WORLD SENSING

IoT in mining

AMICOS project

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Connecting matters

Today’s agenda

01. What is IoT?

02. Innovations

03. Needs for IoT

04. Applications

05. Conclusion

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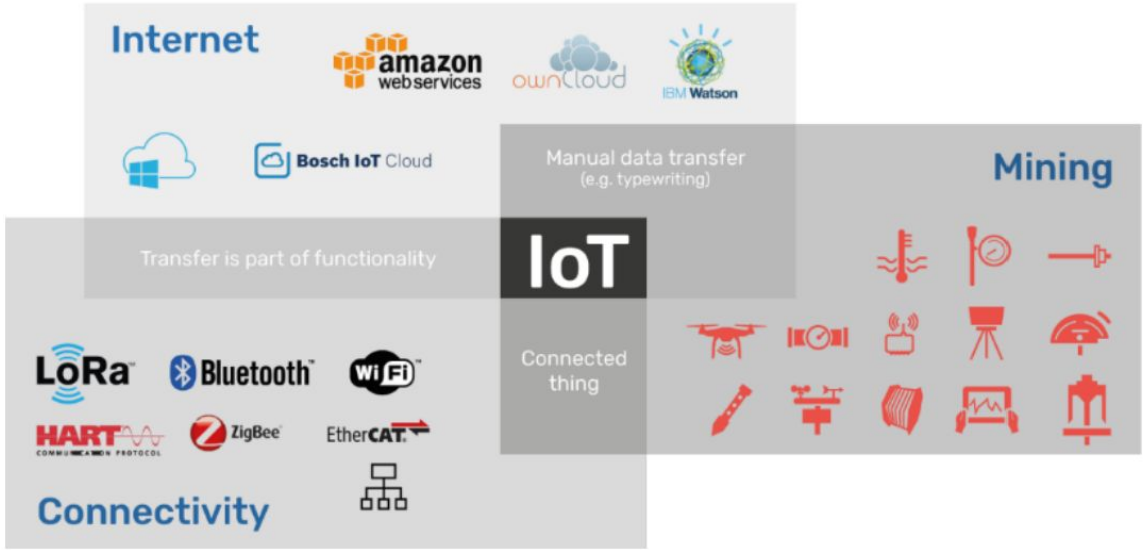
What is IoT?



- Objects
- Connectivity
- Processing power

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What is IoT? Objects

1. Energy/Power
2. CPU
3. Antenna
4. Sensor

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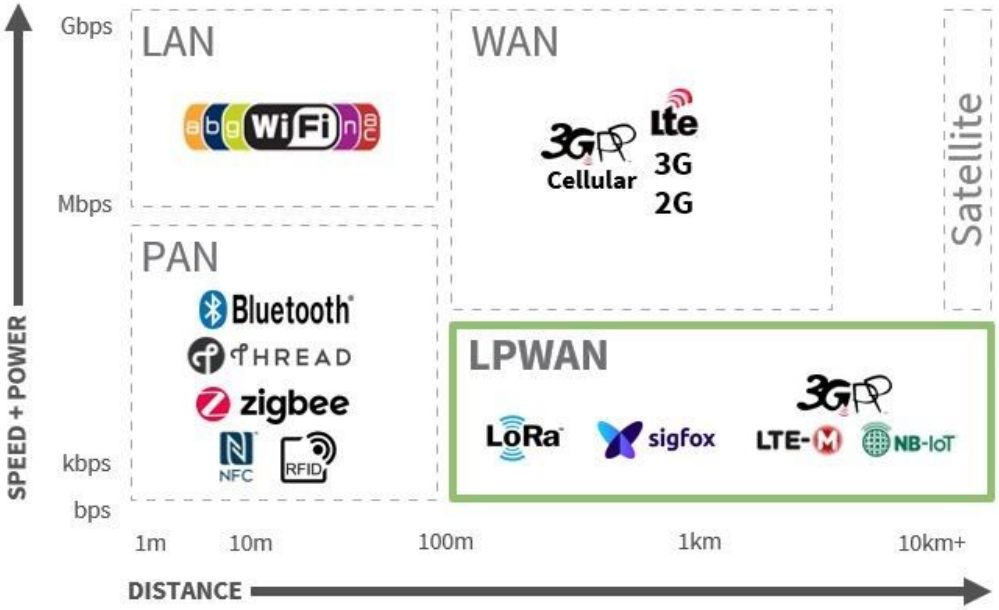
What is IoT? Communication



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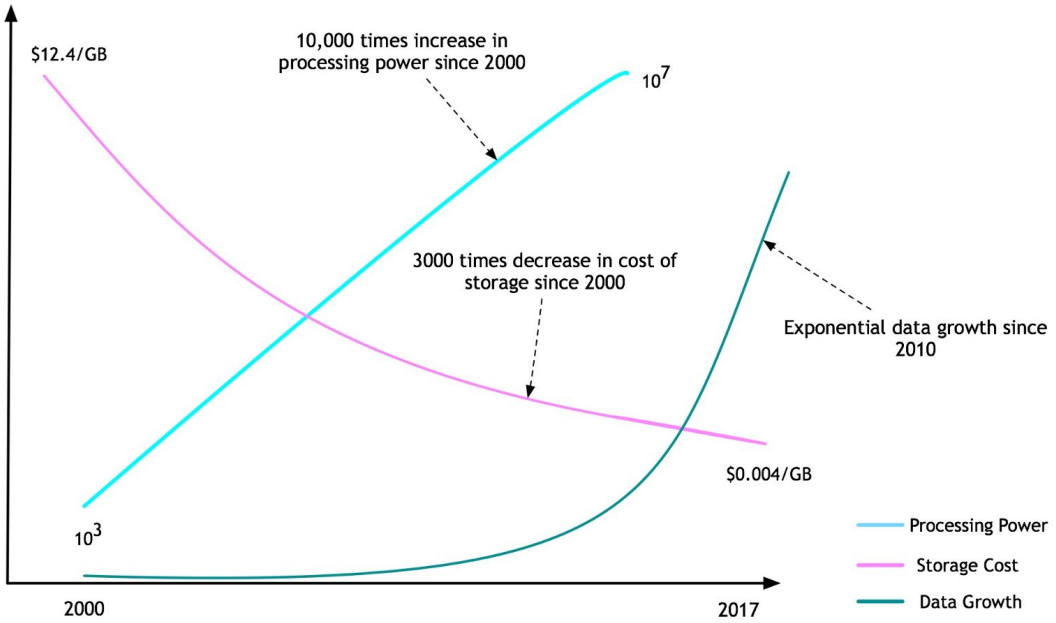
What is IoT? Processing



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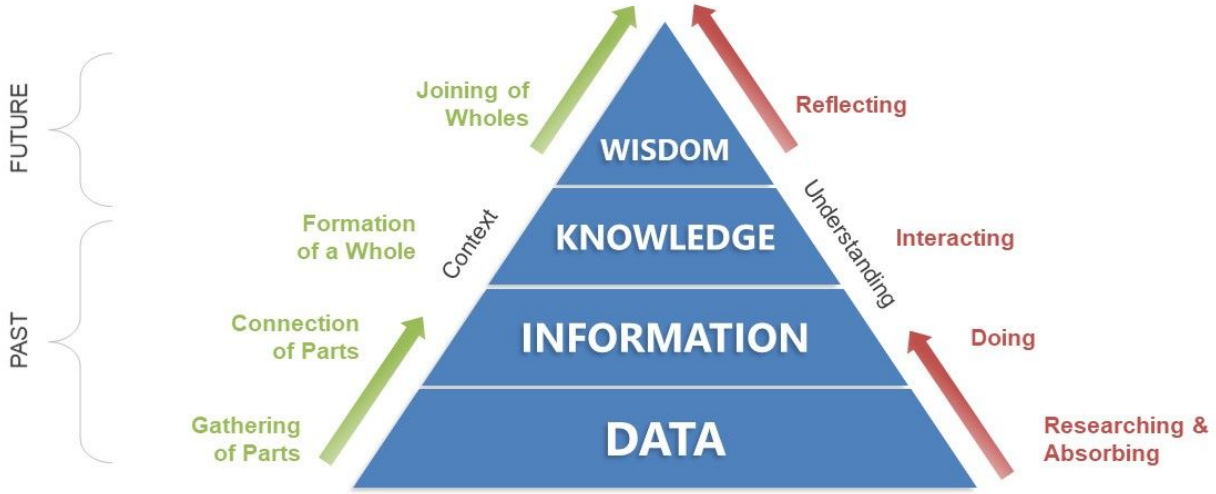
What is IoT? Processing



ANALYTICS

CLOUD platform

EDGE solution

DEVICES

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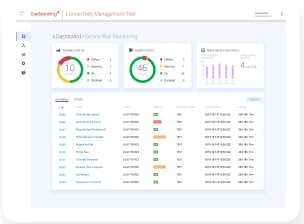
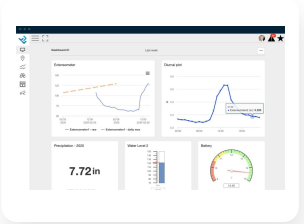
What is IoT? Processing

DEVICES	CMT EDGE	CMT CLOUD	ANALYTICS
			
Edge devices	Connectivity Gateway	Connectivity Device, data & network management	Software Application Data visualization

Low → *High*

Processing capability

DATA → INFORMATION → KNOWLEDGE → WISDOM

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Lack of infrastructure resilience Increased risk of failure

In the U.S. alone, 56,007 bridges out of 614,387 are rated as structurally deficient, which equates to 9.1 percent of the bridges in the country.*

- Poor quality of construction
- Age
- Extreme climate events

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The Wireless Monitoring Solution

Monitoring solution

→ EDGE DEVICES

- Robust, low-power, reliable and secure network of LoRa devices.
- Compatible with a wide range of geotechnical, geospatial and structural sensors.

→ CONNECTIVITY & NETWORK MANAGEMENT

- Uses a star network topology.
- Longer range, not affected by radio signal obstructions.
- Does not need repeaters or network planning and is not critical path dependent.
- Device, data and network monitoring software and configuration mobile app.

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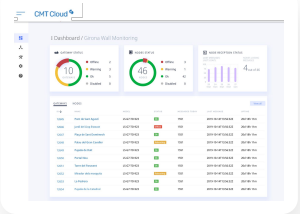
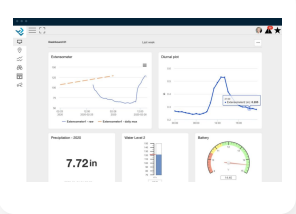
E2E system

Edge devices
Wireless data loggers
Wireless sensors
Digital logger

Connectivity
Gateway



Connectivity
Device, data & network management



Software Application
Data visualization

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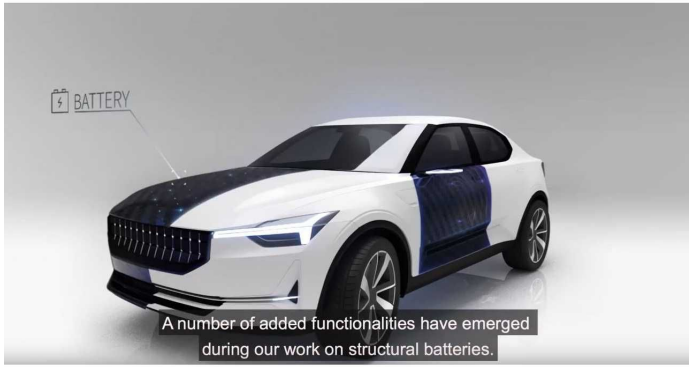
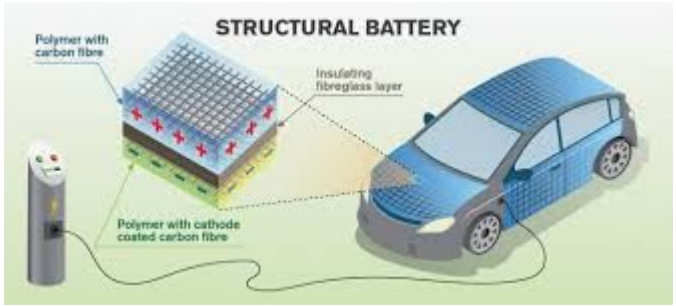
Innovations - objects/batteries





TESLA

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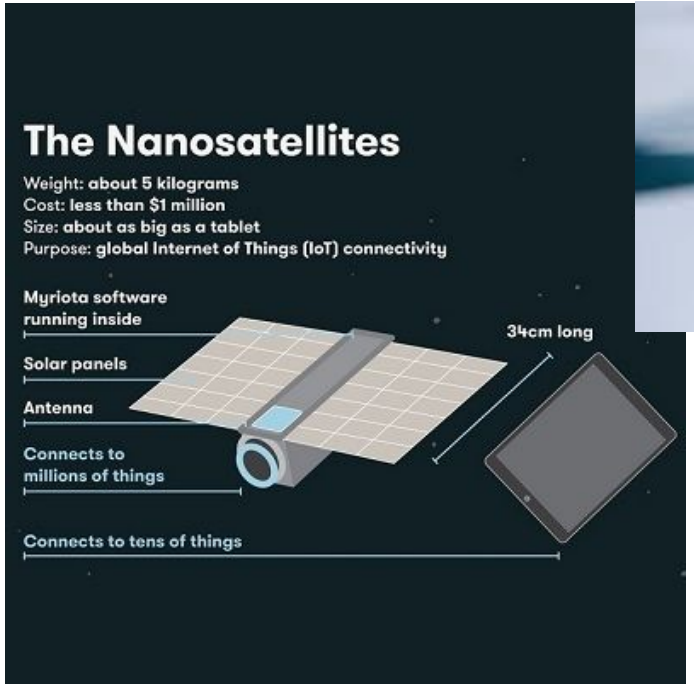
Innovations Communication



SATELIOT®

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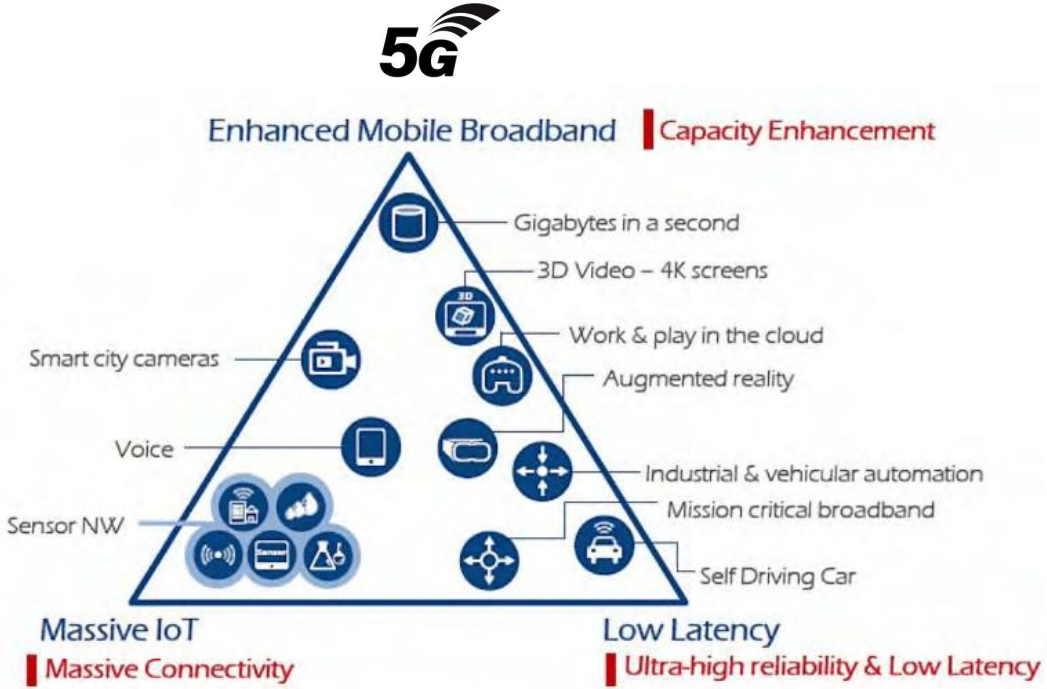
Innovations Communication



neutroon

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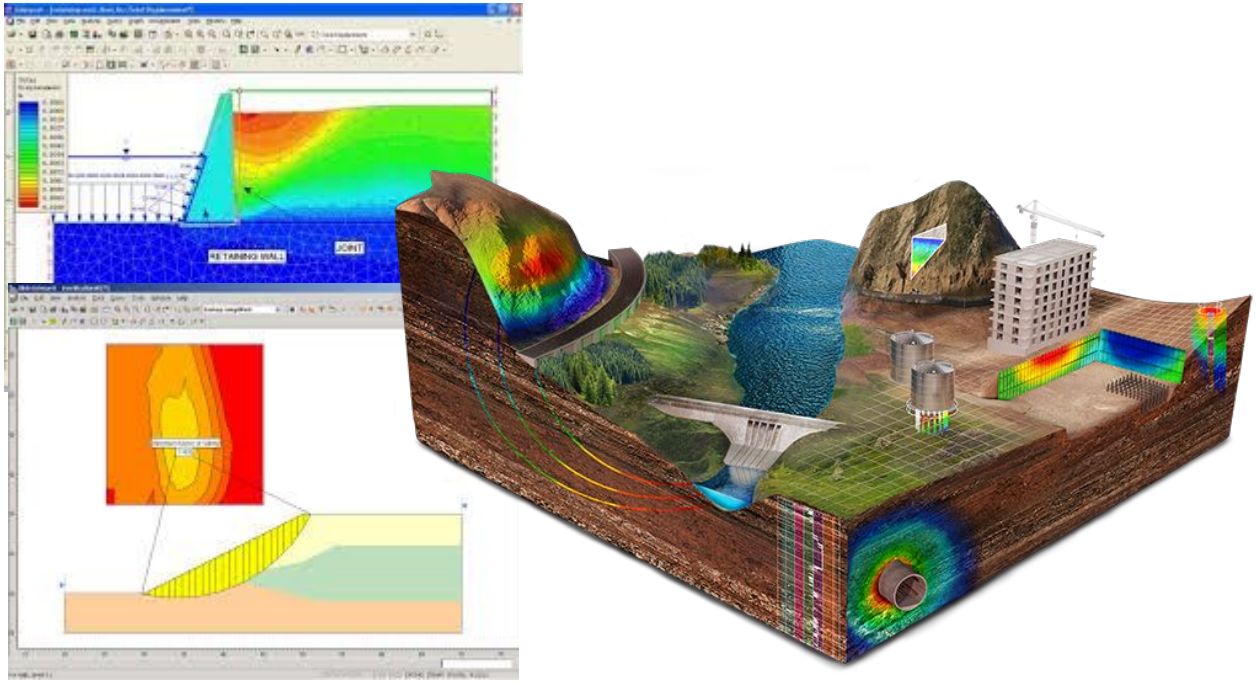
Innovations Analytics



MIDAS GEOTECH

FLAC3D™

PLAXIS

rocscience

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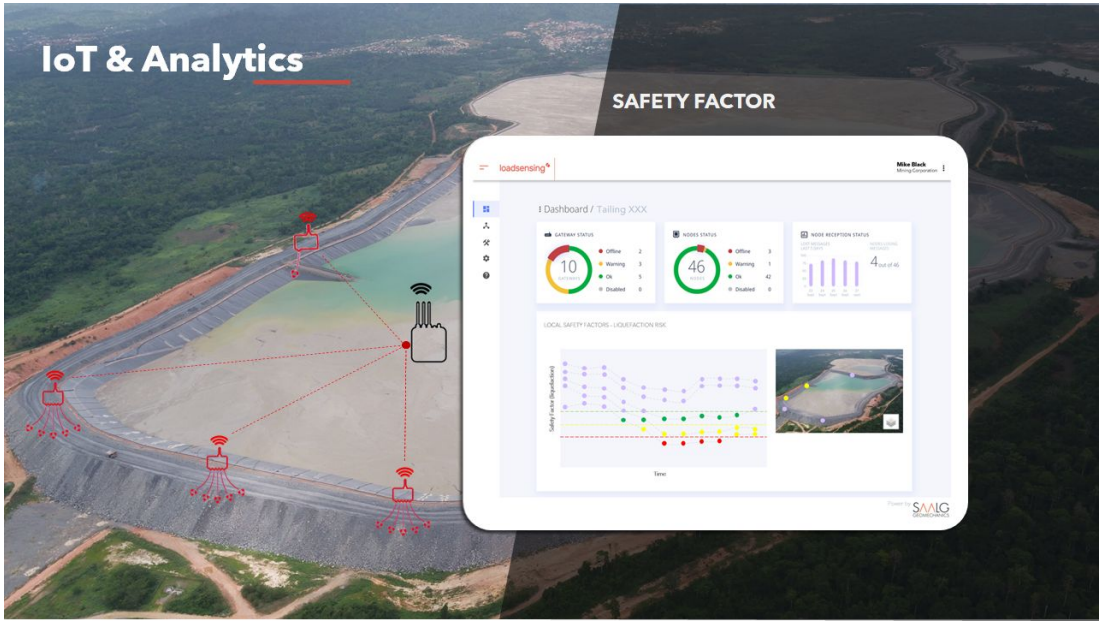
Innovations Analytics



SAALG GEOMECHANICS

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Today’s agenda

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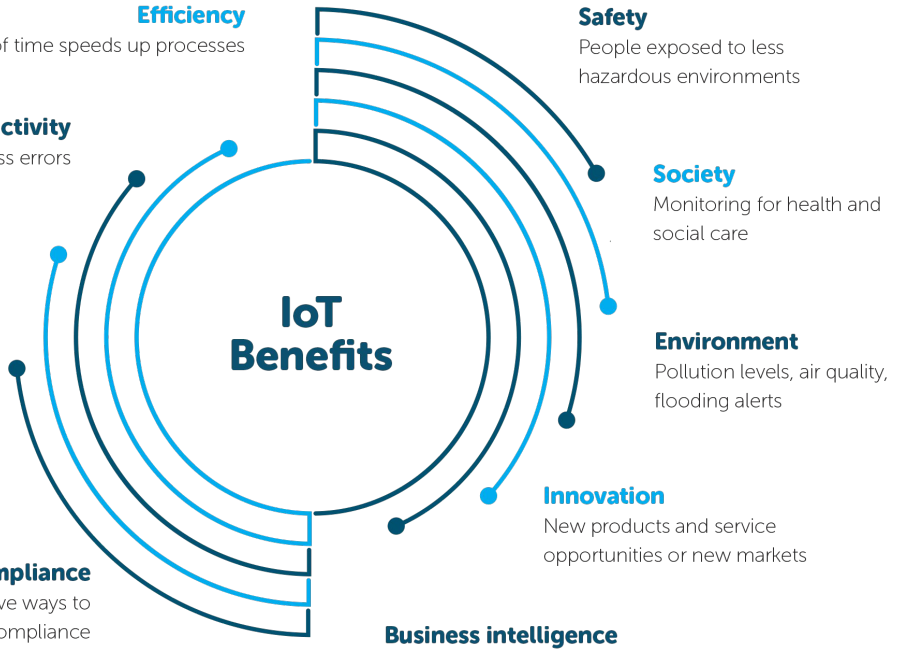
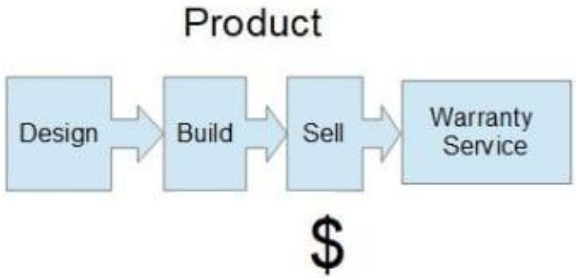
Benefits of IoT



Benefits of IoT Sustainability



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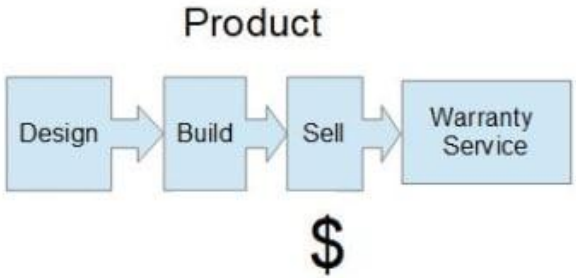
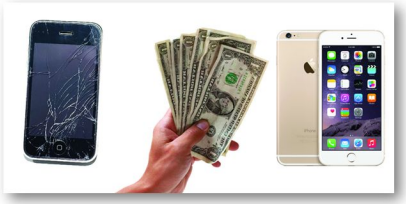
Benefits of IoT Sustainability



(planned obsolescence)



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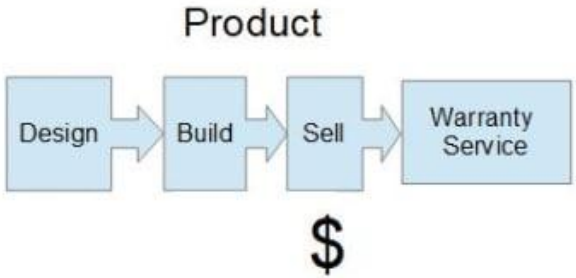
Benefits of IoT Sustainability



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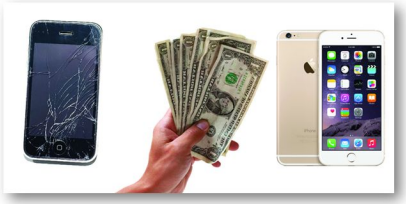

Sustainability issue:
+ more demand,
- less resources

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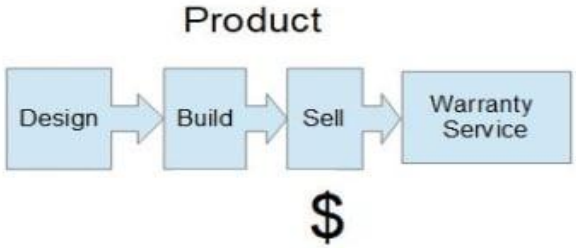
Benefits of IoT Sustainability



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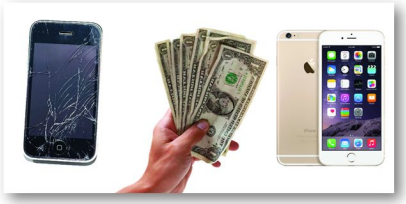

Sustainability issue:
+ more demand,
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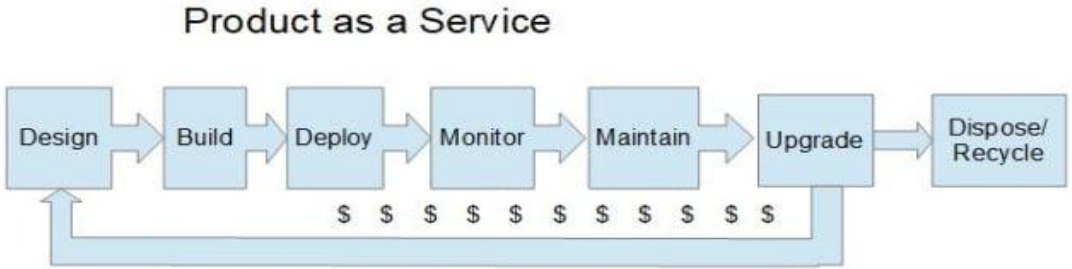

ubeeqo

Cooltra

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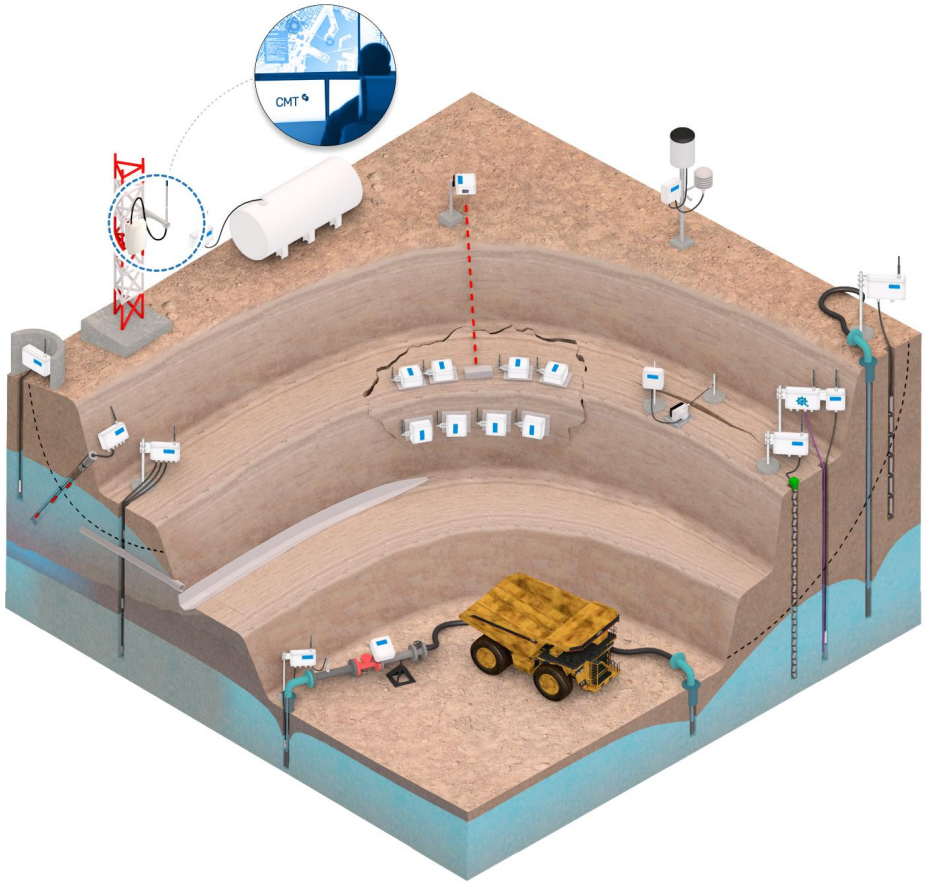
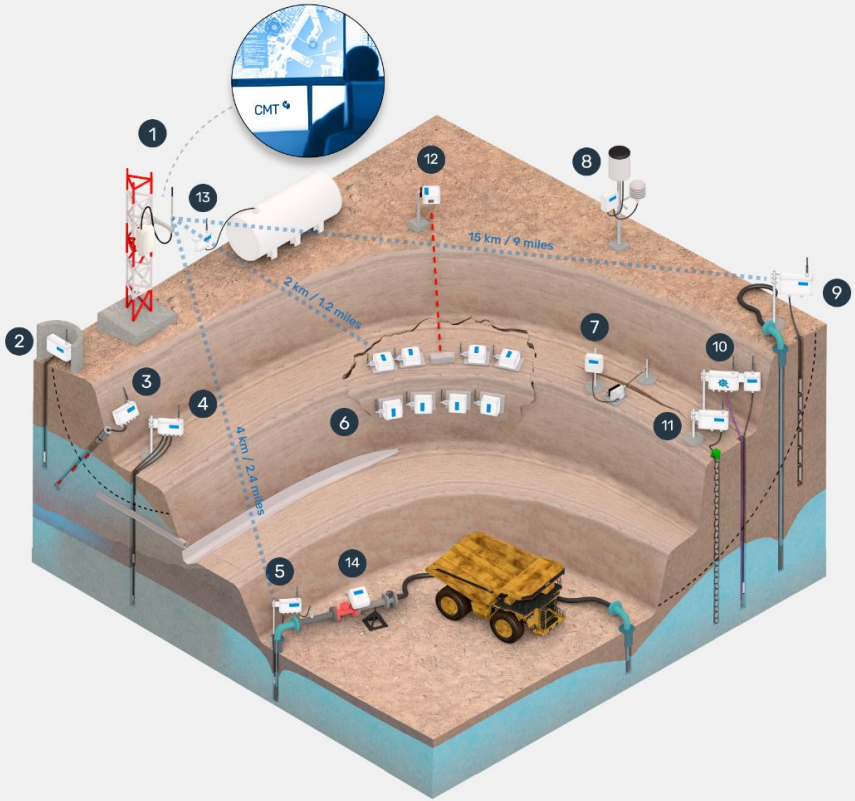
Vertical applications (I)

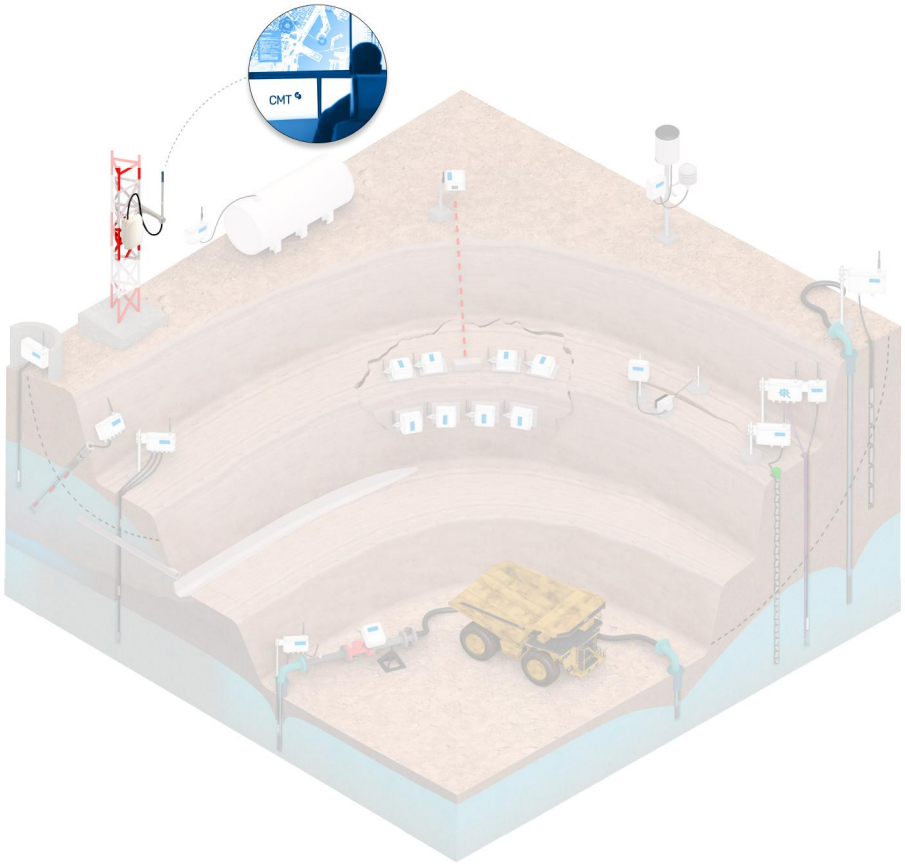


IoT Remote Monitoring in Open-pit Mines

Monitor Open-pit Mines more Efficiently



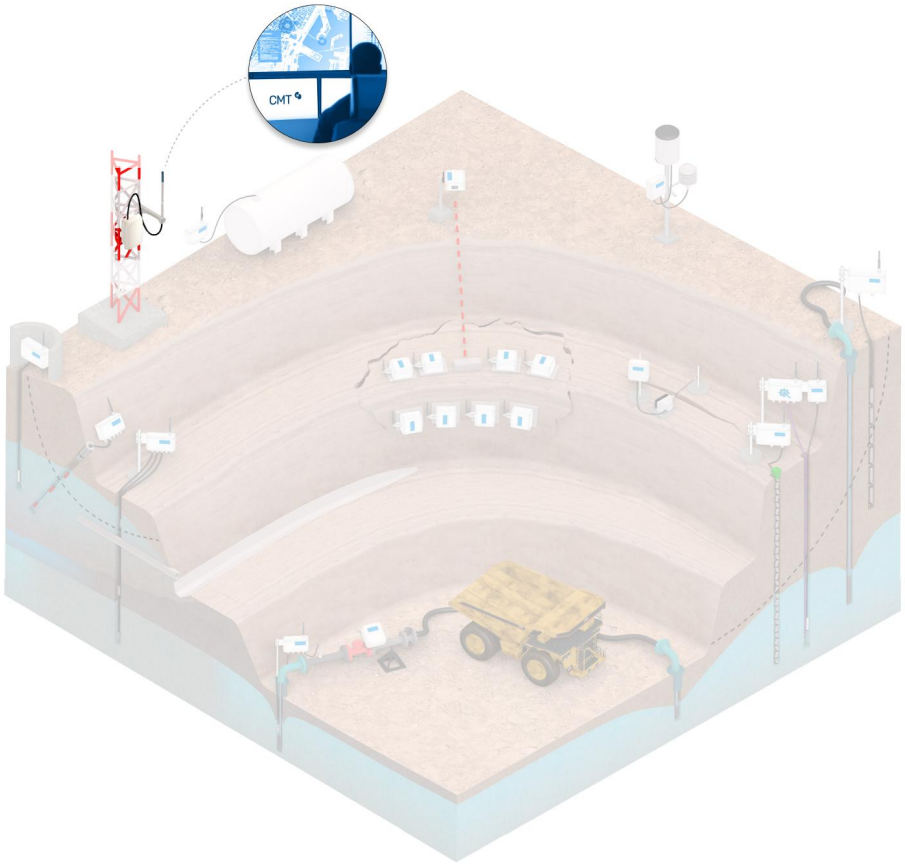
1. Remotely manage and monitor your deployed devices and networks. Obtain monitoring data either on-premise or through the cloud. The gateway sends all data to the **Connectivity Management Tool (CMT)** based on your selected sampling rates. Integrate your data analytics software in CMT to create complete monitoring reports.
2. Analyze the quality of the water with a water quality probe connected to a **digital logger**.
3. Measure vertical deformation at various depths with a multi-point borehole extensometer (MPBX) connected to a **vibrating wire 5-channel data logger**.
4. Monitor pore water pressure through vibrating wire piezometers in a borehole connected to a **vibrating wire 5-channel data logger**.
5. Monitoring water level and temperature in the dewatering well and pressure in the pipe through a water level sensor and a pressure transmitter connected to an **analog data logger**.
6. Detect slope movements in real time (less than 2 seconds in most cases) through the **Tilt90-x wireless tiltmeters** for the **Event Detection Solution**.
7. Monitor movement across surface cracks with a draw wire sensor connected to a **Piconode.**
8. Monitor precipitation with a rain gauge and air temperature with a thermistor connected to a **Piconode**. If you need to monitor more parameters, use a weather transmitter connected to a **digital logger**.
9. Assess horizontal displacements through in-place inclinometers connected to a **digital logger** mounted on a pole.
10. Assess the pore water pressure with a piezometer connected to a **vibrating wire 1-channel data logger.** Locate the depth of a sliding surface using coaxial cables and a Time-Domain Reflectometer (TDR) connected to an **analog data logger**.*
11. Assess horizontal displacements through ShapeArrays connected to a **digital logger**.
12. Check the relative distance variation of the slopes with the **LaserTilt90**, a 3-in-1 laser distance meter, inclinometer and data logger, pointing at a target surface.
13. Monitor diesel fuel levels with a fuel tank level sensor connected to a n **analog data logger**.
14. Pumping rate measured with a water meter connected to a **Piconode**.



IoT Remote Monitoring in Open-pit Mines

Connectivity Management Tool (CMT)

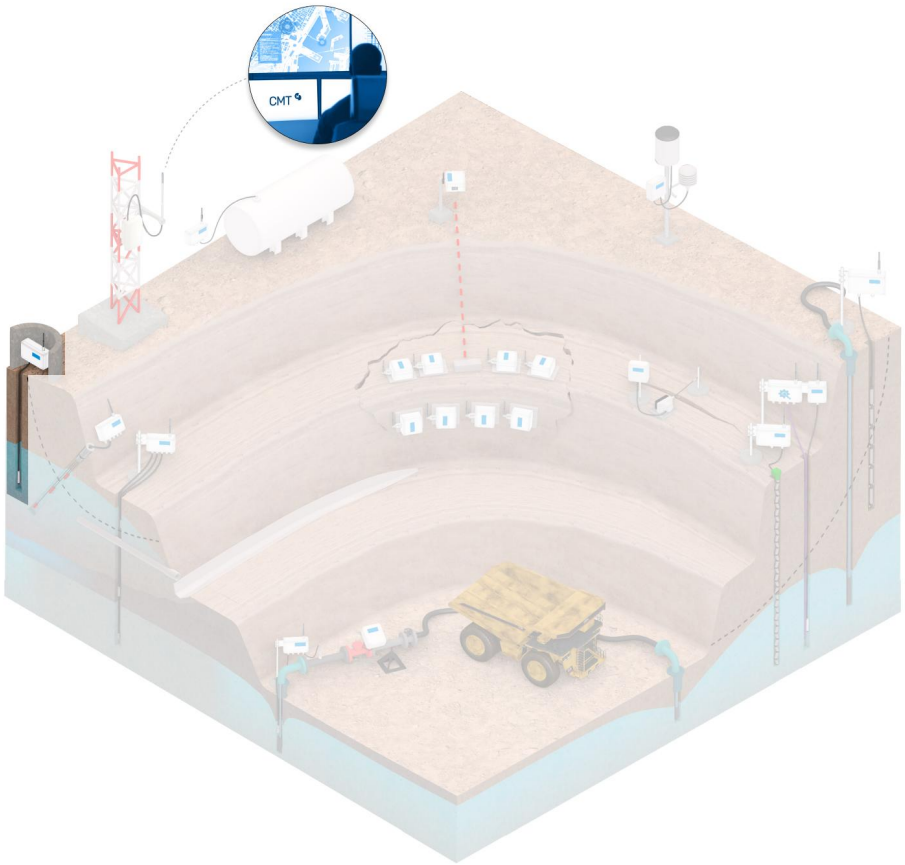
Remotely manage and monitor your network on-premise or in the cloud.



IoT Remote Monitoring in Open-pit Mines

Connectivity Management Tool (CMT)

Integrate your data analytics software to create complete monitoring reports.

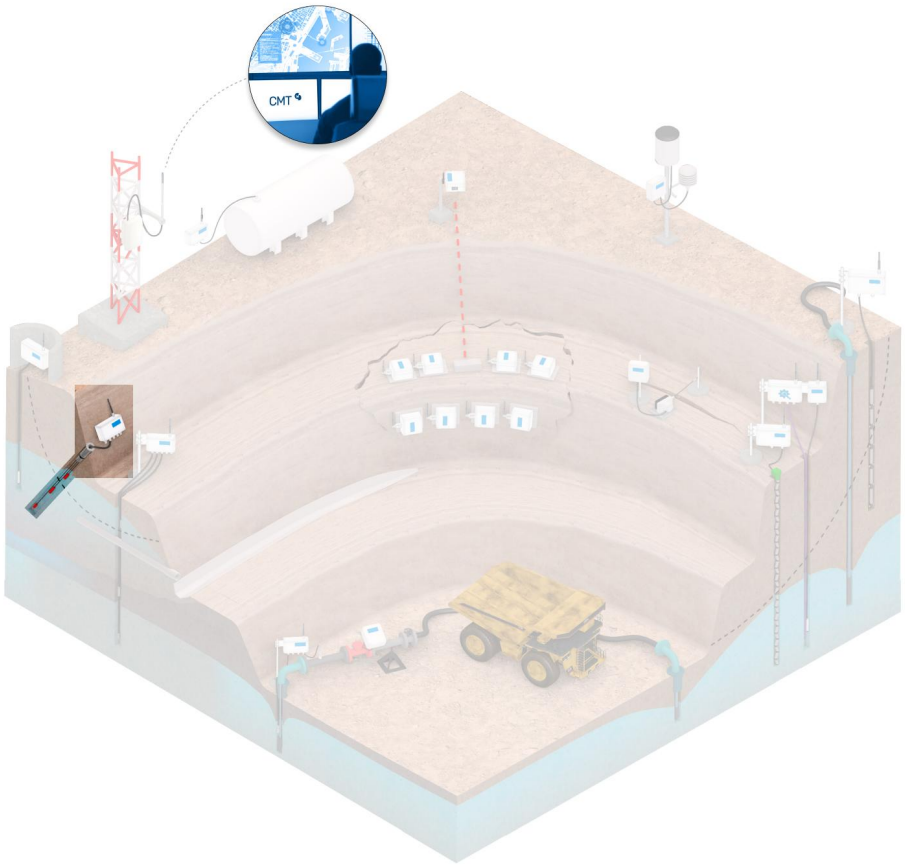


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Water quality

Sensor
Water multi-parameter probes (pressure, temperature and conductivity)
examples: Keller Series 36 Xi W (CTD) and In-Situ Aqua TROLLL® 200

Edge device
Digital logger



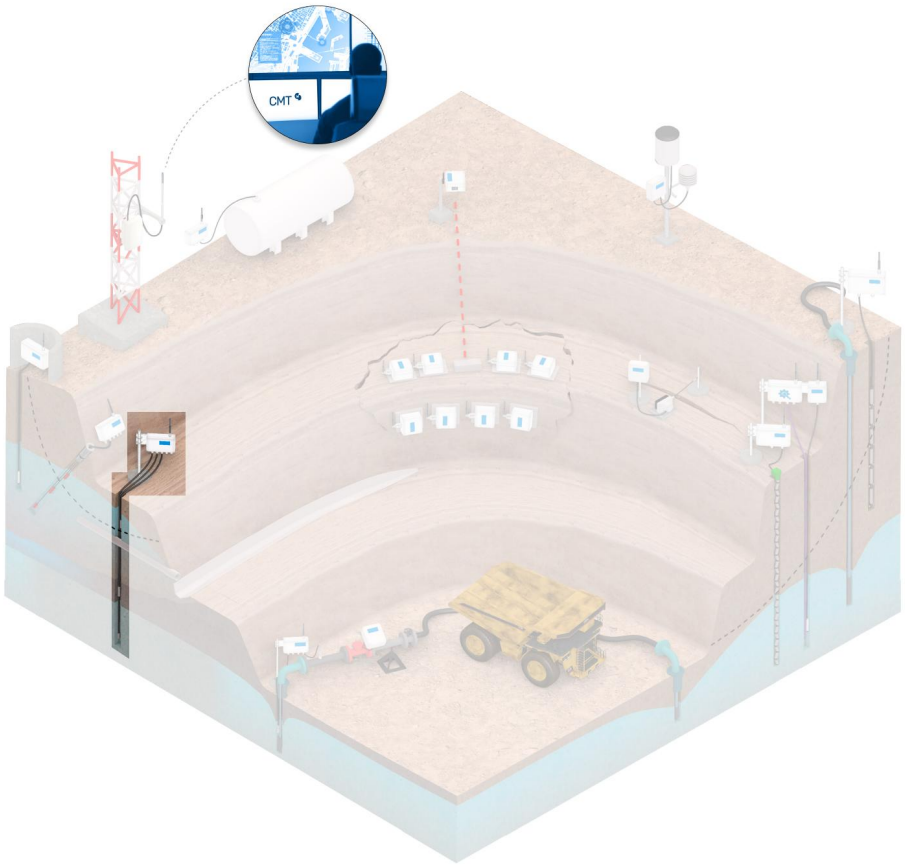
IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Vertical deformation at various depths

Sensor
Multi-point borehole extensometer (MPBX) equipped with vibrating wire displacement sensors

Edge device
Vibrating wire 5-channel data logger

Other options:
MPBX equipped with up to 4 potentiometers connected to an Analog 4-channel data logger or digital MPBX from Sisgeo, MDT connected to a Digital logger

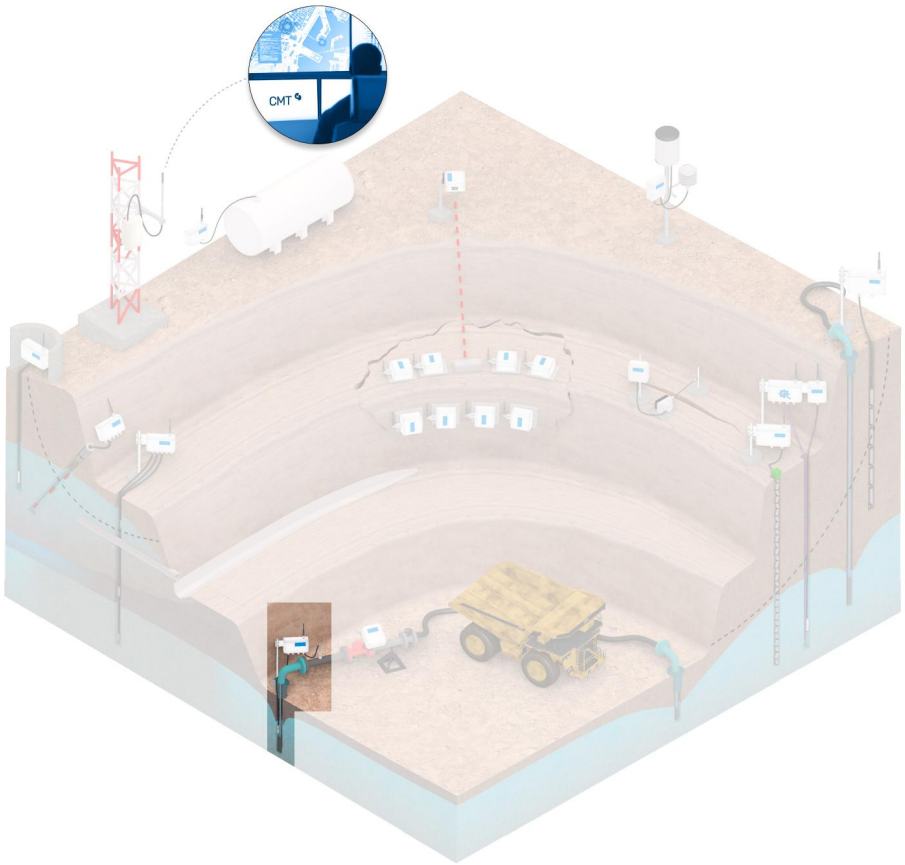


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Pore water pressure

Sensor
Vibrating wire piezometers in a borehole

Edge device
Vibrating wire 5-channel data logger

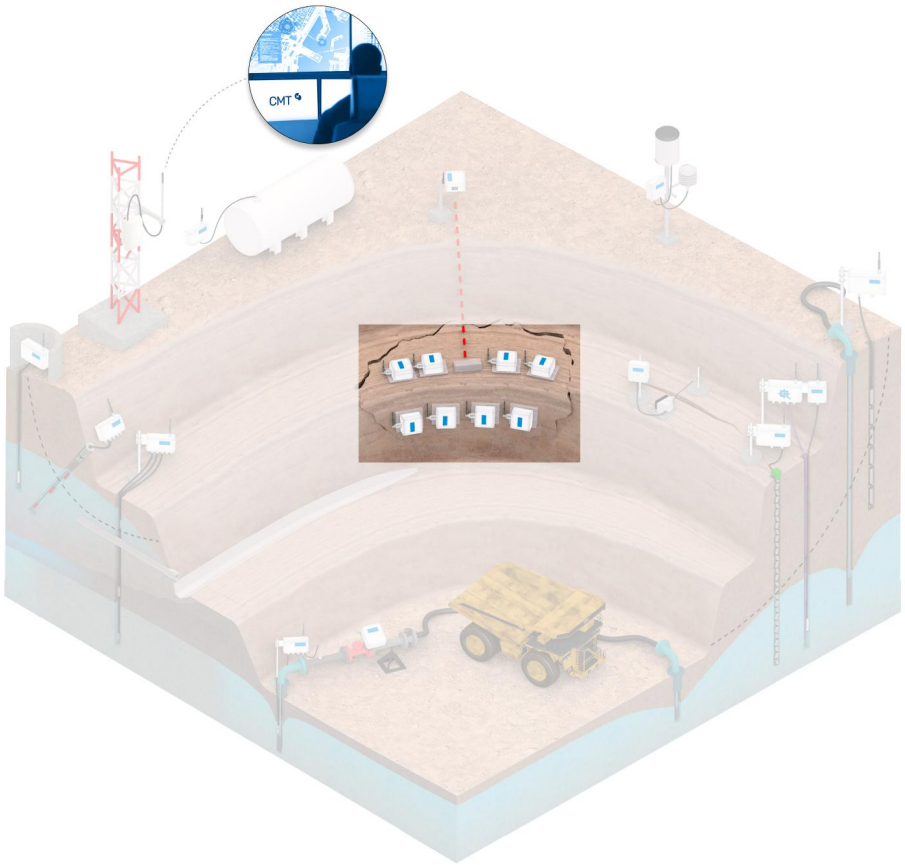


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Water level and temperature in the dewatering well and pressure in the pipe

Sensor
Water level sensor and a pressure transmitter

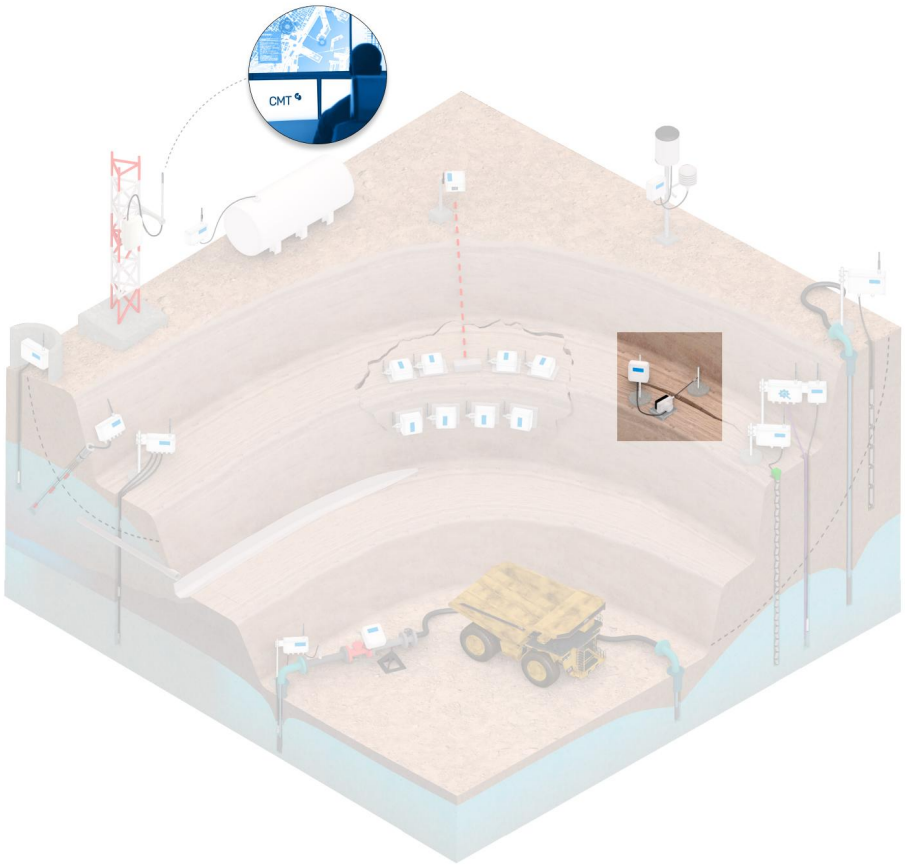
Edge device
Analog data logger



IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Slope movements in real time

Sensor / Edge device
Tilt90-x, a 2-in-1 inclinometer and data logger, for the Event Detection Solution

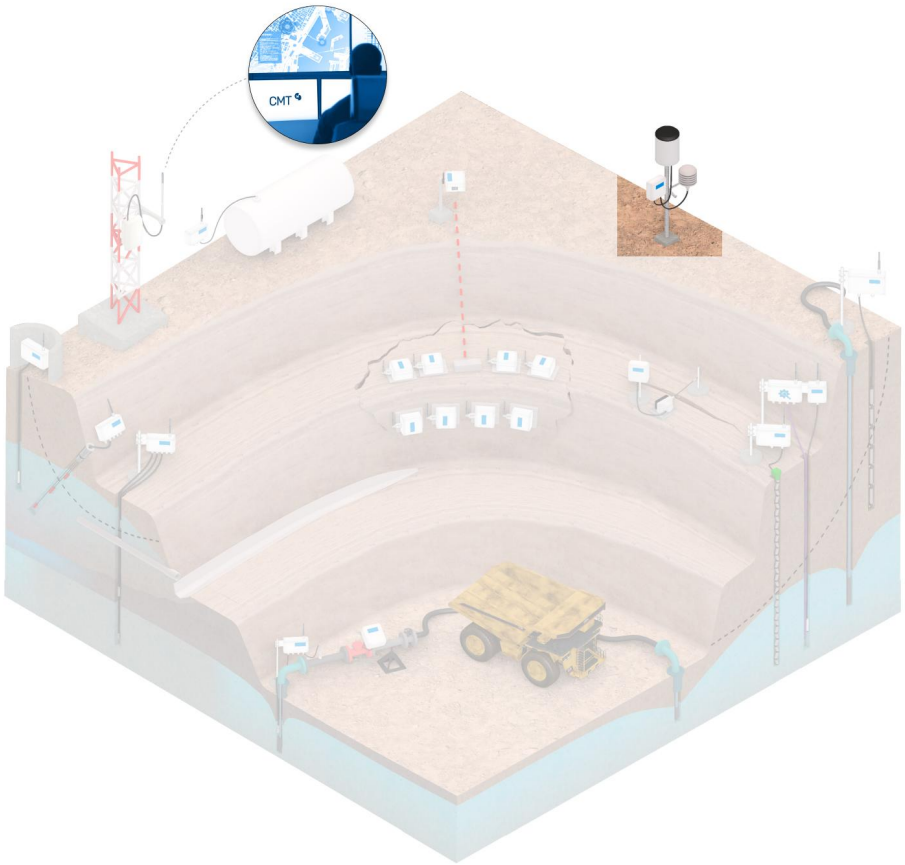


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Movement across surface cracks

Sensor
Draw wire sensor

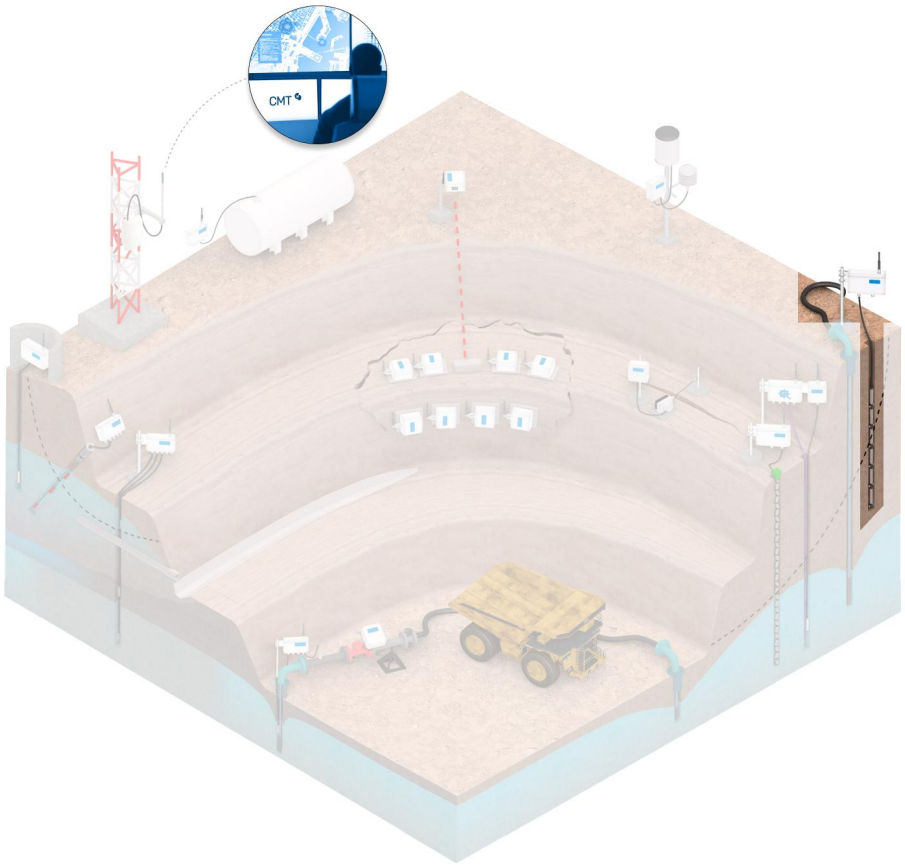
Edge device
Piconode



IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Precipitation, air temperature and other weather parameters

Sensor / Edge device
Rain gauge with thermistor connected to a Piconode or a weather transmitter connected to a Digital logger

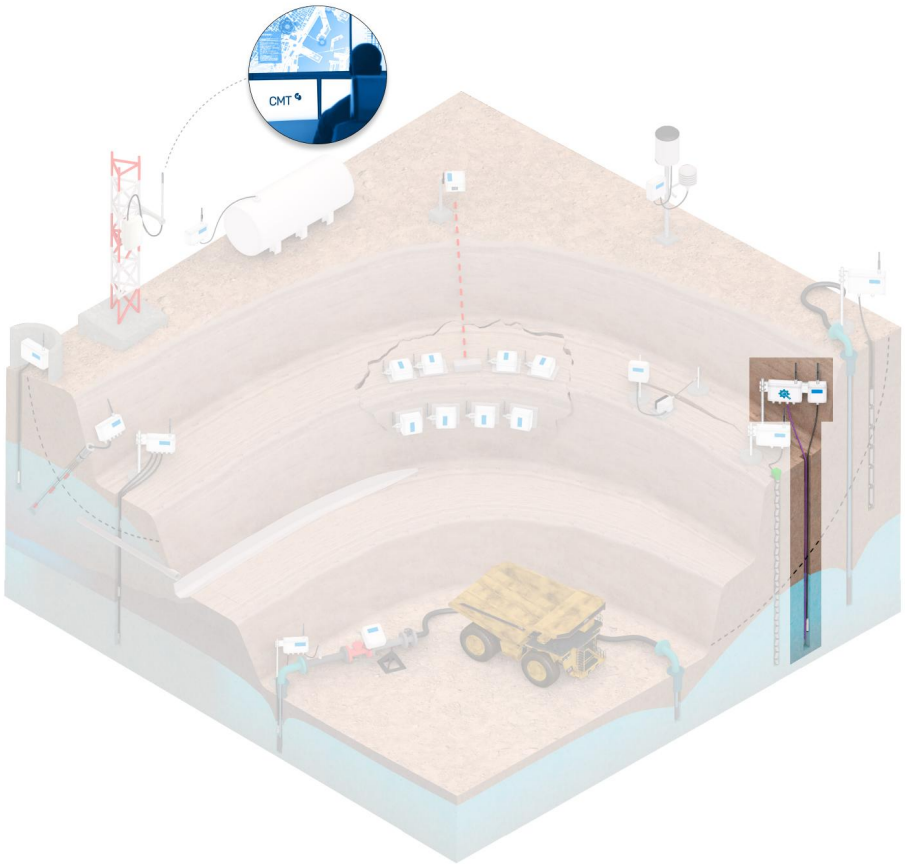


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Horizontal displacements

Sensor
In-place inclinometers

Edge device
Digital logger



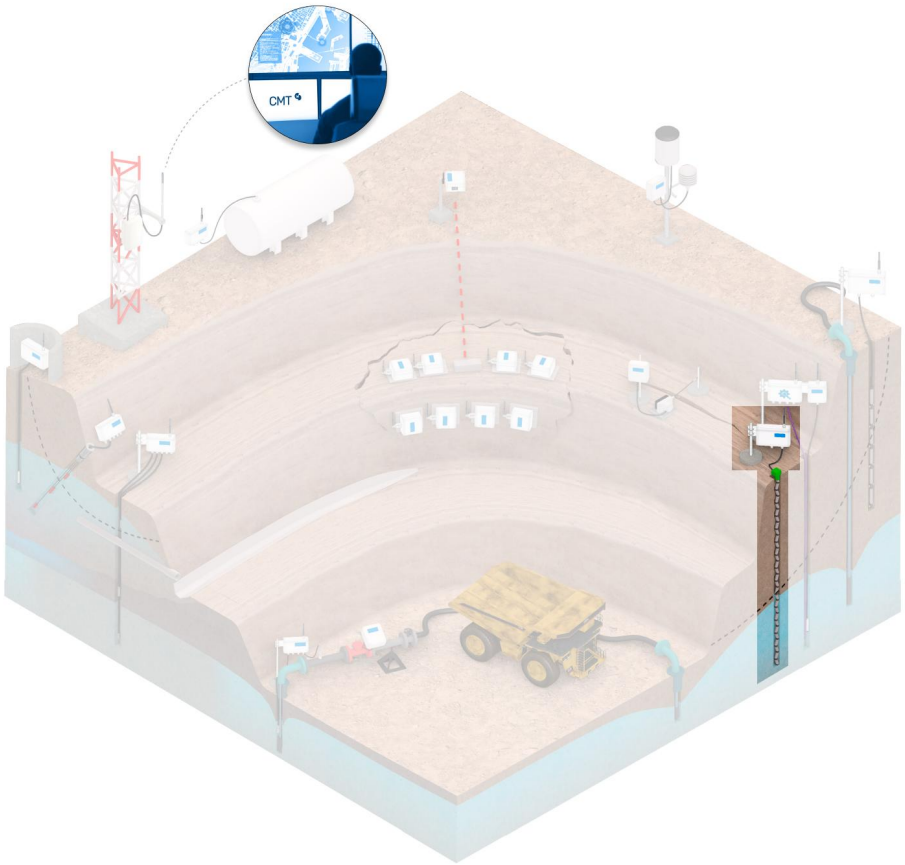
IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Pore water pressure

Sensor / Edge device
Piezometer connected to a vibrating wire 1-channel data logger

Monitoring need / Physical Parameter
Depth of a sliding surface

Sensor / Edge device
Coaxial cables and a Time-Domain Reflectometer (TDR) connected to an Analog data logger (contact Worldsensing for more details)

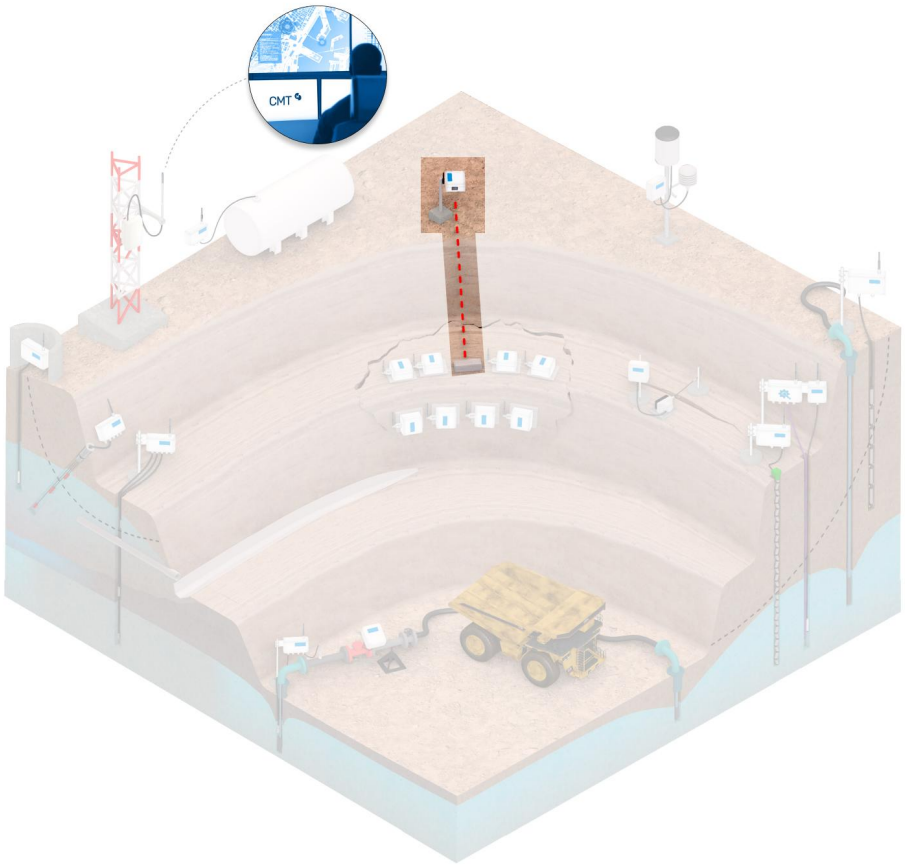


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Horizontal displacements

Sensor
ShapeArray

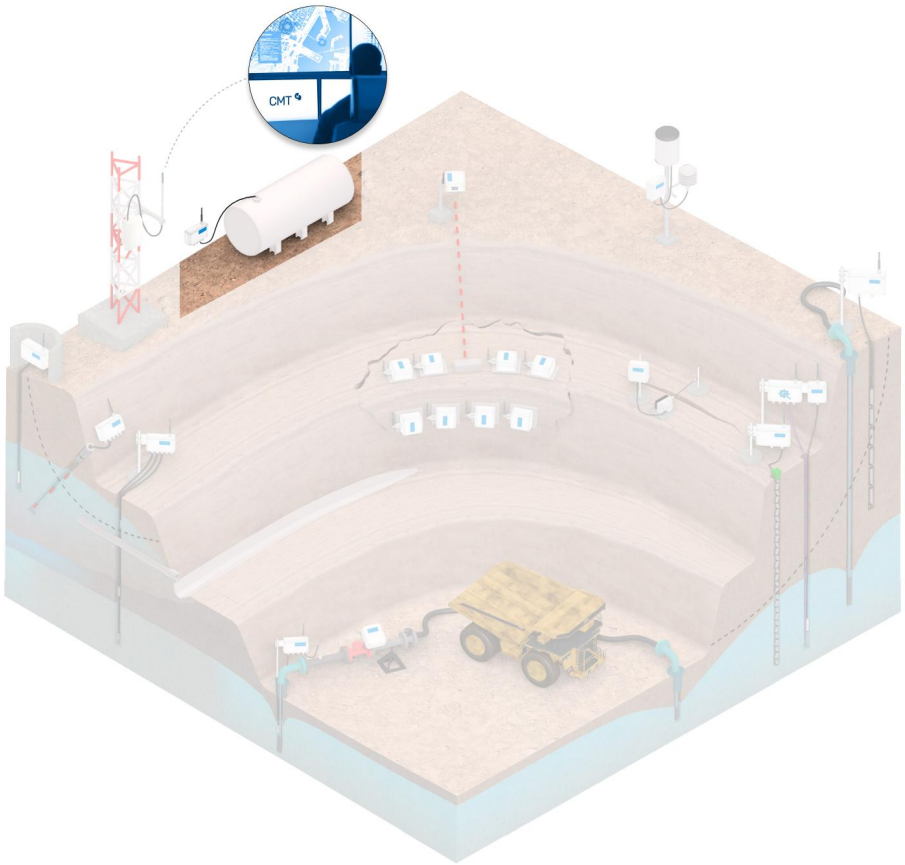
Edge device
Digital logger



IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Relative distance variation of the slopes

Sensor / Edge device
LaserTilt90, a 3-in-1 laser distance meter, inclinometer and data logger, pointing at a target surface

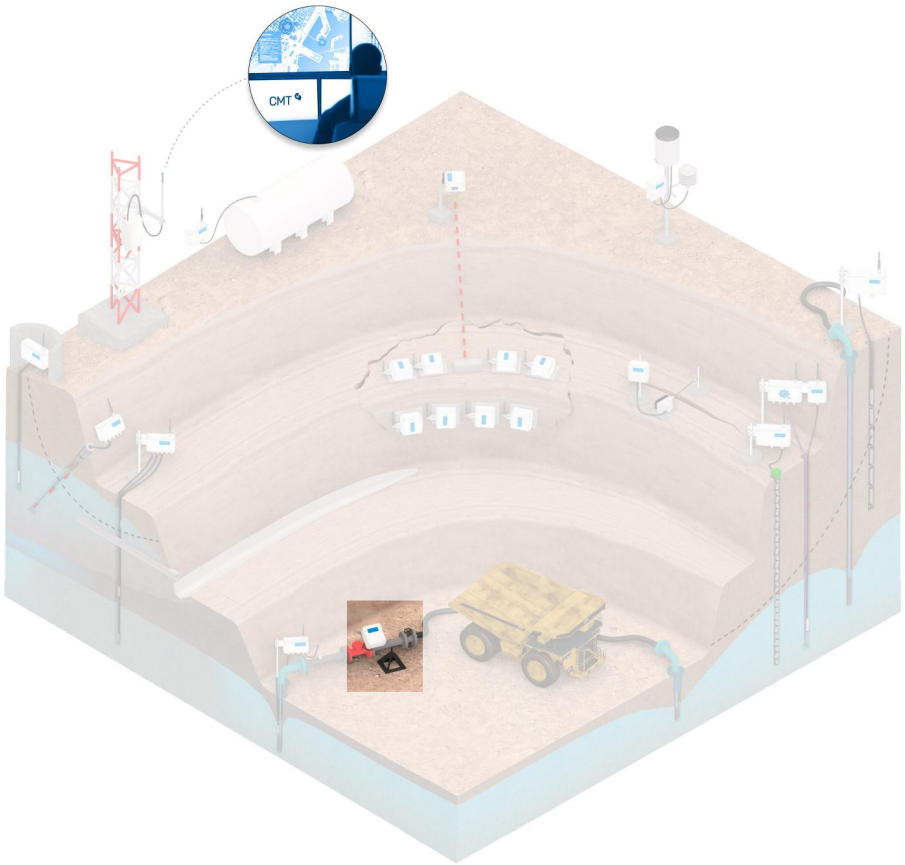


IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Diesel fuel levels

Sensor
Fuel tank level sensor

Edge device
Analog data logger



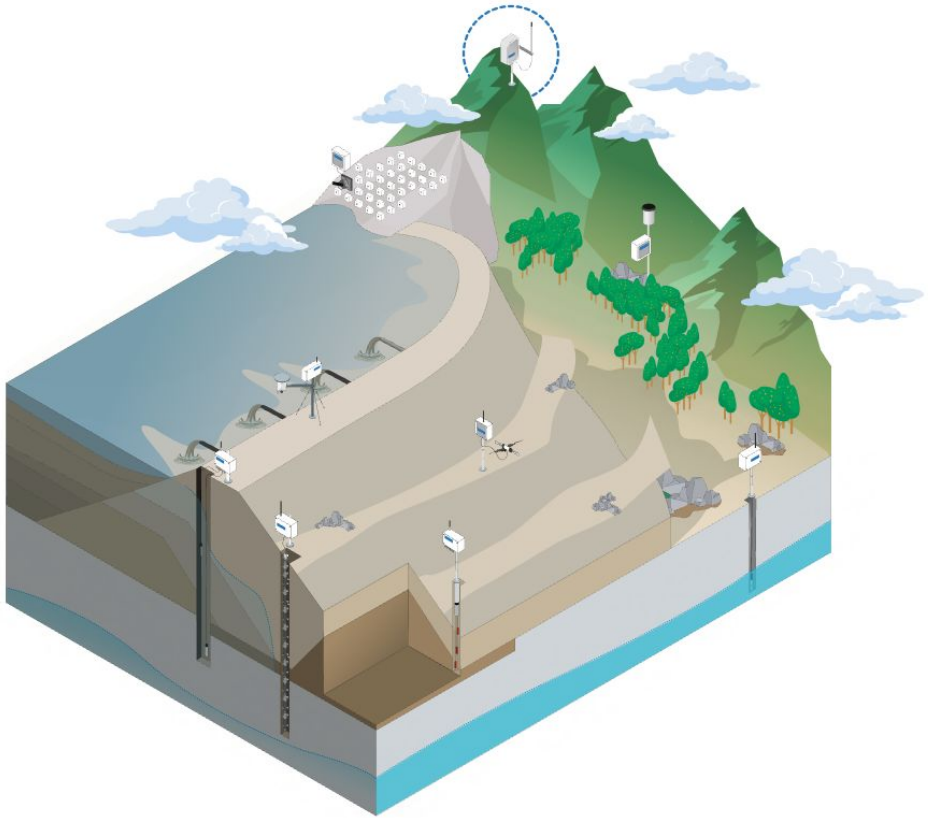
IoT Remote Monitoring in Open-pit Mines

Monitoring need / Physical Parameter
Pumping rate

Sensor
Water meter

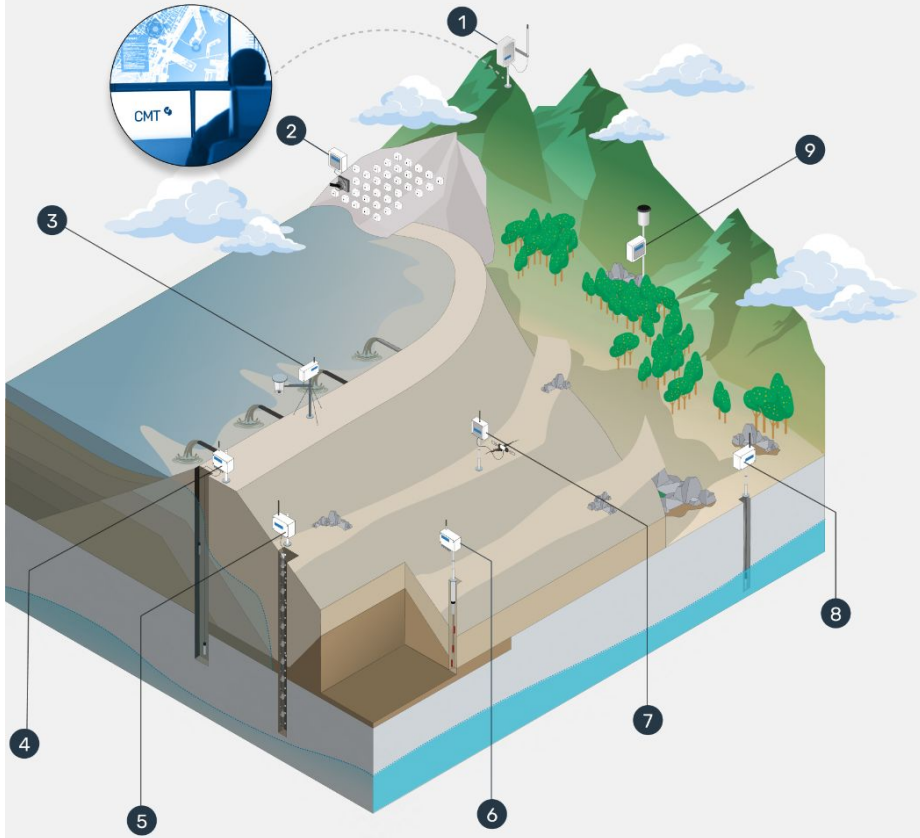
Edge device
Piconode

Vertical applications (II)

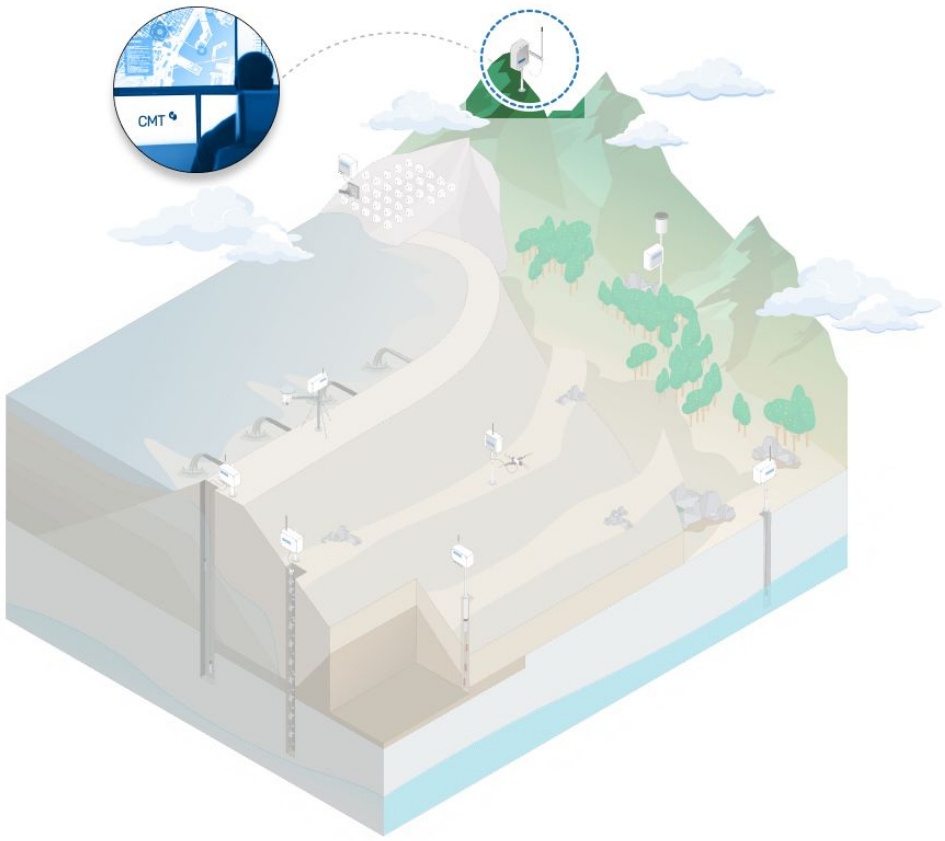


IoT Remote Monitoring in Tailings Dam

IoT Remote Monitoring in Tailings Dams



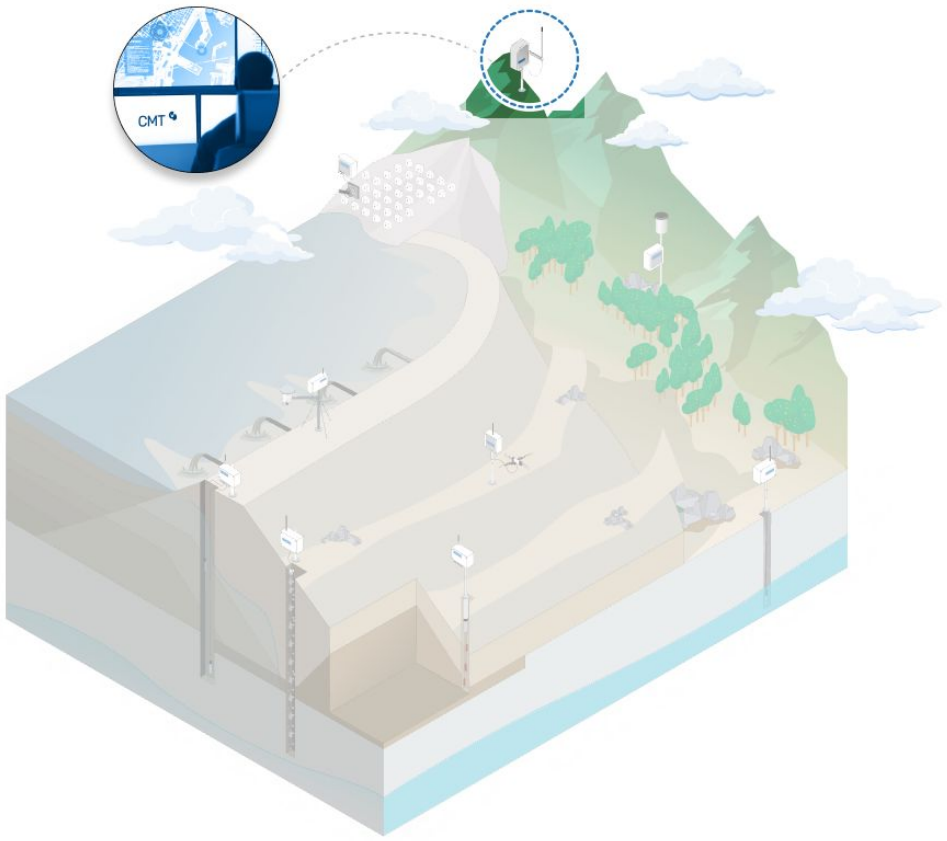
1. Remotely manage and monitor your network and all deployed devices either on-premise or through the cloud through a **gateway** sending data to the **Connectivity Management Tool (CMT)**. Integrate your data analytics software in CMT to create complete monitoring reports.
2. Monitor tension and the remaining load in anchorages with load cells connected to a **Piconode**.
3. Check water levels through an **analog data logger** connected to a water level meter.
4. Monitor pore pressure through piezometers in a borehole connected to a **vibrating wire 5-channel data logger**.
5. Assess horizontal displacements through in-place inclinometers or ShapeArrays connected to a **digital logger**.
6. Measure vertical deformation at various depths with a multi-point borehole extensometer (MPBX) connected to a **vibrating wire 5-channel data logger**.
7. Monitor movement across surface cracks with a crack meter connected to a **vibrating wire 1-channel data logger.**
8. Analyze the quality of the water with a water quality probe connected to a **digital logger**.
9. Measure rail fall with a rain gauge connected to a **Piconode**.



IoT Remote Monitoring in Tailings Dams

Connectivity Management Tool (CMT)

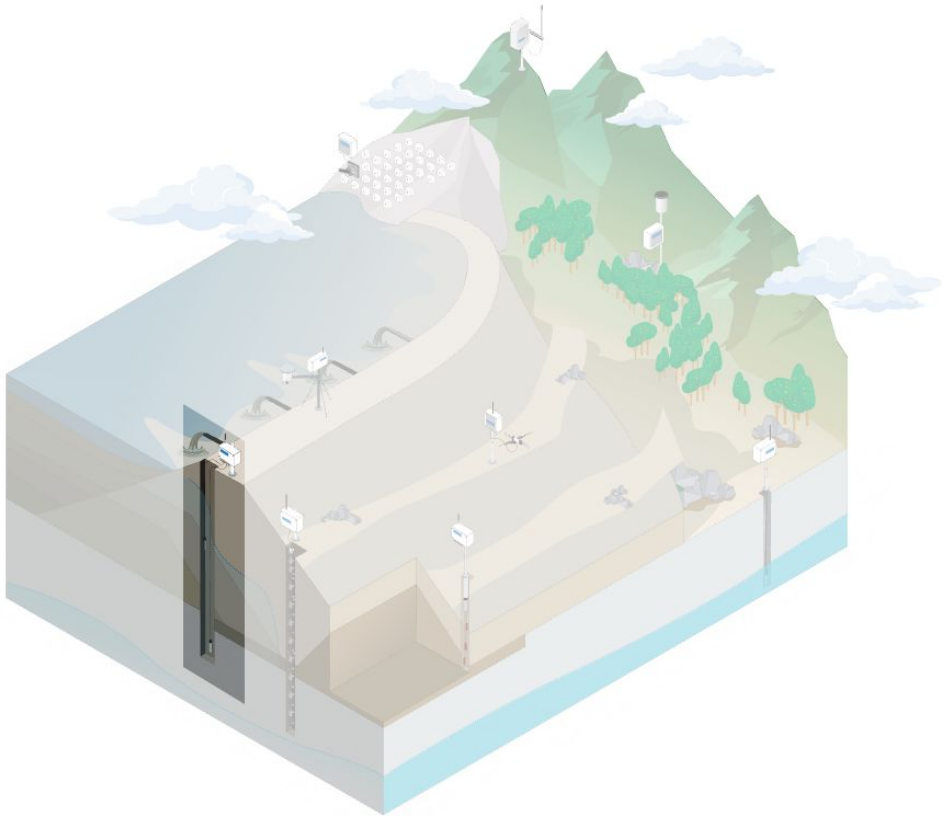
Remotely manage and monitor your network on-premise or in the cloud.



IoT Remote Monitoring in Tailings Dams

Connectivity Management Tool (CMT)

Integrate your data analytics software to create complete monitoring reports.



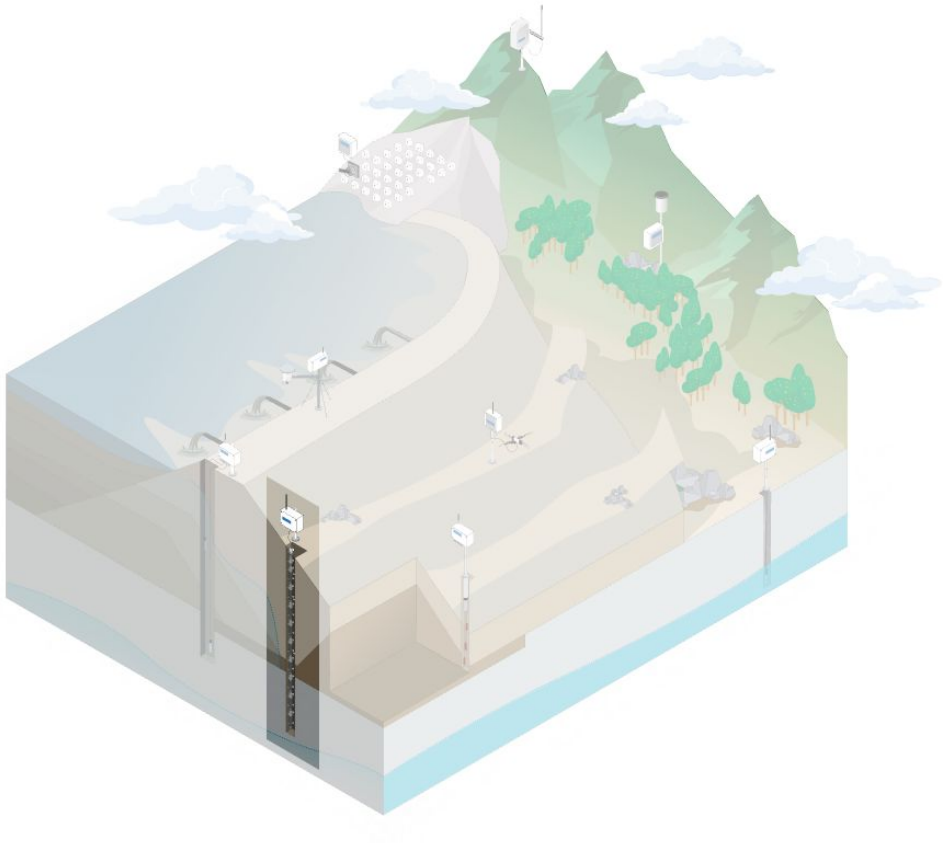
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Pore water pressure

Sensor
Piezometers in a borehole

Edge device
Vibrating wire 5-channel



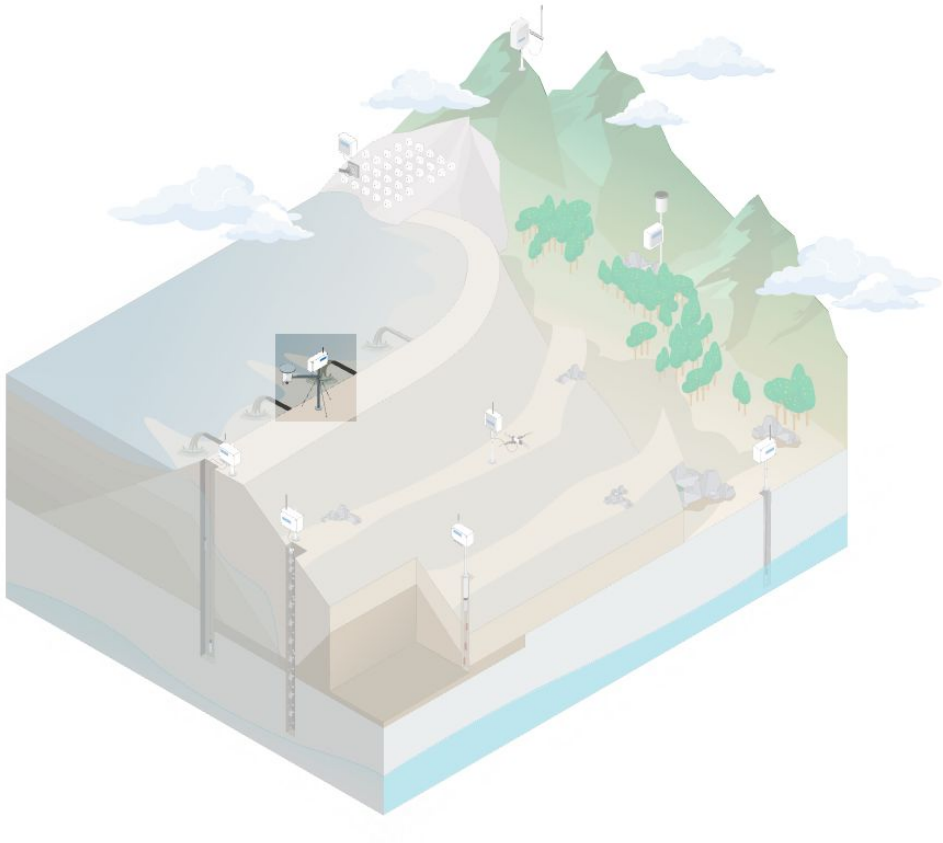
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Horizontal displacement

Sensor
In-place inclinometer (IPI)

Edge device
Digital logger



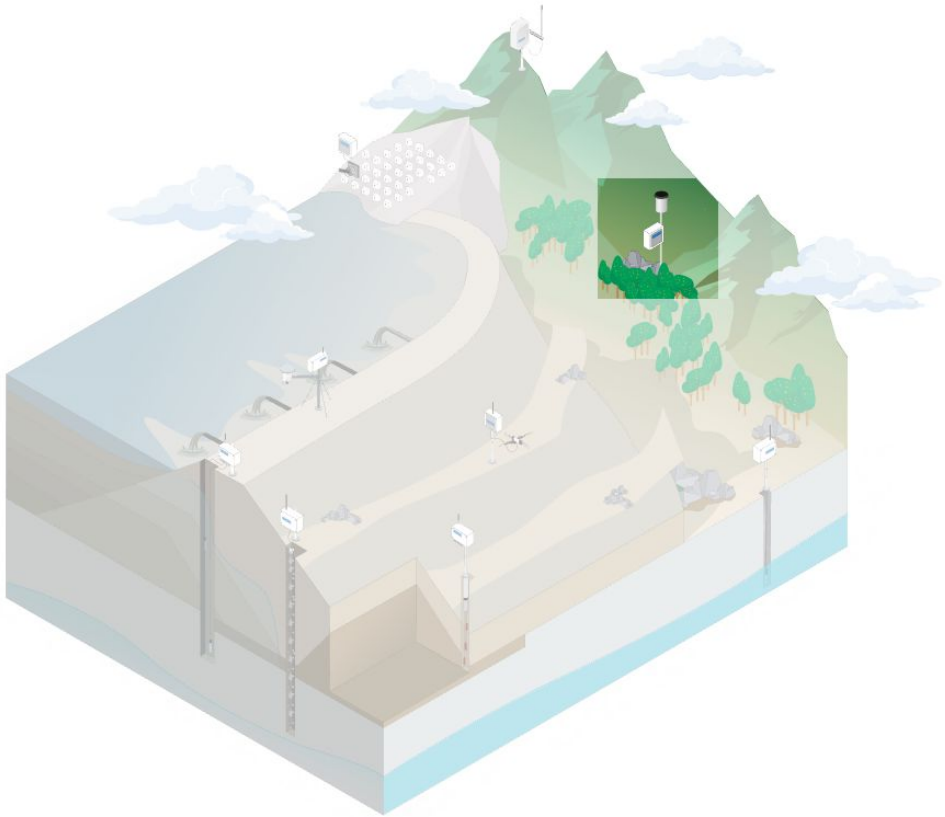
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Water level

Sensor
Water level meter

Edge device
Analog data logger



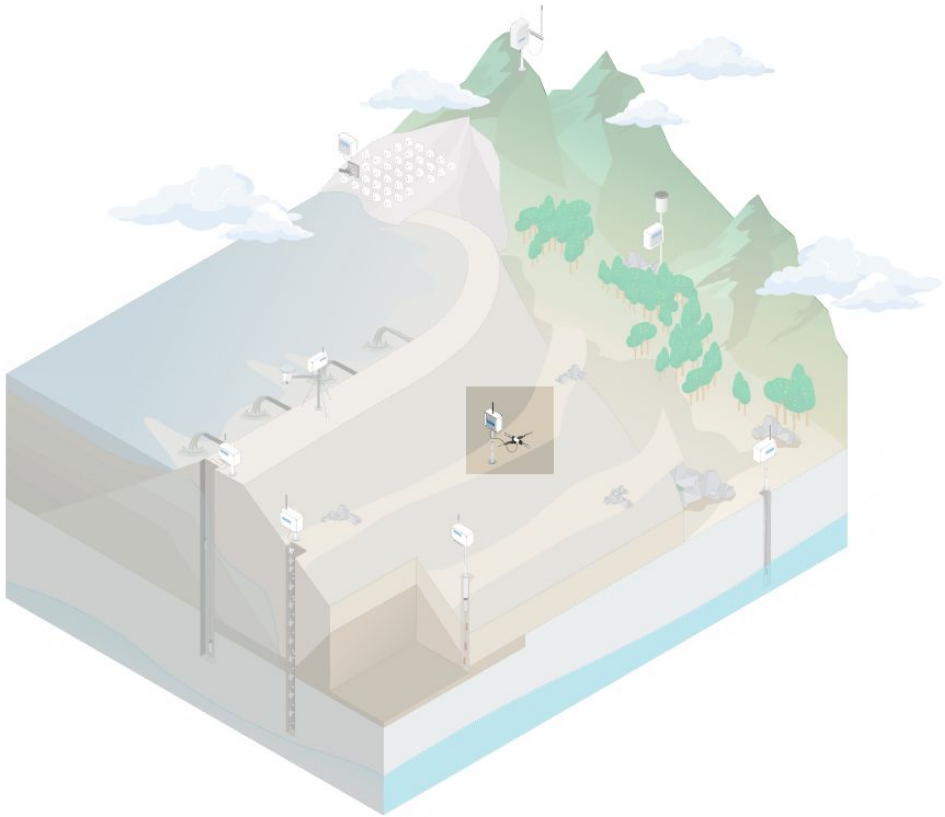
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Rainfall monitoring

Sensor
Rain gauge

Edge device
Piconode Analog 1 channel



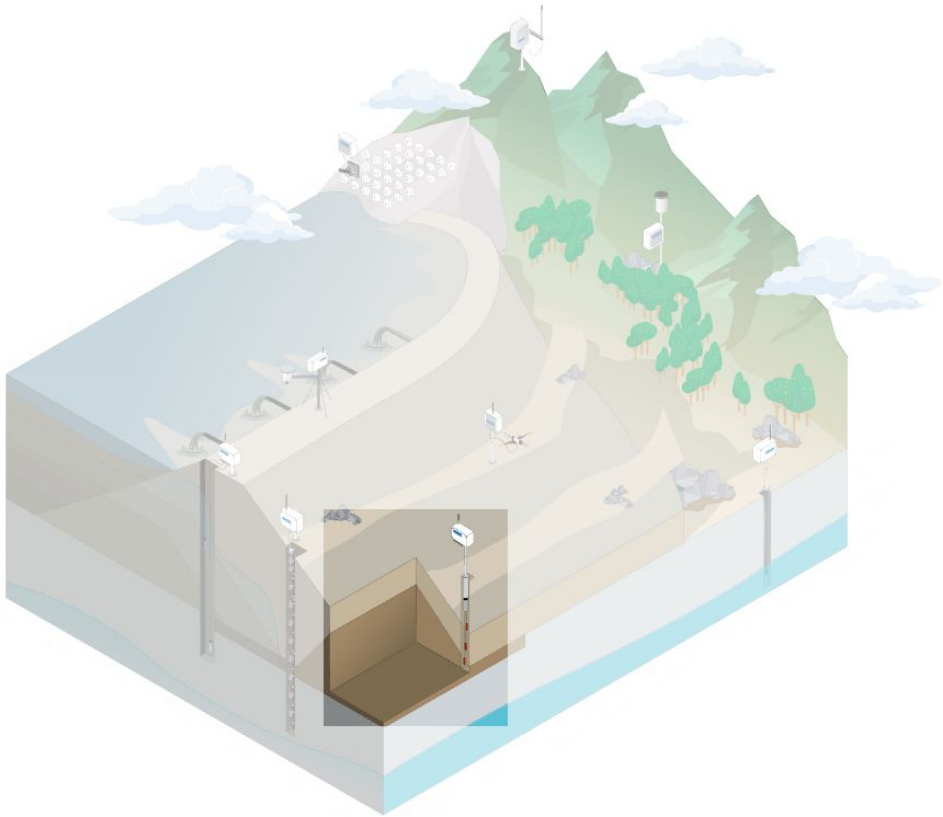
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Movement across surface cracks

Sensor
Crack meter

Edge device
Vibrating Wire 1 channel



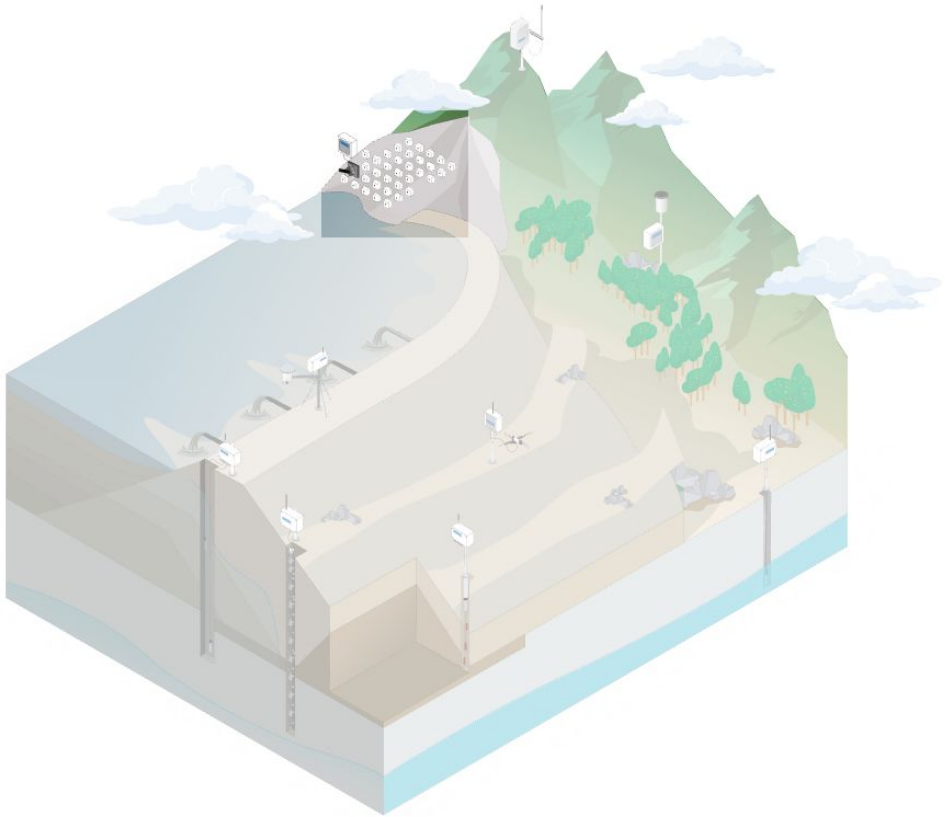
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Vertical deformation at various depths

Sensor
Multi-point borehole extensometer

Edge device
Vibrating wire 5-channel



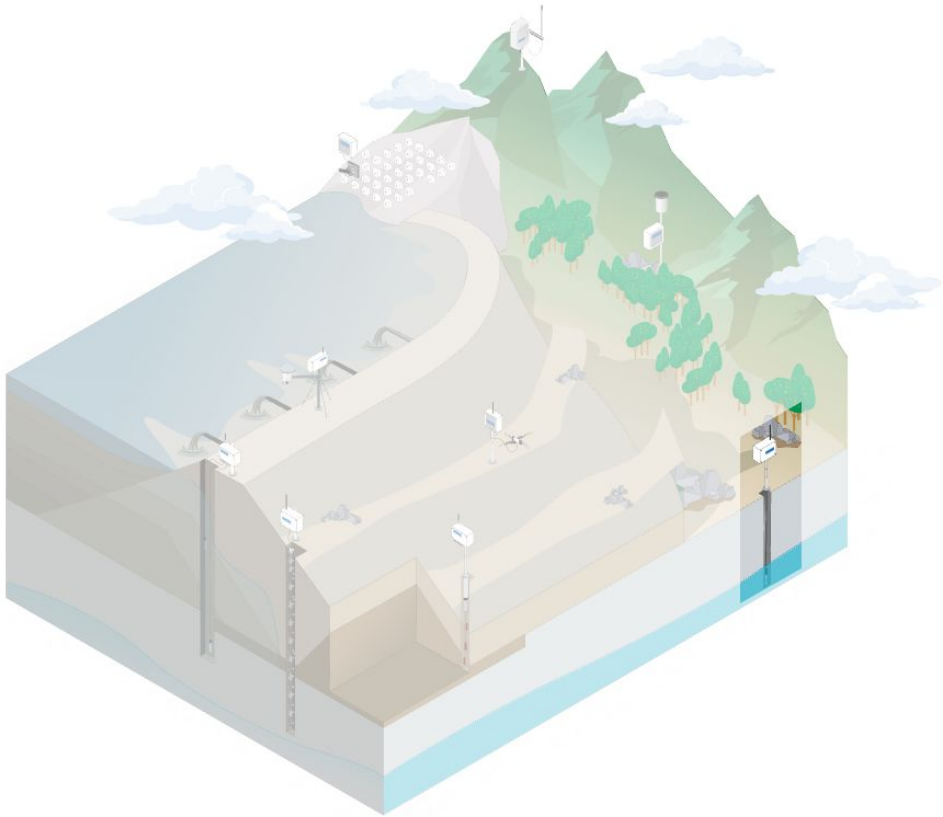
IoT Remote Monitoring in Tailings Dams

Monitoring need / Physical Parameter

Tension monitoring. Remaining load in the anchorages

Sensor
Load cells

Edge device
Piconode Analog 1 channel



IoT Remote Monitoring in Tailings Dams

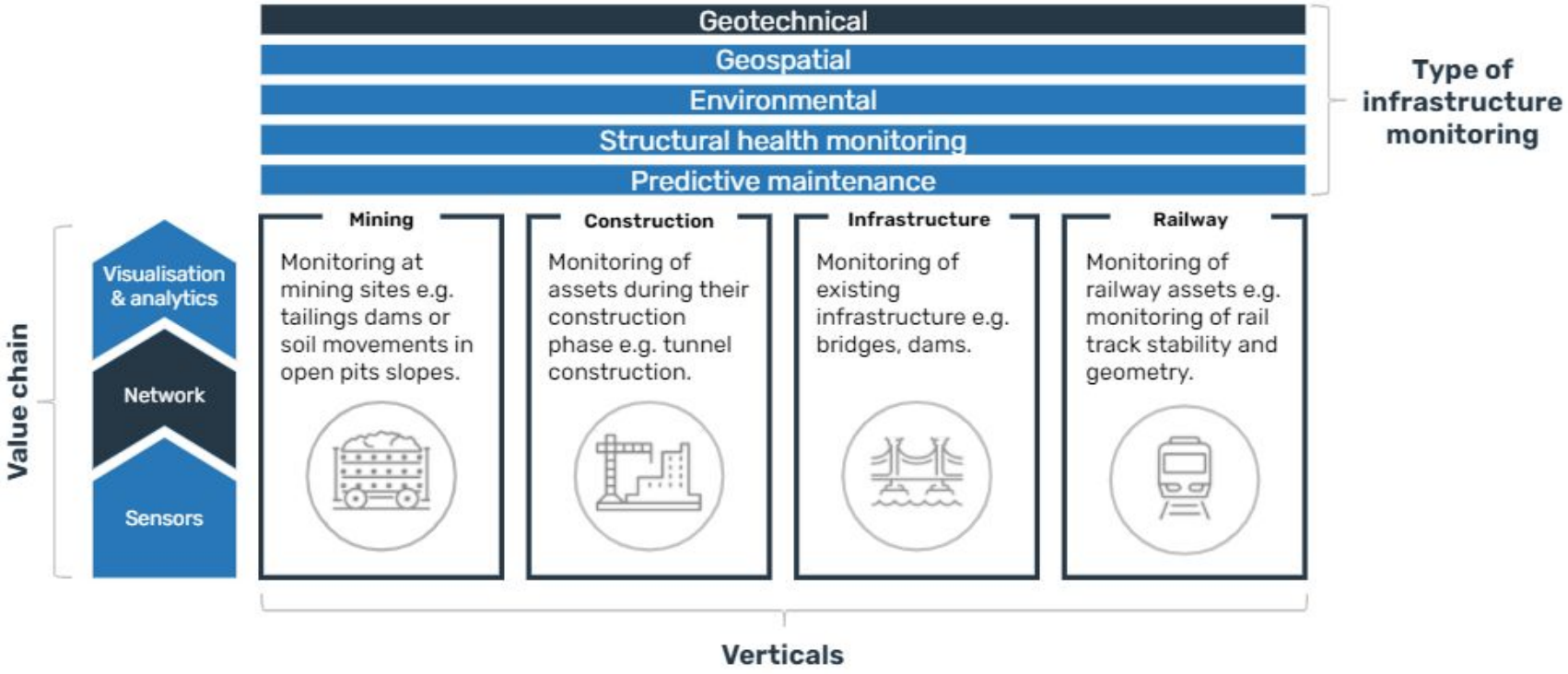
Monitoring need / Physical Parameter

Water quality monitoring

Sensor
Water quality probe

Edge device
Digital logger

Transversal applications



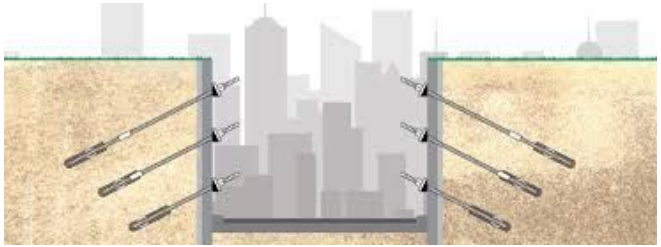
Geotechnical (I)

- ➔ The branch in civil engineering concerned with the engineering behavior of earth materials.
- ➔ It uses the principles and methods of soil mechanics and rock mechanics for the solution of engineering problems and the design of engineering works.

Keywords: **“earth materials”**

Geotechnical Project

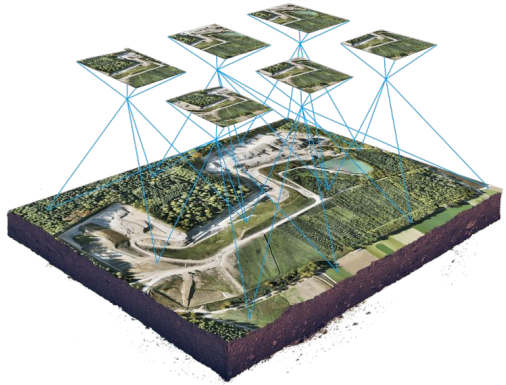
Project: Ground anchor monitoring.



Geospatial (II)

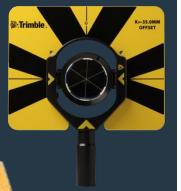
- ➔ This is the science and study of spatially-related information focusing on the collection, interpretation/analysis and presentation of the natural, built, social and economic environments.
- ➔ Geomatics is one of the fastest expanding global markets and a truly worldwide profession.

Keywords: **“spatial”**



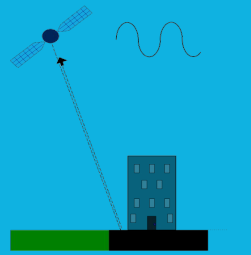
Geospatial

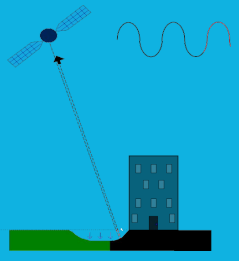
Total Station



Ground-based radar

Satellite InSAR



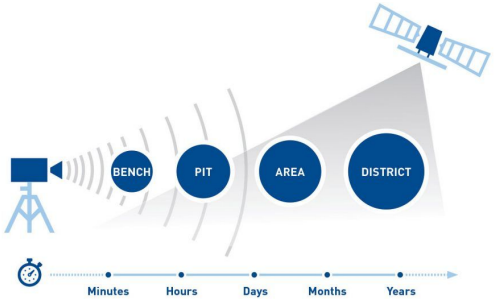


GNSS

Cameras*

Geospatial Project

Project: Rockfall monitoring

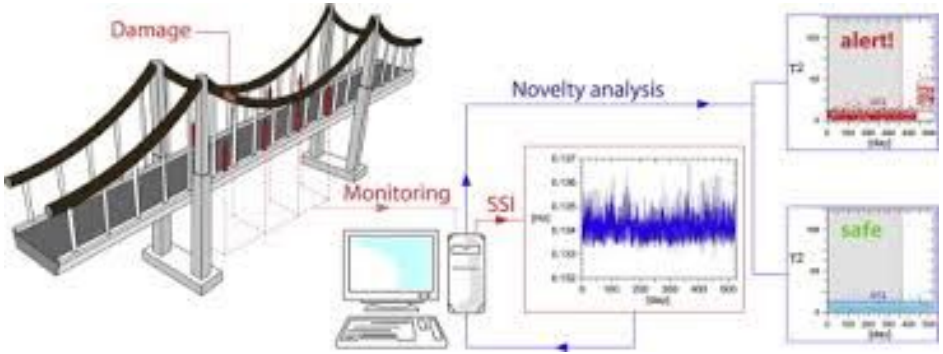


In geotechnical you would add a load cell to study the force while here you just detect the consequences of the forces.

Structural Health Monitoring (III)

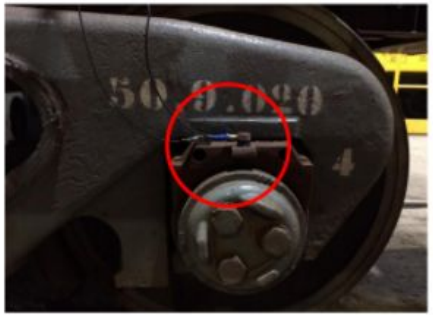
- ➔ SHM refers to the process of implementing a damage detection and characterization strategy for engineering structures such as bridges and buildings.
- ➔ Here damage is defined as changes to the material and/or geometric properties of a structural system, including changes to the boundary conditions and system connectivity, which adversely affect the system's performance.

Keywords: **“structure analysis”**

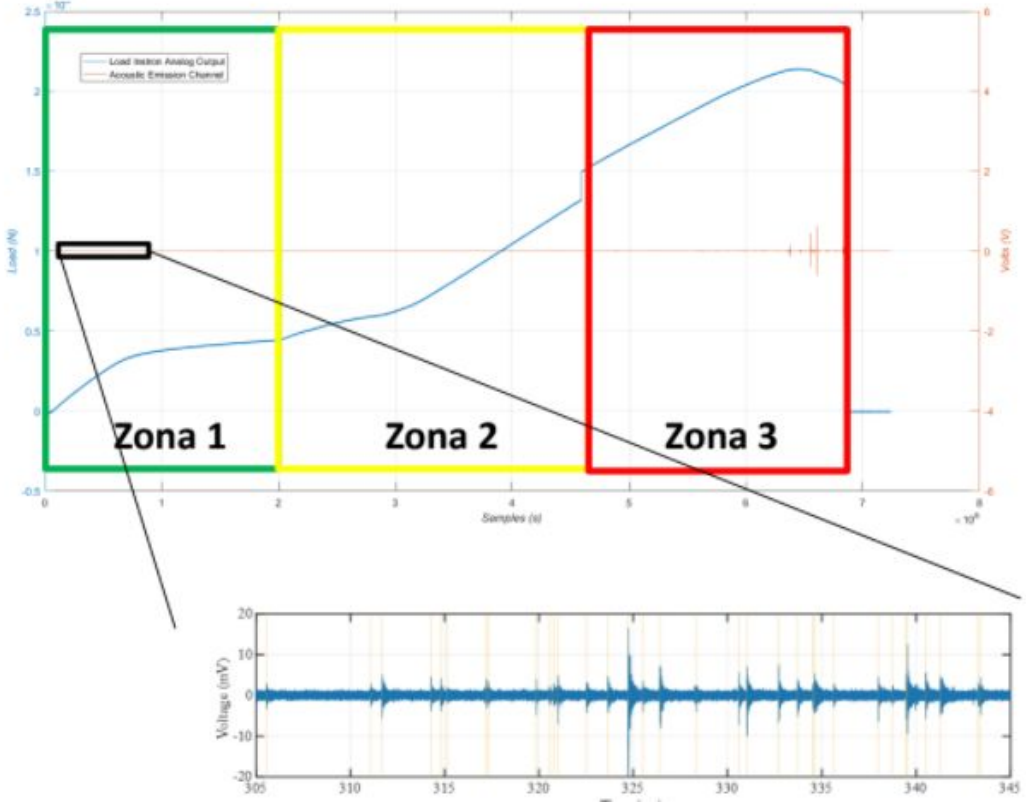


Structural Health Monitoring Project

Project: Anticipate a failure in the boogie of a FGC train



Structural Health Monitoring Project



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Summary

1. **Geotechnical** → "hearth material" → it very useful to understand and anticipate a potential problem in a physical infrastructure due to a chain-reaction where the health material is a key parameter (rock, send, etc.)

2. **Geospatial** → "spatial" → it is very useful to detect potential issues when they are already shown (vertical and/or horizontal displacement) or generate detailed mapping for construction

3. **Structural Health Monitoring** → "structure" → it is very useful to study structure and anticipate problem in a physical assets due to external/internal forces generation

Today’s agenda

01. What is IoT?

02. Needs for IoT

03. Applications

04. Innovations

05. Conclusion

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Conclusion

- IoT composed from three key elements (objects, communication, processing).
- Innovations in the three elements (special attention to communication).
- IoT as key driver for sustainability target.
- IoT used in different monitoring applications in mining (open pit and tailings dam) and transversally (geotechnical, geospatial and SHM)

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Thank you.

AMICOS

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Connecting matters