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AWS FOR INDUSTRIAL

Drive Industry 4.0 results with machine learning

Discover the key to smarter, faster, more cost-efficient growth

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Accelerate your digital transformation with machine learning

Industrial companies, such as those in manufacturing, energy, mining, agriculture, and transportation, are increasingly looking to fuel digital transformation—from optimizing operations to accelerating design to reinventing supply chains. For these organizations, data has become the connective tissue that holds their complex industrial systems together.

In efforts to collect, analyze, and make sense of data, industrial companies have increasingly adopted new technologies, such as cloud computing, the Internet of Things (IoT), advanced analytics, and machine learning (ML).

When properly implemented and utilized, these solutions improve operational efficiency and workplace safety through predictive maintenance, computer vision (CV), and advanced automation.

Machine learning, in particular, has emerged as a critical enabler of digital transformation. With its ability to detect anomalies quickly and grow

smarter over time, machine learning is driving business value across existing systems and new solutions alike. Numerous case studies have demonstrated the potential of machine learning to grow revenue and lower costs.[1]

Challenges persist, however. Liberating the data trapped in these systems can be difficult. And organizing, understanding, and making effective use of the mountain of data created by intelligent technologies may require rethinking long-standing processes and accelerating innovation.

In this eBook, we'll explore how today's industrial companies are leveraging machine learning to drive digital transformation and its associated benefits. Then we'll take a look at common challenges in the industrial world—and how AWS can help you successfully adopt machine learning to overcome them.

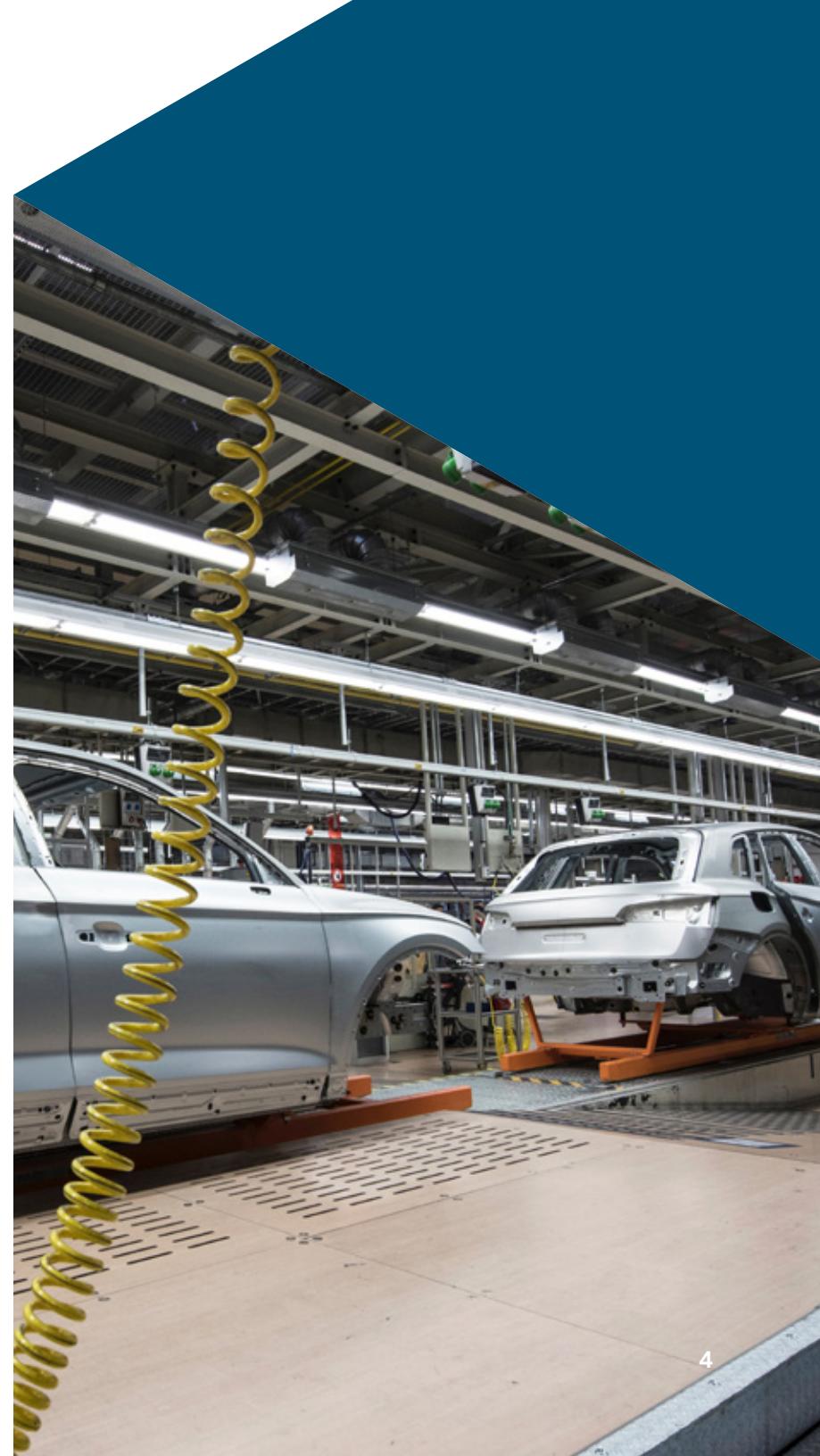[1] https://aws.amazon.com/machine-learning/customers/

What is machine learning?

You've probably heard artificial intelligence (AI) and machine learning described in a number of ways, so let's take a step back and review their exact definitions:

Artificial intelligence (AI) is a way to describe any system that can replicate tasks that previously required human intelligence. Almost always, this is related to some kind of complex decision-making task where human judgment would normally be required. Most use cases for AI are looking for a probabilistic outcome—making predictions, classifications, or decisions with a high degree of certainty and in ways that are similar to human judgment.

Almost all AI systems today are created using machine learning. Machine learning uses large amounts of data to create and validate decision logic. This is known as a model. The AI system feeds input data into that model, and then the model outputs human-like predictions or classifications. Essentially, machine learning is the underlying technology that powers intelligent systems.

Machine learning benefits the bottom line

According to a study by McKinsey & Company, the adoption of machine learning solutions with AI capabilities is up across nearly all industries. Of the surveyed organizations, 63 percent reported revenue increases from AI adoption in the business units where their companies use AI, and 44 percent reported cost savings from AI adoption in the business units where it's deployed.[2]

Leveraging machine learning can make your organization more competitive through increased revenue and reduced costs. For example, a recent study in the oil and gas industry revealed executives expected new digital applications to deliver, on average, a 10 percent increase in revenue due to faster production and an 8.5 percent decrease in costs due to operational efficiencies.[3] Another report showed that, between 2015–2018, the rise of "smart factory" initiatives led to a 10 percent increase in production output and a 12 percent uptick in labor productivity, on average.[4]

Machine learning helps your business realize these benefits in a number of ways. It creates new revenue streams by enabling you to enhance your products with smarter capabilities. It increases operational efficiency by allowing you to proactively address breakdowns, shortages, and other challenges. And it trims costs by reducing redundancies, streamlining infrastructure, and improving quality assurance.

2 https://www.mckinsey.com/featured-insights/artificial-intelligence/global-ai-survey-ai-proves-its-worth-but-few-scale-impact
3 https://www.strategyand.pwc.com/gx/en/insights/2020/digital-operations-study-for-oil-and-gas/2020-digital-operations-study-for-energy-oil-and-gas.pdf
4 https://www2.deloitte.com/content/dam/insights/us/articles/6276_2019-Deloitte-and-MAPI-Smart-Factory-Study/DI_2019-Deloitte-and-MAPI-Smart-Factory-Study.pdf

Among companies that have adopted AI/machine learning:[2]

63%
report increased revenue

44%
report cost savings

Data, data everywhere.
Now what?

Industrial systems create vast amounts of data. Applying machine learning can help you better understand and leverage that data, transforming it into insights that can increase product production per hour, enhance quality, lower the cost of products, and improve asset uptime.

Machine learning thrives in data-rich environments. No matter where you are in your digital transformation journey, machine learning can help you better manage, make sense of, and leverage your data. The result: smarter decisions that advance your business objectives, such as increased productivity, efficiency, or safety.

AWS offers the broadest and deepest set of machine learning services to accelerate your digital transformation, including purpose-built industrial ML services and supporting cloud infrastructure. We also provide many other solutions to help you extract, ingest, store, and interpret large industrial datasets. Our data lake solution automatically configures the core AWS services necessary to easily tag, search, share, transform, analyze, and govern specific subsets of data across a company or with other external users. And advancements in IoT and storage make it easy to securely access, collect, and organize your data on a massive scale—even with limited connectivity.

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How today's manufacturers are driving results with machine learning

Deutsche Bahn

Deutsche Bahn uses IoT connectivity to power its cloud solution and gain insights on its trains in Europe. The company needed to ensure it could always receive fast, secure reporting and have the ability to share new information or requirements quickly, with minimal downtime. In all, Deutsche Bahn improved uptime across 6,500 trains and 37,000 miles of track running throughout Europe.[5]

BP

Producing around 3.3 million barrels of oil every day, BP can't afford a breakdown. With machine learning solutions, BP can build predictive maintenance tools to reduce repair costs and prevent shutdowns at its automatic diesel stations. The company is using machine learning to increase safety, improve operations, and facilitate faster decision-making.[7]

Pentair

Pentair builds IoT and machine learning-enabled applications from the information gathered from factory sensors to improve beer filtration processes and boost performance by 10 percent. With the promise of more data from the solution, the company hopes to build more use cases and business models in the future.[6]

INVISTA

With machine learning solutions that break data out of silos and away from on-premises systems, INVISTA can analyze automated visual inspection data and use AI to identify opportunities to produce even higher-yield fibers. This helps them create higher-quality products, like more secure automobile airbags. Through its optimization and rightsizing efforts and by migrating its data centers to AWS, INVISTA is saving more than $2 million per year.[8]

5 https://aws.amazon.com/solutions/case-studies/deutsche-bahn-case-study/
6 https://aws.amazon.com/partners/success/pentair-brightwolf/
7 https://aws.amazon.com/solutions/case-studies/bp/
8 https://aws.amazon.com/solutions/case-studies/invista-case-study/

Maximize the value of your data with AWS machine learning

AWS offers a broad range of machine learning tools and services to help industrial organizations implement a successful strategy and achieve their unique business goals. Here are a few scenarios that show how AWS solutions work.

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Improving asset performance

You want to improve productivity and reduce unplanned downtime with solutions that can provide visibility into manufacturing asset performance data across sites, conduct remote monitoring of machines, and enable predictive maintenance.

The AWS solution for you: Amazon Monitron or Amazon Lookout for Equipment

Amazon Monitron is an end-to-end system (wireless sensors, gateways, AWS service, and mobile app) that uses machine learning to identify abnormal behavior in industrial machinery, enabling you to implement predictive maintenance that reduces unplanned downtime—with no machine learning experience required. There's a low upfront hardware investment, and it is a pay-as-you-go service. With Amazon Monitron, you can:

- **Start monitoring equipment in minutes**
  Quickly install Amazon Monitron wireless sensors and gateways using the Amazon Monitron app. The solution automatically analyzes the data and sends you an alert when it detects abnormal machine conditions. No development work or machine learning experience is required.

- **Detect machine issues before they occur**
  Take proactive actions when abnormal conditions occur, reducing costly and unplanned downtime.

- **Get the highest standards of data security**
  Benefit from sensors and gateways that are secure. Communication between sensors and gateways and the Amazon Monitron Service also remains secure—with data encryption at rest and in transit.

- **Increase accuracy with continuous improvement**
  Enter feedback on the alerts in the Amazon Monitron mobile app, and the solution will learn from it to continuously improve over time.

Use cases

Monitron sensors capture temperature and vibration data to identify abnormal machinery behavior in equipment such as:

Motors	Gearboxes	Pumps
Fans	Bearings	Compressors

Amazon Lookout for Equipment uses the data from your existing sensors and systems to detect abnormal equipment behavior so that you can take action before machine failures occur and avoid unplanned downtime. It will automatically build an optimal machine learning model that best learns the equipment's normal behavior, with no data science or machine learning skills necessary.

With Amazon Lookout for Equipment, you can:

- **Get high-accuracy results**
  Gain greater visibility into the health of your equipment with accurate alerts from a custom machine learning model built specifically to your equipment.

- **Respond to issues faster with precision**
  Reduce downtime thanks to automatic monitoring of your equipment and identification of anomalies.

- **Accelerate issue resolution**
  Use data from the solution to trigger automatic actions when anomalies are detected.

- **Improve alert accuracy over time**
  Enjoy continuously improved model performance with a solution that incorporates human feedback and learns expected operational usage trends.

Use cases

Generators
Analyze flow rates, temperature, pressure, and oxygen levels data to detect equipment shutdowns before they happen.

Compressors
Analyze historical maintenance data and sensor data from compressors, including RPMs, inlet/outlet flow rates, temperature, pressure, and vibration to identify abnormal machinery behavior.

Wind turbines
Analyze sensor data like power, pitch blade angle, RPMs, wind speed, vibration, and generator temperature to identify issues before they occur.

Quality control

You want to quickly identify product or process defects and anomalies in manufactured products so you can take action early and avoid costly mistakes and production line shutdowns. Ensuring such quality typically requires human inspection, which can be tedious and inconsistent.

Machine learning can enhance visual imaging accuracy for greater reliability earlier in the quality control process. This augments the abilities of human-quality inspectors, helping you leverage your data to make better decisions.

The AWS solution for you: Amazon Lookout for Vision

Cameras and machine learning, also known as computer vision (CV), can bring the speed and accuracy needed to identify defects consistently, automating visual inspection tasks. **Amazon Lookout for Vision** offers customers a highly accurate, low-cost anomaly detection solution that uses machine learning to analyze images to spot defects and anomalies—with no machine learning experience required.

With Amazon Lookout for Vision, you can:

- **Quickly and easily improve processes**
  Monitor manufacturing quality closely with a solution that uses an automatically generated model to spot differences between the live camera feed of your process line and the baseline images you upload.

- **Increase production quality, fast**
  Get reports of visual anomalies in an easy-to-use dashboard so you can take action quickly to stop more defects from occurring.

- **Reduce operational costs**
  Use insights from the solution to determine whether to schedule maintenance on the process line or reroute production to another machine before costly, unplanned downtime occurs—or before large amounts of bad product are produced.

- **Benefit from low setup costs**
  Transform less-costly cameras (that you may already have installed) to become machine learning-enabled visual inspection cameras—no machine learning experience required.

- **Get accurate results in challenging conditions**
  Accurately detect defects even when natural lighting variations and other conditions found within industrial environments occur.

- **Continuously improve accuracy**
  Enjoy continuously improved model performance with a solution that learns from human feedback, resulting in higher accuracy and improved performance.

Use cases

Detect part damage
Identify flaws in a product's surface quality, color, and shape, including dents, scratches, and poorly welded surfaces.

Identify missing components
Identify the absence, presence, or placement of objects, like a missing capacitor in a printed circuit board or an omitted label on a battery casing.

Uncover process issues
Catch defects with repeating patterns, like scratches in the same spot on a silicon wafer or an incorrectly sized product.

Improving operational efficiency at the edge

You want to increase efficiency by automating visual inspection tasks, even in limited connectivity environments. You need a solution that automates processes and enables fast decision-making.

The AWS solution for you: AWS Panorama

AWS Panorama is a machine learning Appliance and Software Development Kit (SDK) that allows you to bring computer vision toon-premises cameras, making predictions locally with high accuracyand low latency.

You can use AWS Panorama to automate tasks that traditionally require human inspection, such as evaluating manufacturing quality, identifying bottlenecks in industrial processes, and monitoring workplace safety—even in environments with limited or no internet connectivity.

With AWS Panorama, you can:

- **Add machine learning to your existing cameras**
  Plug the AWS Panorama Appliance in and connect it to your network, and it will automatically discover your existing fleet of IP cameras.

- **Make decisions in real time**
  Analyze video feeds within milliseconds from a single management interface across a variety of locations.

- **Enable CV in limited connectivity environments**
  Run CV models directly on the device (at the edge) and access real-time predictions in remote and isolated places where network connectivity can be slow, expensive, or intermittent.

- **Meet data privacy and governance requirements**
  Process and store video on-site—enabling compliance with data privacy and governance requirements.

- **Get started quickly with CV applications**
  Build your own CV applications or choose from a range of production-ready ones from AWS and third-party developers.

Use cases

Quality control
AWS Panorama detects manufacturing defects and delivers alerts so that you can take immediate corrective action.

Site safety
Use AWS Panorama to identify when vehicles or machinery are straying into off-limit zones. The solution can integrate with your safety systems to sound an alert or even shut off machinery.

Supply chain efficiency
AWS Panorama can provide critical input to supply chain operations by tracking throughput, recognizing bar codes or labels, and optimizing freight operations.

Forecasting demand and managing inventory

You're struggling with resource forecasting and inventory management. Your supply and demand estimates might be constrained by traditional systems that can't calculate supply chain changes with the speed and accuracy required. Changing datasets or any irregularity disrupts prediction accuracy because your forecast model can't change fast enough to keep up.

A machine learning-powered supply chain solution with forecast capabilities can model changes or irregularities in the supply chain, re-evaluate demand, optimize performance, and adapt to product or distribution changes.

The AWS solution for you: Amazon Forecast or Amazon SageMaker

Based on the same technology used at Amazon.com, **Amazon Forecast** is a fully managed service that uses machine learning to combine time-series data with additional variables to build highly accurate forecasts. Amazon Forecast requires no machine learning experience to get started and reduces time spent on forecasts from months to hours.

With Amazon Forecast, you can:

- **Get up to 50% more accurate forecasts**
  Enjoy highly accurate forecasts with a machine learning model that automatically discovers how time-series data and other variables affect each other.

- **Create virtually any time-series forecast**
  Build forecasts for virtually every use case. Amazon Forecast can work with any historical time-series data and use a large library of built-in algorithms to determine the best fit for your needs automatically.

- **Secure your business data and peace of mind**
  Protect data privacy with security that encrypts every interaction you have with Amazon Forecast. Administrators can also control access to the solution through a permissions policy—ensuring that sensitive information is kept secure and confidential.

Amazon SageMaker helps data scientists and developers prepare, build, train, and deploy high-quality machine learning (ML) models quickly by bringing together a broad set of capabilities purpose-built for ML.

With Amazon SageMaker, you can:

- **Accelerate innovation with purpose-built tools**
  SageMaker is the most comprehensive ML service with purpose-built tools for every step of ML development, including labeling, data preparation, feature engineering, statistical bias detection, AutoML, training, tuning, hosting, explainability, monitoring, and workflows.

- **Start generating accurate forecasts quickly**
  SageMaker provides several built-in machine learning algorithms, such as DeepAR, that are optimized for forecasting use cases and can be readily used to train and deploy ML models.

- **Get functionality designed from the ground up to work together**
  Use Amazon SageMaker's integrated capabilities for machine learning development to eliminate months of writing custom integration code and ultimately reduce costs.

Use cases

Demand planning
Forecast the appropriate inventory levels for various sites and locations.

Financial planning
Forecast key financial metrics such as revenue, expenses, and cash flow across multiple time periods and monetary units.

Resource planning
Plan for the right level of available resources, such as staffing levels, inventory, and raw materials.

Scaling to manage industrial assets and data

You want to make it easier to collect, store, organize, and monitor data from industrial equipment so you can make better data-driven decisions. But you're experiencing difficulty scaling across industrial assets, device fleets, and large datasets.

IoT connectivity solutions allow you to scale with greater ease and generate ROI quickly. These solutions rely on connected systems to expand a system's reach, activating data in new areas through a web of sensors, gateways, routers, applications, and platforms. These solutions intelligently organize the resulting data, enabling you to quickly interpret it as actionable insights that boost efficiency.

The AWS solution for you: AWS IoT SiteWise

With **AWS IoT SiteWise**, you can model physical assets, processes, and facilities; monitor operations; quickly compute common industrial performance metrics; and create applications that analyze industrial equipment data to make more informed, data-driven decisions. Best of all, you don't need to hire a technical expert to use it.

With AWS IoT SiteWise, you can:

- **Collect data consistently from all your sources**
  Gather data reliably from multiple facilities, structure it, and make it accessible and understandable—without developing additional software.

- **Identify issues quickly with remote monitoring**
  Assess the performance of your industrial equipment remotely and across locations—no need to dispatch multiple technicians to diagnose and fix the problem.

- **Improve cross-facility processes with a central data source**
  Get visibility across industrial facilities to streamline operations, as well as identify gaps in production and waste. Automatically discover and visualize live and historical asset data through customizable charts and dashboards.

- **Process and monitor data on-premises for shop floor applications**
  Benefit from software (Preview) AWS IoT SiteWise Edge, which runs on premises—securely connecting to and reading data from equipment or local historian databases. Once you have modeled your equipment and environment in the cloud, AWS IoT SiteWise Edge uses the same models locally to maintain consistency across both cloud and local environments, reducing duplication, effort, and development costs.

Use cases

Visualize factory or line performance
View your manufacturing process and identify deficiencies, production gaps, or product defects.

Monitor industrial assets remotely
Monitor asset performance remotely in real time and access historical equipment data from anywhere to pinpoint potential problems, dispatch the right resources, and both prevent and fix issues faster.

Compare industrial processes across facilities
Group sensor data streams from multiple locations by production line and facility so your process engineers can better understand and improve processes across facilities.

Getting more value from your data

You need to integrate unstructured machine data streams from multiple machines with many different communication protocols, on-premises software, databases, and automation systems. Product development, purchasing, manufacturing, logistics, and service all must work from a unified, consistent stream of data to ensure accuracy, enable efficiency, and avoid duplicate efforts.

Migrating to the cloud and data lake architectures can help. Data lakes can organize data and help foster integration between applications and platforms to enhance operational efficiency, improve quality management, and even generate new methods of collection and analysis.

The AWS solution for you: AWS Lake Formation or tools from the AWS Snow Family

Building a data lake requires manual, time-consuming tasks so data can be loaded, transformed, secured, and audited. **AWS Lake Formation** automates many of those manual steps and reduces the time necessary to build a successful data lake using Amazon Simple Storage Service (Amazon S3) from months to days.

With AWS Lake Formation, you can:

- **Build data lakes quickly**
  Move, store, catalog, and clean, your data faster. Simply point AWS Lake Formation at your data sources, and it will automatically move the data into your new Amazon S3 data lake.

- **Simplify security management**
  You can use the solution to centrally define security, governance, and auditing policies in one place—versus doing these tasks per service—and then enforce those policies for your users across their analytics applications.

- **Provide self-service access to data**
  Build a catalog that describes the different datasets available, along with which groups of users have access to each. This helps users be more productive by allowing them to find the right datasets, quickly and easily.

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The **AWS Snow Family** is a collection of physical devices that helps securely migrate large amounts of data into and out of the cloud without depending on networks. This helps you apply the wide variety of AWS services for analytics, file systems, and archives to your data. The AWS Snow Family is beneficial for organizations that run operations in non-data-center environments and in locations where there is a lack of consistent network connectivity.

The AWS Snow Family consists of three products:

- **AWS Snowcone**
  Collect, process, and move data to AWS with this portable, rugged, and secure solution—either offline by shipping the device or online with AWS DataSync.

- **AWS Snowball**
  Use this data migration and edge computing device for data collection, machine learning and processing, and storage before shipping it back to AWS.

- **AWS Snowmobile**
  Move up to 100 PB of data in a 45-foot-long shipping container—ideal for multi-petabyte or exabyte-scale digital media migrations and data center shutdowns.

Use cases

Manufacturing
Use the AWS Snow Family for on-site manufacturing data collection and analysis and to securely migrate existing large datasets to AWS. Tune processes, improve safety, efficiency, and productivity, and even anticipate failure. Over time, this data arrives back in AWS for analytics on a large scale that can highlight meaningful trends or patterns.
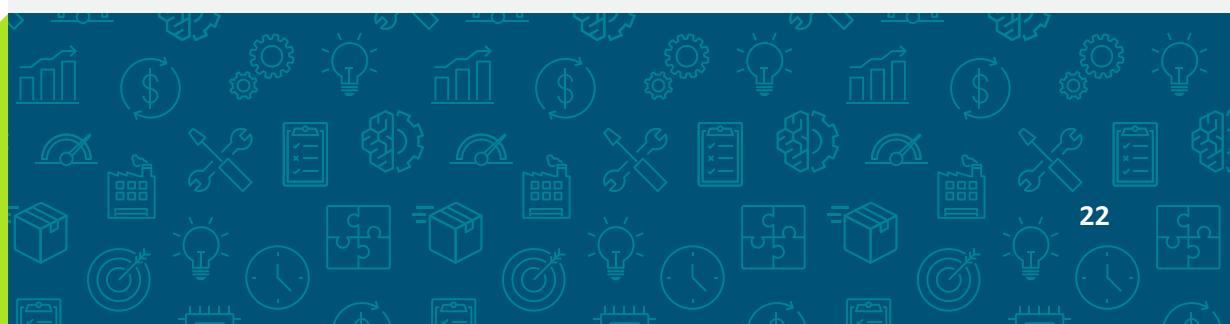
Edge computing
Collect sensor and machine data from edge locations with limited or no connectivity, process it to gain immediate insight, and then transfer it to AWS. The AWS Snow Family provides a secure path to migrate your data to the cloud, where you can centrally manage the configuration and operation of AWS Snow Family devices deployed at your factories, plants, and other locations around the world.

Industrial IoT
Activate industrial IoT at factories, mines, oil fields, pipelines, and other locations with bandwidth and space limitations. AWS Snowcone's compact design allows for the device to be installed or adhered to surfaces that have minimal extra space. The device's ruggedized construction enables it to withstand vibration, dust, and humidity in factory and other industrial environments.

Transportation, logistics, and autonomous vehicles
Gather data on the conditions of your entire fleet of vehicles and the surrounding environment. Deploy AWS Snowball or AWS Snowcone on individual vehicles to collect data, process it locally for immediate insights that can be used by the driver and/or dispatch, and transfer the data to AWS for broader, long-term analysis.

Accelerate innovation today

Today's industrial companies are using emerging technologies to glean new insights from their mountains of data—accelerating productivity, boosting efficiency, improving safety, and providing them with a critical competitive advantage. With its predictive powers and ability to grow smarter over time, machine learning is essential in the effort to manage, interpret, and leverage the insights within that data for the greatest business impact.

AWS offers the perfect blend of machine learning capabilities and ease of use. We can help you enjoy the benefits of machine learning across nearly every component of your technology ecosystem—all while requiring minimal expertise, setup, and downtime.

Leverage machine learning for your digital transformation to become a leader in the Industry 4.0 era. Harness the full potential of innovative technologies that improve efficiency and productivity so you can adapt quickly to business challenges in your digital transformation journey.

Learn more about AWS solutions for industrial companies ›