



A Guide to Simplifying Big Data in Complex Environments

How advanced drop-in sensor technologies are transforming data collection and shaping the future of industrial operations

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Industrial Operators, We Hear You

Often, when an operations team is looking at connecting their network assets to capture, control and analyze data, they think long-term. Creating network analysis spreadsheets, diagrams, and connectivity coordination elements are a big job no matter what.

For geographically dispersed industrial operations, the complexities are compounded: rugged terrain, hard-to-reach or even perilous locations, an array of remote plants or depots, off-the-grid connectivity, challenging weather. Yet, operational visibility into intelligent data at the edge—and manipulating that information—transforms data into actionable insight, better asset management, greater environmental responsibility, less waste and more improved decision-making. The power of data is shaping the future of industrial operations.

This is all well and good, you might say, but the topic of data may seem as overwhelming as the abundance of data itself. FreeWave, in its joint venture with ModuSense, is happy to share the truth: data needn't be thought of as complex or out of reach.

Stay with us as we explore how drop-in sensor technologies are transforming data collection and shaping the future of industrial operations. You'll learn about a plug-n-play option that provides connectivity and access to data, even in remote areas, with simple solutions. With the cost of remote satellite solutions and sensor technology now within reach, you have the means to put your time and energy back where it belongs—running your business and elevating your operational performance.

This eBook will outline how an industrial operation can easily install satellite-connected solutions with a single pane of glass—one platform that reveals all your remote data so you can access and act on reliable data faster with greater ease. Of course, ideas are easier to grasp through their impact on the real world, so you'll find three specific use cases relevant to a wide range of industrial applications: water monitoring, air quality and weather monitoring, and smart agriculture.

What Got Us Here Won't Work

Innovation moves us forward. New ideas supplant those that came before them. In the industrial sector, this is particularly true.

A quick tour of history makes this point clearer. The mid-eighteenth century marks the First Industrial Revolution where water and steam power was used for production followed by electric power during the Second Industrial Revolution. The Third Industrial Revolution capitalized on information technology (IT)

and automation. The Fourth Industrial Revolution is underway, summed up best as the blurring of lines between physical, digital and biological boundaries.¹

The Fifth Industrial Revolution is a nanosecond away, characterized by a higher purpose – using technologies like artificial intelligence (AI), internet of things (IoT), virtual reality and big data to, quite simply, save the planet.

¹ Klaus Schwab, "The Fourth Industrial Revolution: What it Means, How to Respond," World Economic Forum. January 14, 2016, <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

Salesforce co-founder Marc Benioff tweeted this snappy and on-point message back in 2019: "The 5th Industrial Revolution will be about saving the planet & restoring trust & equality. How do we use this amazing new tech to undo the damage we have caused to our air, oceans, & forests? Let's innovate for our planet not just ways to get off of it."²

We see how data connects life through the work we do. And we know, without question, that what brought industrial operators to this point will not lead them forward.

Case in point: water monitoring. For decades, manual sampling has been the accepted practice. Yet, we know that this is not sustainable and it definitely will not solve the water problems of tomorrow.

According to Water Technology, "More than 80% of industrial waste landing in rivers, streams and lakes is untreated."³ Why?

Here again, industrial water operators face unique challenges like large water distribution networks and high energy costs. With greater compliance mandates, manual sampling is like seeing only a fraction of what is in front of you. Plus, it requires data analysis and laboratory testing, which is both expensive and time-consuming. Probes and online analyzers are limited and require recalibration and cleaning. This points to remote solutions that provide continuous, reliable data flowing through a single pane of glass or centralized interface—simple and accessible.

Now, let's take a look at what's next for industrial operations . . .

Landscape of Technology Advancements

Technology Makes Data Simple

IIoT is commonplace among the industrial market space. It's been around for decades already, and it's here to continue to evolve. The breakthroughs that are happening now are almost at breakneck speeds. It's incredible how quickly innovation has happened as we've entered this era. IIoT, though, is not to be thought of as a technology category.

Now, onto the good stuff. Some of what you'll learn might sound a bit like science fiction (which is pretty cool!). This is part of simplifying your tech stack so there are fewer barriers between you and the information you need to run your operations more efficiently, while achieving greater sustainability.

Four key advancements are ushering in a new age of IIoT: satellite technology, sensor technologies, a single pane of glass interface and edge computing. The good news is costs are coming down, making the power of data a strategic option for more people around the world who are leading industrial applications.

Satellite Makes Connectivity Accessible from Anywhere

With advancements from vendors like [Swarm Satellites](#), offering the smallest commercially operational satellites in space (they've actually been described as the size of a toasted cheese

The 5th Industrial Revolution will be about saving the planet & restoring trust & equality. How do we use this amazing new tech to undo the damage we have caused to our air, oceans, & forests? Let's innovate for our planet not just ways to get off of it."

-- Marc Benioff

² Marc Benioff on Twitter, <https://twitter.com/benioff/status/1088962182664994816?lang=en>

³ Meena Sankar, "Top Water Quality Monitoring Challenges in Industrial Applications" in Water Technology, August 13, 2021, <https://www.waterteconline.com/process-water/article/14207355/top-water-quality-monitoring-challenges-in-industrial-applications>

sandwich and weigh just 400 grams), to condensing compute power to the edge, the options for data connectivity in lower bandwidth areas abound.

Solutions now are embedded with components like Swarm and that small size significantly reduces each satellite's launch cost, making the Swarm network more affordable and their consistency unrivaled. Its constellation covers every point on Earth, which means accessibility to real-time data anywhere, any time. Here's why:

The Swarm network stands apart from other satellite networks for industrial environments. As you can see, the energy of flight is literally in its name. Swarm satellites circle the globe, flying from the North Pole to the South Pole and back again all day long in a polar orbit fashion. It's about an hour and a half round trip. This means one of these low-altitude satellites will be positioned overhead every 90 to 100 minutes, delivering rich data and offering a good view of the planet from all sorts of different angles. Satellites with polar orbits are used for advanced monitoring of the weather, military applications and capturing images of Earth.

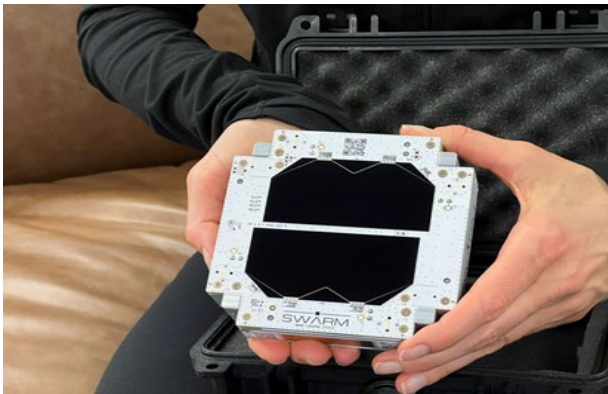


Image provided by Swarm Technologies © 2022 Swarm Technologies, Inc.

In contrast, geostationary satellites are typically based along the equator, which means they are stationed on the horizon, easily obscured by surrounding mountains. They spin at the same rate of the earth which is why they focus on the same area. In our view, data connects with life – and for many industrial operators that life resides in challenging environments where consistent connectivity and signal reliability are imperative. You can't act on data that's impossible to obtain.

Drop-In Sensors Make Data Scalable

Drop-in sensors are your boots on the ground. Advanced sensing technologies are scalable, starting with depth and length. You can drop sensors into a borehole up to 200 meters deep (with the addition of a long cable) and the outcome remains the same as dropping the sensor into a small tank a couple of meters deep.



Scalability continues by adding sensors for even greater data collection. ModuSense has developed a uniform solution where the outcomes are reliable and common across all of the resource monitoring characteristics, no matter the configuration. One key component is the gateway which is connected to "things" (sounds a bit strange, we know, but the gateway is what makes "things" smart like a sensor, mobile phone or other device). The application logic and data is stored in the gateway. ModuSense's gateway has two ports, which means you can plug in a second sensor and the data will simply flow, scaling your data by leaps and bounds.

Let's take water monitoring as an example. It's common to have two, unconnected tanks sitting side-by-side. Perhaps you want to monitor water levels in each of them discreetly. Simply attach a second sensor and drop it in the second tank and watch that data flow. These gateways can have additional sensors added to them, which turns them into even more elaborate solutions.

Continuing with our water level monitoring, you can also scale the solution by adding soil moisture data or ambient weather conditions. There are a lot of different solution sets to suit your requirements and help you think bigger with greater simplicity.

Bluetooth connected sensor nodes can be within a couple hundred meters of the main gateway, giving you up to 32 monitoring devices within range of a single gateway.

A Single Pane of Glass Creates Operational Transparency

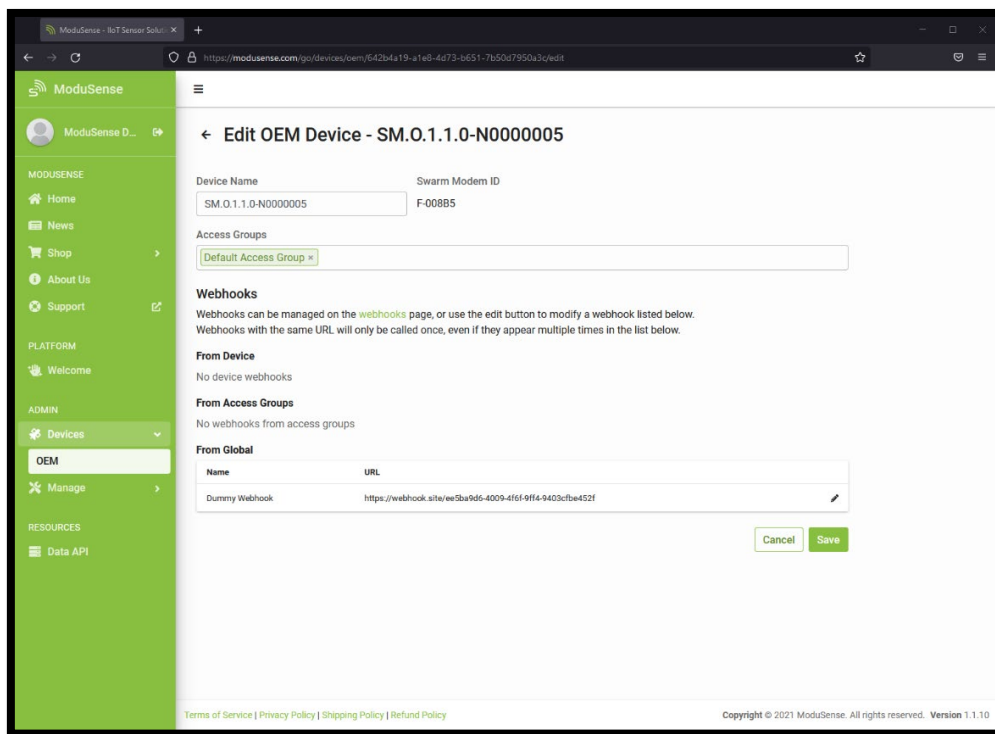
Bringing all your data together in a single pane of glass provides you, your team and your users with easy-to-use and easy-to-access dashboards to visualize the information coming from the field. Imagine a single pane of glass as your mission central, your command center whereby you can better understand trends, set alerts and see notifications based on under or over thresholds—and then use those insights to drive operational change in your business.

This is where you leap beyond your competitors and make changes in your business that allow you to do more with less and, ultimately, improve your bottom line through mitigating risk.

Edge Computing Inspires an Operational Ecosystem

You can see your ecosystem of capability take shape—and, using our running example of water monitoring—extend far beyond simply gathering data surrounding water levels in a tank. This larger ecosystem is a roadmap for industrial operators to improve operations as it connects technology with the demands of your use case, your business model and goals, the key problems you are solving, and advanced condition monitoring and maintenance unique to industrial-automation assets.

According to an article by Smart Industry entitled "What's the Value of a Standardized Ecosystem in the Era of IIoT?" we see how an ecosystem matters in a world with bloated tech stacks and data silos: "This standardized ecosystem promises to be a crucial enabler for scalable, remote-access business solutions and services that are required to meet changing market demands in the evolving industrial automation sector."⁴



Configuration and Data Monitoring

4 Glenn Shultz, "What's the value of a standardized ecosystem in the era of IIoT?" in *Smart Industry*, May 31, 2021

Three Solutions by Use Case

Let's explore how monitoring solutions help in three use cases and, ultimately, impact everyday life: water monitoring, air quality and weather station monitoring, and smart agriculture.

Use Case #1

Water: Life's Critical Component

One of the most common use cases for drop-in sensor technology is arguably water resource monitoring. It's a scarce resource around the globe and becoming scarcer every day. Did you know that only 1% of the water on the planet is drinkable and even less is both drinkable AND accessible?

Water is vital, and without it, it would be impossible to grow anything in many drought-stricken regions. That's why technology that can help farmers manage and save water is welcome news.

For farmers, with most of their data in the most remote parts of the world, this breakthrough in low-cost communication technology creates a new wave of possibilities—one of which is monitoring and controlling water resources. This applies to water use in just about anything from troughs and tanks to rivers and boreholes, all via those tiny satellites in the sky.



Water also plays a big role in dairy farming and livestock environments where animals drink a huge amount of water. A dairy cow can consume the equivalent of 50 gallons of fresh water a day. The average dairy operation of around 2000 cows will consume around 100,000 gallons of water a day. Farmers and industry leaders capturing this water from wells, dams, or other locations like tributaries, know just how critical the role of water is to their operation, ranch or farm. Often, the water's location where it is captured, stored, and monitored, is also geographically difficult to access.

Keeping an eye on the status of that resource can be complex or expensive. That's where satellite prevails allowing you to easily drop in a solution that can keep an eye on the level of water in a tank or the amount of water. In a well, we can drop the sensor down a well hole, giving the farmer peace of mind that the supply of fresh drinking water to the stock at that area of the land is readily available.

Also, drop-in sensors can help mitigate the risk of emptying a tank because of a leak or even monitoring a river or stream that has the potential to dry up. Transparency into ongoing trends and issues gives you control over potential operational disasters unique to very large properties in challenging environments.

Remote Water Management. Made Easy.

Instead of trailing through the back blocks to check on water storage, [ModuSense Water Level Monitoring](#), available from FreeWave, can relay water levels, usage information and alerts straight to any mobile device. Because it's solar-powered, with a battery back-up, it can be placed in the most remote locations, and it will happily operate away, sending you critical updates day and night.

Use Case #2

Air Quality and Weather: Breathing Easier

When you think of air quality management, you might envision urban areas or industrial centers. Yet, air quality monitoring is not always reserved for cities in order to understand the breathing conditions for humans. It can be used in many different ways and is one part of weather station monitoring where knowing conditions can help you breathe easier with actionable insights in hand.

Temperature, humidity and air provide important data points for industry use. Here, we use the [ModuSense Air Quality Sensor](#) which monitors various sizes of particulates ranging from 2.5 microns to 10 microns. For wind speed and wind direction, we use the [ModuSense Wind Speed Anemometer](#).

Some interesting use cases come out of this beyond purely monitoring the quality of the air and the environment. There are even installations that provide early warnings for smoke coming from a forest fire with the wind blowing in the right direction.

Healthy Bees

Air quality management also plays a role in apiculture, or the business of bees.

Bees are incredibly sensitive to barometric pressure, humidity and temperature, all of which play a role in their ability to produce as a colony; bees also need to maintain a central weight to operate at peak performance. As such, the best way to ensure a quality harvest from a beehive is to maintain the colony's weight and manage the hive's temperature. With proper data insights, we can do this remotely by studying and monitoring the internal collective health and conditions of the hive. Without lifting the hive's lid, which disrupts the harvest process, we can virtually control the bees' environment without the extra cost or time of added deployments. These insights are easy to monitor from a single pane of glass, making critical

information accessible faster than a bee can fly (which is pretty fast at 20 mph!).

Integrating special IIoT sensors, we developed the [HiveBeats Environmental Monitoring Sensor](#), [HiveScale V5 and Brood Monitoring Sensors](#) that now provide precise insights into the life of a bee, which ultimately determine if and when human intervention is needed. This allows for significantly fewer errors to occur and saves time and money along the way.



Photo courtesy ModuSense © 2022.

Rock Mass Behavior

As mentioned earlier, the Swarm satellite network uses a polar orbit to do its job, circling the Earth every 90 to 100 minutes with greater consistency and signal reliability than geostationary satellites. This is particularly important in rock mass and excavation monitoring where safety of people is dependent on understanding the behavior of earth materials.

Again, we see a simple solution to a long-term complex problem.

Installing attenuation cages on a hillside to gauge rockfall, debris and these sorts of things simply requires installation of a sensor with a high-resolution tilt. Sensors can be installed on the cage themselves so if hillside moves or any rocks fall and get caught by the attenuation cage, it will affect the angle that the cage is positioned. The tilt sensor reports changes in inclination on a single pane of glass—a central dashboard—so you can easily take the necessary actions.

ModuSense has also extended several options in the geo tech space by burying sensors in the soil, grafting them into rock or bolting them into rock. This reveals extremely high-resolution changes within a given environment.

Let's take an example. If you can clearly see the soil is moving—even half a millimeter a day—then, you can predict the likelihood of a hillside collapsing.

Such insight prepares you for what's "next" – the next rainfall, the next storm or even when a major tree might come down.

Monitoring the environment you operate in and understanding what "good" looks like is the insight you need to anticipate change and make rock solid decisions (we couldn't resist!).



Photo courtesy ModuSense ©2022

Use Case #3

Smart Agriculture: Monitor, Know, Grow

In the poem named "The Farmer" by Amelia Barr, she writes: "The farmer's trade is one of worth/He's partner with the sky and earth ..." ⁵
No matter where technology takes us, these words hold true: the farmer nourishes life and they are intuitively tied to their environmental surroundings.

Smart agriculture—using IIoT technology to monitor conditions in the field—is a competitive advantage for farmers and their lands. Intelligent farming means making the most of automation in agriculture and ensuring field data is easily accessible no matter where the information is generated. Before you can automate agricultural processes, however, you need technologies that let your devices in the field communicate with each other—that's where IIoT enters the picture.

Here's how:



1. Smart ag sensors collect data surrounding soil quality, weather, crop growth, and herd health so you can track the state of your business, equipment efficiency, and workforce performance.
2. IIoT gives farmers more control over internal processes and lowers production risks. You can improve distribution forecasts with better production output visibility.
3. IIoT gives farmers more production control to reduce waste and improve cost management. When you can monitor crop growth or herd health anomalies in real-time, you can lessen the possibility of yield loss.
4. IIoT process automation increases business efficiency. Smart devices allow you to automate critical production cycle processes like irrigation, pest control, fertilization, and more.
5. Automation can enhance product quality and output. Agriculture automation gives you more control over production processes, helps you maintain higher crop quality standards, and enhances growth capacity.
6. Agriculture automation gives farmers real-time visibility into storage conditions like grain-bin level monitoring and ensures blowers only operate during off-peak electrical hours, saving as much as 50% in energy costs.

⁵ Amelia Barr, "The Farmer," a poem, <http://www.online-literature.com/amelia-barr/4386/>

7. Precision agriculture technologies let you schedule off-peak hour irrigation, allowing you to save as much as \$30,000 per year in energy costs. You can automate water consumption reporting processes to ensure regulatory compliance.
8. Smart ag technology helps farmers monitor feed intake to improve livestock health and mitigate feed shrink.
9. Real-time kinetics from precision agriculture technologies on self-driving and autonomous tractors improve guidance and steering accuracy up to 100 times compared to traditional GPS.
10. The industrial internet of things (IIoT) powers high-accuracy robotic weeders to reduce herbicide consumption by 20% for intelligent weed control.

Your Use Case is Unique

While we've outlined three use cases here, there are many more, including:

- Vehicle tracking
- Smart cities
- Predictive equipment maintenance
- Fire protection
- Energy conservation
- Employee safety
- Process monitoring
- Solar
- Wind power management
- Smart irrigation
- ... and so much more.

In fact, how you use data in your own unique complex environment could require an innovative solution no one else has even thought of yet. While ModuSense's solutions are simple and easily deployable, they are far from off-the-shelf. We innovate with you to find the right solution for the right application that produces the right outcomes – so you can act on data with confidence.

Solutions for Simplifying Big Data

Many of the world's leading industrial companies operate in challenging environments. Monitoring vulnerable areas of infrastructure leads to improved operational performance. It's expensive, and even risky at times, to send people in poor conditions with poor cellular coverage.

With ModuSense, available exclusively from FreeWave, you can monitor your critical environments and get answers straight from the field.

Simple installation. Affordable subscription. All-in-one platform.

Each monitoring solution is a ready-to-deploy, satellite-connected solution designed specifically for IIoT. Installation is as easy as setting a post in concrete, assembling the equipment in mere minutes, and double checking the sensor readings. Then, breathe easy knowing you can leave the location while having ongoing knowledge about conditions anywhere, any time.

- No configuration requirement
- No complicated assembly
- No guesswork

Accurate data readings are sent to dashboards and alerts to mobile devices via the ModuSense Data Platform, making critical information gaps a thing of the past.

The ModuSense platform, available from FreeWave, delivers resources, solutions and expert service to make remote operations more efficient, critical data more intelligent, and time and money savings a true competitive advantage. Reimagine the future by connecting data with life's most important questions today.

FreeWave Technologies' joint venture with [ModuSense](https://modusense.com)—a New Zealand based industrial internet of things (IIoT) platform provider - powers remote data collection solutions for everything from water monitoring to vehicle tracking and smart agriculture. To learn more about FreeWave and ModuSense and what solutions they have for your business, visit <https://freewave.com/> or call the team at 866.923.6168

FAQ: 5 Real Questions We've Been Asked

Q: Does the ModuSense device really work with the satellite system?

A: Yes. Satellites with polar orbit the globe every 90 minutes or so and there are more than 150 satellites up there right now, with more being launched every day.

Q: Are there any countries off limits to Swarm satellites?

A: There are countries still yet to be approved. The list of countries approved for Swarm grows each week. They have worked very hard to achieve the large list of countries already approved.

Q: Do you have the most up to date satellite list available?

A: Yes, simply contact us and we can follow up with Swarm on its progress in any part of the world.

Q: Can sensors be connected through alternative methods like wireless point-to-point, multipoint and microwave systems?

A: We sing the praises of being modular at ModuSense! We can accommodate alternative carriers upstream. With satellite, we have several carriers we currently support. We also support cellular, as well.

Q: Can I install the sensor myself?

A: We do ask to work with our customers to validate specifications before implementing and using the tools. We look at power requirements, power consumption per day, per week, per month, etc. to ensure the best possible outcome.



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