IOT ANALYTICS
MARKET INSIGHTS FOR THE INTERNET OF THINGS

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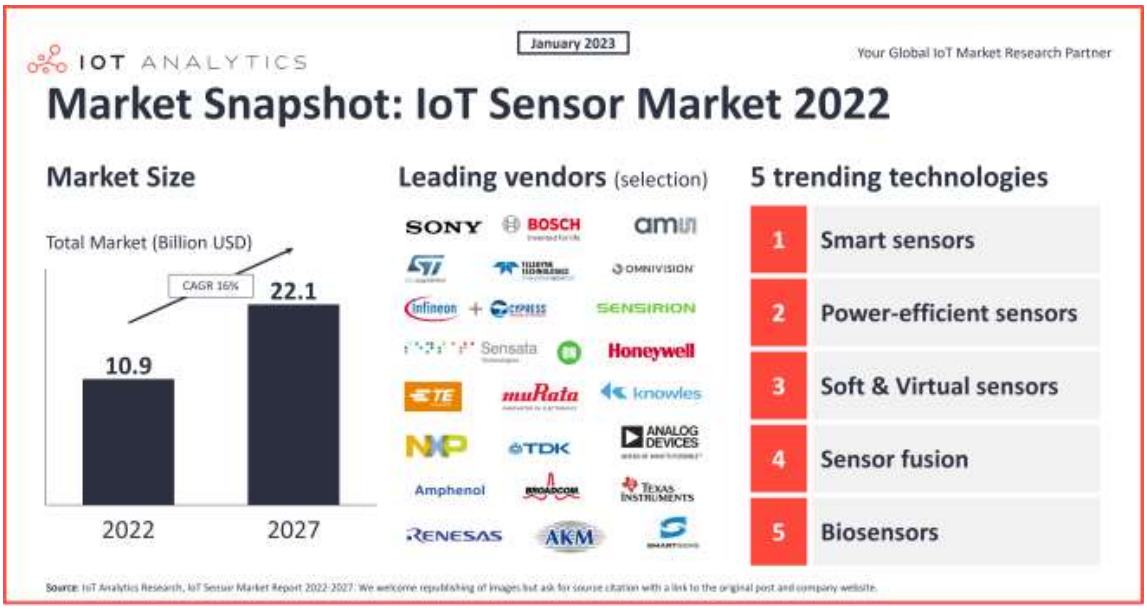
INSIGHTS RELEASE

5 IoT Sensor technologies to watch



Hamburg/Germany, January 16, 2023: IoT Analytics, a leading global provider of market insights and strategic business intelligence for the Internet of Things (IoT), AI, Cloud, Edge, and Industry 4.0, published a 136-page report titled "IoT Sensors Market Report 2022-2027". The report details the market for sensors, with a specific focus on IoT sensors, incl. Sensor vs. IoT sensor definitions and market shares, industry deep dives, competitive landscape, and company profiles. The following article highlights the current IoT sensor market and 5 trending technologies.

Key insights:

- IoT sensors represented one-third of all sensors shipped in 2022, according to new research on the topic. The average IoT device now comes with four sensors.
- 5 sensor technologies are set to change the IoT sensor landscape in the coming years, i.e., 1. smarter sensors; 2. more power-efficient sensors; 3. soft and virtual sensors; 4. sensor fusion; 5. biosensors.

Key quotes:

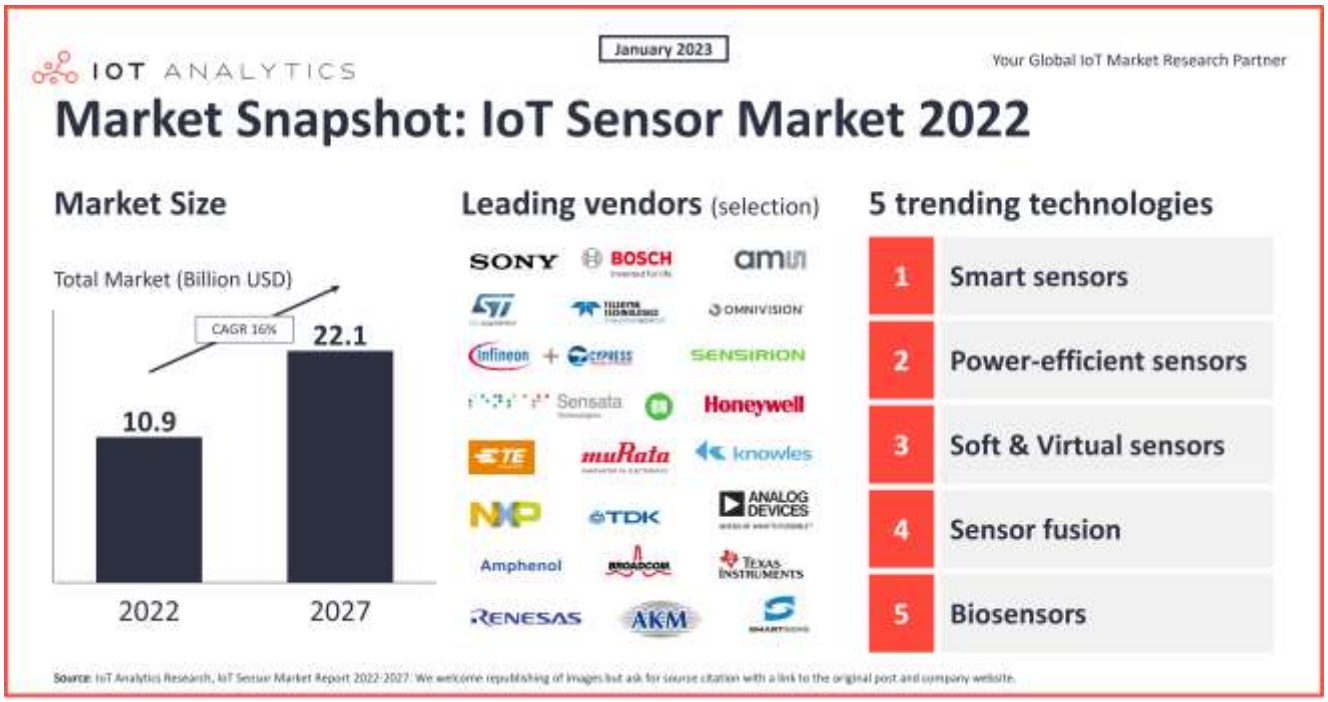
Knud Lasse Lueth, CEO at IoT Analytics, says: "*One-third of all sensors shipped in 2022 were IoT sensors, meaning they were part of an IoT-connected device. The market for IoT sensors reached $10.9B in*

2022 and is predicted to grow at a compound annual growth rate of 16% in the next five years."

Satyajit Sinha, Principal Analyst at IoT Analytics, adds: "*The rise of the Internet of Things in recent years has gone hand-in-hand with the rise of sensors. On average, four new sensors are connected with every new IoT device that comes online. With approximately 14 billion current IoT connections, this means more than 50 billion connected sensors have been deployed*."

50 billion IoT sensors and counting

The rise of the Internet of Things in recent years has gone hand-in-hand with the rise of sensors. On average, **four new sensors are connected** with every new IoT device that comes online. With approximately 14 billion current IoT connections, this means more than 50 billion connected sensors have been deployed. IoT sensor technology plays a crucial role in the IoT tech stack because these sensors collect data from the physical world and convert it into digital signals.



One-third of all sensors shipped in 2022 were IoT sensors, meaning they were part of an IoT-connected device. According to the **136-page IoT Sensor Market Report 2022–2027**, the market for **IoT sensors reached $10.9B in 2022 and is predicted to grow at a compound annual growth rate of 16% in the next five years**.

The market for **MEMS-based IoT sensor**s is particularly strong and accounted for 50% of global sensor revenue in 2022. The leading companies in this market segment are **Bosch Sensortec** and **ST Microelectronics.**

The market for **image sensors** is also particularly important for the IoT because three of the most important IoT use cases drive its adoption, i.e., machine vision, connected surveillance cameras, and advanced driver-assistance systems for cars. Leading sensor vendors in this segment include **Sony** and **AMS AG.**

5 trending sensor technologies

There are several exciting technological innovations in the IoT sensor market. In this article, we highlight five IoT sensor technology trends that are set to change the IoT sensor landscape in the coming years.

1. Sensors are becoming smarter and can act as edge devices

Sensors are becoming increasingly advanced. Key IoT sensor technology innovations include a much higher computing capacity and the ability to detect signals from multiple discrete sensing elements. The industry refers to these more advanced devices as “smart sensors.” Instead of simply passing on the sensor signals to the next level in the value chain, smart sensors can process signals directly (e.g., validating and interpreting the data, displaying the results, or running specific analytics applications); in this way, sensors become edge devices.

The most advanced smart sensors are now also incorporating AI into their design. These sensors are designed for AI inference, which has numerous advantages, e.g., decisions can be made immediately, and sensitive data can be processed without sending it elsewhere and creating the risk of data theft.

Example: In January 2022, **Amazon** unveiled its Ring home security glass-break sensors, which utilizes AI technology and a Syntiant NDR101BQQF neural processor for detecting glass breaking directly on the sensor. The sensor accurately detects glass-break events, such as windows being smashed or cracked, up to 25 feet away and sounds an alarm on the spot.

2. Sensors become more power-efficient (e.g., for energy harvesting)

Ever more sensors use renewable energy sources to power themselves, such as solar or kinetic energy, thereby eliminating the need for battery replacement or another power source. This innovation improves the reliability and longevity of IoT devices, particularly those deployed in remote or inaccessible locations. These devices are self-sustainable and contribute to a reduction in the environmental impact of the entire system setup.
The use of energy harvesting is leading to changes in sensor design, making the sensors more power-efficient via the following changes:

- **Reducing the form factor.** Using small ultra-low-powered microcontrollers (such as the STMico STM8L) sensors do not consume too much energy.
- I**mproving the signal-to-noise ratio**. To save energy, sensors can include a signal processing component that filters out noise or interferences so that they use their power in a targeted way that detects and measures the actual signal.

Example: Eco is a temperature and humidity sensor designed for use in indoor environments. It is powered by an indoor solar cell, which allows it to operate inside buildings without batteries or external power sources. The device can last up to 30 days in the dark due to its energy-efficient design and the use of a solar cell. The device is connected via LoRaWAN technology, which allows it to transmit data wirelessly over long distances using minimal power. This makes it ideal for use in various indoor environments, such as offices, warehouses, or factories.

3. Soft & virtual sensors increasingly complement physical sensors

In some cases, it is impractical or costly to install a physical sensor (e.g., in complex or hazardous environments). Upcoming alternative solutions include soft and virtual sensors.
A soft sensor is a computational algorithm that estimates the value of a difficult-to-measure quantity, based on other existing physical sensors and algorithms/computational models that infer the value of the measured quantity.

A virtual sensor is similar to a soft sensor, the difference being that its values are not based on existing physical sensors but purely on algorithms/computational models.

Example of a soft sensor: Rockwell Automation's Predictive Quality software application creates predictive models that use real-time data from instruments and laboratory analyses to estimate process and product conditions. These models are based on historical plant data and act as inferential sensors to predict quality parameters (as an alternative to additional physical sensors) (Link).

Example of a virtual sensor: In 2021, **Siemens** developed a pocket-sized edge computer that can be attached to an asset (e.g., a motor) and help to calculate virtual sensor values. For example, the temperature can be calculated in real-time by feeding the latest operational motor data into the digital model. This operation needs neither an on-site thermometer nor any other actual sensor reading, as it relies on machine status parameters and a virtual model of the motor (Link).

4. Innovations around sensor fusion (particularly for autonomous driving)

Sensors are an essential component of autonomous vehicles, as they provide it with information about its surroundings. The vehicle's onboard computer uses this information to navigate and make decisions. Three key sensors for autonomous driving include LiDAR, radar, and 3D cameras (image sensors). Major car OEMs, such as **Mercedes, BMW, Volvo, and General Motors**, have opted for LiDAR as a sensor for autonomous driving. Previously (prior to 2021), **Tesla** mostly relied on radar technology. Recently, however, the company began the transition to Tesla Vision (a camera-based system) by removing radar from the Model 3 and Model Y in 2021, followed by Model S and Model X in 2022.

Companies, including **Sony, Mobileye, and Waymo**, are currently focusing on IoT sensor technology innovation by combining cameras with other sensing technologies like LiDAR and radar to improve the image analysis of their autonomous driving solutions. As cameras, radars, and LiDARs sense different features of the environment, the idea behind this combination (also referred to as "sensor fusion" or "redundancy") is to provide systems with a richer single-world model to decide a course of

action or calculate an output. Overall, the sensors in an autonomous vehicle work together to provide a complete picture of the vehicle's surroundings, enabling it to make safe and efficient driving decisions.

Example: **Sony** is relying on the benefits of using cameras with either LiDAR or radar for object recognition tasks in autonomous driving applications. For example, the company is currently working on a solution that combines camera and radar. This combination may be beneficial for recognizing people and vehicles at night. The camera and LiDAR combination is beneficial for parking assistance functions, which require highly accurate distance measurements (Link).

"*Autonomous vehicles will only succeed when all of the technological pieces are built as a single integrated system, enabling synergies among all of its parts. It is a formidable task to build the full stack from silicon up to the full self-driving system–this is what Mobileye has set out to do*."

Prof. Amnon Shashua, CEO and Founder of Mobileye

5. Biosensors are becoming more mature (mostly for healthcare applications)

Biosensor and disposable sensor technology have matured in recent years and have been adopted in the healthcare industry. Recent breakthroughs in biosensor research suggest that this technology is also nearly market-ready in other sectors. The term "biosensor" is short for "biological sensor." The bio element interacts with the tested analyte, and the transducer converts the biological response into an electrical signal. Depending on their application, biosensors are also known as immunosensors, optrodes, resonant mirrors, chemical canaries, biochips, glucometers, or biocomputers.

Example of a biosensor: Abbott FreeSTyle Libre is one of the most commercialized biosensor solutions for glucose monitoring. The FreeStyle Libre system currently has more than 3 million users globally. In Q2 of 2022, Abbot reported more than 25% organic growth in sales of FreeStyle Libre systems.

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