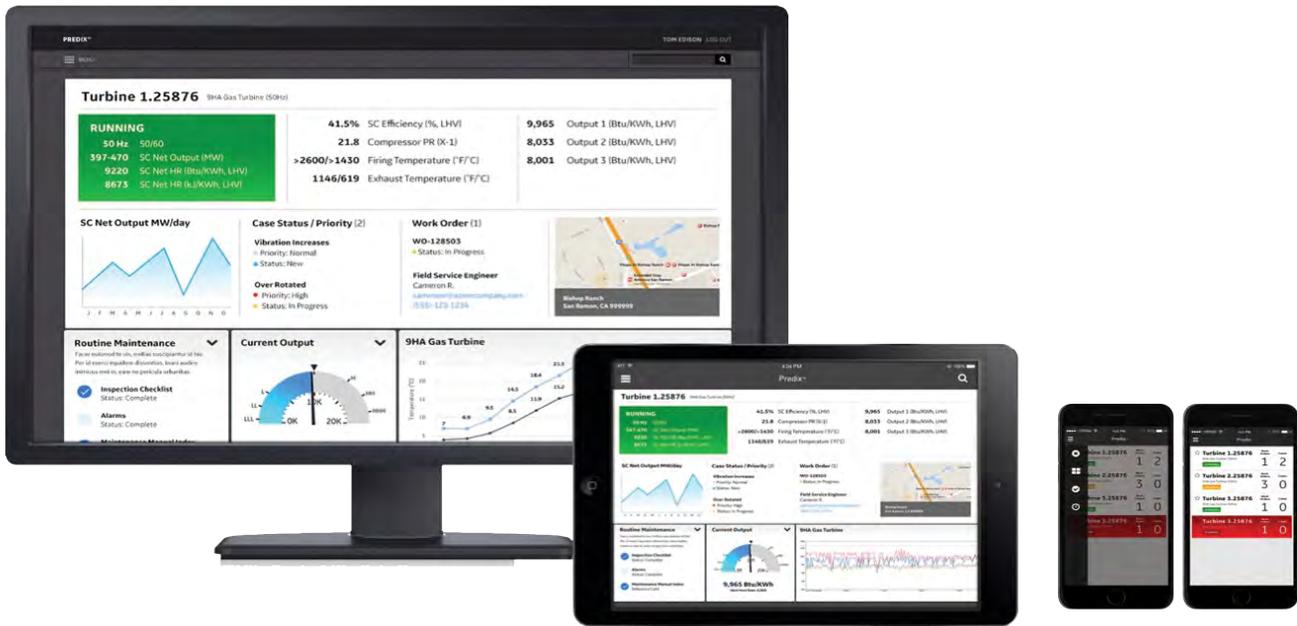
- **Operational analytics:** Data is analyzed in real time at the source — an aircraft engine, wind turbine, MRI machine, etc. — to detect problems so that split-second changes can be made in the operation of the asset to prevent damage or to optimize performance.
- **Historical analytics:** The collection and analysis of petabytes of historical operational data. From this analysis, it is possible to build a large-scale predictive model that can be used to more efficiently operate entire manufacturing plants or fleets of equipment.

Predix analytics enable a feedback loop between operational and historical analytics. Operational analytics at the edge ensure the efficient operation of assets, but those analytics can be improved over time based on historical analysis. Data scientists are able to publish analytics in Python, Java, and Matlab.

Predix also offers descriptive, predictive, and prescriptive analytics, providing a comprehensive approach to uncovering relationships in data. Each group of analytics has its own use. However, waiting until all the infrastructure and operational capabilities are in place to support all three is not optimal. Instead, start small by identifying a workable problem, and use descriptive analytics as even small insights can generate big outcomes.

- **Descriptive analytics help determine what happened and why.** Descriptive analytics summarize data to gain insights from the past and determine how the past might influence the future. For example, an airline might assess the health of an engine over 6 months to determine if preventative maintenance is required.
- **Predictive analytics help determine what might happen next** by forecasting based on a model. For example, an oil company might look at how specific oil wells can be combined to increase the overall production of the entire field.
- **Prescriptive analytics help to improve the decision-making process.** Prescriptive analytics determine possible actions towards a solution that has the largest impact on a company's bottom line. For example, hospitals might look at what new opportunities exist to maximize physician throughput based on the mix of physicians, technicians, and operating rooms.

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Building contextually relevant user experiences

Predix supports the building of responsive web, mobile, and embedded applications that scale gracefully from smart phone to desktop. The Predix user experience (UX) system provides developers and designers with simple, modular, and cohesive solutions for theming, layout, and UI components with tailored integration points into the rest of the Predix platform stack.

Internationalization, localization, and compliance are taken care of within the system. Applications are not only context-aware, but also context-adaptive — meaning they will change according to the context, so users can visualize and interact with the application in a way that is relevant to them. This paradigm removes the need for multiple applications and context switching by users.

Brownfield integration

To take advantage of the Industrial Internet, integration with existing—and future—equipment, data, and analytics is critical, especially in brownfield sites. Predix achieves this at a number of levels:

- **Machines:** Connect machines of any vendor or vintage. Predix machine supports a number of protocols, including OPC-UA, DDS, and MODBUS, as well as TCP-based sockets communication.
- **Data:** Standard connectors are included for time series, location, ERP, and CRM systems. Custom connectors can also be built to incorporate proprietary data schemas.
- **Programming languages/tools:** Support is provided for Java, Node.js, Python, Artifactory, GitHub, JaCoCo, and Ruby on Rails.
- **Analytics:** Support is provided for Java, Matlab, and Python.
- **Mobile devices:** By supporting HTML5, existing desktop browsers, smartphones, and tablets can be used across the business.

Developing smarter to innovate faster

Building Industrial Internet apps comes with some unique requirements and needs that separate them from traditional IT apps. Typically developers spend up to 80% of their time integrating and upgrading systems and technologies, versus only 20% of time spent on innovation. GE has years of experience building software apps for industry, and the design of Predix incorporates those learnings with tools and services that decrease the amount of time spent on integration. In fact, the time spent on innovation is now closer to 80%. Development teams are relieved from time consuming integration tasks, such as building software server stacks, integrating and configuring products, systems and 'things', managing SLAs (service level agreements), and scaling and securing infrastructure.

Microservices as building blocks

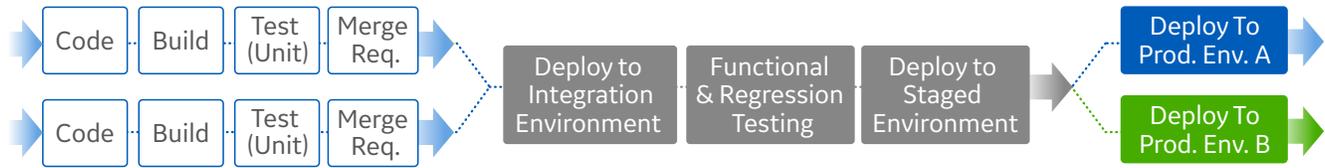
Predix microservices are reusable software modules that can be leveraged as building blocks to rapidly create applications. Because they are developed and delivered as discrete services, these microservices can



be loosely coupled into apps without the complexity and dependencies of traditional, monolithic app architectures. Additionally, because microservices can be developed as separate, stand-alone components, developers can use their favorite language and tools. The microservices architecture provides a level of isolation, enabling small teams of developers to deliver new capabilities and to version existing services, such as Connectivity, Asset, Field Agent, and Time series, incrementally. Microservices are also great enablers for continuous delivery, allowing frequent releases for users while keeping the rest of the system available

and stable. They are also easy to maintain, so once solutions are deployed, updates are much simpler and more efficient, eliminating code recompilation and streamlining operations. Apps and microservices built on Predix also benefit from the availability and scalability of the underlying infrastructure provided within GE's own managed data centers.

The screenshot shows the Predix user interface. On the left is a navigation menu with items like 'Alert Profiles', 'Cases', 'Analytic', 'Dashboards', 'Admin Overview', and 'Analytics Catalog'. The main area displays a 'Queue' of alerts, with one selected: 'PUMP ROTOR JOURNAL BEARINGS.Bearing: 1 - Bearing Problem'. This view includes sections for 'ALERT INFORMATION', 'ANALYSIS', 'SCAN GROUP DATA', and 'NOTES'. Green arrows point from labels above to specific UI elements: 'Filter Microservice' points to the 'Alert Profiles' menu; 'Event Microservice' points to the 'Queue' header; 'Case Microservice' points to the 'Create Case' button; 'SmartSignal Microservice' points to the 'ANALYSIS' section; 'Timeseries Microservice' points to the 'SCAN GROUP DATA' section; and 'Note management Microservice' points to the 'NOTES' section.



Continuous development using DevOps

Predix provides a set of development and operations (DevOps) tools that provide tight integration between functions that have traditionally been siloed, including development, quality assurance, and IT, enabling a more integrated and iterative environment from build to release to deployment operations.

By tightly integrating these functions in a single environment, teams shorten their development cycles significantly and make the agile vision of incorporating frequent user feedback simple.

DevOps provides the software environment to make agile a reality. It also enables continuous development, where a new module or feature set can be automatically rolled into production as soon as it is completed. This results in building new capabilities faster and at a lower cost.

Features include:

- agile planning through the Track & Plan service.
- source control management (SCM) through GitHub service.
- automated build and deploy with the Delivery Pipeline service.
- load testing tools.

Operating an applications business

Building applications is one thing; ensuring that they are actually being used and can be profited on (when desired in the future) is another. For any successful application strategy, placing the user at the center of that strategy is critical. Predix offers a rich development environment that allows developers to rapidly build, test, and deploy applications. Together with its user experience (UX) framework, Predix also helps users visualize data in a way that is

contextually relevant and useful to them no matter the device they use. It also helps answer the nagging questions related to application commercialization: What is an application's adoption rate? How are users using it? What features or services are not being used, and why? And, based on those factors, what is the best subscription strategy?

The Predix Business Operations (BizOps) service enables a data-driven decision-making process for businesses wishing to maximize their application efforts and speed time to usage or market.

By placing the user at the center of every business operation, development teams can iteratively build, split-test, and launch components of their apps across different users.

UNDERSTANDING USAGE FOR DEVELOPERS

BizOps helps an organization roll out applications across different parts of its business. By placing the user at the center of every business operation, development teams can iteratively build, split-test, and launch components of their apps across different users. BizOps provides complete visibility into how each component is used, identifying the best and worst performing products, packages, user groups, and distribution channels. This offers invaluable insights for developers, as they can uncover the real impact of the way they package their application to drive long-term user engagement.

BUILDING A SUBSCRIPTION BUSINESS

BizOps considers the lifetime value of each individual subscriber. It does so through advanced segmentation capabilities that enable applications to iteratively create pricing plans for each segment and to meter the service so that the cost-to-serve model is transparent. By understanding the cost

dynamics of a service provided, and effectively segmenting the market to create appropriate subscription pricing models and terms, businesses can have complete visibility into the revenue and cost dynamics of the service they are offering to maximize subscriber revenues.

Industrial grade security that builds end-to-end trust

Companies need a strategy for adopting security that better positions them to take advantage of the opportunities presented by the Industrial Internet. They need a way to effectively bridge the worlds of IT and OT in a manner that can establish end-to-end security and trust — from the factory floor to users on their devices. GE has developed a comprehensive security strategy that combines security certifications, hardware, software, expertise, and best practices to create an environment of trust for industrial companies. These ‘pillars of trust’ are represented below.

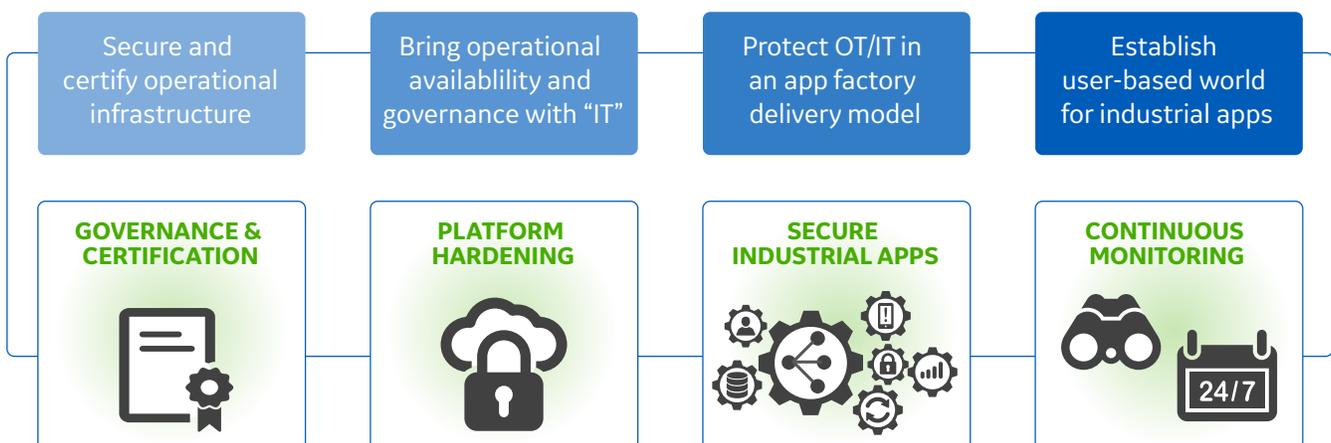
Governance and certification

Governance and certification are essential components of an Industrial Internet platform that deals with sensitive information. Predix builds in governance end-to-end — from the end-user right through to the operational infrastructure. Instead of layering

governance and certification onto existing IT data workflows, Predix integrates them directly into its architecture. Predix is built on a common infrastructure governance model based on ISO 27001/2, NIST 800-53, and FIPS 140-2 to manage the availability, integrity, and security of the data of each end-user enterprise. Predix leverages common controls that enables support compliance with over 60 national and international governing body regulations, meeting or exceeding the requirements of customers from a very broad range of industry sectors.

Platform hardening

When evaluating cloud technology, industrial companies are frequently concerned about levels of accountability and visibility into the proper functioning of the system. If a problem occurs, it is essential to have clarity on what went wrong, where



it went wrong, and how to fix it. To that end, GE has implemented platform hardening at every layer and connection to remove unnecessary services, applications, and network protocols, as well as configure OS user authentication and resource controls appropriately. Automated and manual controls are deployed to identify and patch system vulnerabilities. Common and layer identity for users, devices, software, and data are enforced. This results in unified and clean run-time environments.

Secure industrial apps

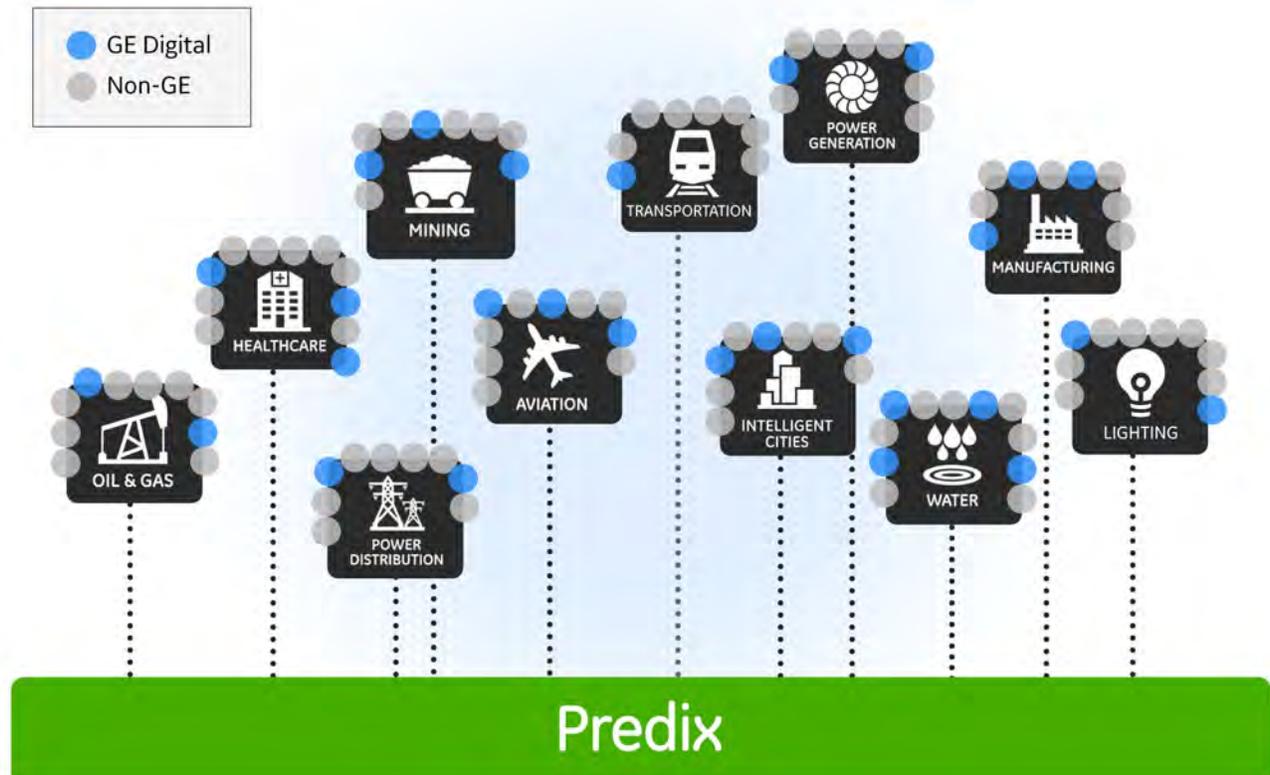
Establishing a secure software development environment is critical. Security, governance, and privacy cyber protections are automatically built into Predix, without impacting the developer or the application itself. The Predix infrastructure team follows a complete “DevOpsSec” (Development-Operations-Security) process for all apps and microservices. As part of DevOpsSec, Predix makes tools available to help developers create secure workflows, handle data properly, evaluate app users, and dynamically test applications and APIs throughout the development process. This includes the ability to establish a baseline and highlight potential security concerns prior to deployment.

By combining DevOpsSec with static and dynamic automated testing, Predix helps keep new code as clean as possible. Predix can also survey new microservices arriving into the development area to detect any abnormal or suspicious behavior. This approach greatly reduces the possibility of malware making its way into the run-time environment.

Continuous monitoring

Maintaining security requires comprehensive visibility. Predix achieves this through continuous monitoring at every layer, with data loss protection and malware detection from the external networks all the way through to the application or microservice. This visibility extends into the exchanges to/from the OT environment, and creates a “heat-map” dashboard for the Predix Security Operations team to protect customers served by Predix. The Predix team also provides guidance for the shared responsibility of the user organization to implement controls at application and data layers. Additional capabilities include:

- full Security Operations Center (SOC) and tooling.
- automated isolation and monitoring of incidents.
- app-to-app behavioral evaluation.
- chain of custody for data communities maintained.



Growing the ecosystem

GE cannot grow the ecosystem alone, as the vision is bigger than just one company. GE partners with other technology companies, academia, consultants, and systems integrators to drive important advances in Predix functionality that businesses can leverage for their own use. Only those partners that pass rigorous audits to prove their technical and operational skills together with customer references are chosen. The result is a marketplace in which GE's partners provide many of the new capabilities.

GE's partners include Accenture, Cisco, Infosys, Intel, Pitney Bowes, Pivotal, Softbank — proven players in the market that are co-innovating and leveraging industry know-how and technologies.

GE is also a founding member of the Industrial Internet Consortium (IIC), an open membership, not-for-profit group of public and private institutions that focuses on developing use cases and test beds; sharing best practices, reference architectures, and case studies; and influencing global standards development to ensure interoperability.



Why choose GE?

GE used Predix to transform itself.

GE saw a tremendous opportunity to transform the company through the Industrial Internet to drive revenue and services growth, and reduce cost. To do that, it had to do things differently. However, the software and analytics tools required didn't exist in the market. So GE built Predix, which it now actively deploys in its own business, IT, and manufacturing operations.

GE knows industry. Decades of experience in industries from power generation to manufacturing to healthcare have enabled GE to create a platform that meets the unique needs of industry.

GE secures and monitors 50 million data elements of its customers' industrial assets everyday, all in an effort to prevent unplanned downtime for its customers.

The Predix cloud provides hyper-scale elasticity,

mission-critical availability, and security support for data at rest and in motion.

GE manages data at an industrial scale to meet the high velocity, high volume, and high variety of data from industrial machines.

GE is able to securely connect industrial assets from any vendor or vintage anywhere with broad connectivity and security capabilities that allow for the management of complex asset data models.

Only GE can enable industrial data science by leveraging its physics and engineering-based models, and its statistical and heuristics models. And only GE can incorporate learnings from industrial business processes.

Achieving breakthrough levels of productivity and profitability is possible. Predix is here to help.

Learn more

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Appendix A

Predix cloud security

The table below lists additional security in place to protect the Predix infrastructure.

Isolated customer environments	Enable multi-tenancy to ensure that a customer's business environment and data are hidden from others as needed to ensure privacy.
OS security	Harden and maintain base OS images for provisioned virtual machines based on Predix hardening standards and related guidelines developed to comply with ISO27002/01 and SSAE16 SOC 2 standards and industry best practices.
Hardware security	Architect and securely deploy hardware for the cloud infrastructure based on Predix hardening standards and related guidelines developed to comply with ISO27002/01 and SSAE16 SOC 2 standards and industry best practices.
Secured storage	Provide encrypted block and object storage with associated services.
Secured data in transit within the cloud network	Secure the network (using IPsec and SSL/TLS protocols) based on controls defined in Predix hardening standards and related guidelines.
Federated identity management	Use tools that leverage the existing identity stores and remove the burden of identity management. Secure single sign-on (SSO) services for access to Predix cloud.
Vulnerability and patch management	Test and update software and hardware based on security advisories and regular vendor patch releases utilizing proper change management procedures.
Monitoring and logging	Actively search for network intrusion, malicious activities, and compliance policy violations that are a threat to the infrastructure; communicate and remediate any incidents.
Rigorous risk assessments against the cloud infrastructure	Perform penetration testing and compliance scanning to detect any vulnerabilities and compliance violations and quickly remediate them; perform assessments against security controls and procedures.

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