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Volunteering for the future – Geospatial excellence for a better living

CENAGIS geo-cyberinfrastructure as a R&D environment for a Surveyor 4.0

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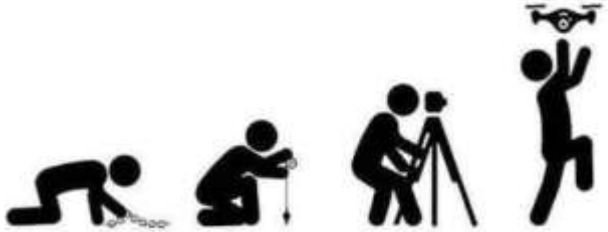
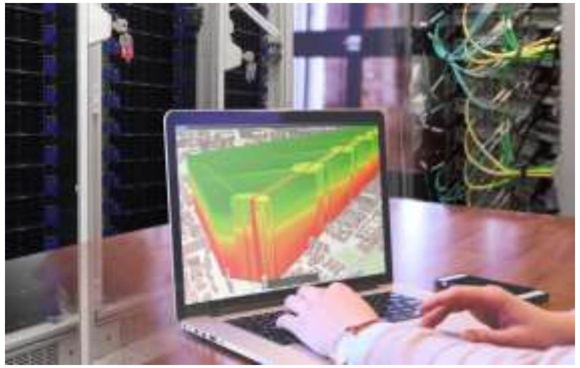
Industry 4.0 and Surveyor 4.0

- Industry 4.0 is associated with concepts such as Artificial Intelligence, Internet of Things, Augmented Reality, Virtual Reality, Cloud Computing, Big Data, Cybersecurity, System Integration, Blockchain, Digital Twins, Robotics, 5G, etc.
- Without IT knowledge, a surveyor has limited ability to consciously use and create intelligent solutions that collect, processing and analyse spatial data.
- The advantage of surveyors over other professionals is a deep understanding of spatial information acquisition, taking into account many aspects, including legal.
- Combined with IT knowledge, this allows for the birth of Surveyor 4.0 as an important player in the era of Industry 4.0





Industry 4.0 and Surveyor 4.0

- In construction, the surveyor's job is, in many ways, becoming much easier, given the number of tools at their disposal. At the same time – and for the same reason – it's never been more complex (Hayes 2021).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Surveying technology - a bright future
By Mike Hayes | 09 July 2021

https://www.constructiontechnology.media/news/surveying-technology-a-bright-future/8013472.article

Using augmented reality surveyors can see how a plan is likely to affect the surrounding environment

The Spot robot from Boston Dynamics aids surveying via photographic imagery, BIM model capture and more

Industry 4.0 and Surveyor 4.0

- “As data collection becomes more efficient and sensors become more powerful, the emphasis is shifting to the office software, feature extraction and modelling automation” (GIM International)

https://www.constructiontechnology.media/news/surveying-technology-a-bright-future/8013472.article

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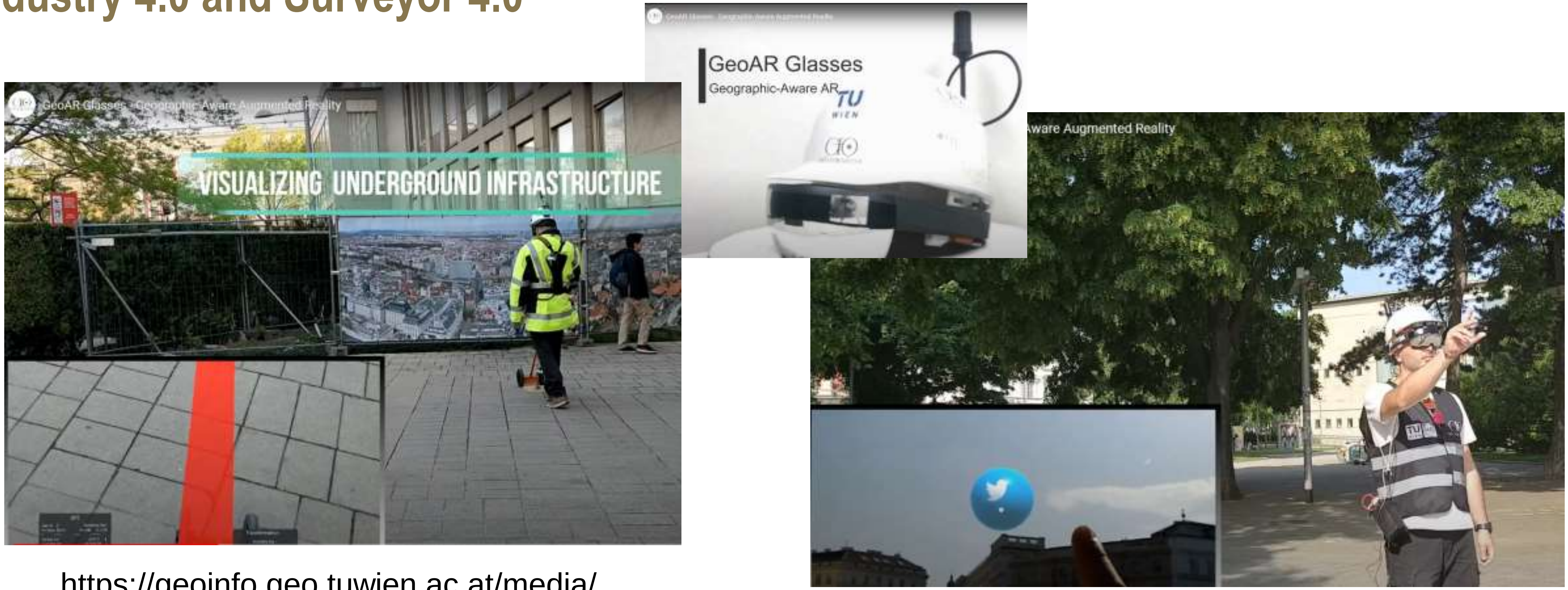
Industry 4.0 and Surveyor 4.0



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New tools and work environments

- Surveyor 4.0 tasks are increasingly similar to those of geo-information and IT specialists - deep collaboration required
- Surveyor 4.0 needs modern tools and work environments to meet the challenges posed. As in most cases in technology development, it starts with scientific work and R&D experiments.
- How to meet these challenges?

CENAGIS - a geo-cyberinfrastructure dedicated to research and development experiments on geospatial data dedicated to surveyors, cartographers and geographers

CENAGIS

New tools and work environments

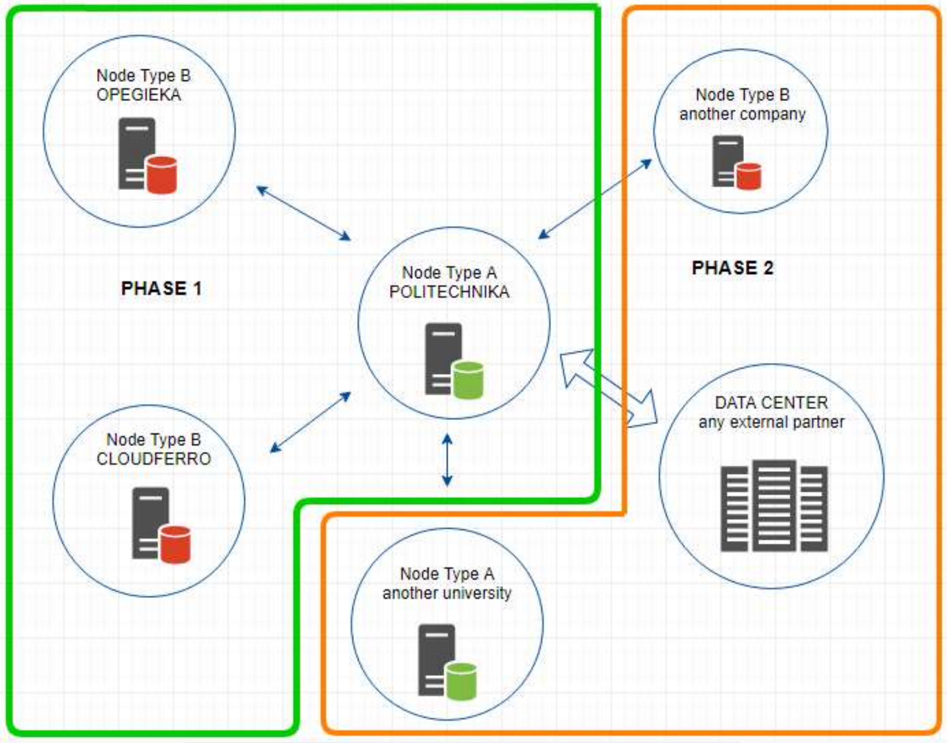
- In 2022, a 3-year project was completed at the Warsaw University of Technology, resulting in the creation of CENAGIS cyberinfrastructure. Cyberinfrastructure is the main component of **The Centre For Scientific Geospatial Analyses And Satellite Computations**
- Project was conducted in cooperation with WUT, OPEGIEKA, Hexagon and Cloudferro.
- CENAGIS implementation has been co-financed from the European Fund for Regional Development within the Priority Axis I "Utilisation of research-and-development activities in economy", Activity 1.1. "Research-and-development activities of research units" of the Regional Operational Programme of the Mazovia Voivodship for the period 2014-2022
- **The CENAGIS system is a sandbox IT environment where technologies and geospatial data can be tested and verified.**

CENAGIS Platform – objectives

- CENAGIS is an advanced IT cloud infrastructure (cyber-infrastructure) allowing for implementation of geospatial analyses, satellite computations, geodata processing and geodetic calculation
- The main objective of the computations carried out in the environment is to develop algorithms and models ready to be used by various services and operational activities carried out by different industries and public institutions.
- Increase science-industry cooperation
- Increase collaboration among researchers - creation of virtual research teams

CENAGIS Platform - system architecture and technologies

- CENAGIS Platform currently (PHASE 1) consists of one academic (WUT) and two commercial nodes - OPEGIEKA and CloudFerro Company
- The CloudFerro node provides access to ESA's collection of satellite imagery
- CENAGIS provides the convenient access to big sets of spatial data (with the structures developed especially for scientific purposes), as well as an analytical platform dedicated for scientific analyses
- In the next phase (PHASE 2), development is planned to include more nodes, both academic and commercial



CENAGIS Platform - system architecture and technologies

There are four main subsystems visible in the CENAGIS infrastructure from the user's point of view:

1) Virtualization subsystem
2) Computing subsystem (Big Data Subsystem)
3) Application serving subsystem (Geoinformation Hub)
4) Data repository

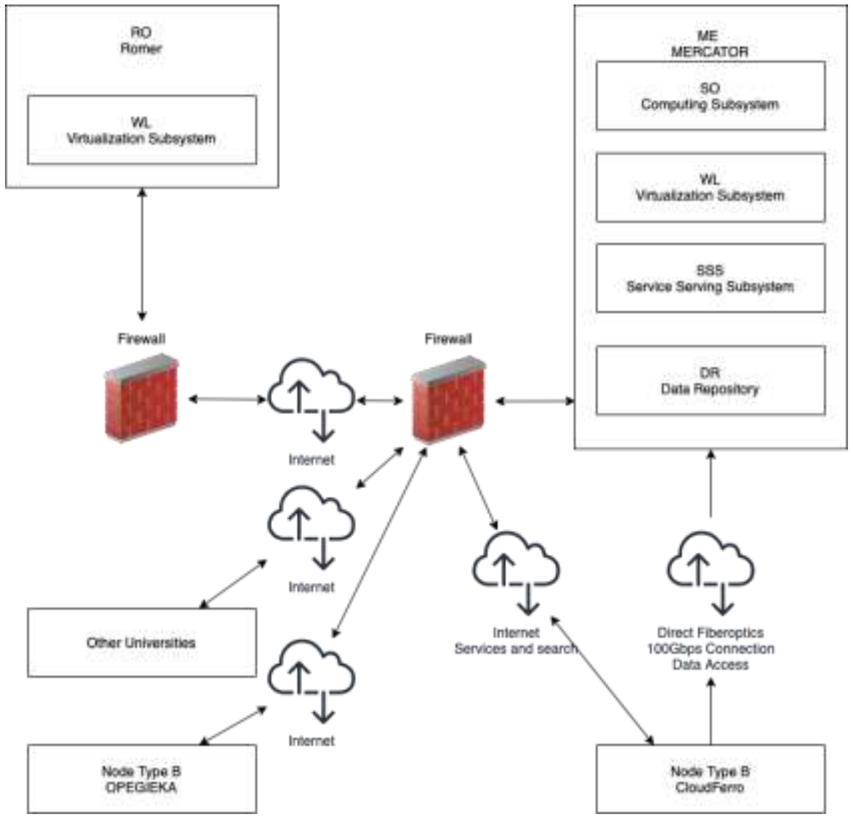
Virtualization Subsystem	Computing Subsystem
Software: Hexagon (Geomedia, Erdas Imagine/Apollo, M. App. Enterprise, Geospatial Portal, Luciad), ArcGIS, FME, QGIS, PostGIS, GeoServer), Dephos (Limon) **Computer operating system**: Windows, Linux **Hypervisor**: KVM + CloudStack	**Software**: GeoMesa, RasterFrames, Dephos, Accumulo, Jupyter Lab, self-created programming libraries **Computer operating system**: Linux **Big data management technologies**: HDFS, Mesos, Spark, other.

The CENAGIS platform was implemented in a manner that allows users to use services in 4 typical cloud models: IaaS (Infrastructure-as-a-service), PaaS (Platform-as-a-service), SaaS (Software-as-a-service), CaaS (Containers-as-a-Service) depending on their needs.

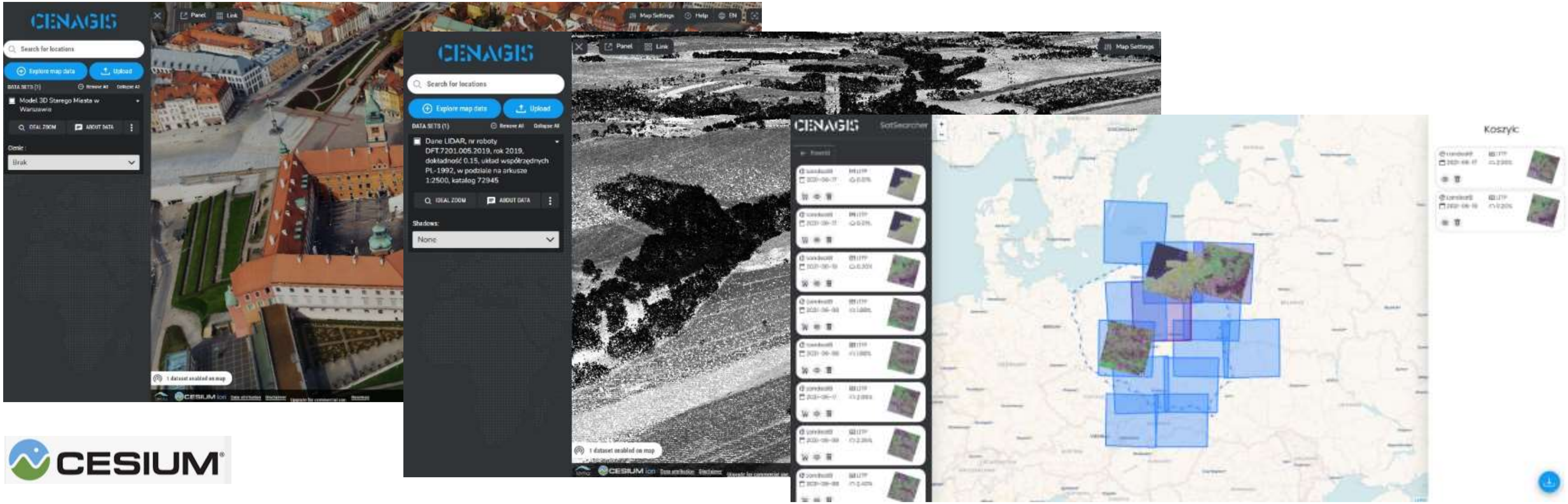
CENAGIS Platform - system architecture and technologies

From the hardware side, there are two computer clusters MERCATOR and ROMER (named after famous cartographers - a world-famous one and one of the greatest Polish cartographers) and there is a central subsystem for handling synchronization of various services.

High-level IT architecture of the CENAGIS Platform



Examples of CENAGIS Platform use - data exploration



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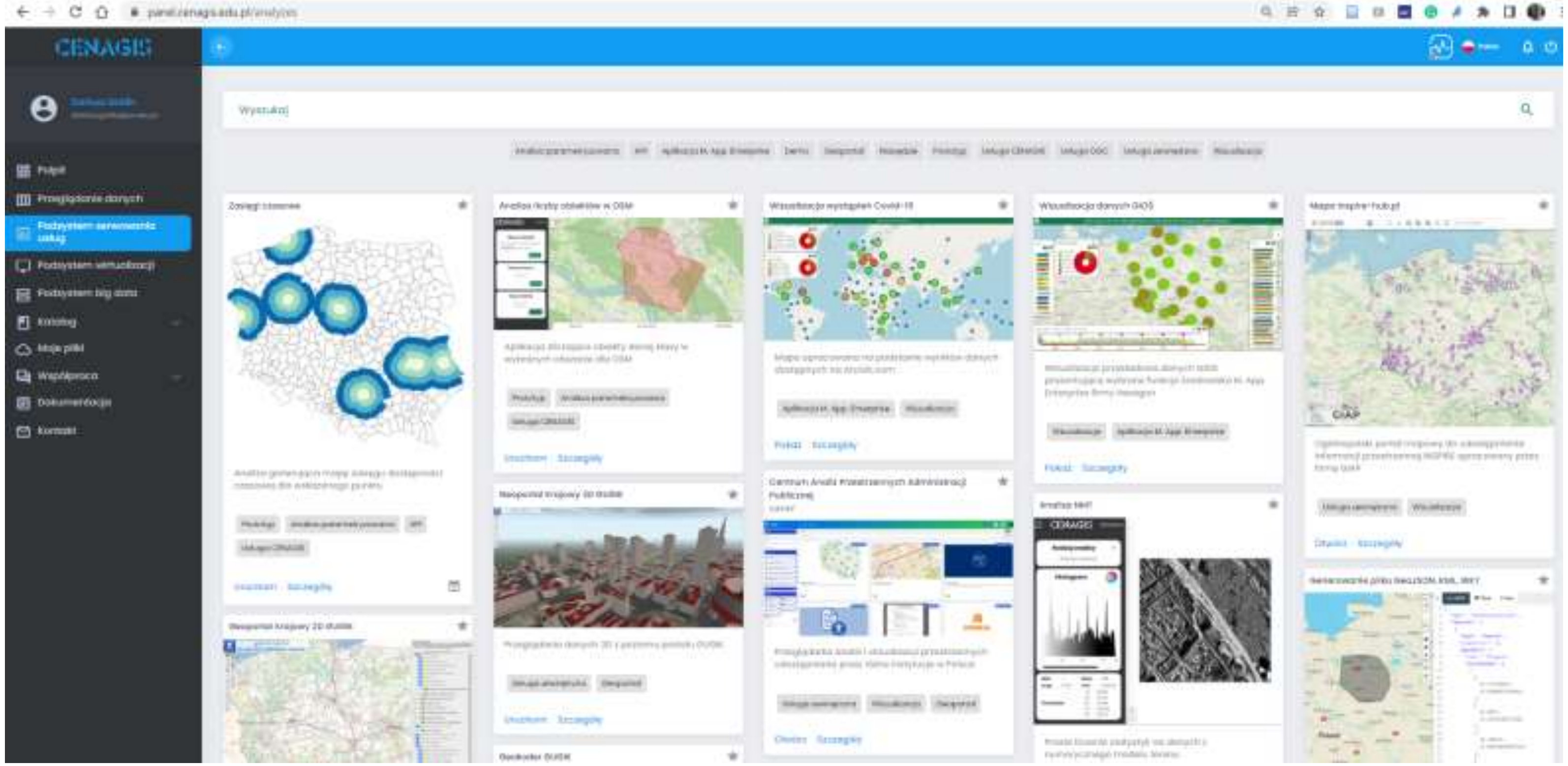
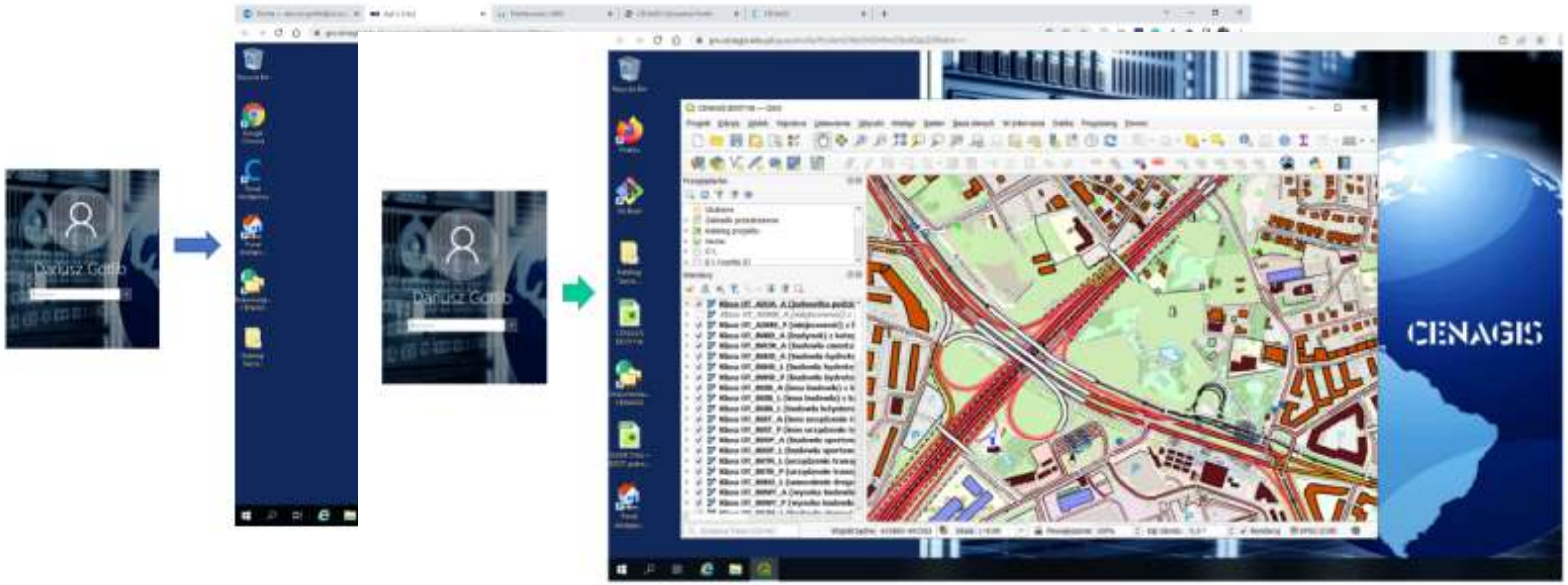
Possibility of visualization in CENAGIS MapViewer nad CENAGIS SatExplorer

Examples of CENAGIS Platform use – the Geospatial Service Node



CENAGIS platform also serves as a Geospatial Service Node.

Examples of CENAGIS Platform use - virtual laboratories



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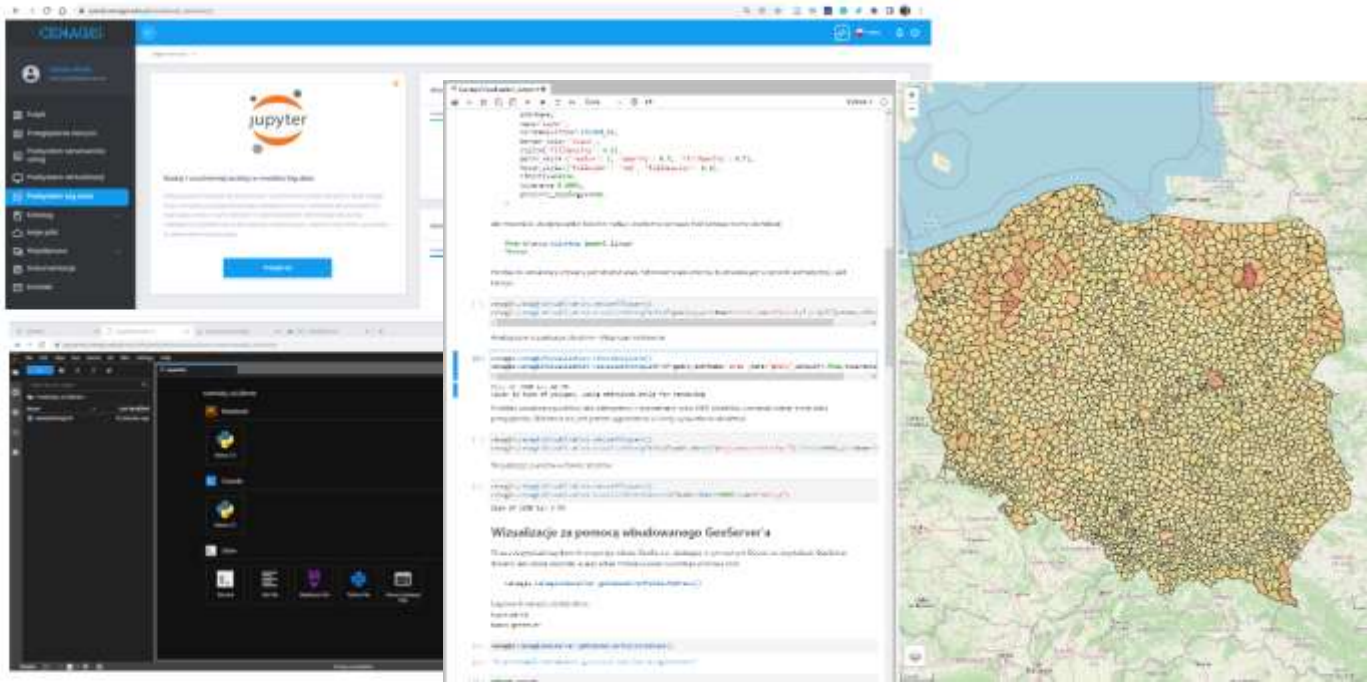
- Each virtual computer provides easy access to large geospatial data resources from the CENAGIS Repository
- Access to software (QGIS, Hexagon – number of licenses are available, ESRI – Bring Your Own License model) with configured connection to CENAGIS Repository data is also assured (using PostGIS)

Examples of CENAGIS Platform use - spatial big data analyses

The infrastructure allows to use distributed computing technology on several dozen nodes with the use of tens of GPU cards (NVIDIA TESLA T4 16GB). Users have a possibility to use containerization technology and tools prepared to work with spatial big data e.g. GeoTrellis, Geomesa, Accumulo

Access to a big data environment through the JupyterLab interface

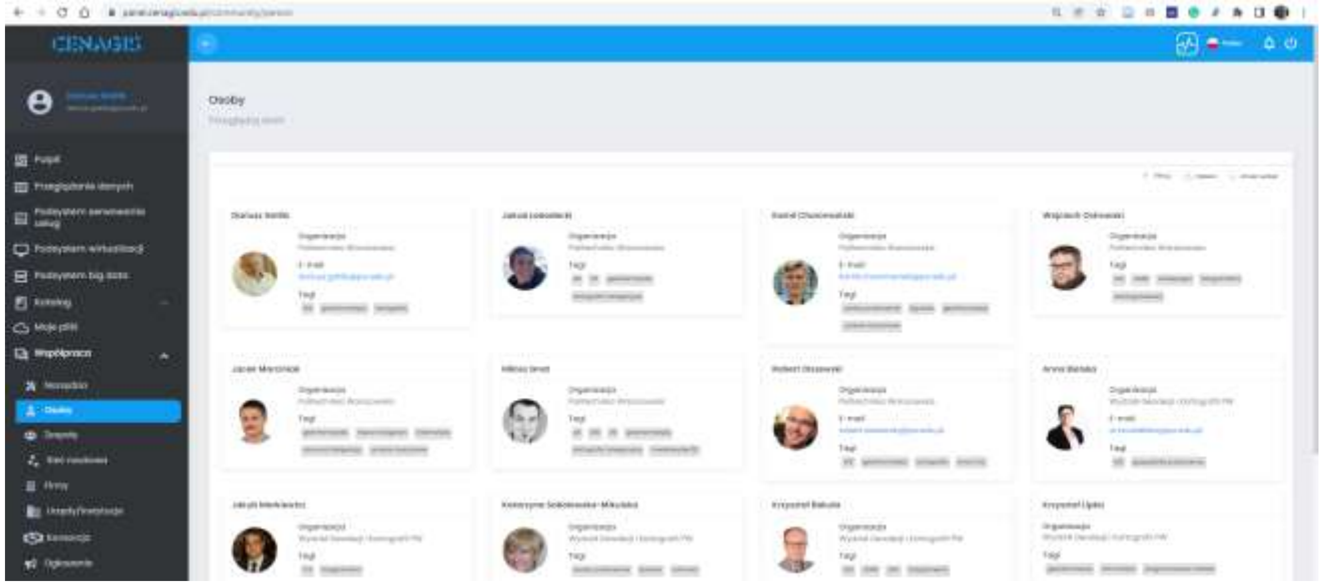


jupyterhub python geomesa GeoTrellis hadoop APACHE Spark accumulo

Examples of CENAGIS Platform use - teams collaboration

Apart from the typical data processing tools, the CENAGIS Platform provides additional utilities supporting user collaboration (shared disk space, chat, forum, teleconference platform, bulletin board). The purpose of this type of solution is primarily:

- Finding partners for research projects
- Validating ideas
- Promoting and sharing the results of research
- Promoting and sharing data
- Promoting new technology solutions
- Collaborating to create more complex projects



Examples of CENAGIS Platform use - sample projects

- „AI tool for detecting building components and site changes”
- „Improvement of methods of acquisition and processing of remote sensing data from unmanned UAV flying platform
- „Methods for analysing, forecasting, and recommending COVID-19 containment with a particular focus on geospatial analysis”
- „MARS - Development of a concept and prototype system for simulation of Mars terratransformation process”
- „Implementation of the Smart Villages concept in the Mazowieckie Voivodeship”
- „Maloutena and Agora in the urban plan of Paphos”

Summary

- In the era of Industry 4.0, the role of the Surveyor is also expanding and, to some extent, changing
- The surveyor 4.0 needs an access to powerful computing resources, large volumes of geospatial data from a variety of sources, and IT solutions to meet new customer requirements
- The dynamics of change generates the need for access to testing environments with functionality adapted to different levels of surveyors' experience
- Environment in which, on the one hand, one can learn new technologies and, on the other hand, to experiment and look for a new technological solutions with commercialization potential
- Such considerations were at the core of the CENAGIS geo-cyberinfrastructure project
- CENAGIS =SANDBOX to support surveyors and other geo-information professionals
- In addition to cyberinfrastructure, CENAGIS offers access to state-of-the-art laboratories and instruments - see the another FIG article: "One-Stop-Lab CENAGIS: from Calibration of Surveying Devices and Application Testing to Large-Scale Geodata Computation"

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Consortium members

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Thank you for your attention

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