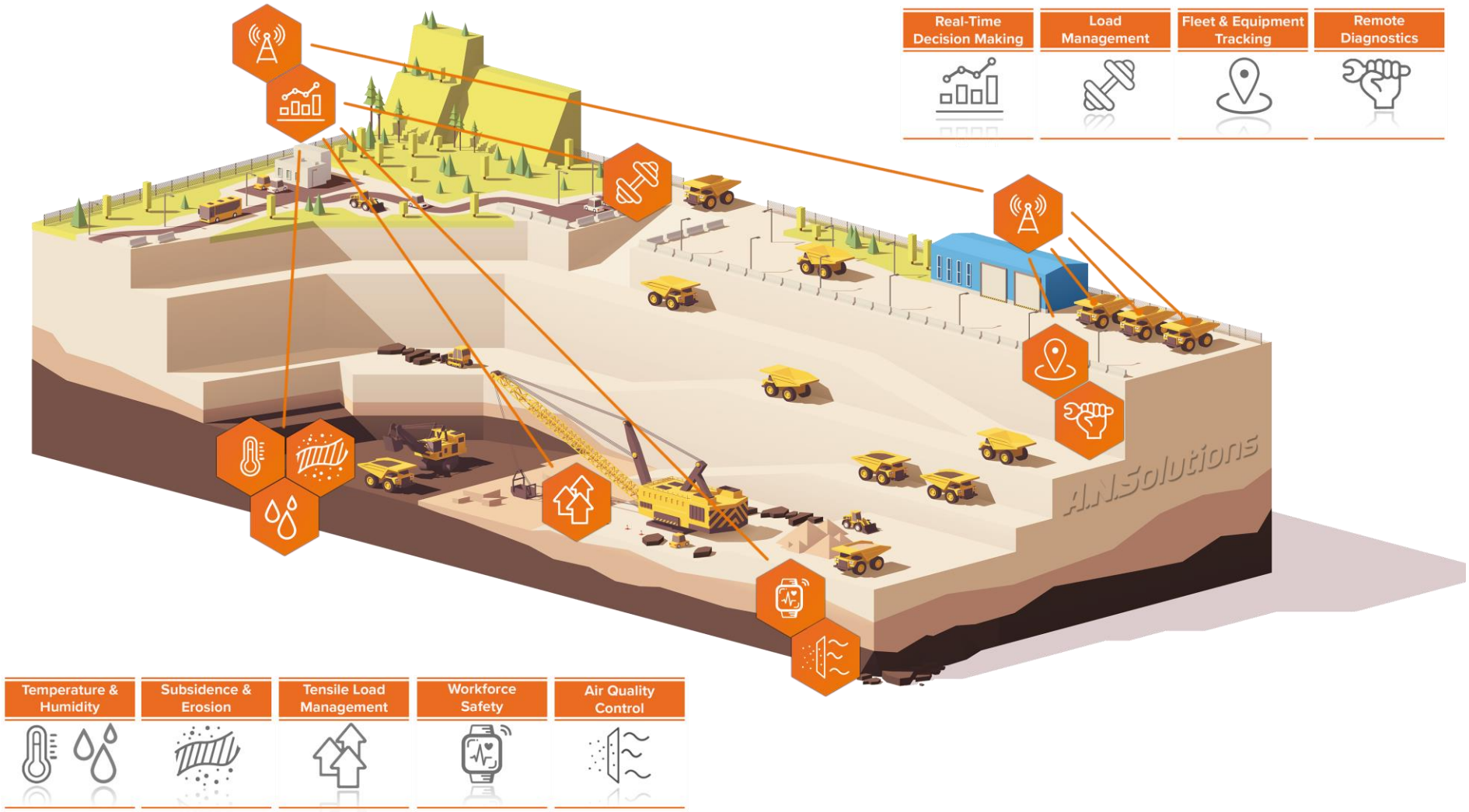

IoT Solutions for Mining

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Contents

Digitalization of Mines

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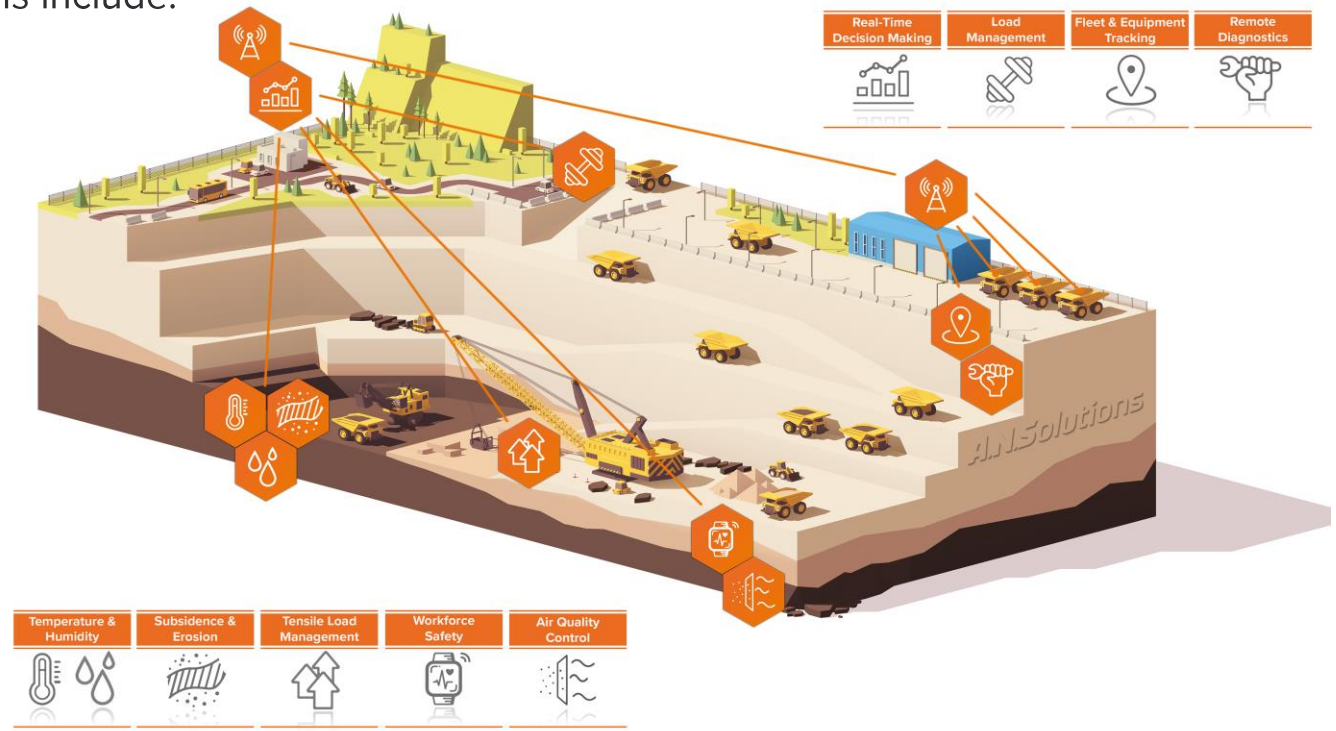
Modern mining operations require a real-time monitoring of various parameters in order to ensure workers' safety, and increase the efficiency and cut costs by optimizing the equipment use and work processes. Examples of monitored parameters and systems include:

- Worker's vital signs
- Temperature
- Humidity
- Methane gas concentration
- Volatile Organic Compounds (VOC) in the air
- Subsidence and soil erosion
- Dump truck load
- Tensile load
- Equipment and vehicle diagnostics
- Alarm and traffic control systems monitoring
- Remote battery management for EVs
- Wireless infrastructure for autonomous vehicles operation



Digitalization of Mines (Continued)

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Benefits of Wireless Sensor Networks (WSN)

- Easy placement in hard-to-reach places (where it's difficult to run cables)
- Flexibility: Easy to set up, remove or reposition.
- Scalability: More sensor nodes can be added to the existing network.
- Easy maintenance:
  - Nodes operate autonomously with battery of up to five years.
  - Over-the-Air (OTA) software updates and configuration.
- Integration with the legacy systems: WSNs can compliment the existing systems such as SCADA combining the sensor data.
- Secure Cloud connection: Valuable sensor data is uploaded to the Cloud for analysis, visualization and distribution to the responsible parties.

How Sensor Network Operates

- Wireless sensor nodes form a self-healing mesh network.
- Battery-powered nodes can work autonomously for up to 5 years.
- The nodes transfer sensor data to the gateway that uploads it securely to the cloud.
- Operator can send commands via gateway to individual nodes.

Smart Mining Challenges

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Whether underground or open-pit, a mine environment presents serious challenges to deploying wireless sensor networks:

- Difficult conditions for radio signal propagation
- Interference from the mining equipment
- Long distances
- Hard to reach locations for maintenance
- Hazardous environment
- Harsh operating conditions
- No GNSS signal underground.
- No common infrastructure for open-cast and underground.
- ATEX requirements.

IP 67

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ATEX

Important Design Considerations

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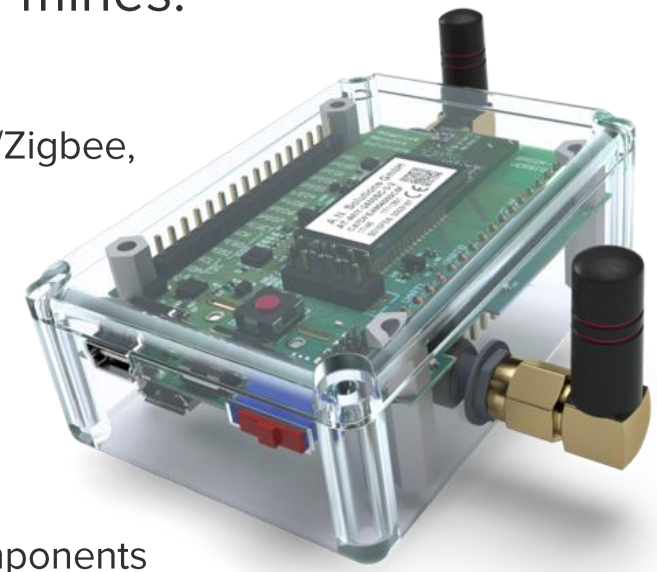
Key factors to address the challenges of WSN deployment in mines:

- Selecting the wireless technology that is just right
  - How to choose from dozens of wireless technologies and standards (IEEE 802.15.4/Zigbee, 6LowPAN, LoRa, UWB, etc.)?
  - Should you use Sub-1 GHz, 2.4 GHz or another frequency band?
  - How to future-proof your design?
- Antenna design is the key
  - How to choose the right antenna type for the task?
  - How can a custom chip antenna design improve the performance?
- Hardware platform
  - How to select the best-performing microcontroller, radio transceiver, and other components while keeping the BOM low?
  - What are the other selection criteria?
- Software fine-tuning
  - What is the role of software in the overall system's performance?
  - Embedded vs. networking software?



Use Case #1: Heavy Equipment Fleet Management

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Wireless connectivity allows to monitor in real-time:

- Equipment location
- Vehicle's health
- Daily usage
- Fuel consumption
- Emissions
- Load
- and more

Benefits

- Equipment usage optimization
- Remote diagnostics and preventive maintenance
- Operating cost reduction

Use Case #1: Heavy Equipment Fleet Management (Continued)

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Case in Point: Dump Truck Load Monitoring

Why is the dump truck load monitoring important?

- Helps avoid accidents due to overloads.
- Prevents road damage and resulting repair costs.
- Ensures compliance with the rules and fair competition.

Benefits

- Quick setup
- Flexible positioning
- Wireless transmitter sends the weight data directly to gateway/cloud

The most cost-effective solution for monitoring of dump truck load is a mobile wheel load scales with wireless connectivity.

Use Case #2: Ground Subsidence and Erosion Surveillance

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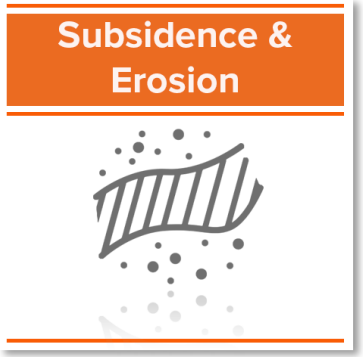
- Subsidence and soil erosion pose a significant safety risk to workers, equipment and buildings.
- 3D accelerometer/gyroscope sensors for low/high G allow to non-intrusively monitor the erosion and subsidence in real-time
- Additionally, the soil moisture sensors help determine when the soil moisture reaches certain thresholds, which may indicate shifts underground.
- Ground Penetrating Radar (GPR) is another noninvasive surveillance method.
- Connecting the sensors wirelessly allows automated data collection and 24/7 monitoring resulting in effective accident prevention.

Benefits

- Improved safety
- Accident prevention
- No need for manual inspections



Use Case #3: Explosion Prevention in Underground Mines

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- Explosions are the ever-present danger in underground mining. Ineffective ventilation may result in a buildup of exhaust from mining equipment, coal dust and other hazardous airborne particles. During dynamite blasting, the concentrated gases can ignite. Combustion of the suspended particles is another cause of explosion. Human toll can further increase due to the subsequent collapse of mine structures. Methane-gas explosions is a major cause of accidents in underground mining.
- Levels of fresh air and hazardous airborne particles must be monitored 24/7. Due to continuous drilling and changing configuration of drifts, wireless portable nodes are the best solution for effective monitoring.

Benefits

- Quick deployment of wireless nodes
- Accurate real-time surveillance
- Increased safety / Accident prevention

Building Reliable Wireless Solutions

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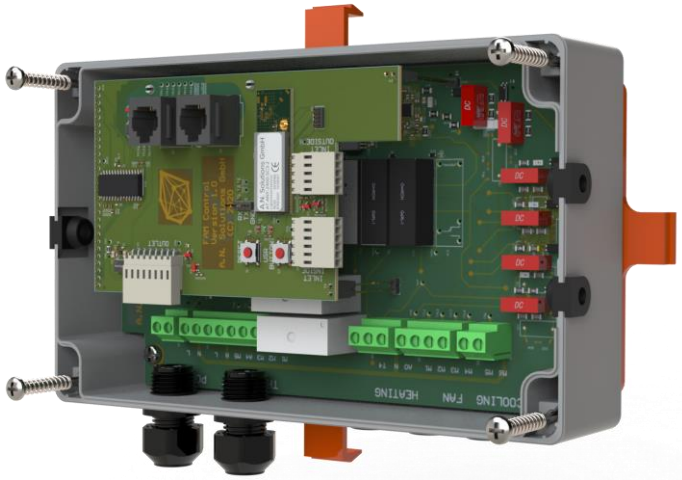
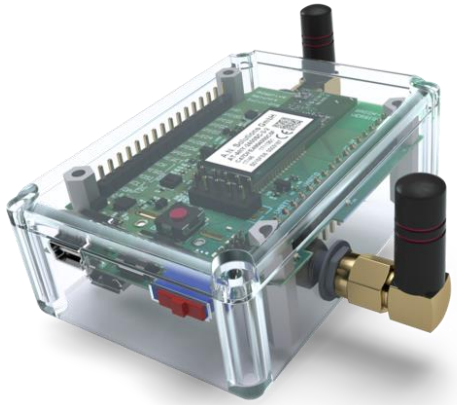
We have the expertise to improve your mining operations and build reliable wireless solutions for

- Integration of legacy systems with wireless sensor networks;
- Optimization of battery life, range vs. signal strength, and other important characteristics, according to the client's requirements;
- Software fine-tuning for a secure and efficient sensor data acquisition and storage;
- Advanced antenna design for reliable data transmission;
- Rapid product prototyping using 3D modeling;
- Safety and compliance certification assistance;
- and more.

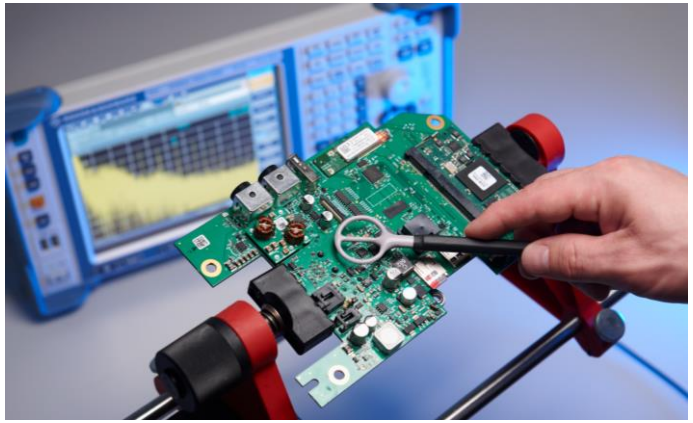


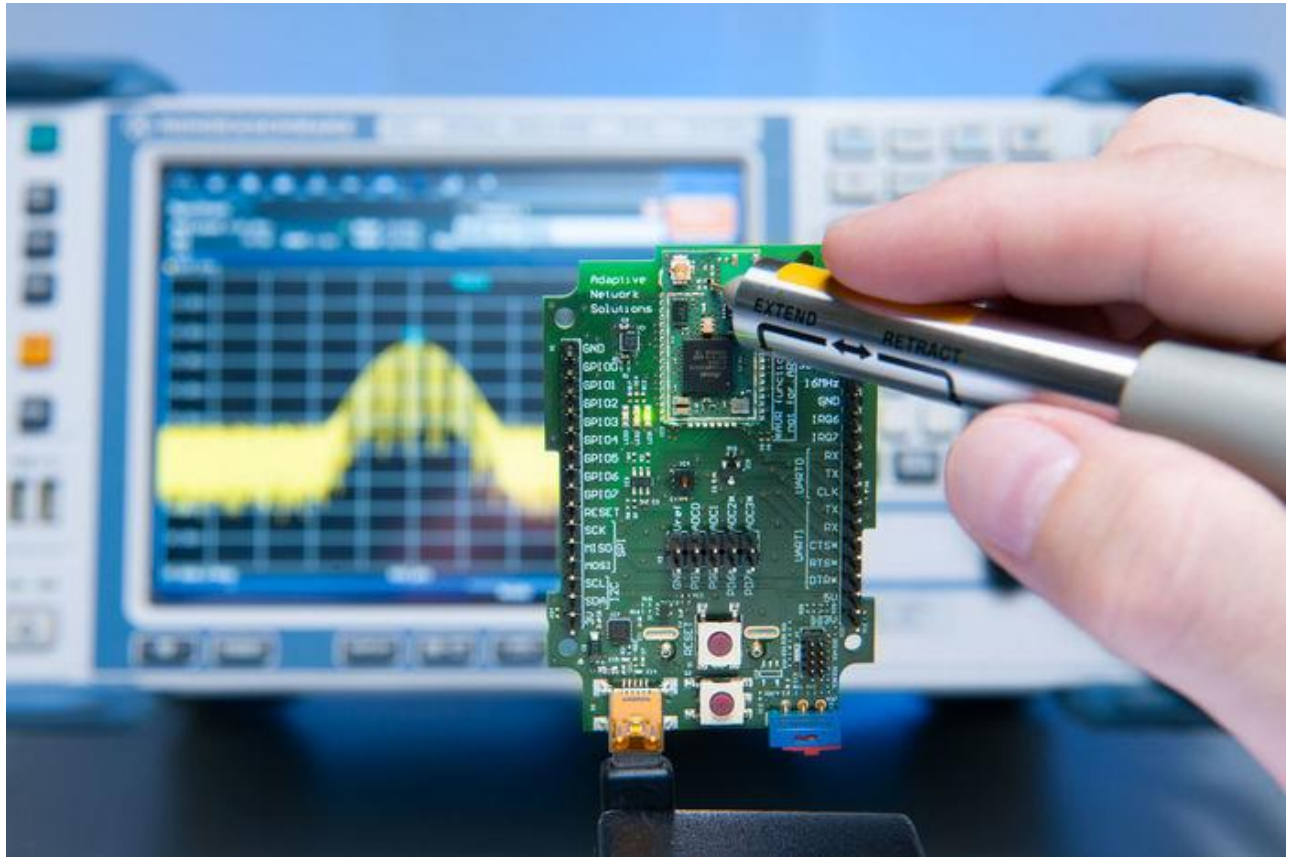


Partnering with Experts

A.N. Solutions offers many advantages for its clients and partners:

- In-depth expertise in all aspects of IoT solutions;
- Thorough understanding of wireless protocols and components in 169MHz up to 5.2GHz radio spectrum;
- Its own product line of rugged Sub-1 GHz and 2.4 GHz wireless components;
- ATEX-compliant solutions and designs capable of operating in the -85°C to 145°C temperature range exceeding standard IP67 requirements;
- Ecosystem of industry-leading vendors and service providers, incl. Bosch Sensortec, Microchip, Nordic, Qorvo, Sensirion, and more;
- A wide range of ready reference designs;
- Flexible engagement options and tech support packages;
- Uncompromising "Made in Germany" quality.





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THANK YOU!