



The *illuMINEation* project started in September 2020 and is a 3 ½ - 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 important recent project activities.

SUCCESSFUL PROJECT COMPLETION

RESULTS & IMPACT

After 42 months of hard work, great team effort and fantastic collaboration, the *illuMINEation* consortium is pleased to announce the successful project completion in February 2024. The *illuMINEation* project significantly supports the digital transformation of the mining sector in many ways. Its impact is multi-faceted, encompassing safety improvements, environmental sustainability, talent attraction and industry collaboration. The mining industry is embracing the age of automation and digitalization, and *illuMINEation* is paving the way for a future where mining is not only efficient and environmentally sustainable, but also technologically advanced and socially accepted.

One of the key achievements of the project lies in its potential to support the implementation of digitalization initiatives in the mining sector. By utilizing Industrial Internet of Things (IIoT) technologies, *illuMINEation* provides a framework for the efficient management of mining activities to increase operational efficiency.

The project focused on the development of low TRL solutions that, among other things, help to reduce human involvement in hazardous mining operations. Consequently, the project results address safety concerns by minimizing the risks associated with mining activities, playing a crucial role in reducing accident rates and contributing to a safer working environment. This change not only makes mining safer for workers, but also increases the overall

TOPIC 1

Successful project completion

TOPIC 2

Installation of intelligent rock bolts achieved

TOPIC 3

Low-cost environmental monitoring devices

TOPIC 4

illuMINEation IIoT platform:
The Fog & Cloud layers

TOPIC 5

7th and final Consortium Meeting

reliability and credibility of the industry.

It is expected that the incorporation of IIoT into mining operations will lead to a significant reduction in negative environmental impacts. By optimizing processes and mineral resource extraction, illuMINEation paves the way for a more sustainable mining industry. The resulting increase in efficiency not only benefits the environment, but also has an economic impact and positions the mining sector as a responsible steward of natural resources.

The project has successfully contributed to increasing the level of automation in mining and challenging the perception of the industry as a traditional and resistant sector to radical innovation. By integrating IIoT technologies, illuMINEation has taken an important step towards a future where mining becomes a fully automated digital domain. This transformation not only increases efficiency, but also positions the mining sector in line with the progressive nature of other industries and makes it more attractive to stakeholders and investors.

The innovative use of advanced technologies is likely to attract new talent to the mining sector. By shedding its traditional image and adapting to modern industries through digitalization, mining will become an attractive field for people with expertise in information technology. The potential for collaboration with IT companies is significant as the sector opens its doors to technological integration and mutually beneficial partnerships.

In summary, the illuMINEation project has substantially contributed to reshaping the mining industry

through its innovative digitalization approaches. The results of the project promise not only to revolutionize mining, but also to promote sustainability, safety and technological progress.

INSTALLATION OF INTELLIGENT ROCK BOLTS ACHIEVED

USE CASE TESTING

In autumn last year, the project team of the Montanuniversitaet Leoben

has been to the Boliden Kristineberg mine to successfully install the first set of intelligent rock bolts developed in the project. A total of nine rock bolts have been installed in dedicated profiles of a new stope. The bolts comprise a sensor printed on their surface, and a data transmission unit (wired or wireless). This will allow for continuous monitoring of deformation of the bolts, ultimately leading to better understanding of the rock mass enabling improved mine designs in conjunction with the Safe Zone Concept also developed in illuMINEation.



LOW-COST ENVIRONMENTAL MONITORING DEVICES

USE CASE TESTING

The team of our project partner KGHM CUPRUM recently installed the latest version of low-cost environmental monitoring devices developed as part of illumination. The devices are located at the test site of the former "Babina" coal mine in southwestern Poland and wirelessly deliver sensor data to our project's IIoT platform. The water in these post-mining reservoirs is created by the flooding of the open pits and with our sensor solution, the water quality can be monitored accurately and continuously. The monitoring device is based on low cost, widely available sensors and development board (Arduino compatible). This

device measures physicochemical parameters of water (groundwater) and atmospheric air. Measurements are sent to the IIoT platform via the LoRaWAN network, where they can be visualized and processed.

ILLUMINATION IIoT PLATFORM

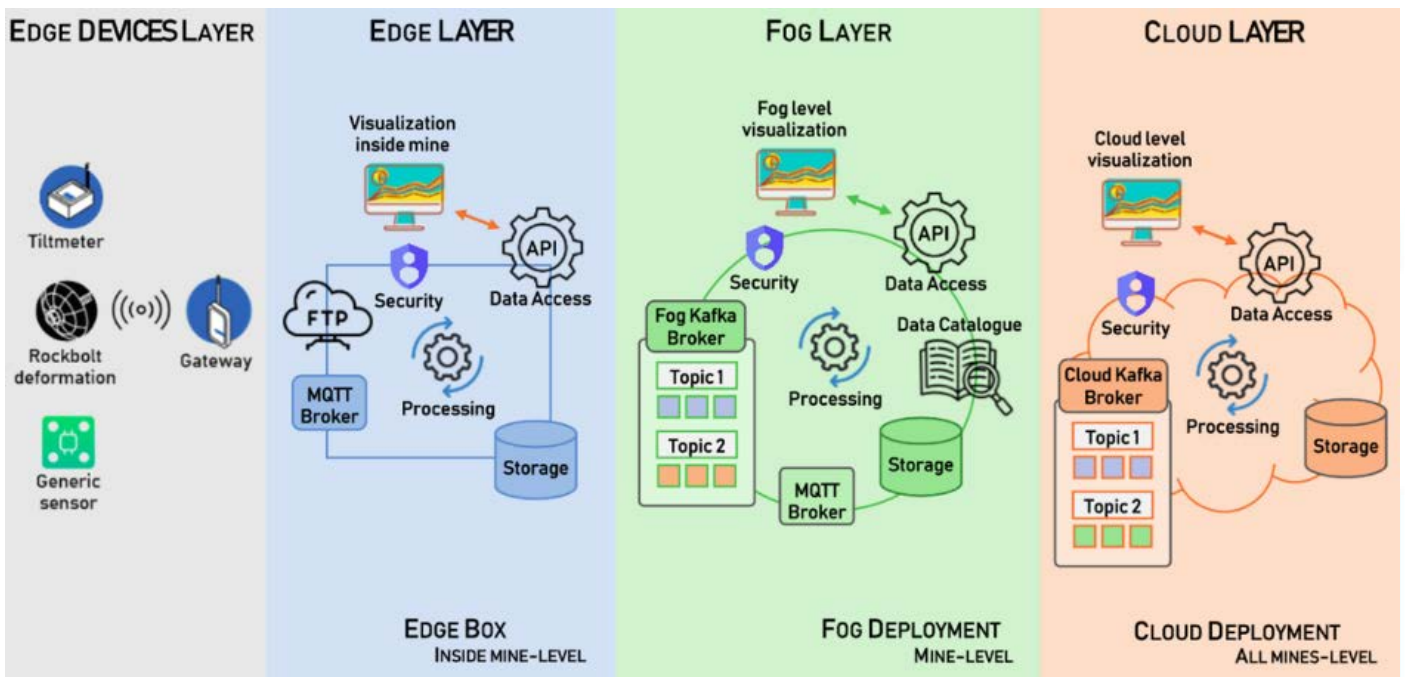
THE FOG & CLOUD LAYERS

In our last newsletter edition, we introduced the Edge Node of our multi-level platform solution. In this edition we present the two upper levels, the Fog and the Cloud Layers. The **Fog Layer** of the Industrial Internet of Things (IIoT) platform is considered at mine level. That is to say, a Fog Layer is established for each mine which provides a mine perspective, independent of other mining

operations within a larger mining corporation. Consequently, it is perfectly suited to provide mine-level aggregations and mine-site-specific KPIs and statistics.

Data delivered from the Edge Layer can be published to the Fog Layer through a standardized streaming mechanism. Subsequently, internal Fog processes are in charge of cleaning, filtering, processing, persisting and serving the data. For this purpose, a set of big data technologies are used to conform the solution. If required, the incoming data is forwarded to the Cloud Layer. In addition, a sophisticated API provides a set of useful functionalities like enabling data import into or discovery of persisted data within the Fog Layer. Moreover, a user interface to discover existing data structures is offered as well.





Finally, it is worth mentioning that due to the integration and utilisation of container technologies, the Fog Layer is flexible enough to deploy new ad-hoc developments to deal with use case specific requirements.

The main focus of the **Cloud Layer** of the Industrial Internet of Things (IIoT) platform is to provide highly available, performant and scalable storage, streaming and processing solutions for mining applications and algorithms. While the scope of the edge layer is to obtain and transfer the data acquired from a set of sensors and the Fog Layer focuses on

aggregating, storing and processing low-level data for a single mine site, the Cloud Layer on the other hand provides added value from data aggregated over multiple mining operations within a larger corporation. Ingression of data streams into the cloud is done through widely popular Apache Kafka. Data is being segmented into partitioned persistent collections, so-called topics. This approach allows application developers to create real time applications and functions operating directly on data streams powered by tools such as ksqlDB, Kafka Streams and Apache Flink, or to transfer the data into a

variety of other types of persistent storage using Kafka Connect, each depending on the specific use case: from relational databases, document stores to timeseries databases. All the components are hosted in a cloud solution utilising IaaS and PaaS paradigms. Discovery and connectivity between the components are realised through HashiCorp Consul technology. Applications are deployed using the OpenStack cloud computing platform and the RedHat OpenShift enterprise Kubernetes container platform.



7TH AND FINAL CONSORTIUM MEETING

WROCLAW, POLAND

In early-January, the project team members met for the 7th and final illuMINEation consortium meeting in

Wrocław, Poland, kindly co-organised and hosted by our colleagues from KGHM Cuprum and KGHM Polska Miedź. During the meeting, the partners presented the many great achievements that were made during the 42 months. The meeting also focussed on

Dissemination and Exploitation of the project developments and results, as well as on the final reporting and project closure. As part of the Consortium Meeting, the participants were able to make an underground visit to KGHM Polska Miedź S.A.





illuMINEation

THE FUTURE OF MINING

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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