FIG Working Week 2024
19-24 May
Accra, Ghana
Your World, Our World: Resilient Environment and Sustainable Resource Management for All

UAV Photogrammetry and Lidar Data in Inventory and Management of Civil Infrastructure Facilities Using Digital Twin

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Digital Twin – what we need and why we need them?

From surveyors' point of view geometry is the most important – then attributes of twin's classes

Existing and new twins – where is surveyor's (geospatial engineer's) role? New buildings have their documentation in CAD, old need our measurements!

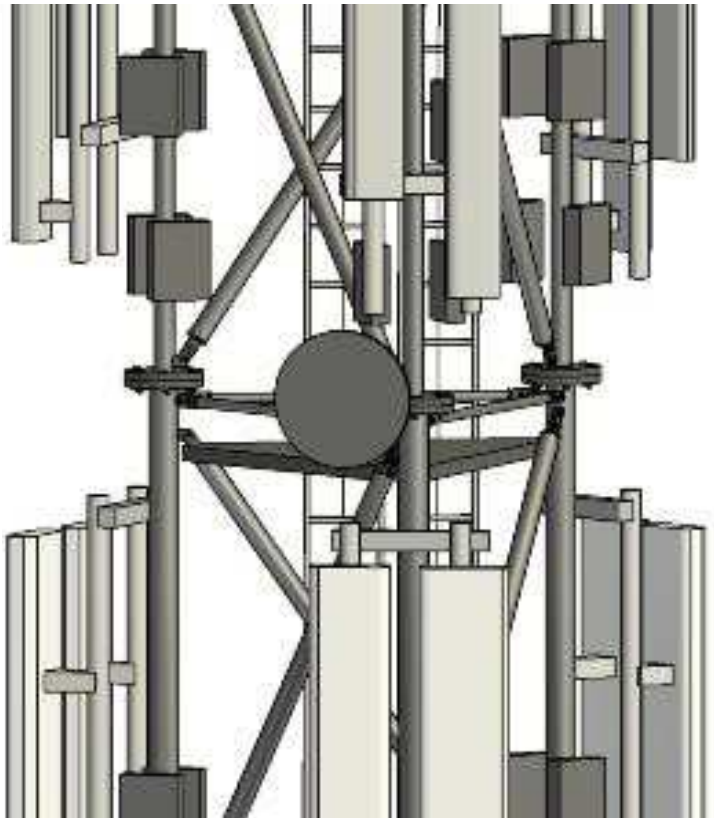
Twins' structures - solid vs. mesh?

Arising questions

- What structure/format of digital twin is the best?
- What technology can acquire the best data to ensure digital twin's quality
- What we can do with digital twin? What are benefits coming from having them?

What structure/format of digital twin is the best?

- Mesh generation is automatic, but it can not be always perfect; it needs semantics (segmentation and classification)
- Solid model production is time consuming; geometry and semantics with attributes must be done
- What should be recommended there?

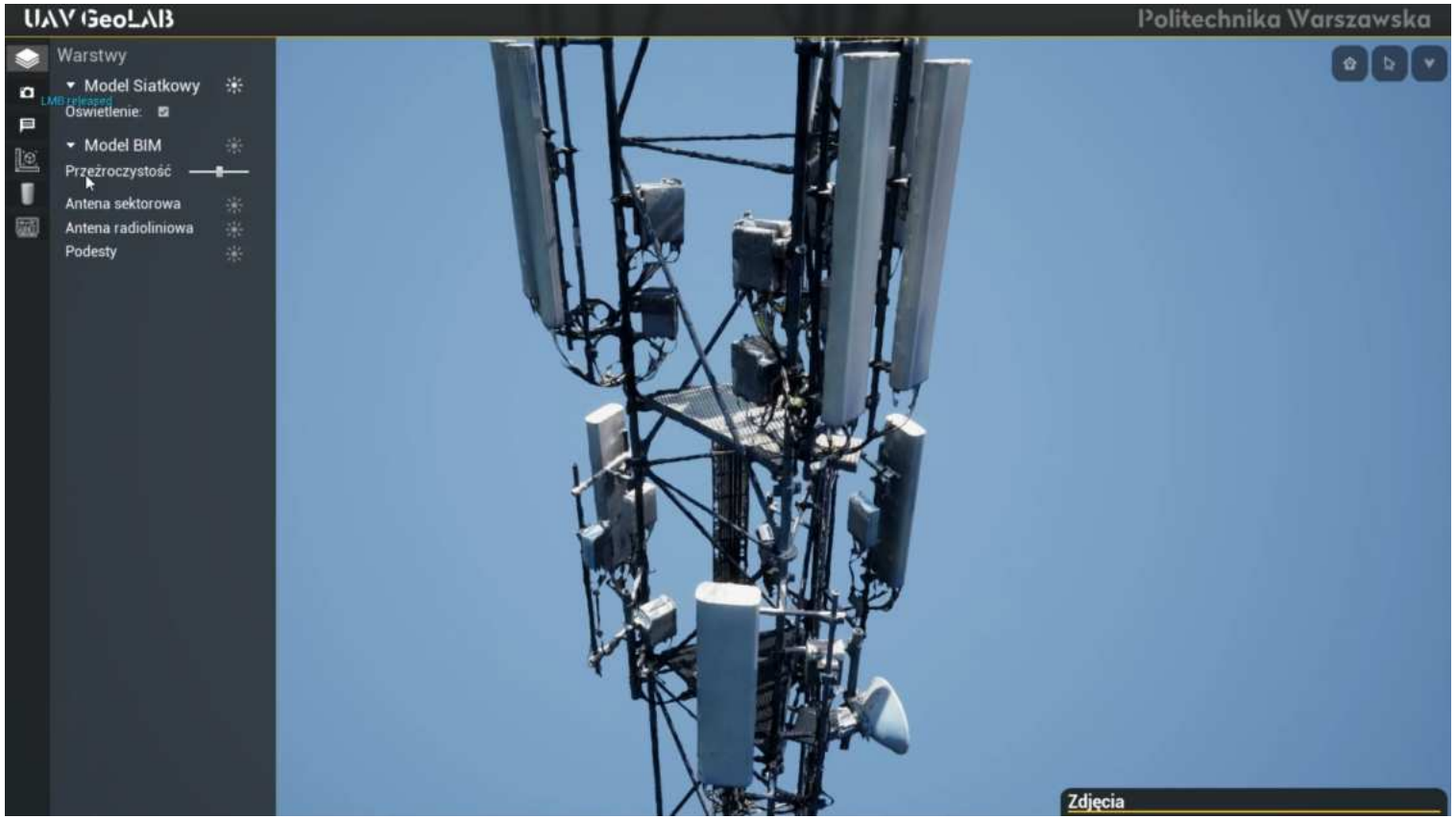


Proposal of hybrid city digital twin model

What structure/format of digital twin is the best?

The proposal in our research group is to provide digital twin of infrustructure objects that

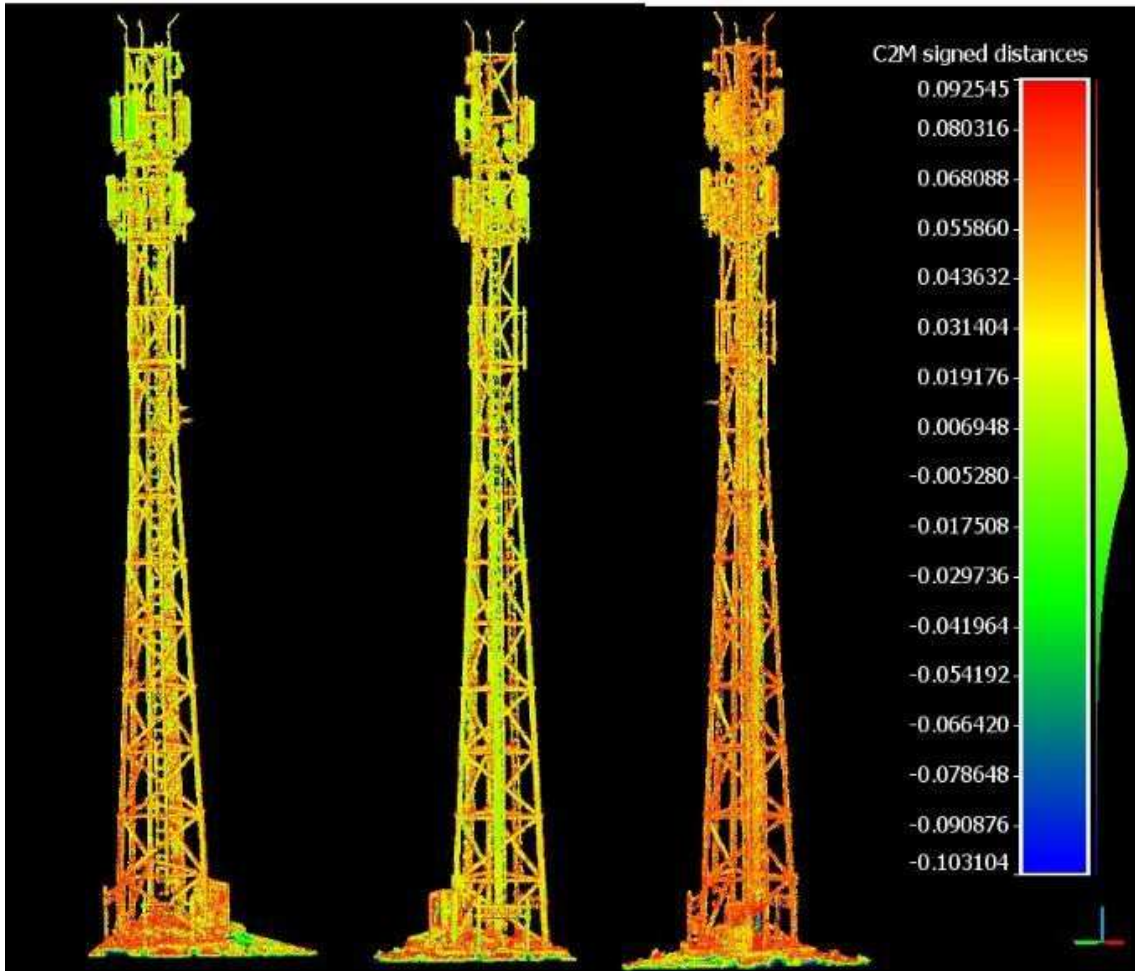
- Integrates mesh and solid model
- Provides source data (point cloud and images) to have details visibile in redundant data
- Shows mesh-based realistic model for inventory and for navigation
- Provides solid model as database of model parts / classes with atributes
- Allows to develope the object database
- Is based on game engine



What technology can acquire the best data to ensure digital twin's quality

- To provide both accuracy and detailedness we can discuss only photogrammetry and lidar techniques
  - Close-Range and UAV photogrammetry (computer vision algorithms involved)
  - Terrestrial Laser Scanning (TLS) and UAV laser scanning (ULS)
- Both techniques provide point clouds (mostly coloured) – images are collected

ULS error – 2.0 1.4 cm



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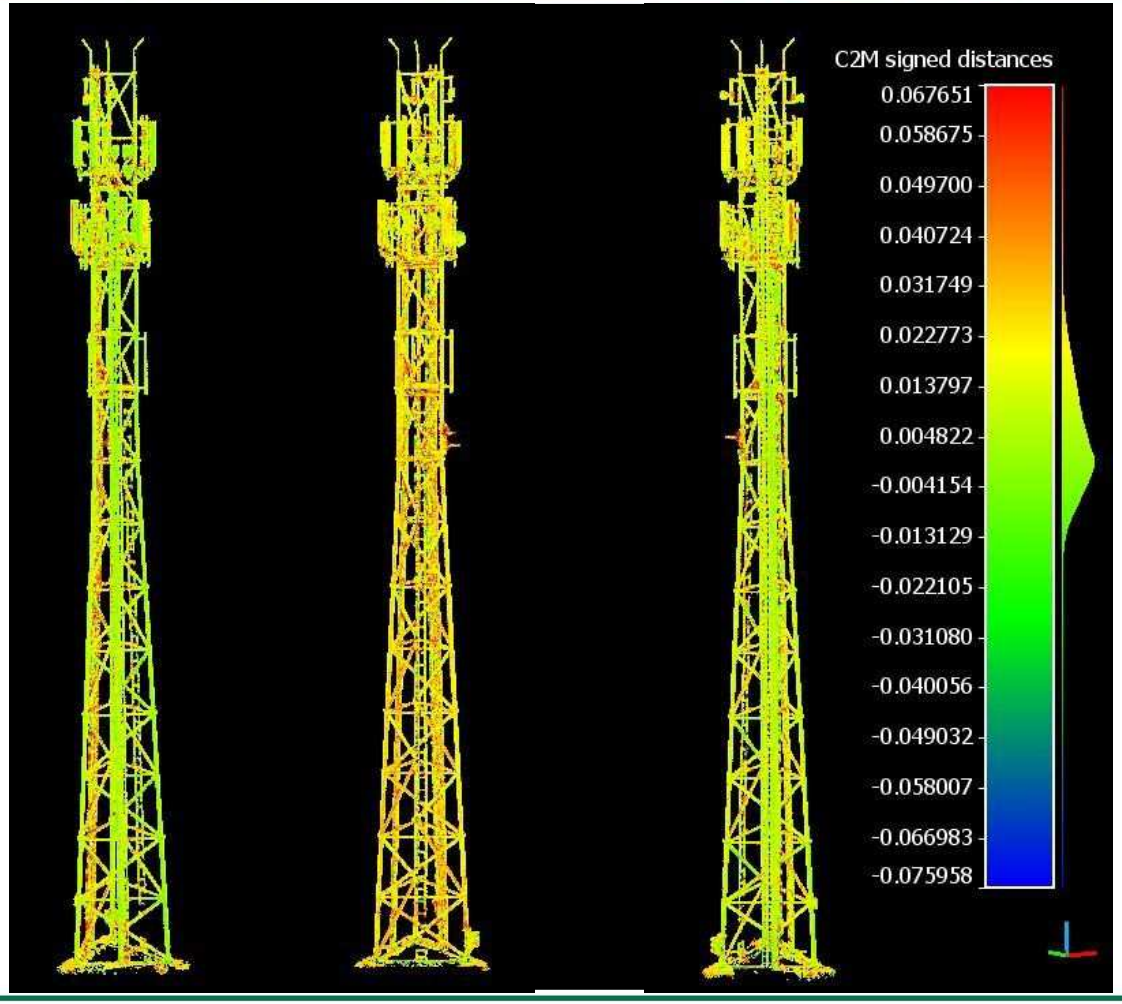
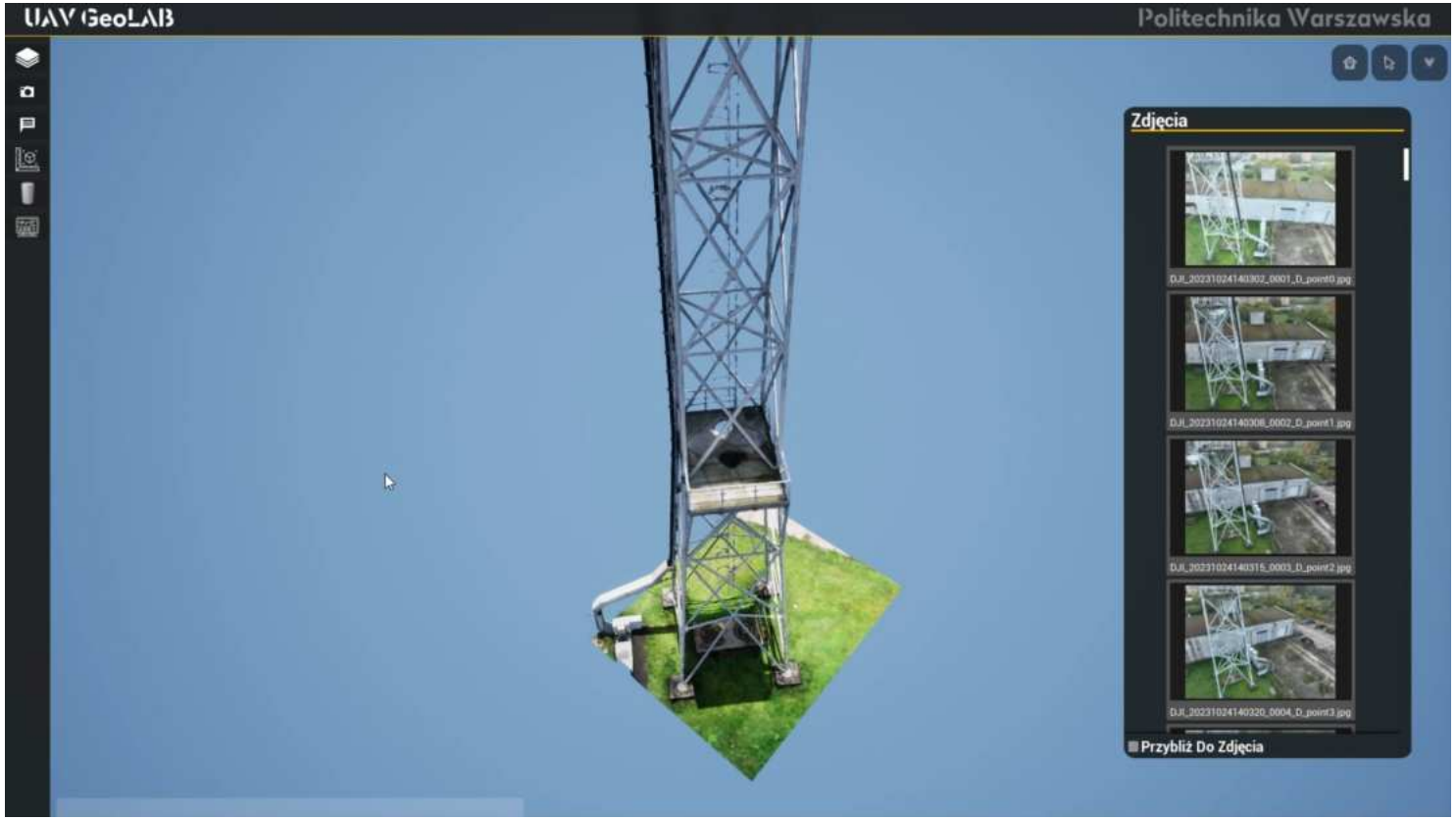
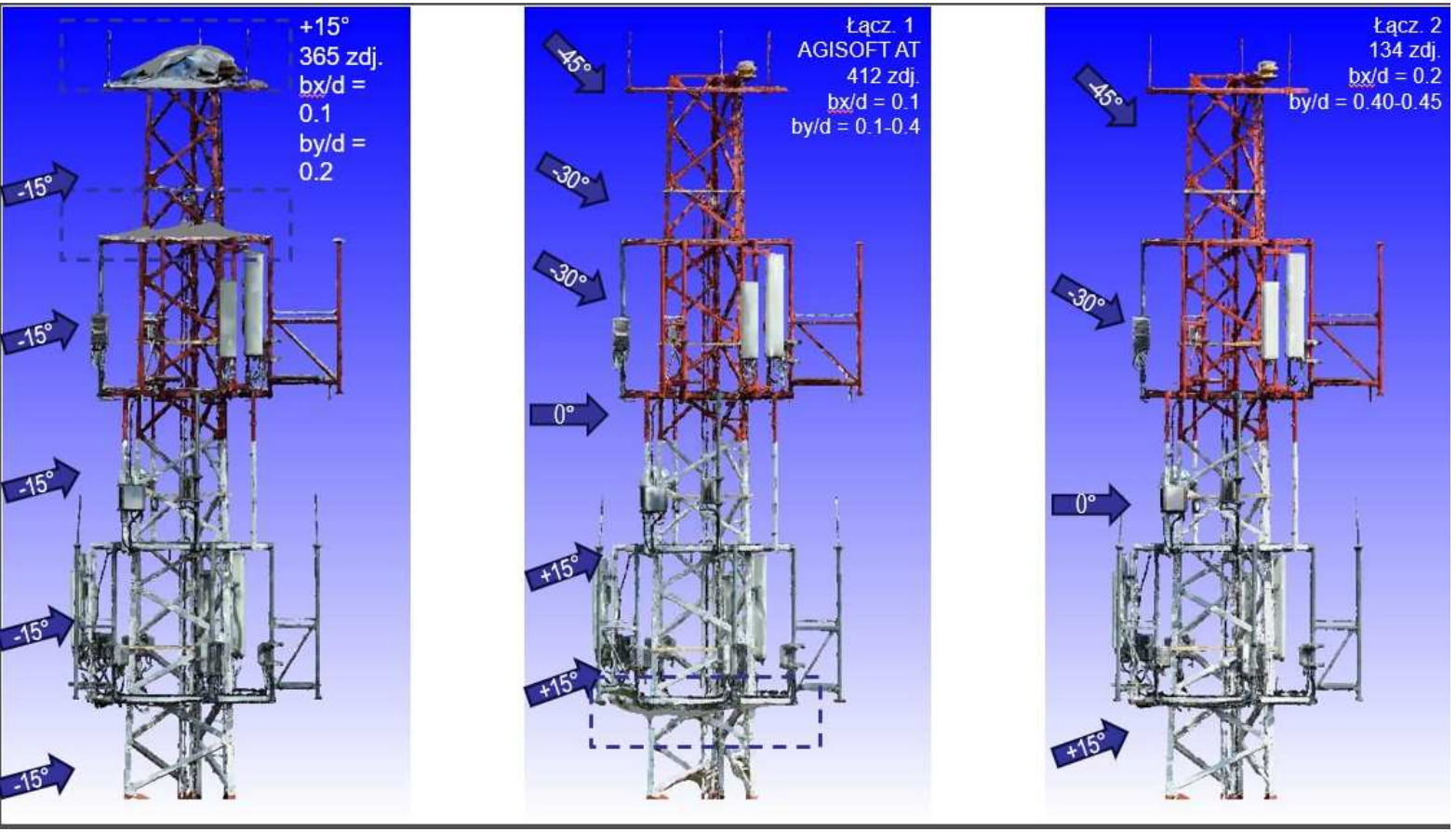
DIM error – 0.5 1.2 cm



Which technology matching vs lidar

- No matter which technology is used, geometrical data should be coloured point cloud - usually images can also collected
- Technology should **minimize obscured areas**
- The methodology, the accuracy, and parameters are related to the purpose; we should select proper processing parameters and the software (different DIM algorithms)
- The crucial is **georeference**

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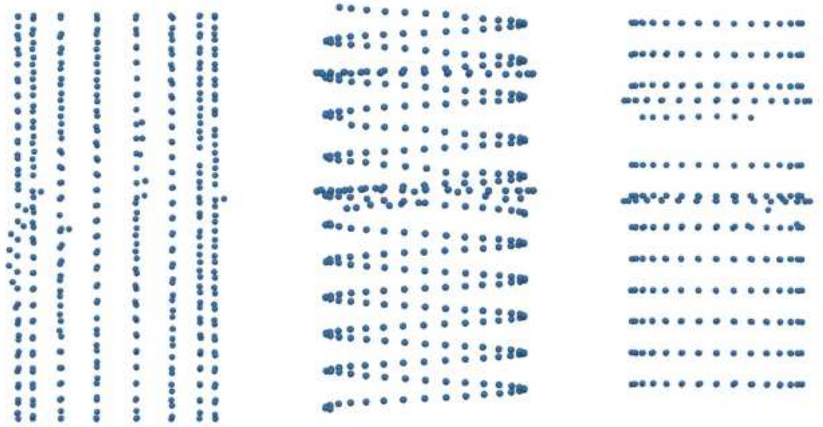
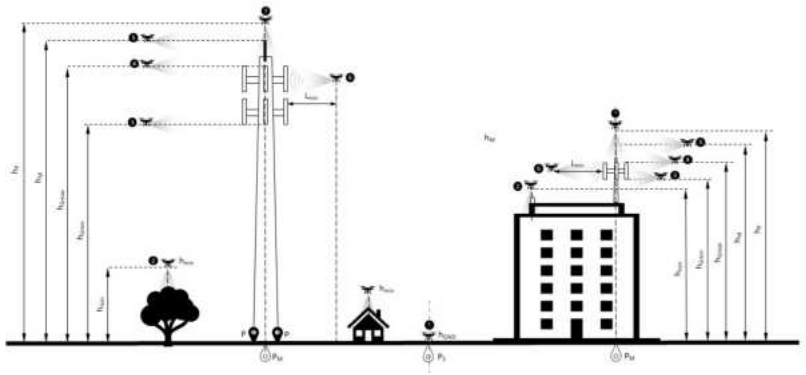
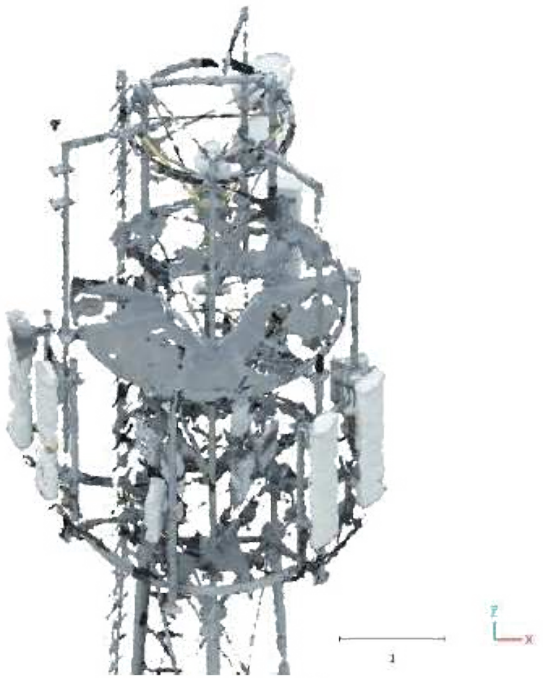




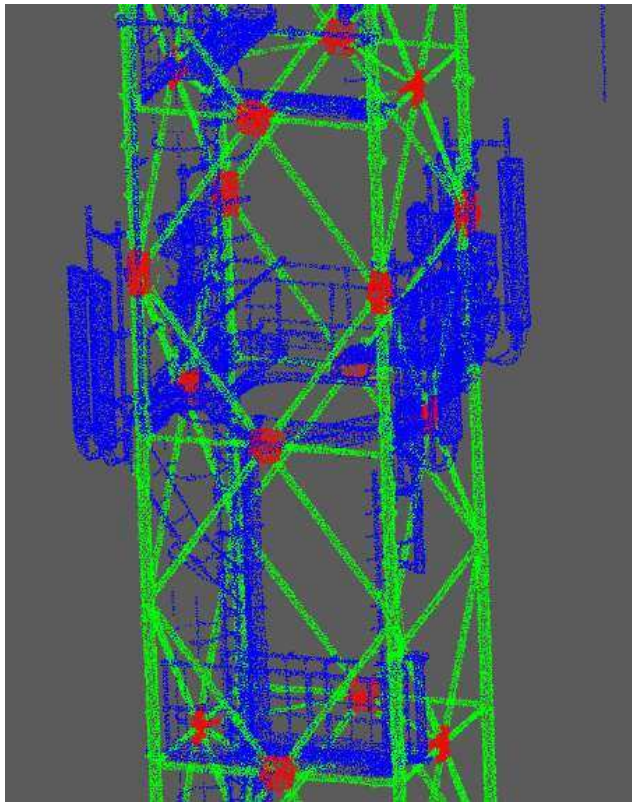

Agisoft Metashape

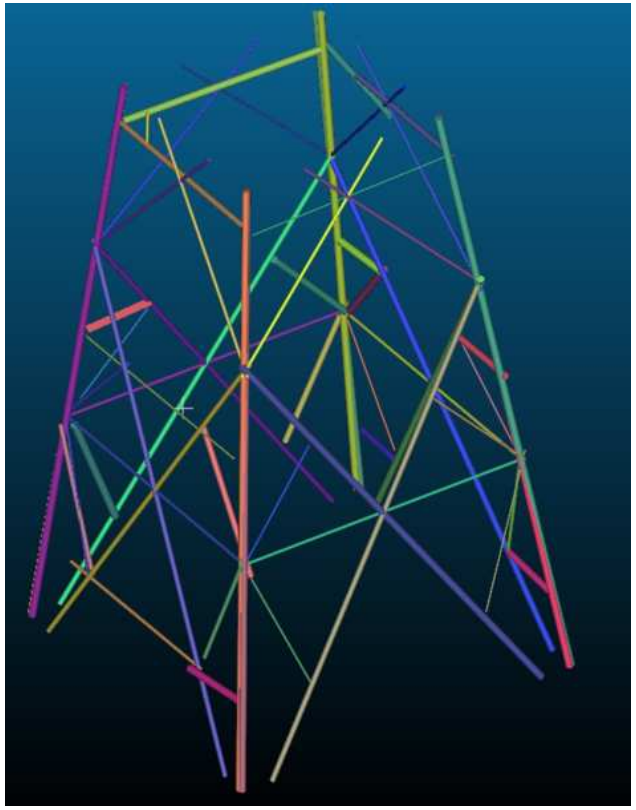

Pix4Dmapper

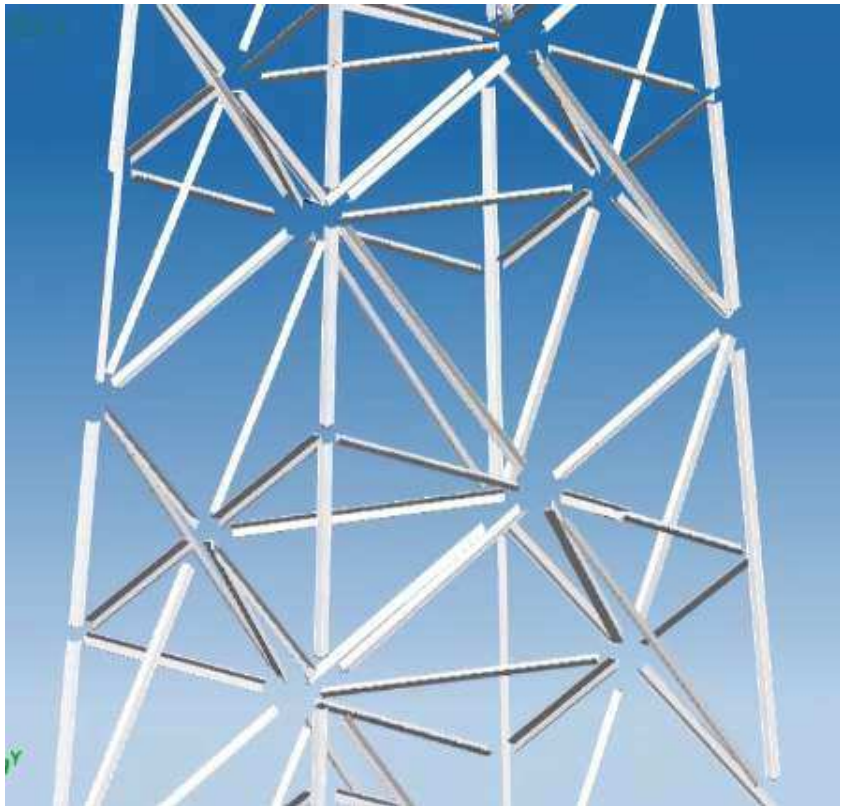

ContextCapture


RealityCapture

Classification / Segmentation / Recognision / Modelling





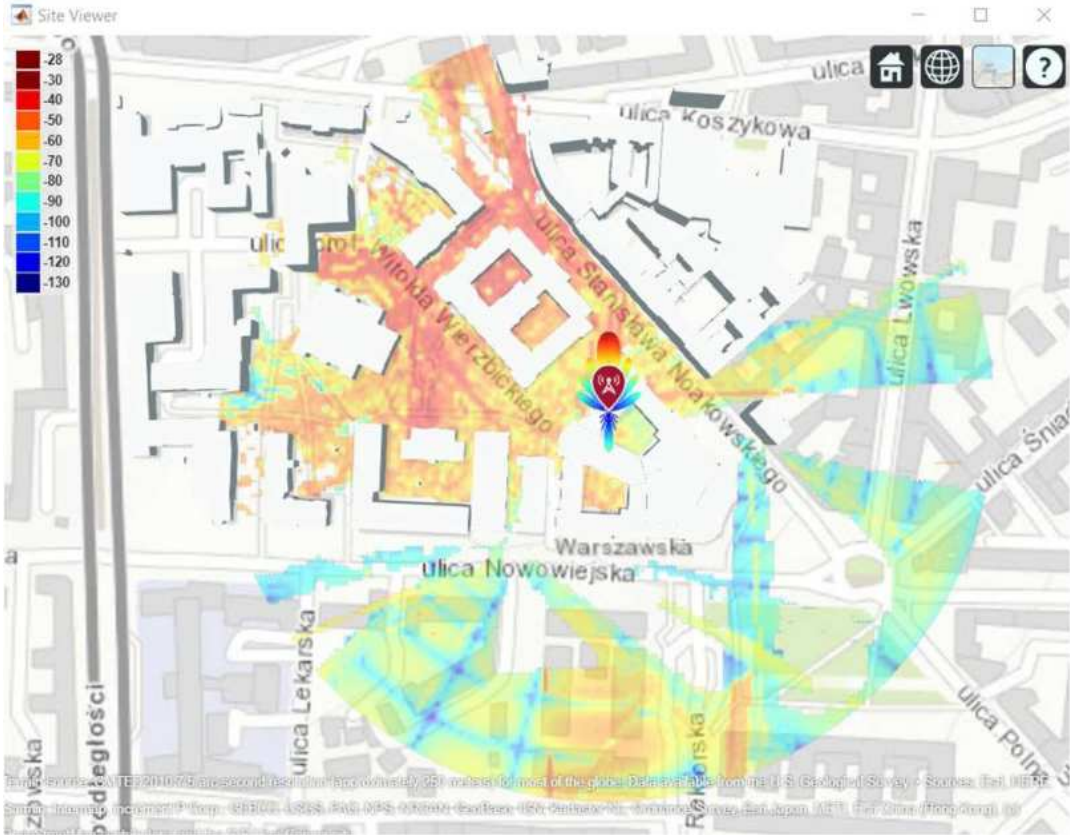


Measurements

- Measurements can be done on mesh model as the first attempt
- Detailed measurement can be performed in georeferenced images

Analysis

- Having the digital twin of the infrastructure allows for many analysis:
  - GIS analysis of selected phenomena propagation (i.e. signal map availability),
  - Management of the infrastructure – adding new elements,
  - Preparing simulations including or excluding some sensors – updating the signal map availability,
  - Verifying the conditions of infrastructure and tagging the elements for direct inventory or change,



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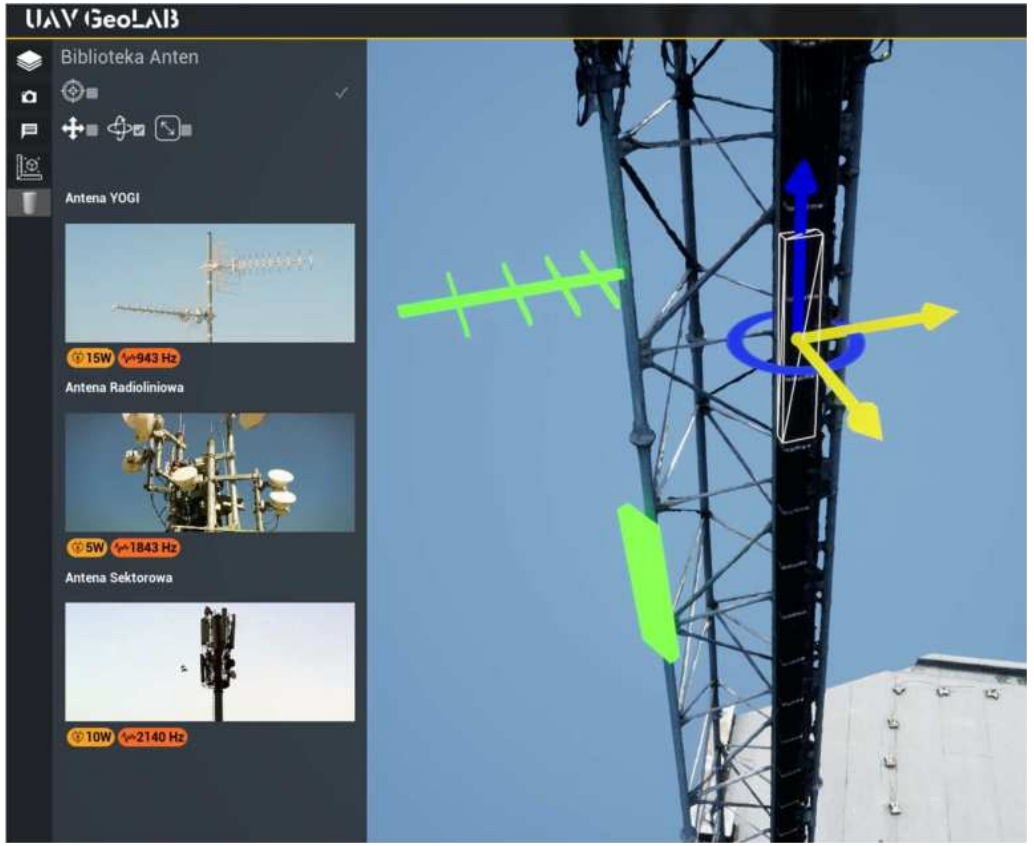
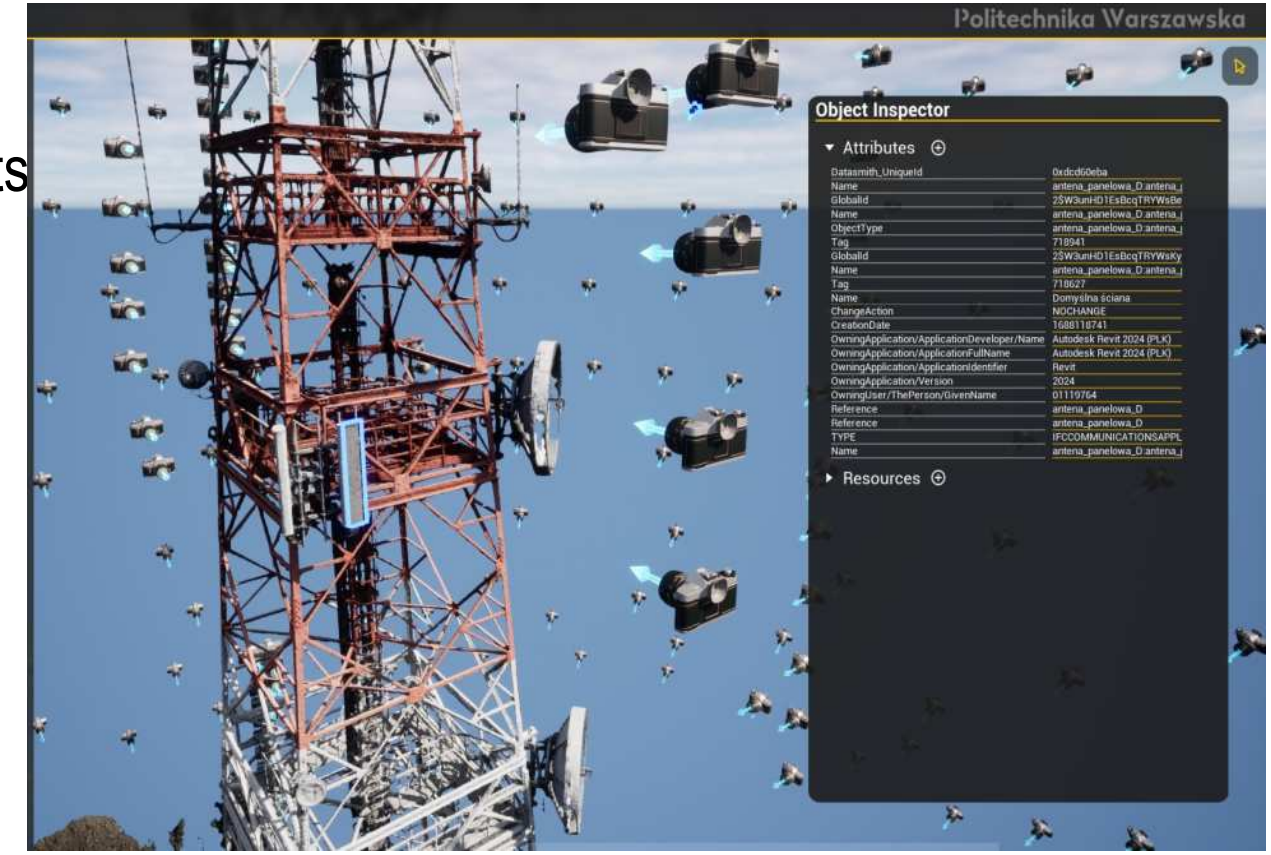


Conclusion

- Hybrid digital twin including solid and mesh model type seems to be the best option using the benefits of both structures
- The role of the model can not be limited to geometry, but can be developed also for navigational purposes
- In digital twin generation proper remote survey data collection and georeferencing is essential



Acknowledgment

- Thanks for Łukasz Wilk, Jakub Modrzewski, Wojciech Ostrowski, Magdalena Pilarska, Paulina Zachar, Przemysław Banat, Adam Kostrzewa and Skysnap team for working together on digital twins and helping preparing the figures and movies

- Presentation parts about digital twins of telecommunication masts were done during works financed within the project “MAST - Digital twin of masts as an innovative inventory service using unmanned aerial vehicles and artificial intelligence”, carried out by an interdisciplinary research team of SkySnap Sp. z o.o. company and Faculty of Geodesy and Cartography of Warsaw University of Technology, financed by the National Centre for Research and Development, grant no POIR.01.01.01-00-0980/20

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