



The *illuMINEation* project started in September 2020 and is a 3-year project funded by the European Commission. Nineteen partners are collaborating in order to develop bright concepts for a safe and sustainable digital mining future. With this newsletter, the interdisciplinary *illuMINEation* consortium provides a short summary of some important recent project activities.

INTELLIGENT ROCK BOLTS

FIRST SUCCESSFUL INSTALLATION TESTS

Our project partners RHI Magnesita and DSI Underground conducted the first-time installation of sensor bolt heads developed in the course of the *illuMINEation* project at the Breitenau underground mine.

Intelligent sensor bolt heads (add-on nuts) consist of various sensors, a microprocessor, a rechargeable battery, and a device for data transmission to a gateway.

This low-cost intelligent rock bolt assembly allows just-in-time recording and visualization of geotechnical and environmental measurands on a large-scale basis – an important milestone towards underground digitalization.

TOPIC 1
Intelligent Rock Bolts

TOPIC 2
First iteration of the
illuMINEation IIoT platform

TOPIC 3
First physical
Consortium Meeting

TOPIC 4
Mid-term report



The major focus of these first tests was put on handling and practicability, signal range (transmission capacities in underground environment), battery lifetime, and integration of the measurement series into the illuMINEation IIoT-Platform. All tasks have been successfully accomplished, with the next steps being updates to the systems based on the learnings of the installation tests, and further roll out to geotechnical data acquisition. Additionally, further tests in other use case partner mines are being planned.

FIRST ITERATION OF THE ILLUMINEATION IIOT PLATFORM

PROJECT REPORT

The first deployment of the illuMINEation platform is focusing on providing basic infrastructure and functionalities necessary for the project use cases. The platform itself is a distributed system that consists of several components on subsequent

layers reflecting mining infrastructure. Deployed components are enabling data to be streamed from sensors to upper layers, opening it up to various operations like transformation, processing or preparation for visualization. Tools and services that have been chosen for the platform are open-source and state of the art solutions.

The first layer is called the Edge and comprises of various sensors collecting data inside the mine (e.g. rock bolts, environmental sensors) and sending it, by utilising Gateways, to a collection unit called the Edge Box, where the initial time-aware and location-aware processing of the data is performed. Output of operations from multiple Edge Boxes is transferred to the next platform layer.

The second layer of the platform is called the Fog. It comprises of several deployments of the Fog instances, each representing local, individual mining operation. Emphasis of this layer is to extract, transform and persist all the sensor data and to provide Big Data and AI/ML

processing capabilities to run algorithms on data collected locally by the mine. Results of those operations, as well as raw data collected from the Edge, can then be send to the third and final layer of the platform.

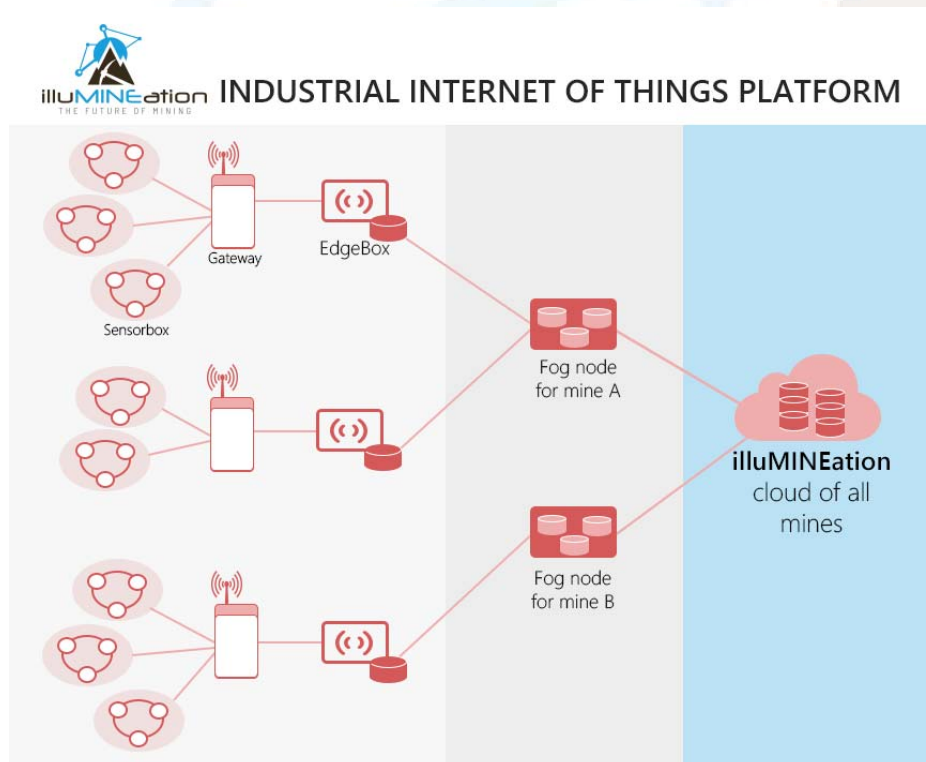


This layer is called the Cloud. It provides a single infrastructure that provides a set of global services to safely store and process data coming from a multitude of Fog instances (e.g. different mine sites of a company). It serves as a basis of creating scalable, real-time applications that utilise all the streaming data within the illuMINEation platform.

FIRST PHYSICAL CONSORTIUM MEETING

After more than 21 months since our project started and after having held numerous virtual meetings, tele- and video conferences, all our consortium partners were finally able to meet in real life during our first physical project consortium meeting in Leoben. The two-day event was organised by the project coordinator Montanuniversität Leoben and held on the 8th and 9th of June.

The two days were filled with exciting presentations, fruitful discussions and very productive workshop sessions. The project partners reflected on the achievements reached



so far and presented the first encouraging project results. Another focus of the meeting was the planning of the upcoming first major field test campaigns with our use case partners.

illuMINEation would not be what it is without its highly committed consortium partners and the fantastic work all the involved experts are contributing to the project. It was a very successful meeting and great to meet everyone face to face!

With this we want to thank all project partners for their great work and we are very much looking forward to the next project phase.

MID-TERM REPORT

SNAPSHOT OF ACHIEVEMENTS

The specific requirements for the IIoT platform were further refined by the industry use case partners (i.e. participating mining companies and equipment manufacturers), based

on the challenges they face in their respective operations. This use-case-driven-approach will maximize the usability and application of the new technologies developed by illuMINEation.



A thorough assessment of available sensor options for deployment in mining operations has been undertaken, on the one hand investigating available off-the-shelf low-cost sensors and, on the other, sensors linked to specific needs for a digital mine management system.

Sensors for rock stability monitoring are already under development and accompanying numerical simulations being performed. Atmospheric

measurement will be performed via two alternative sensor combinations. Data transfer will be maintained through LPWAN communication to specific gateways connected to the mine infrastructure (mostly WiFi). For the surface environmental monitoring, sensor combinations and evaluations have been developed based on low-cost sensors.

Autonomous drone use under harsh underground mining conditions is challenging. Appropriate sensor suites which could minimize the platform weight, maximize the flight-time and still provide accurate navigation and collision-free performance was initially investigated, incorporating LiDAR, various camera solutions, UWB, and different IMU sensors.

The application and integration of a drilling monitoring and evaluation system have been assessed. Data was analysed to develop required processing routines. A new approach is being developed to correlate rock structural condition with the response of drilling parameters. The



assessment of deviations in borehole paths is underway in order to define the distribution of stress in the rock mass when blasting.

In support of a sensor-based monitoring system for mining machinery, data loggers have been mounted on selected machines. This data is being combined with telematics and maintenance data, in order to develop algorithms for the prediction of remaining useful life of components and systems. Investigations are ongoing to define suitable parts

for additive manufacturing of machine spare parts. Evaluation criteria used are based on various aspects such as weight, size etc.

Comprehensive literature studies were performed on battery aging, focusing on newest scientific literature for large batteries, substantially increasing the knowledgebase in respect to functionality and behaviours. Analysis of battery data commenced and the concept for the estimation of capacity degradation developed.

The first iteration of a reliable, large-scale data-intensive and highly adaptable IIoT platform was built, capable to process data for various mining-related applications. A general concept for visualization integrated in the IIoT platform was developed. First example dashboards for time series, photos and videos were prepared. Investigations on visualization components for a digital twin system suitable for the IIoT platform commenced and initial considerations for the integration of VR and AR display devices were carried out.

Editorial

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Check out our project website and follow us on LinkedIn and Twitter to find out the latest news and stories from the project!



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