

39th APCOM Conference:
MINING GOES DIGITAL
Wrocław, 3rd-7th of June 2019

Program



Welcoming address

The abbreviation "APCOM" stands for "Applications for Computers and Operations Research in the Minerals Industry". When the conference started in 1964, it was an informal meeting of scientists from different universities in the USA together with the "Society of Mining Engineers" (SME) of the United States. During the years the APCOM conference was performed in a mostly bi-annual rhythm. Up to today APCOM maintained its original logo formed around a punch card clearly remembering the historic origin of the conference from the times prior to the revolution caused by the era of semiconductors.

In the beginning, APCOM focused on the optimization of geostatistics and resource estimation and a number of methods used in these fields were initially presented and discussed on APCOM conferences. This field still today is an important part of any APCOM. During the years, information technology has dramatically developed, new algorithmic methods evolved and the entire fields of electronic communication, machine automation, autonomous machines and process optimization developed. Consequently, today, APCOM is much more than a meeting of specialists in geostatistics and resource estimation: The APCOM has expanded to a conference covering all kinds of Information and Communication Technology in the mineral industry: Already in 2005 on the conference in Tuscon/AZ, the term "Mining Process Optimization" was presented as the next paradigm shift in mining after mechanization and automation, which marked another example of the continued innovative impact of the APCOM. Well ahead of the current discussions about "Digital Transformation".

In this tradition the 39th APCOM 2019 is performed in Wrocław (Poland), a town with innovative tradition from the early times of industrialization when the town was German Breslau. A few examples can only give a glimpse of the importance of the town's historic industrial and academic achievements:

- 10 Nobel prize winners (out of 102 Germans) were born or working in Breslau.
- The first publicly owned electric power station in Germany went in operation in 1882.
- Electric public trams were introduced 1892.
- The world's biggest free span concrete hall ("Jahrhunderthalle" - "Hala Stulecia") was built in 1912 (it is an Unesco world cultural heritage site today).
- Diesel electric fast trains "Flying Silesian" featuring a top speed of 205 km/h were developed 1935 at Linke-Hoffmann Werke in Breslau, running abt. 500 km Berlin-Bytom (Beuthen) in 4 hrs 17 min!

Today Wrocław again is a leading innovation hub in Middle-Eastern Europe hosting the internationally highly acknowledged Wrocław University of Technology. A large number of big and small innovative companies are active not only in the area of Information and Communication Technology, but also in Chemistry, Biotechnology and Engineering. World known names like Google, Nokia, IBM, Bombardier or Volvo Buses are just few examples. Also KGHM as a world leading copper producer operates a research center in the city. In this tradition the 39th APCOM conference titled "Mining Goes Digital" presents innovative IT related papers from Resource estimation and geostatistics, Mine Planning, Robotics, equipment automation, autonomous guidance and many other integrative aspects of digital transformation in the minerals industry. A few papers also provide inputs from other industries into the mining community to create potential synergies. This evolution of the APCOM from its origins in resource estimation to a general mining IT related conference also emphasizes the importance of a holistic view on the optimization of the overall mining operations from the resource to the preparation plant in the era of digital transformation.

In this view, the APCOM conference in Wrocław also marks a change in the appearance of the conference logo: The original APCOM logo was changed slightly: The attentive reader may have observed that the original punchcard was exchanged by a more up-to-date symbolic PCB layout and an upgraded font set. So the APCOM can be recognized as "the" leading international event for Information Technology in mining for many years to come.

Dr. Christoph Mueller
Chairman of the 39th APCOM 2019

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AGH

General Program



03.06.2019, Monday

- 10:00-16:00** IREDES Workshops
IBIS Styles Hotel, Conference level 1st floor
- 17:00-20:00** Pre-registration and welcoming reception
IBIS Styles hotel, Conference level 1st floor

04.06.2019 Conference Day 1, Tuesday

Congress Center of Wrocław University of Science and Technology (WUST)

- from 8:00** Registration
- 09:00-10:30** Opening Plenary
- 10:30-11:00** Coffee break
- 11:00-13:00** Technical sessions
- 13:00-14:00** Lunch
- 14:00-15:30** Technical sessions
- 15:30-16:00** Coffee break
- 16:00-17:30** Technical sessions

Partner Program:

- 10:00-16:00** Historic town walk and Odra River cruise (start: place: Congress Center of WUST)

Social Event:

- 20:00-23:00** Official Conference Dinner (separate Ticket)
IBIS Styles Hotel, Conference level 1st floor

05.06.2019 Conference Day 2, Wednesday

Congress Center of Wrocław University of Science and Technology (WUST)

- from 8:30** Registration
- 09:00-10:30** Plenary Session
- 10:30-11:00** Coffee break
- 11:00-13:00** Technical sessions
- 13:00-14:00** Lunch
- 14:00-15:30** Technical sessions
- 15:30-16:00** Coffee break
- 16:00-17:30** Technical sessions

Partner Program:

- 09:00-16:00** Tour of Lower Silesia
In front of the IBIS Styles Hotel

Social Event:

- 20:00-23:00** Casual Conference Barbecue (incl. in conference price)
Letnia, ZOO Wrocław, Service Entrance on Zoo Tram Station

06.06.2019 Conference Day 3, Thursday

Congress Center of Wrocław University of Science and Technology (WUST)

- from 8:30** Registration
- 09:00-10:30** Plenary Session
- 10:30-11:00** Coffee break
- 11:00-13:00** Technical sessions
- 13:00-14:00** Lunch
- 14:00-15:30** Technical sessions
- 15:30-16:00** Coffee break
- 16:00-17:00** Journalist summary of the APCOM 2019 and panel discussion
- 17:00-17:15** Presentation of the APCOM 2021 host city
- 17:15-17:30** Closing of the conference

07.06.2019 Field Trips (starting from hotels - see page 15)

08.06.2019 - 10.06.2019 APCOM Post Conference hike in the Karkonosze mountains

Departure: 08:00am at the IBIS Styles Hotel

Technical program

Tuesday, 4th of June



Room 10AC, Opening plenary

Christoph Mueller

9:00	Welcome and opening	Dr Christoph Mueller
9:30	State-of-the-Art Mechatronic Systems for Mining developed in Poland	Dr Małgorzata Malec
10:00	Industrial Internet of Things and Gamification Applied to Fleet and Personnel Management	Dr Sean Dessureault

10:30 Coffee break

	Room 10B, Session S04 General Aspects of Digital Transformation: Trends in Digitalization and Education Jörgen Appelgren	Room 10AC, Session S03 Resource Estimation and Geostatistics: New Technologies in Geostatistics Prof. Antonio Nieto	Room 10D, Session S02 Mine Planning in Digital Transformation: Geomechanic Risk in Mine Planning Marek Andrzejewski
11:00	Digital technology trends and their implementation in the mining industry Lars Barnewold	Evolving estimation techniques for an evolving world class stratiform copper deposit at Kamo-a-Kakula, Democratic Republic of the Congo George Gilchrist	Economic Optimization of Rib Pillar Placement In Underground Mines Alexandre Barbosa Andrade
11:30	Investing in engineering, research and education in Africa to derive a roadmap for ensuring local digital mining success. Winfred Assibey-Bonsu	Recursive Convolutional Neural Networks in a Multiple-Point Statistics framework Sebastian Avalos	A Data Science Model on Production Level Pillar Stability at El Teniente Mine Ricardo Quevedo Caro René Quezada Castañeda
12:00	Virtual Reality Mine: a vision for digitalised mining engineering education Rudolf Suppes	Application of machine learning classification to geochemical and geophysical data Dr Katherine Silversides	Incorporation of mineralisation risk into underground mine planning Rafael Rosado
12:30	Development of Optimized Processes in Construction Management Supported by Building Information Modeling (BIM) with special Focus on Procurement Klaus Boede	Critical Review of Mineral Resource Classification Techniques in the Gold Mining Industry Prof. Kadri Dagdelen	Parametric analysis of the optimal depth of an open-pit gold mine Dr Régis Motta

13:00 Lunch

Lunch

Room 10B, Session S07
Scheduling and Dispatch:
Optimization of Dispatch and
Scheduling
Oleg Nagovitsyn

14:00 Improvements in plan-driven
truck dispatching systems for
surface mining

Dr Mehran Samavati

14:30 A two-stage solution approach
for a shift scheduling problem
with simultaneous assignment of
machines and workers

Cinna Seifi

15:00 Framework of optimal opera-
tional indices for the open pit
mines production scheduling
problems

Mohammad Reza Moghadam

Room 10AC, Session S06
Resource Estimation and Geo-
statistics: Drilling Data in
Resource Classification
Prof. Kadri Dagdelen

Multivariate Gaussian Process
for distinguishing geological
units using measure while
drilling data

Dr Katherine Silversides

Optimal Drill Spacing For
Resource Classification -
Practical Suggestions from
historical Literature

Marek Nowak

Influence of drilling spacing
on the mineral resources
uncertainty

Carlos José Evangelista Silva

Room 10D, Session S05
Mine Planning in Digital Trans-
formation: Mine Planning

Marek Andrzejewski

Multi Stage Dumping
Sequence - A New Approach
for Waste Disposal

Mr Bruno Kuckartz

A procedure to generate
optimized ramp designs using
mathematical programming

Dr Nelson Morales

Understanding Plan's Priori-
ties: Short Term Scheduling
Optimization

Alexandre Barbosa Andrade

15:30

Coffee break

Room 10B, Session S10
Mine Safety in Digital Transfor-
mation: S10 - New Systems in
Coal Mine Safety
Prof. Oliver Langefeld

16:00 Proximity Detection of Explo-
sive Methane Clouds in Long-
wall Mines

Prof. Jürgen F. Brune

16:30 A sensitive carbon monoxide
monitoring system for fore-
casting coal spontaneous
combustion

Dr Zhaowei Wang

17:00 Application of laser methane
sensor in on-line monitoring of
gas pipeline

Hui Meng

Room 10AC, Session S09
Resource Estimation and
Geostatistics: Resource
Modeling and Simulation
Prof. Kadri Dagdelen

Multivariate Geostatistical
Simulation using Principal
Component Analysis

Maria Bolgkoranou

Covariance table and PPMT: a
fast automatic spatial continui-
ty mapping to multiple
correlated variables

Jonas Kloeckner

Application of Multivariate
Localized Uniform Conditioning
and Conditional Simulation for a
high complex Stockwork Niobi-
um Deposit in Brazil

Laercio Guedes Bertossi

Room 10D, Session S08
Internet of Things and Robotics
UAV Applications in Mining

Prof. Marek Jaszczuk

High-resolution modeling of
open-pit slopes using UAV
and photogrammetry

Prof. Javad Sattarvand

Lithological Hyperspectral
Characterisation for UAV
Sensor Selection

Mr Filipe Beretta

Enhancement of Explosive
Energy Distribution using
UAVs and Machine Learning

Prof. Javad Sattarvand

20:00-23:00 Social Event: Official Conference Dinner (separate Ticket)

Conference Dinner (extra ticket needed!) at the IBIS Styles Hotel with legendary Polish food, drinks and world known music by European artists touring the world with a well known tribute show

Technical program

Wednesday, 5th of June



Room 10AC, Plenary Session S11

From Geostats to Human Machine Interaction, Dr Sean Dessureault

9:00	Application of Locally Varying Anisotropy (LVA) Kriging at the Grasberg Porphyry Cu-Au-Ag Deposit, Papua, Indonesia	Andrzej Issel
9:30	Performance assessment of antithetic random fields in a stochastic mine planning model	Gonzalo Nelis
10:00	Interaction of man and machine in highly automated equipment: Lessons learned from aviation	Finn Hovgaard

10:30

Coffee break

Room 10B, Session S13

Mine Planning in Digital Transformation: Uncertainty in Mine Planning and Scheduling

Prof. Antonio Nieto

11:00	Generating Pushbacks Using Direct Block Mine Production Scheduling Algorithm	Dr Kadri Dagdelen
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11:30	A spatial clustering algorithm for orebody classification and boundary setting	Prof. Mustafa Kumral
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12:00	Incorporating grade uncertainty into sublevel stope sequencing	Yuksel Asli Sari
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12:30	Underground Mine Planning Optimization Process to Improve Values and Reduce Risks	Dr Hongliang Wang
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Room 10AC, Session S14

Mine Operation and Equipment: Mine Equipment in Digital Transformation

Prof. Håkan Schunnesson

11:00	Monitoring of a stoping operation, digital transformation in practice	Olav Kvist
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11:30	Approach of mining equipment performance with simulation of the use of autonomous trucks	Walter Felsch Jr.
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12:00	Evaluation of trackless mobile machine collision management systems	Dr Herman A. Hamersma
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12:30	An Integrated Simulation Model for Opportunistic Maintenance	Dr Onur Golbasi
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Room 10D, Session S12

General Aspects of Digital Transformation: Optimized Economy of Mining Operations

Klaus Boede

11:00	The application of correlation models for the analysis of market risk factors of KGHM capital group	Prof. Agnieszka Wyłomańska
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11:30	The so called „Green Paradoxon“	Dr Ansgar Bendiek
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12:00	Improvement of investment processes in mining company by implementation of Project Management System	Maciej Wach
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12:30	Human factors obstacles in the implementation of new technologies and automation in the mining industry: Chilean perspective	Dr Eleonora Widzyk - Capehart
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13:00

Lunch

Lunch

Room 10B, Session S16
 Mine Safety in Digital Transformation: New Technology for Underground Safety
Prof. Christoph Dauber

Room 10AC, Session S15
 Resource Estimation and Geostatistics: Ore grade estimation
Winfred Assibey-Bonsu

Room 10D, Session S17
 Scheduling and Dispatch: Scheduling I
Ernest Baafi

14:00 Increased Safety in Deep Mining with IoT and Autonomous Robots
 Franziska Günther

Multi-located cokriging: an Application to Grade Estimation in Mining Industry
 Dr Nasser Madan

Simulation and optimization framework for evaluating the mining operations
 Prof. Hooman Askari-Nasab

14:30 Development of Blast-Induced Ground Vibration Wireless Monitoring System
 Prashanth Ragam

MILP framework for open pit and underground mining transitions evaluation
 Bright Oppong Afur

Mine Schedule Optimization and Mine Operational Realities: Bridging the Gap
 Dr Andrea Brickey

15:00 Fibre Optic Sensors For Coal Mine Combustion Detection
 Dr Tongyu Liu

Grade estimation in a tabular deposit using unstructured grids
 Dr Marcel Antonio Arcari Bassan

Short-Term Production Scheduling of Multiple Mines using Genetic Algorithms
 Pranjal Pathak

15:30

Coffee break

Room 10B, Session S18
 Mine Operation and Equipment: LHD Operation in Digital Transformation
Dr Małgorzata Malec

Room 10AC, Session S19
 Resource Estimation and Geostatistics: MWD Data Analysis and Drill Spacing
Dr Ansgar Bendiek

Room 10D, Session S20
 Scheduling and Dispatch: Scheduling II
Dr Ernest Baafi

16:00 Comprehensive, experimental verification of the effects of the lock-up function implementation in LHD trucks in the deep underground mine
 Tomasz Kaniewski

Rock mass characterization using MWD data and photogrammetry
 Sohail Manzoor

Optimization model for rostering and crew assignment for train transportation
 Dr Jorge Amaya

16:30 Analysis of dynamic external loads to Haul Truck machine subsystems during operation in a deep underground mine
 Justyna Hebda-Sobkowicz

Ore Grade Prediction Using Informative Features of MWD Data
 Samaneh Liaghat

Short-term open-pit mine production scheduling with hierarchical objectives
 Fabián Manríquez

Selection of variables acquired by the on-board monitoring system to determine operational cycles for haul truck vehicle
 Paweł Śliwiński

An Approach for Drilling Pattern Simulation
 Gustavo Usero

The simulation of the excavation sites of coal mines
 Prof. Sergey Kubrin

17:00 From machine construction to mechatronic system design: Digital Transformation is changing the way of thinking!
 Szymon Kochanik

19:30-23:30 Social Event: Casual Conference Barbecue

Casual Barbecue with a live music at the Letnia Restaurant in the Wrocław Zoo. Free access for all regular conference attendees (included in registration fee).

Technical program

Thursday, 6th of June



Room 10AC, Plenary: Day 3

Winfred Assibey-Bonsu

9:00	Rethinking mining transport: Trackless trains for mass transport in mining	Mateusz Juźwiak
9:30	Coupled CFD-DEM modelling of mine dust dispersion in underground roadway	Lihai Tan
10:00	Recoverable resource estimation mixing different quality of data	Christianne Mariz

10:30

Coffee break

Room 10B, Session S23

Mine Operation and Equipment: Optimization of operations and products

Dr Violetta Sokola Szewiola

11:00 Optimization of material logistics by using leading edge electronic Information and Communication Technologies (ICT) in underground coalmine

Dr Max Thomas Stoettner

11:30 Development of a Machine Vision System Based on Deep Learning Algorithm for Automated Quality Monitoring of Iron Ores

Dr Amit Kumar Gorai

12:00 Comparison between regression models and neural networks applied to forecast geometallurgical variables

Fernanda Gontijo Fernandes Niquini

12:30 Development assumptions of a data and service management centre at KGHM S.A.

Paweł Pyda

Room 10AC, Session S22

Resource Estimation and Geostatistics: Resource Estimation

Winfred Assibey-Bonsu

Decluster Weights as a Measure of Average Sample Spacing Applications in Mineral Resource Classification

Dr Rex Bryan

Transforming Exploration Data Through Machine Learning

Ian Whitehouse

Geostatistical simulation with heterotopic soft data without the LMC

Cristina Araujo

Room 10D, Session S24

Enabling Technologies and Synergies from other Industries: New Equipment Technology

Dr Sean Dessureault

Designing Top Layer in Internet of Things for Underground Mines

Dr Shimin Feng

Version control system applied to resource modeling projects

Dr Camilla Silva

Development of a low-cost proximity warning system for mine equipment using smartphone and Bluetooth beacons

Jieun Baek

The concept of walking robot for mining industry

Artur Muraszkowski

13:00

Lunch

Lunch

Room 10B, Session S27
Enabling Technologies and Synergies from other Industries: Technology for Coal Mining
Prof. Christoph Dauber

14:00 The Digital Mine eco-system

Willem Fourie

14:30 An Operational Data Based Framework for Longwall Shearer Performance Measurement

Enver Yilmaz

15:00 Application of DEM-FEM methods in tests of loads on idlers

Błażej Doroszuk

Room 10AC, Session S26
Mine Operation and Equipment: Optimization of operations
Dr Jürgen Brune

Mineberry - Remote Monitoring of Abandoned Shaft Openings

Prof. Bernd vom Berg

Artificial Intelligence Using Real Time Data

Louis-Pierre Campeau

LTE, 4G and 5G - Broadband Mobile Communication in Mining Applications

Wesley Santos

Room 10D, Session S25
Mine Planning in Digital Transformation: Modelling in Mine Planning and Operation
Dr Małgorzata Malec

Break line and shotpile surfaces modeling in design of large-scale blasts

Oleg Nagovitsyn

Modelling and forecasting geometallurgical recovery at a phosphate mine

Laura Buarque Andrade

Application of a digital model of deposit in Polish hard coal mines on the example of Polish Mining Group Ltd.

Dr Violetta Sokoła-Szewioła

15:30

Coffee break

Room 10AC: APCOM Conference Summary and Closing

Carly Leonida, Paul Moore

16:00 Journalist summary of the APCOM 2019 and panel discussion

Carly Leonida, Paul Moore

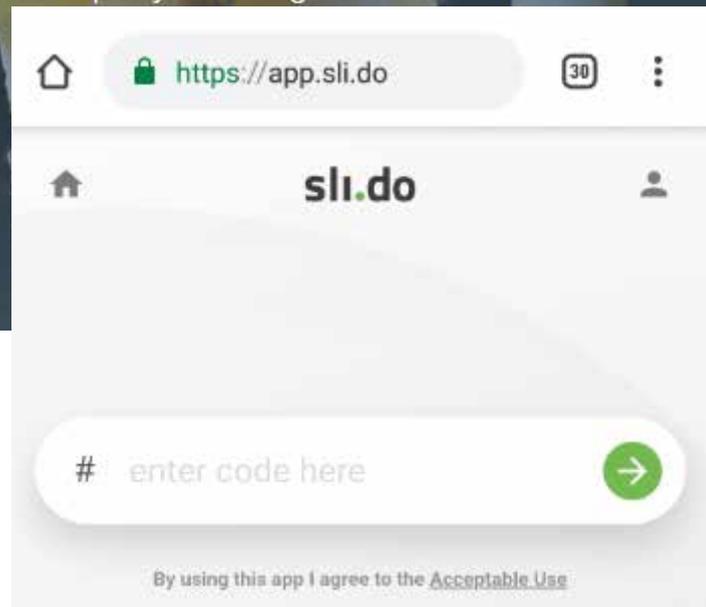
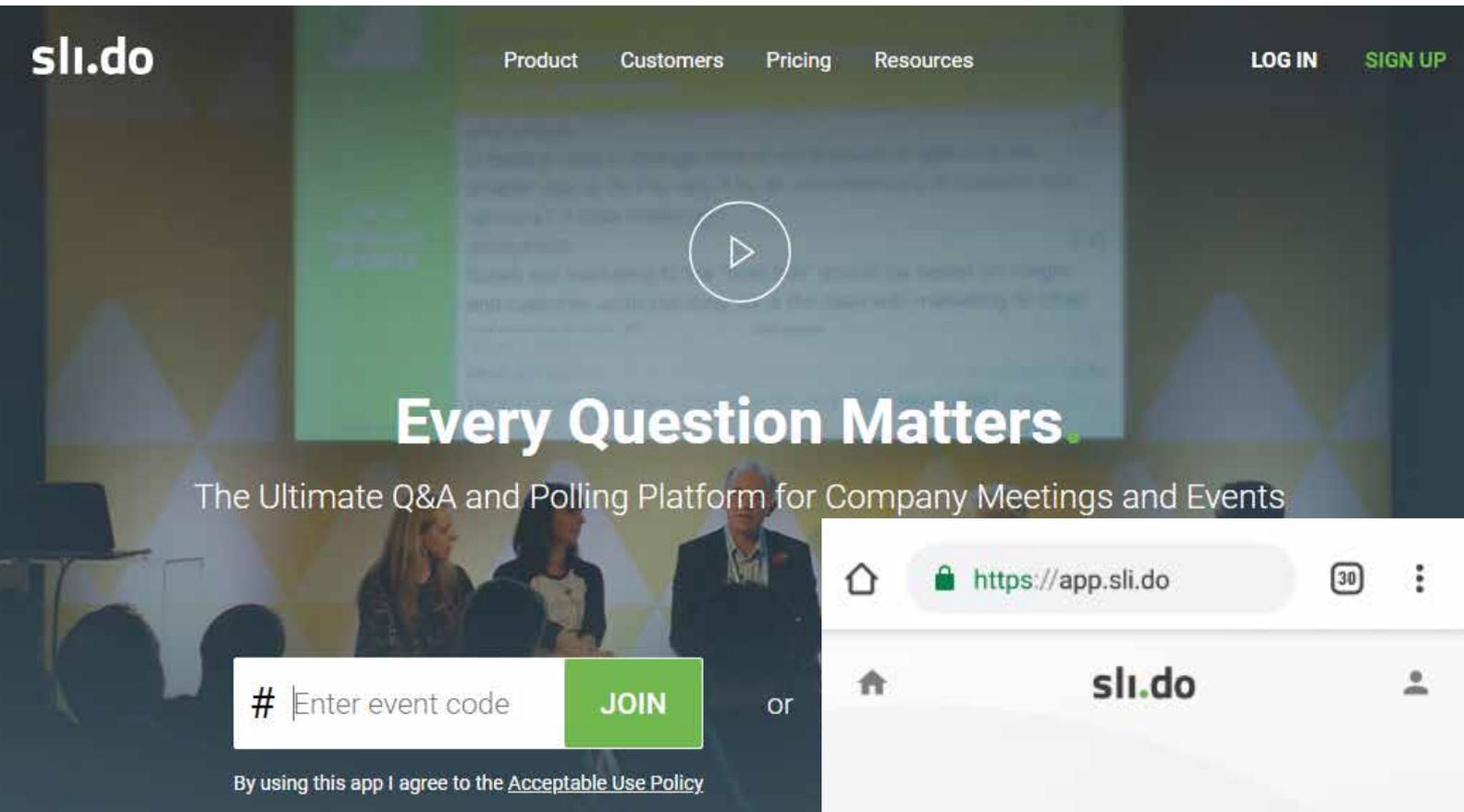
17:00 Presentation of the APCOM 2021 host city

Surprise

17:15 Closing of the conference

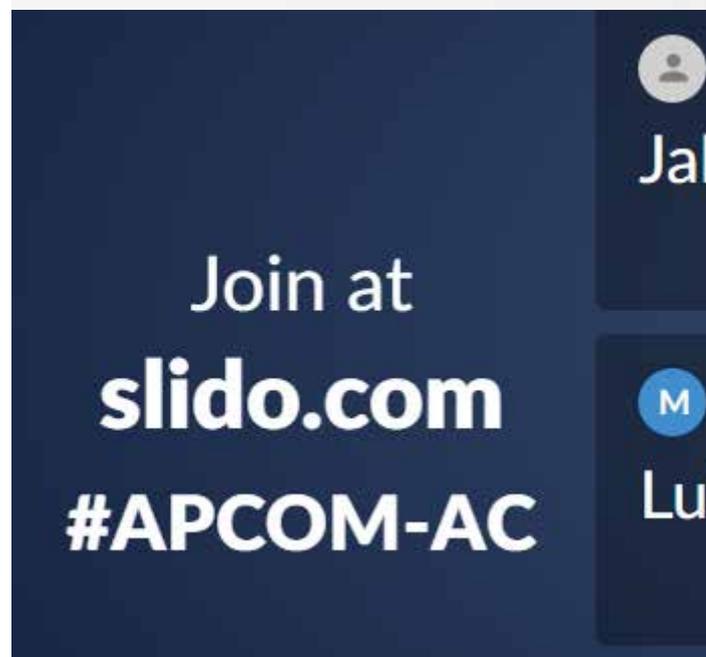
Dr Christoph Mueller

Submitting questions



To submit electronic questions:

1. Go to: www.sli.do on your PC or mobile
2. Enter:
 - APCOM-AC to ask speaker in room AC,
 - APCOM-B to ask speaker in room B,
 - APCOM-D to ask speaker in room D
3. Type your question in the field assigned to it. You can do this anytime, during his presentation or after.
4. Read questions from other attendees, choose the questions you also like
5. Speaker can read and answer questions just after his presentation!



City



1. Conference Venue:

Convention Center of the Wrocław University of Technology
Centrum Kongresowe Politechniki Wrocławskiej
Address: ul. Janiszewskiego 8, 50-372 Wrocław
building D-20

2. Casual dinner (Wed, June 5):

Letnia
ZOO Wrocław
Address: ul. Wróblewskiego 1-5, 51-618 Wrocław

3-7. Hotels:

3. IBIS Styles Wrocław Centrum
Conference hotel (**welcoming reception, conference dinner**):

Address: pl. Konstytucji 3 Maja 3, 50-083 Wrocław
Phone: (+48) 71 733 48 00

4. Novotel Wrocław Centrum

Address: ul. Powstańców Śląskich 7, 53-332 Wrocław
Phone: (+48) 71 733 48 00

5. Q-Hotel Plus Wrocław

Address: ul. Zaolziańska 2, 53-334 Wrocław
Phone: (+48) 71 749 17 00

6. Radisson Blu Hotel

Address: ul. Purkyniego 10, 50-156 Wrocław
Phone: (+48) 71 375 00 00

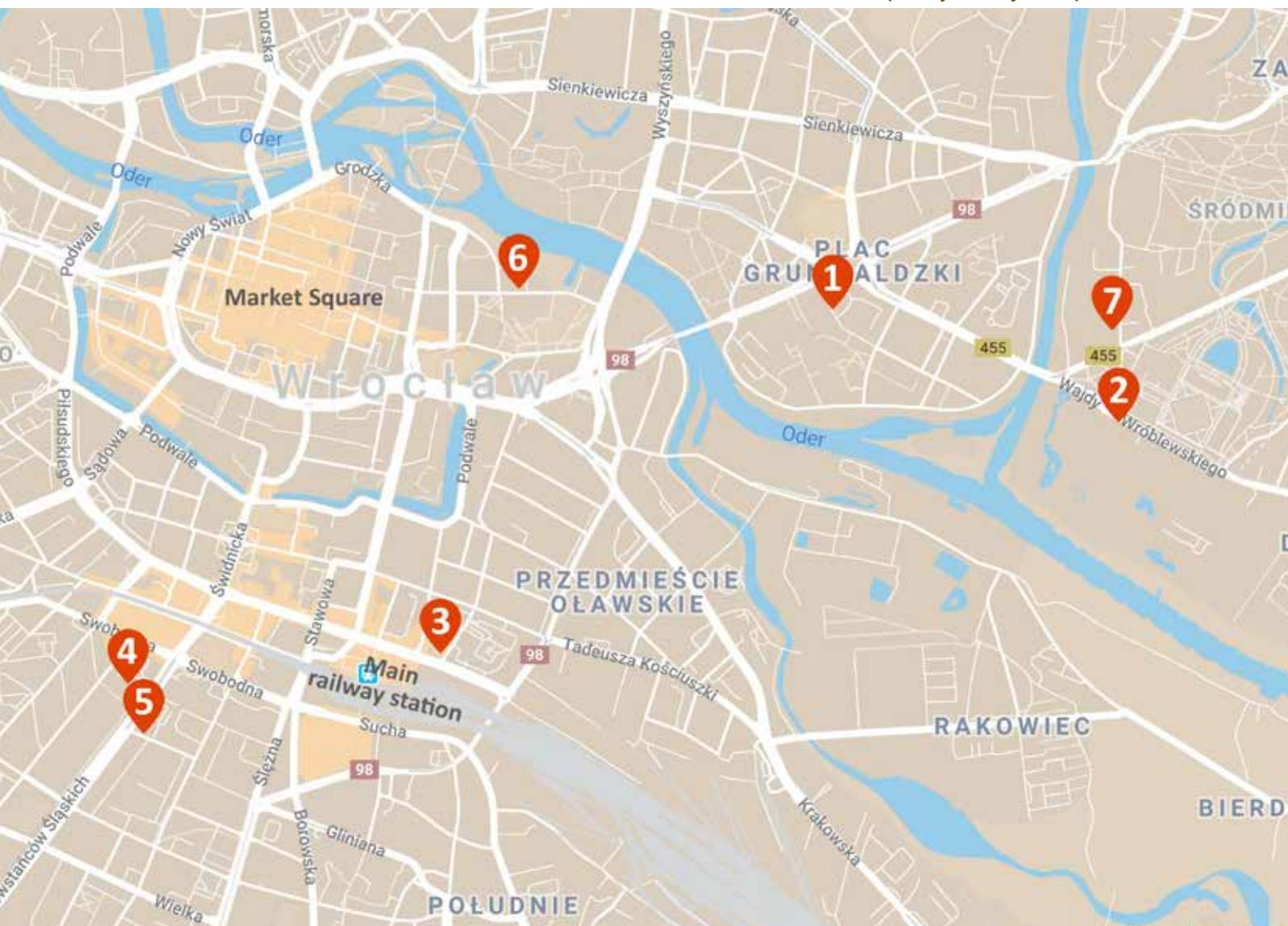
7. Grape Hotel & Restaurant

Address: ul. Parkowa 8, 51-616 Wrocław
Phone: (+48) 71 73 60 400



Remember to validate your ticket!

Trams and buses routes planner:
<https://jakdojade.pl/wroclaw>





Casual barbeque

Place: Letnia, Zoo Wrocław

Tram Station: Zoo

Tram lines: 1, 2, 4, 10

Barbecue takes place at the Letnia Restaurant, which is located at center of the ZOO. Yes, you will be able to see giraffes and other animals while having fun with barbecue!

To get into the ZOO please use the Service Entrance - not Main Entrance as it will be closed at the time of event. It is located 100 meters right from main ZOO Entrance. After entering the ZOO please follow the signs to get into the Letnia Restaurant. Please see attached map for detailed route.

You should have your Conference ID Card with you to be allowed to enter ZOO.

Attraction of this barbecue is music by a Polish band - Percival - from Lubin, the hometown of KGHM, who performs real Slavic music.



Field trips - 7th of June



All Field Trips start on 7th of June at IBIS Styles hotel:

Departure at 4:00 a.m.:

KGHM Rudna Mine
KGHM Lubin Mine
KGHM Polkowice Mine



KGHM
POLSKA MIEDŹ

Departure at 7:00 a.m.:

KGHM Smelter in Glogow



HOCHTIEF

Visits in Wrocław:

10:00 Hochtief VASTINT construction site in Wrocław

14:00 Hochtief VASTINT construction site in Wrocław

It is at: Business Garden, Legnicka 48, 50-001 Wrocław, Tram Station "Zachodnia" and then walk to the west on the left side (outbound from the city) along the main road ("Legnicka") underneath the train bridge. The VASTINT construction site by HOCHTIEF POLSKA is directly behind the train bridge on the southern side of Legnicka street - left side when walking outbound! (Look for the HOCHTIEF logos)

All additional info will be provided separately - instructions together with the mobile phone number of the particular guide



Exhibitors



KOMATSU



MobileTronics



Journalists:

MT-Silesia



MineTronics

Geovariances
Where no one has gone before

GEORESOURCES
Portal for Mining, Tunnelling, Geotechnics and Equipment

Carlson

MICROMINE
Intuitive Mining Solutions

**Inżynieria
Górnicza**
KWARTALNIK SPECJALISTYCZNY



Emergency contacts:

112

to call an emergency service please dial 112 for all services: Ambulance, Fire Brigade, Police, Municipal Wardens (Straż Miejska)

As soon as the call is connected, you will be transferred to the appropriate service.

+48 668 464 616

Organizers first contact, polish/english, 24hrs

Please note: The organizers do not provide participants with accident insurance, health insurance, third-party liability insurance or any other forms of insurance.