Metrology for IoT applications

SIM M4DT - TF Metrology for Industry 4.0

Laboratório Costarricense de Metrología(LCM)
Costa Rica

Setiembre, 2022

The Costa Rican Metrology Laboratory (LCM), is the national metrology laboratory, it was created by Law No. 8279 of the National System for Quality, it is an institution attached to the Ministry of Economy, Industry and Commerce (MEIC).

El Laboratorio Costarricense de Metrología (LCM)
(Costa Rican Metrology Laboratory)

El Laboratorio Costarricense de Metrología (**Costa Rican Metrology Laboratory**)

Departamento de Metrología Química (DMQ)

Electroquímica
Materiales Inorgánicos
Materiales Orgánicos
Materiales de Referencia
Ensayos de Aptitud
Investigación y Desarrollo
Soporte a la Industria

Departamento de Metrología Legal (DML)

Etilómetros
Cinemómetros
Opacímetros
Camiones Cisternas
Contenido Neto
Esfigmomanómetros
Balanzas Comerciales
Unidades de Verificación Metrológica

Áreas técnicas del LCM

Departamento de Metrología Física (DMF)

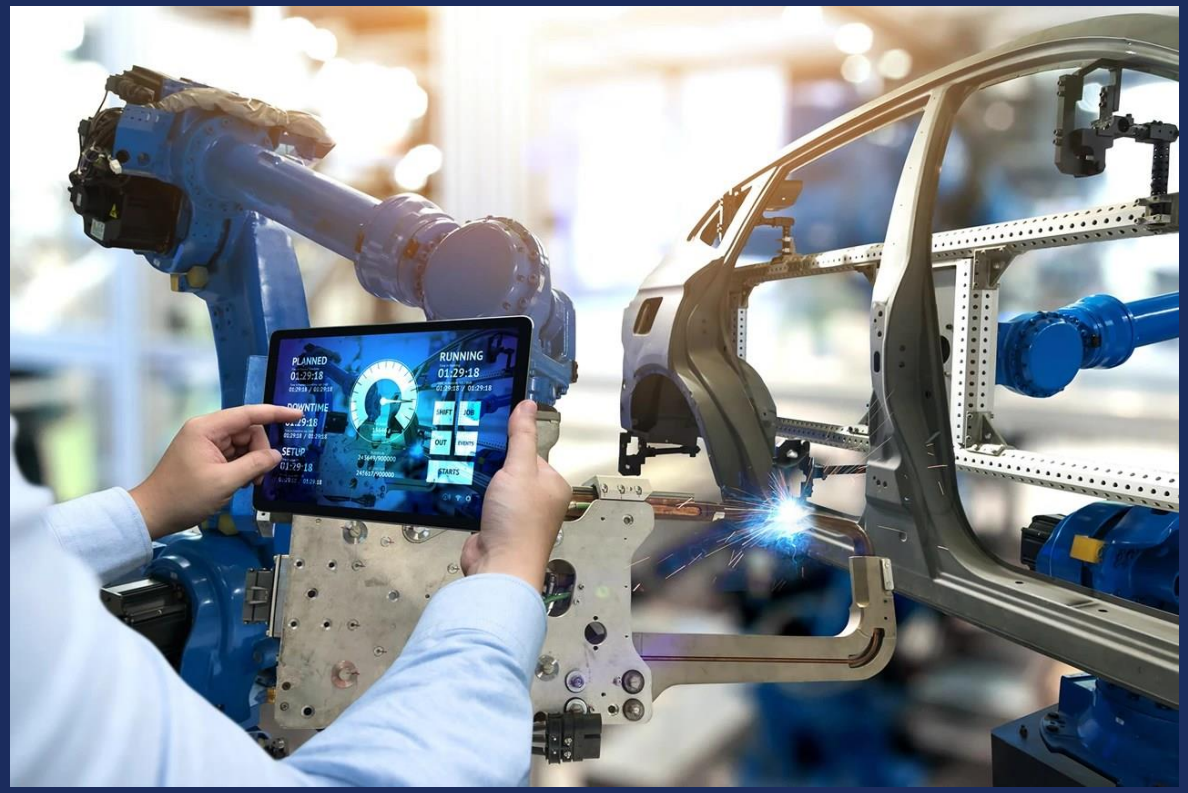
- **Dimensional**
- **Temperatura**
- **Masas y Balanzas**
- **Volumen**
- **Densidad**
- **Viscosidad**
- **Presión**
- **Acústica**
- **Humedad Relativa**

En 2005, LACOMET firma el **Acuerdo de Reconocimiento Mutuo (MRA)** con el BIPM, y se convierte en país asociado a esta organización.

En 2022 se aprueba el **Ley N.º 10107 CONVENCIÓN DEL METRO Y SU REGLAMENTO ANEXO**
Costa Rica se convierte en miembro pleno del BIPM

- ✓ Proyectos, investigación y desarrollo e innovación.
- ✓ Ensayos de Aptitud
- ✓ **Actividades de la Estrategia de Vinculación Industrial (EVI)**

LCM
Laboratorio Costarricense de Metrología



The 4th Industrial Revolution and the interconnected Industry 4.0

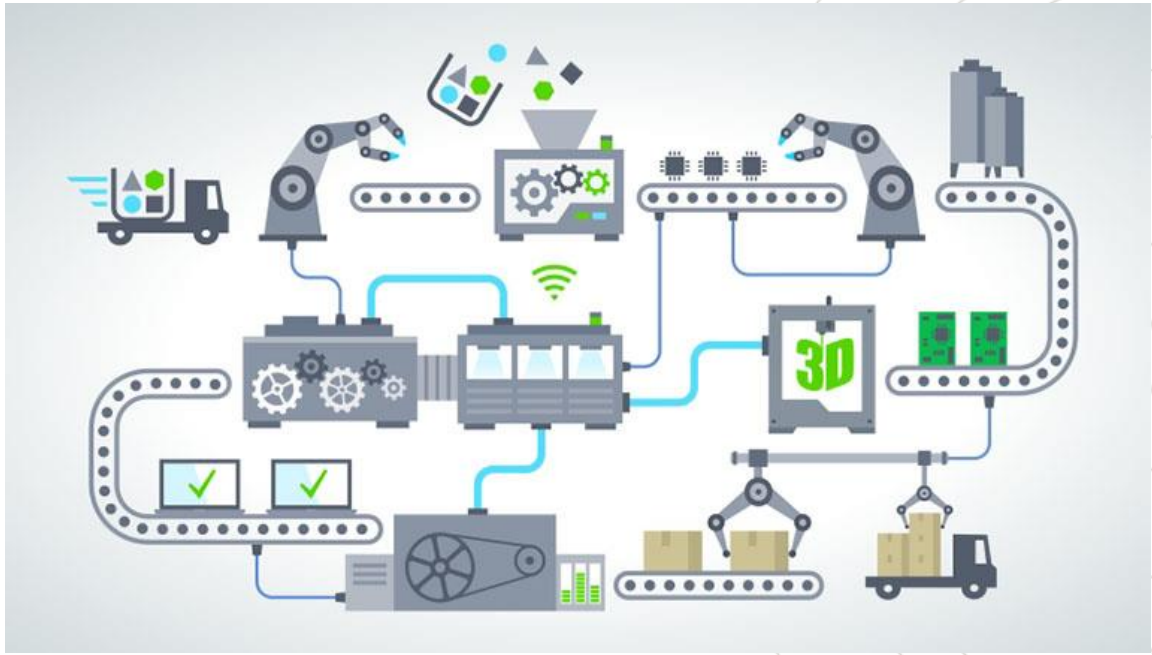
The Fourth Industrial Revolution

The Fourth Industrial Revolution

The fusion of experimental technologies that disintegrate the borders between the physical, digital, and biological areas for the development of a fully interconnected and automated industry is known as the **Fourth Industrial Revolution**.

Klaus Schwab, **Fourth Industrial Revolution: what it means, how to respond**, World Economic ForumThe (Foro Económico Mundial), 2016. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Instantaneity: monitoring and analysis of data in real time.
Virtualization: remote and virtual monitoring of production processes.
Decentralization in decision making: cyber-physical systems that make decisions based on data analysis.
Modularization: the system is divided into modules and produces according to demand.

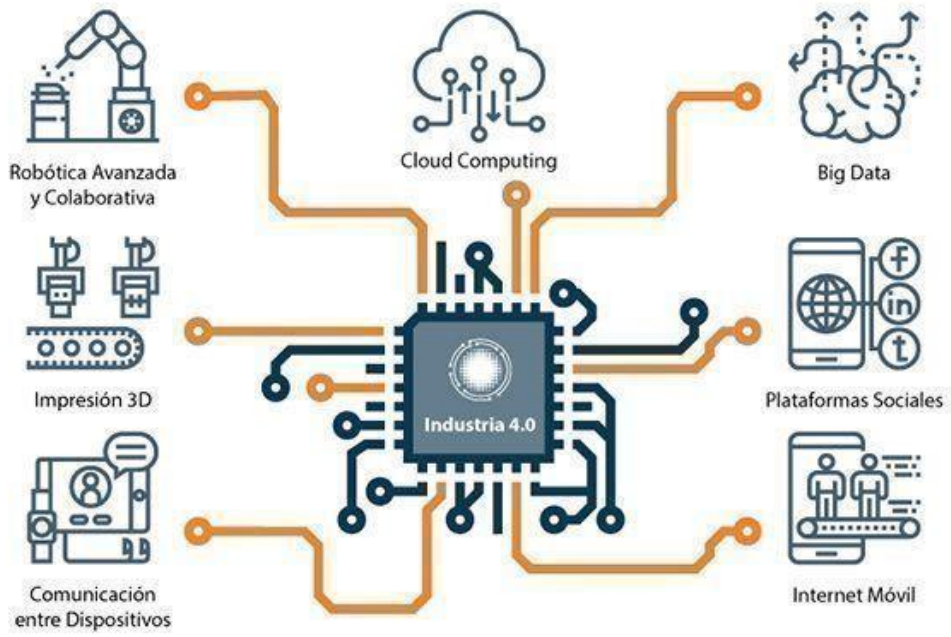


The Fourth Industrial Revolution

The technological developments on which the Fourth Industrial Revolution is based are:

- The Internet of Things (IoT) and the Industrial Internet of Things.
- Storage and use of information in the cloud (decentralized storage of information).
- Big Data and data science (Analytics)

  (use of large amount of data collected to make decisions).
- Cybersecurity (information security).
- Secure blockchains (Blockchain).
- Autonomous robotics and artificial intelligence (AI).
- Image analysis and processing.
- Analysis and processing of biometric data.
- Systems of production, storage and use of energy.
- Drones and global positioning (GPS).
- Virtual reality, augmented reality and virtual simulations (CAE).
- 3D printers (additive manufacturing).

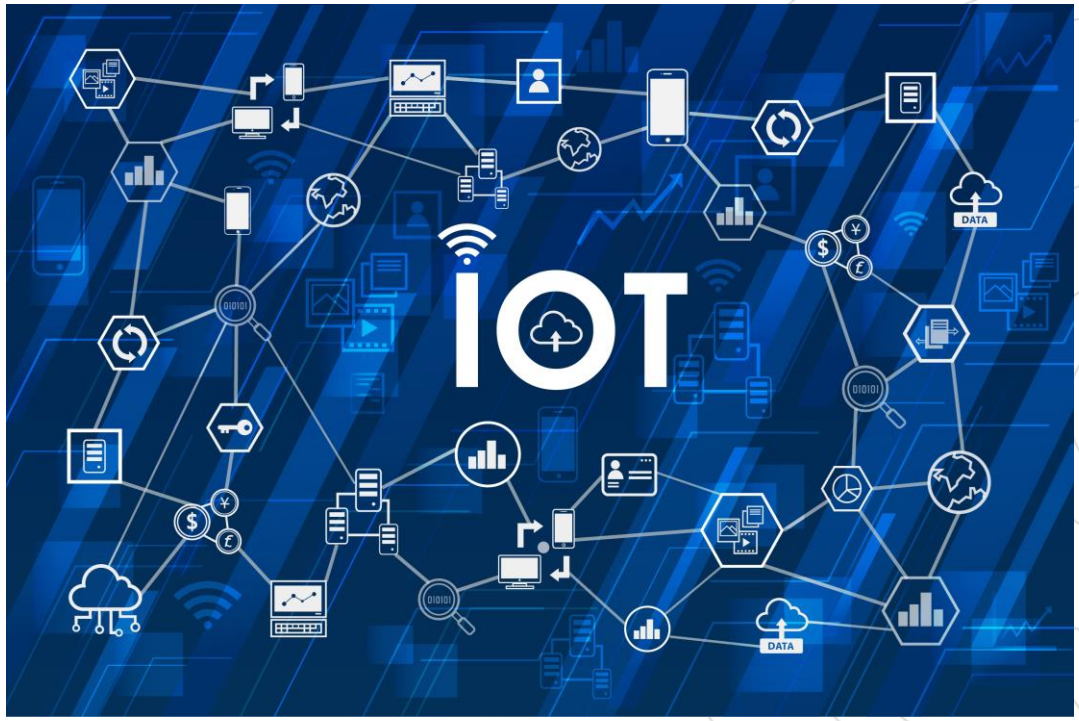


What is IoT?

The IoT, or Internet of Things

The term **IoT**, or **Internet of Things**, is the process that allows connecting day-to-day physical elements through Internet networks, it also refers to the technology that facilitates communication between these devices and the cloud, as well as between the devices themselves, very safely, to work collectively without human intervention.

This technology is based on the use of simple communication chips and accessible high-accuracy sensors, both of increasingly reduced size and very low cost, connected to high-bandwidth networks that constantly send enormous amounts of data. where an IoT application channels information that can be analyzed by mathematical algorithms, or by artificial intelligence, either to exchange information between the network, or to make decisions in real time.

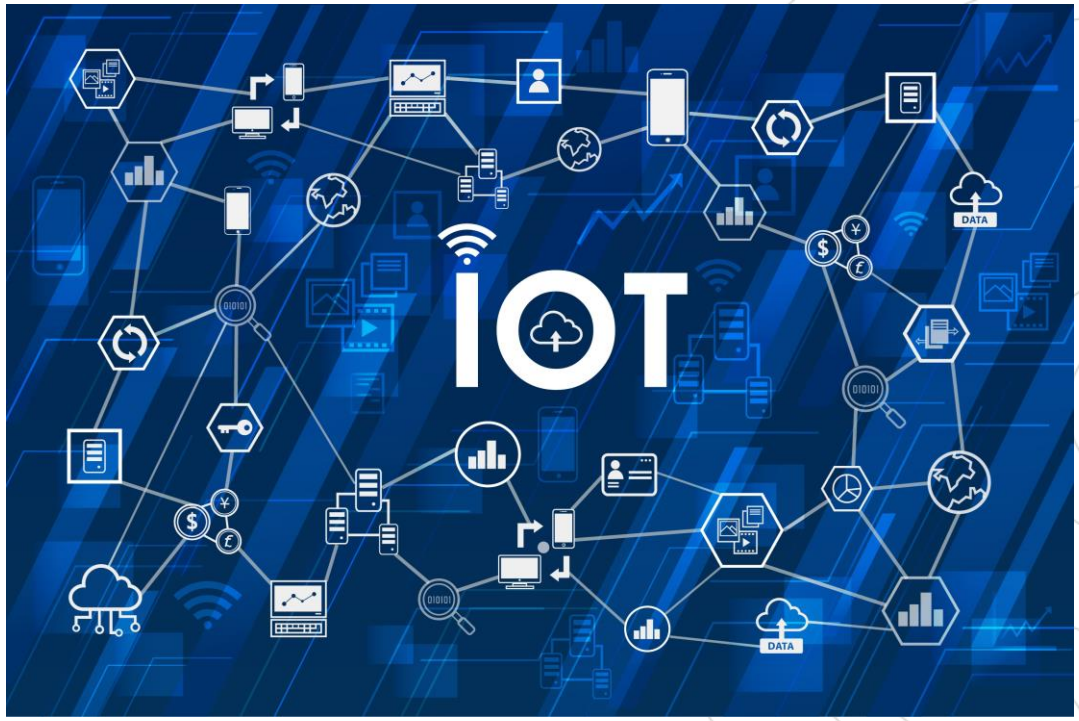


What is IoT?

The IoT, or Internet of Things

In an **IoT** network it is possible to find day-to-day devices and artifacts from the home or office, for monitoring the state of human or animal health, devices for controlling the state of energy supply, water, gas, transport vehicles of all kinds, containers and parcels, telecommunications, among many others.

Some examples of its application can be seen in buildings and smart cities.



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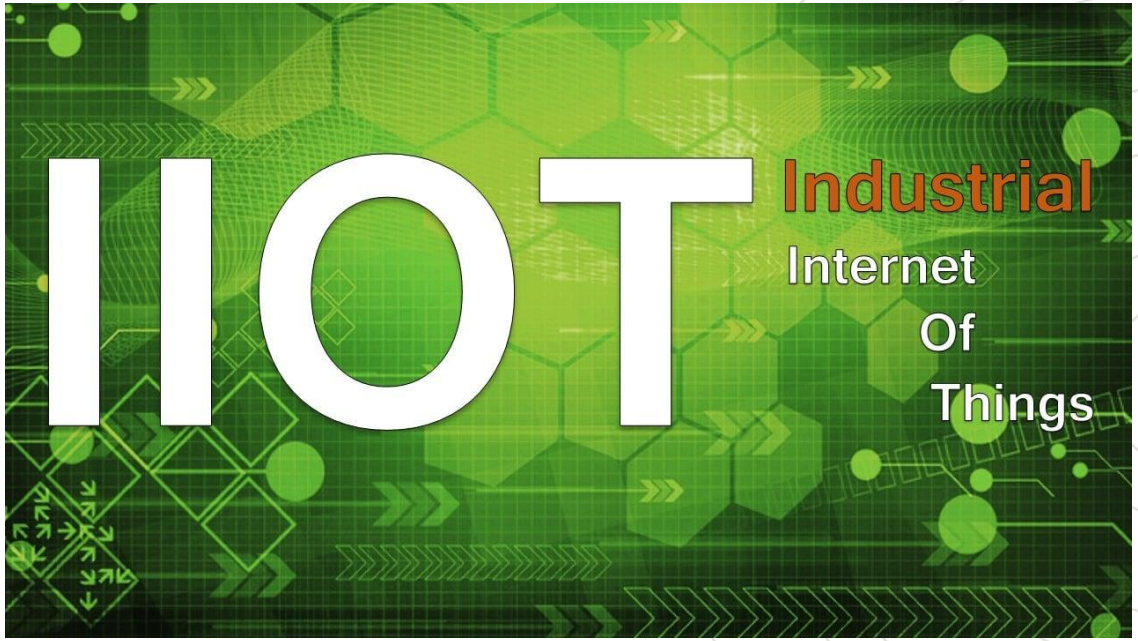
https://www.arimetrics.com/glosario-digital/iot-internet-of-things

What is IoT?

The IIoT, or Industrial Internet of Things

At an industrial level, IoT (**IIoT**) technology has a similar operating principle and is used to interconnect artifacts, devices and sensors that provide constant information, in real time, about the status of different production processes, production lines, the environment. of the plant or work area, safety monitoring, raw materials or finished product, in order to make production more efficient and effective.

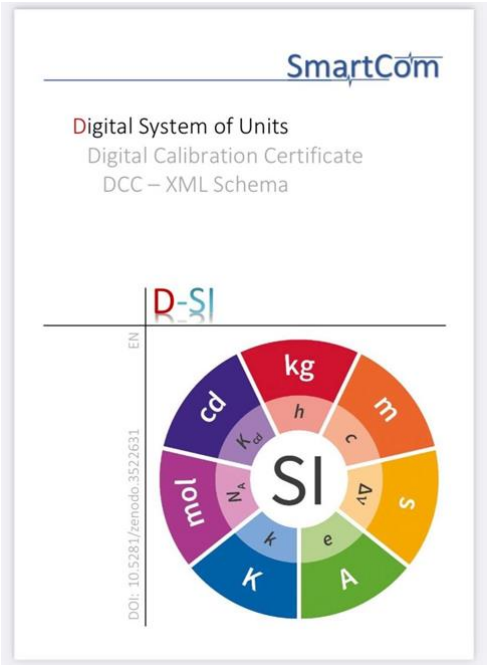
The result is a reduction in maintenance costs, an increase in the useful life of equipment, machines and control and telecommunication systems, safer environments, reduction in production errors, reduction in rework, use of raw materials, efficiency in the logistics of production, and in the transportation and storage of products and parts.



Metrology applied to Industry 4.0

Metrology 4.0

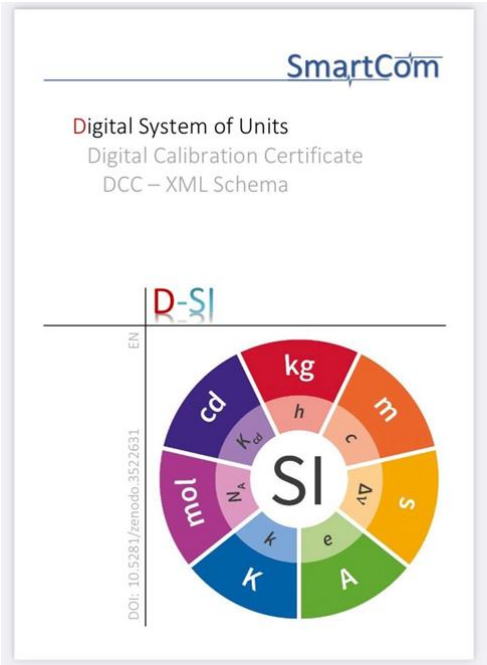
https://www.ptb.de/empir2018/fileadmin/documents/empir/SmartCom/documents_for_download/Digital_System_of_Units_D-SI_2019-11-04_UK_NPL_SmartCom.pdf



Metrology 4.0 is more than a definition, it is a concept, where the science of measurements intervenes to propose adequate parameters for the correct representation of the information associated and traceable to the International System (SI), including methods, tools, representations and expressions of the quantities, units, measurement errors and measurement uncertainty, so that the data and metadata are understandable and usable by machines. It has to do with syntax, semantics, taxonomy, controlled vocabularies, ontologies and every aspect that characterizes and gives digital meaning to the data and metadata associated with a measurement.

Metrología 4.0

https://www.ptb.de/empir2018/fileadmin/documents/empir/SmartCom/documents_for_download/Digital_System_of_Units_D-SI_2019-11-04_UK_NPL_SmartCom.pdf



Metrología 4.0 más que una definición, es un concepto, en donde la ciencia de las mediciones interviene para proponer parámetros adecuados para la representación correcta de la información asociada y trazable al Sistema Internacional (SI), incluidos métodos, herramientas, representaciones y expresiones de las cantidades, las unidades, los errores de medición e incertidumbre de la medición, para que los datos y los metadatos sea entendibles y de uso para las máquinas. Tiene que ver con la sintaxis, la semántica, la taxonomía, los vocabularios controlados, las ontologías y todo aspecto que caracteriza y da sentido digital a los datos y metadatos asociados a una medición.

Metrology at the IIOT for Industry 4.0

The LCM has developed two processes where metrology works to ensure and validate that the data provided by a network of sensors is adequate and consistent.

1. The Industrial Linkage Strategy (EVI) allowed two Interactions between the LCM and the NARIME company:

2020

Hygrothermometer calibration (one set)

(temperature and relative humidity sensors)Rain gauge calibration

2022

Hygrothermometer calibration (two different devices) (temperature and relative humidity sensors)

Still pending: Pyranometer and anemometer

2. Participation in the BID – SIM - Develop of a thermohygrobarometer with digitalization criteria project, has involved the LCM in the calibration of sensors that are possible candidates for the preparation of a possible working device.

Small company entrepreneurship

Metrology at the IIOT for Industry 4.0

"NARIME is a company that seeks to integrate the knowledge of different technological areas (internet of things, big data, artificial intelligence and sensor networks) and agronomics to improve the current inefficient models of the agricultural sector; thus ensuring that an activity as important as agriculture walks hand in hand with new technological trends.

Currently there is a data collection and information interpretation system that provides irrigation recommendations for farmers, to obtain more productive and healthy harvests and optimize the consumption of water resources."

NARIME

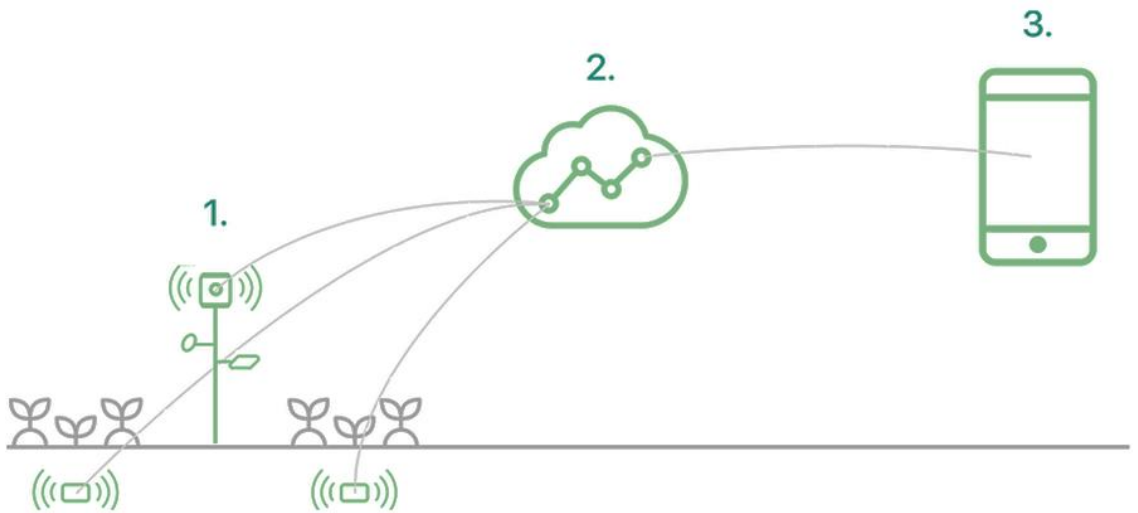
(506) 8314-4762

info@narimecr.com

Metrology at the IIOT for Industry 4.0

How does the system work in the agricultural sector?

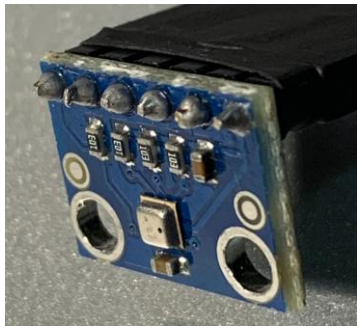
1. The sensors of the IIoT devices are calibrated in the National Laboratory (LCM).
2. A meteorological station is placed to monitor environmental variables (temperature, humidity, radiation, precipitation and wind speed), and a network of unit modules to monitor soil variables (moisture and soil absorption).
3. The data collected by the system is sent and stored in a database (in the cloud).
4. The algorithm uses data on the environment, soil, terrain, type of crop, and type of irrigation system to estimate the irrigation time corresponding to each crop block.
5. This irrigation recommendation is provided to farmers through the App.

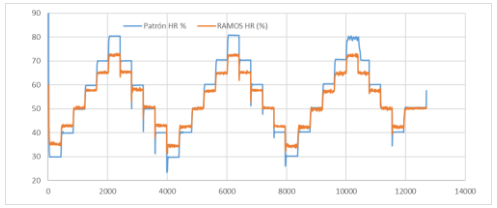


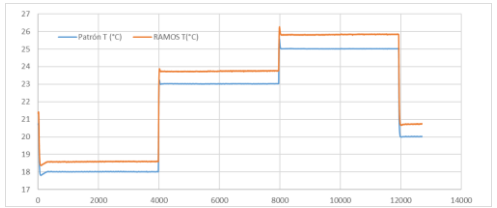
Metrology at the IIOT for Industry 4.0

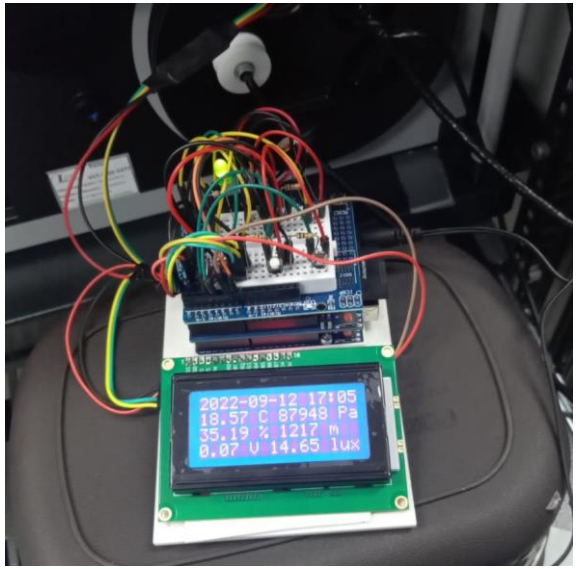
How are the sensors in the LCM calibrated for the THB BID SIM project?

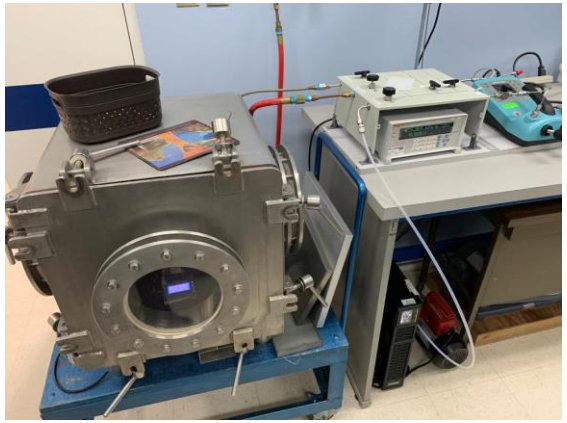
1. A device is made with a microcontroller (ARDUINO) and the sensor to be evaluated (BME 280).
2. A program for the microcontroller was made.
3. The device is placed in the humidity and temperature chamber, with reference to a ROTRONIC equipment.
4. The device is placed in a barometric chamber with reference to RPM4 equipment.
5. Calibration data is analyzed and compared to other sensors.

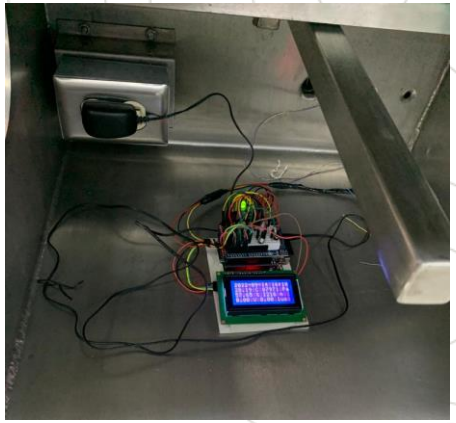












Findings, recommendations and future actions

Findings, recommendations and future actions

Findings in the calibration process:

Currently, a large number of low-cost sensors with good accuracy and stability characteristics are marketed, each of these represents a challenge for the National Metrology Laboratories for the following reasons:

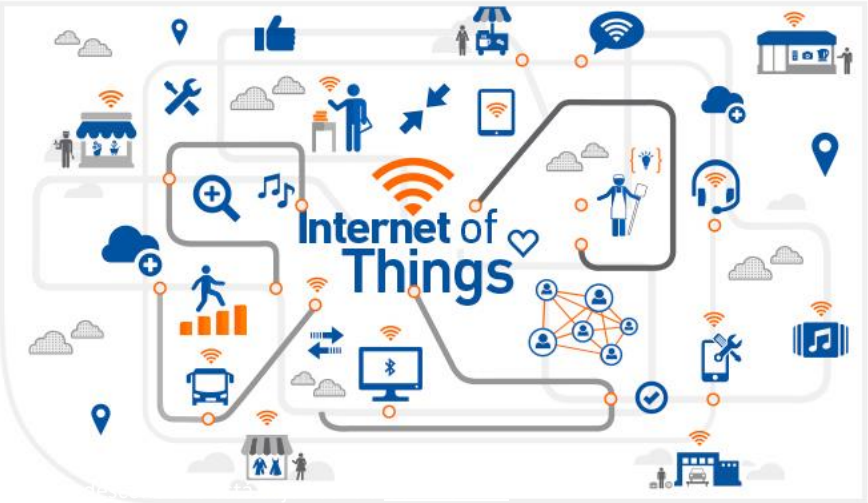
- Different types of measurements
- Different buses for connection and sending of data
- Different ways to integrate with a microcontroller or microprocessor. Each creator proposes the best way for the desired purpose.
- Different ways of programming the device generate results and data with different formats according to the needs of the creator.
- Many times the information generated does not adhere to the SI.

There may be a large amount of data, a large flow of information, coming from the device that the NMI cannot handle.

Many times the large amount of information is not entirely useful for the calibration process, so it must be discriminated.

The NMI may not have adequate or complete capacity to cover all the needs of industry 4.0 in calibrations.

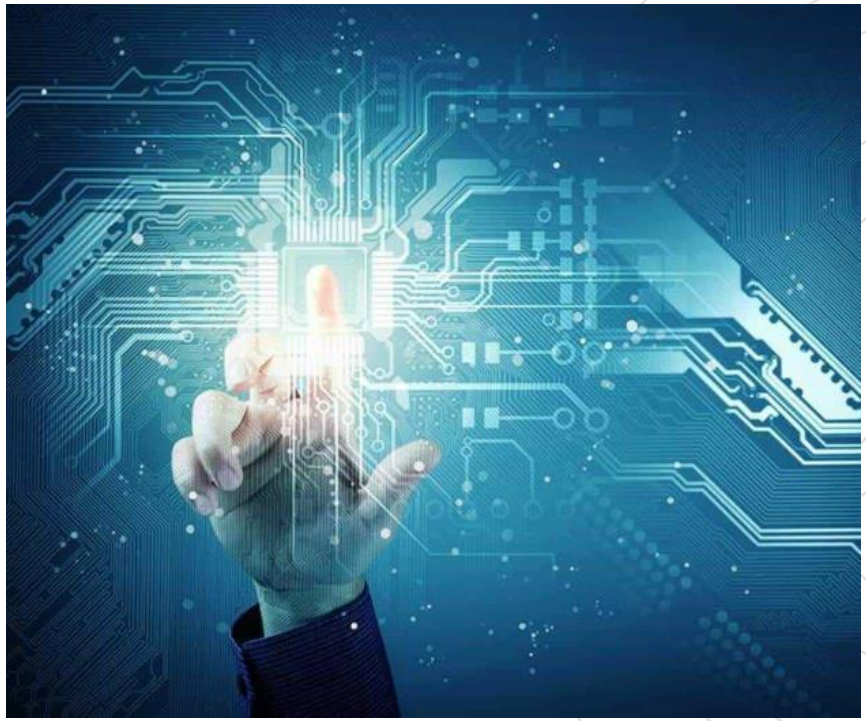
The NMI 's ability to respond to the needs of industry 4.0 can be very slow. Or the NMI might not have the resources to cover this need.



Findings, recommendations and future actions

Recommendations:

- The NMI must have an area, department or working group aimed at recognizing the needs of the industry in terms of digitization and metrology, as well as the new sensors used in the processes.
- The NMI must develop new capabilities that allow it to incorporate calibrations of new devices with particular characteristics of connection, programming and information management.
- The NMI must have good communication with the client and with the creator of the proposed metrological solution, be it a measurement device, an algorithm, a programmed tool, to ensure the validity of the data obtained.
- The NMI must not forget that traceability to SI units is fundamental to ensure the quality of the processes and the client must be aware of this aspect in the development of their process.
- The NMI can implement tools that allow it to improve its response capacity to the need for industry 4.0, either to have more resources to cover this need, or by linking with partners with demonstrated capacity, or with other interested parties that can collaborate. in solving this need.



Findings, recommendations and future actions

Future actions:

- Improve traceability capabilities, as far as possible, to cover the areas required by the industry.
- Create an internal LCM network to integrate environmental condition sensors and remotely monitor work areas and laboratories.
- Increase the participation of other companies that develop low-cost measurement equipment through the Industrial Linkage Strategy (EVI).}
- Involve more technical staff in M4DT activities to diversify the offer of external services.

Alianzas Público Privadas y Convenios interinstitucionales

- Empresa consolidada e instituciones gubernamentales
- 2 APPs funcionando, + 14 convenios vigentes

Programa de Asesoría Técnica en Metrología

- Pymes y emprendimientos
- + de 40 pymes asesoradas

Fortalecer la vinculación del LCM con el sector productivo costarricense, mediante un posicionamiento institucional que responda a las necesidades metrológicas de los distintos niveles de empresariado que se desarrollan en el país.

Proyectos de cooperación nacional e internacional

- 7 proyectos nacionales
- 14 proyectos internacionales

Estrategia de Vinculación Industrial (EVI)

Industrial Linkage Strategy (EVI)

Strengthen the link between the LCM and the Costa Rican productive sector, through an institutional positioning that responds to the metrological needs of the different levels of business that are developed in the country.

¡Thank you very much!

Metrology for IoT applications

SIM M4DT - TF Metrology for Industry 4.0

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