REPORT ON SKILLS-BASED INTERNSHIP

04.09.2026.

Degree Programme, Departmant, University: Erasmus Mundus Copernicus Master in Digital Earth, Paris-Lodron University Salzburg, Université de Bretagne Sud, and Palacký University Olomouc, Geovisualization and Geocommunication

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Declaration

I, Jana Stojsavljević, am providing this statement that this internship report is my original work, and everything reported here is not submitted elsewhere. By this statement I am confirming that everything here is truthfully reported.

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Introduction

This document is providing detailed report on skill-based internship that happend in the GDi Ensemble Global LLC in duration of 8 weeks total in the time period between 02.07.2026.- 27.08.2026. The student position on the internship was GIS and LiDAR Technology Intern – Gdi Ensemble OSS Network Roll-Out Manager. The tasks for this internship that are described in the: What have I done and learn? (Duties and challanges) part of this report are: capturing high-resolution LiDAR imagery and spatial data of telecommunication infrastructure using mobile devices and applications (Scaniverse, SiteScape), field data collection using Field Maps and Survey123, alignment and processing of point-cloud data in CloudCompare, 3D feature modelling and analysis of telecommunication manholes and infrastructure trenches in Esri ArcGIS Pro, preparation of initial process-automation scripts, and the preparation of the accompanying Proof of Work documentation “LiDAR Scanning of Telecommunication Manholes Using Mobile Phones and Their Analysis Using ArcGIS Pro Software.”

Learning and professional objectives

Learning objectives:

1. Knowledge and skills I gained during studies and I want to apply:

- Programming knowledge and dashboard creation (basics).
- Experiences and skills working with LiDAR scanners.
- Experiences and skills working with Mobile GIS applications.

- Skills and knowledge in collecting and analyzing data.
- Skills in 3D modeling and visualization.

2. New knowledge and skills I want to gain:

- Optical network rollout and infrastructure verification processes.
- Modern OSS (Operational Support System) concepts and geospatial solutions are used in telecommunication industries.
- Advanced GIS technologies and spatial data management.
- New knowledge and advanced LiDAR data acquisition, processing, and interpretation.
- Mobile GIS applications and field-data collection workflows (new experiences and skills).
- Metadata extraction and validation processes.
- New 3D spatial modeling and visualization techniques.
- Dashboard creation, spatial analytics, and data visualization methodologies in an advanced and more professional manner.
- Advanced programming skills

Professional objectives:

- Increasing my knowledge in the field of study
- Getting new and improving old skills
- Putting my current skills in use and help out as far as I can
- Learn about working environment

Personal development goals:

- Be able to work in working environment
- Have more knowledge in my field of studies
- Manage time better
- Have more scientific communicational skills
- Be able to present new ideas with ease
- Improve my skills

Statemant on the objectives and goals:

At the end of my internship, I reflected again on all the objectives and goals I wanted to achieve in the first place. In the process of reflecting, I realized that I achieved every objective and goal that was stated before. I, even achieved much more than expected. Through the internship I faced many challenges (described in the next section of this report) that I needed to overcome with this, I learned a lot about patience and self-control. There were times when I wanted to give up, but I pushed hard and I overcame obstacles. That is the one goal that I did not write about, but I think that it is the biggest achievement I reached.

What have I done and learn? (Duties and challanges)

1. Week (29.06.2026.-03.07.2026.)

- Day 02.07.2026

On my first day of the internship, I started with the administrative tasks that needed to be completed before the actual work began. This administrative work is based on some contracts that was needed to be signed. After the administrative work was completed, my supervisor and I discussed the concrete work that I will do.

Discussed work that I need to do was scanning the telecommunication manholes and pipes (if the infrastructure is open, if not just scan the closed manhole) with mobile phone iPhone 12 Pro Max on the 3D scanning applications. After the scanning, the LiDAR scan needs to be uploaded in the ArcGIS environment where it needs to be mapped as the 3D object. The mapped 3D object in the ArcGIS needs to be measurable and in the correct location. The output of this project would be proof of the work document.

In the first iteration of the project, I needed to do the research to see if the given task is feasible or not. Second iteration of the project would be a research where we can find out can we open the application Field maps (ESRI), click on the camera- open the 3D scanning application, scan the infrastructure, upload model form the 3D scanning application to a Field Maps and then put in in the ArcGIS Pro where can we analyze the model and then return the information's back to the Field Maps.

On this project and internship, the main idea was to research and make proof of work documents and then if there was time, think about the automatization of the proof of work and try to implement the same knowledge on the drones.

After discussion and clear goals were made, I started my research. Before coming to my internship, I already researched some of the applications. The chosen applications were Scaniverse, Polycam and StieScape. When I had the applications set, I started by reading about the formats they provided for the export to know what we could do. Everything that I found I recorded in the working document.

- Day 03.07.2026.

On the second day of my internship, I still worked on the formats, but I also took one scan of the interior to see how well the application works. Except formats I also expended my research on the convert of the data, coordinate systems of the applications, types of manholes, possibility of measurements, comparisons between the other mobile phones, LiDAR-s for the android mobile phones etc.

After I described all the formats, I started to work on the next question: Dose the ArcGIS Pro supports them or not? My findings were that the ArcGIS Pro supports the LAS format type.

Explanation of LAS: The LAS file is intended to contain LIDAR (or other) point cloud data records. The data will generally be put into this format from software (e.g. provided by LIDAR hardware vendors) which combines GPS, IMU, and laser pulse range data to produce X, Y, and Z point data [1].

After I figure that the LAS is the only one that is supported, I needed to find the application that will convert the given data.

For the convert of the data, I remembered that for my bachelor's thesis I used the CloudCompare software which provided the convert of the data. The CloudCompare software can also align the data, compare the data, made a mesh out of the data and etc.

Explanation CloudCompare: CloudCompare is a 3D point cloud (and triangular mesh) editing and processing software. Originally, it has been designed to perform direct comparison between dense 3D point clouds [2].

After I had figure out the software, I checked out what was the best format to export if there was not las for exportation in the applications. I decided to go on with PLY format where LAS was not an option. Beside the formats I decided to stop the research for the Polycam application. The reason behind it was that the Polycam is commercial option.

Explanation on the PLY: Polygon File Format is the standard file format for storing 3D Gaussian Splat data. While PLY has been around since the 1990s as a format for storing 3D mesh data, its use in Gaussian Splatting represents a specialized application with unique characteristics and considerations [3].

2. Week (06.07.2026.-10.07.2026.)

In the second week of the internship, I went to the field to measure with the SiteScape application. The survey happened on the Matka Baštijana street in Zagreb, Croatia. There was one open manhole because before that the workers worked on the whole infrastructure (manhole and pipes), but because we came late infrastructure was closed, everything besides that one manhole. We took the scans and went back to the office. On the terrain we saw that there was a plan to dig and work on the other side of the road (other infrastructure), so we decided to come back. In the meantime, we decided to take captures of closed manholes and other holes (Image 1).

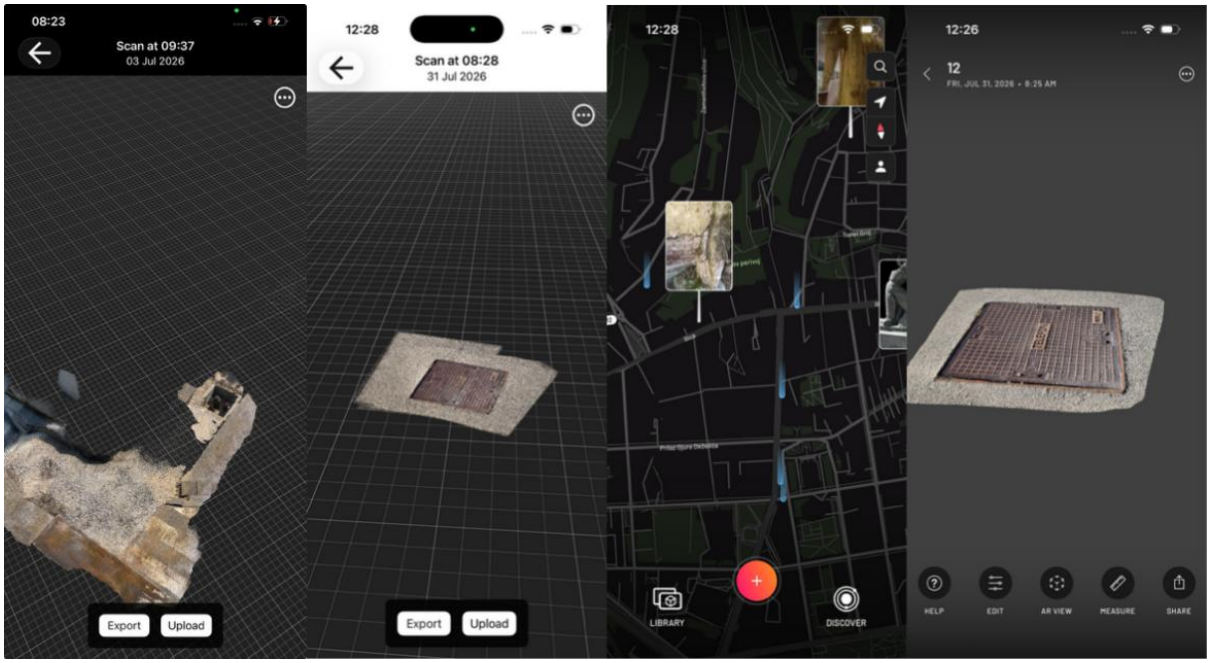


Image 1 Scans from applications

When we went back to the office, we decided to work on the point features first. Because of that I started the captures just with manholes. From the SiteScape 3D application, I decided to export the PLY format and send it to the e-mail address. When I got the e-mail, I took out the capture and put it in the CloudCompare software where I converted it into the LAS. After the convert of data, I put the same converted data into the ArcGIS Pro.

Since I did not work with ArcGIS Pro that often in my previous works, I needed to learn how to input the LAS format of the data. I searched the web and I learnt that for the input of the LAS I need to open geoprocessing tools and find the tool Create LAS Dataset. But before the LAS input, I needed to change the basemap from a 2D map to a 3D map or new local scene. The reason behind this input was in the format of the LAS data, LAS data as we know contains the LiDAR point cloud data with the X, Y, and Z coordinates.

After the input of the data, in the ArcGIS Pro LAS tool, there was a coordinate system input. Usually when the user inputs the data, the coordinate system is imputed by itself. The reason behind that is that the ArcGIS takes the file and reads it. After the reading of the whole file if the file has a coordinate system, software inputs it by default. As we did not have the input of the coordinate system, we could learn that our data does not contain the coordinate system. When I clicked run, the data was successfully imported, but it was placed in the middle of the Atlantic Ocean near Africa.

From that point, I started to have a problem. Because now I need to learn how to align the data, can it be done in the ArcGIS software or not, what coordinate system SiteScape has, etc.

I started figuring out the problem that occurred, I learned that the alignment cannot be done within the ArcGIS environment and that it needs to be done in the other software. As I wrote already, CloudCompare has an alignment process within its environment. The only problem that I had now was with what will I align the point cloud.

For the successful alignment, I needed to have reference points. For the reference points, in this part of study, I made a feature class point in ArcGIS Pro and entered points by myself. After I made points, I needed to insert them and the point cloud into the CloudCompare. When I inserted the data, I was asked by the software will I apply the global shift. The first few times I clicked NO, and after I applied the alignment, the aligned point cloud had distorted itself. What does that mean? Alignment went smoothly, without any problem at all (position is changed) but when the final alignment matrix was applied it distorted itself. By distortion I mean that some points in the point cloud disappeared and point cloud itself become elongated. Now that was another problem, that was needed to be sorted out (Image 2).

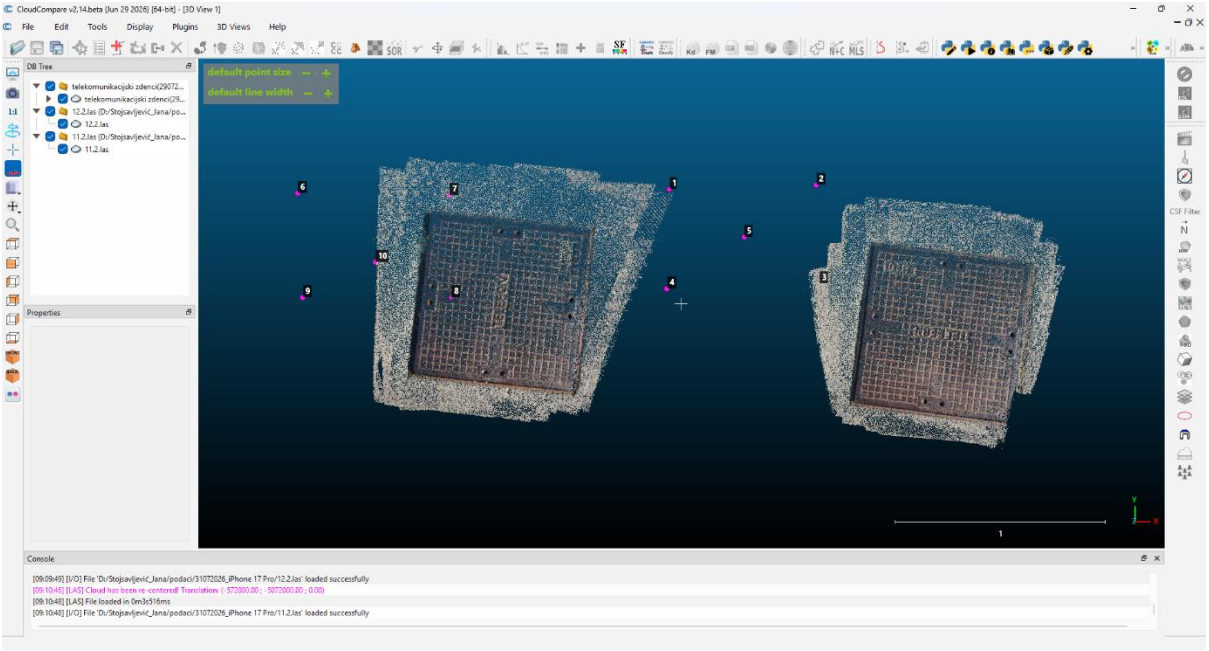


Image 2 CloudCompare alignmant

In the end of the week, I sorted the problem out; the main problem was that the global shift that I did not apply before was actually needed to be applied. The main reason for the global shift in the CloudCompare is that the software works only with local coordinate system. Because of different systems of the data CloudCopare wanted to put them in same to be able to move them without any problem. When I applied the shift, the point cloud and the reference points aligned perfectly.

When I had sorted the alignment of it, I went outside on the field once more to try out Scaniverese application. The interesting contrast between the applications is that the Scaniverse application already has the coordinate system within the application, and it has a LAS format as an output. The coordinate system of the application is WGS84 UTM 33. When I inserted the LAS format that I exported into the ArcGIS Pro, I was

faced with another problem that occurred. This new problem was that the location is indeed correct, but the precision and rotation are incorrect. To solve this I also applied the alignment.

3. Week (13.07.2026.-17.07.2026.)

On the third week of the internship, I was still dealing with the problem of the alignment but I also had the problem with 3D feature classes that I needed to create. After the alignment of the LAS files it was needed to make a 3D features (cubes). The problem was that I did not know how to make them, I figured out that the 3D features needed to be in their own class as the multipatches. When I finally had the cube I also needed the lid of the manhole. For the lid I wanted to take pre-made feature from my college but when it did not work I made it myself. First thing I did was finding the image of it on the internet, after I found it I uploaded the image on the CANVA where I created the butterfly look of it. The reason for the butterfly look of the feature is because that look indicates that the manhole is open. When we have just lid on a feature it means that the manhole is closed but to represent what is inside is to made a butterfly look. When I had the style (png) stored I needed to put it in ArcGIS Pro. Jet again this was new challenge because how to do that know. I figured out that first I need to made a point feature, when I had a point feature I putted it's symbology as the image symbol. After creating it I rotated, sized and move the symbol to the original place (Image 3).

Image 3 Point features

In this week I also documented my progress. Besides the documenting I started to create the internship report.

4. Week (20.07.2026.-24.07.2026.)

In the fourth week I started with transfering some projects from online disk to the local disk. At the moment of transfering the data I figured out that I lost one of the files that I created. After some time of trying to recovered it I figured that it will not work and I crated all from start that was in the file. After the creating the missing file I stated to crate plan for the new survey on the terrain. First thing I did was creating the table of the pre-made reference points that I had from my colleagues. The new table that I crated was the table with coordinates. After the makeage of the table I started to crate the plan for the survey. I had the locations of points and I needed to see what will I survey when. When I divided the points I remembered that we decided to also use the field maps and survey123 applications for the surveying. I found the documentation of two application and I prepared my data in them. After preparing the data I went on the field. I came to the terrain and when I opened my field maps data I saw that I can not see any of the points and that I needed to return to the office. After I returned to the office I started to look for any mistakes that I did when I was preparing the survey. I figured out that the points was left on the unregistered. I registrated the points as the task to me and went back on to the field. While being on the field I figured out that the points I had will not help me a lot since the points was in the middle of the road or not existent. I figure some of the points and I took another manholes while I was out. I returned to the office and send everything to my email. I stated to work on the data that I measured on the field for the detailed analysis (Image 4).

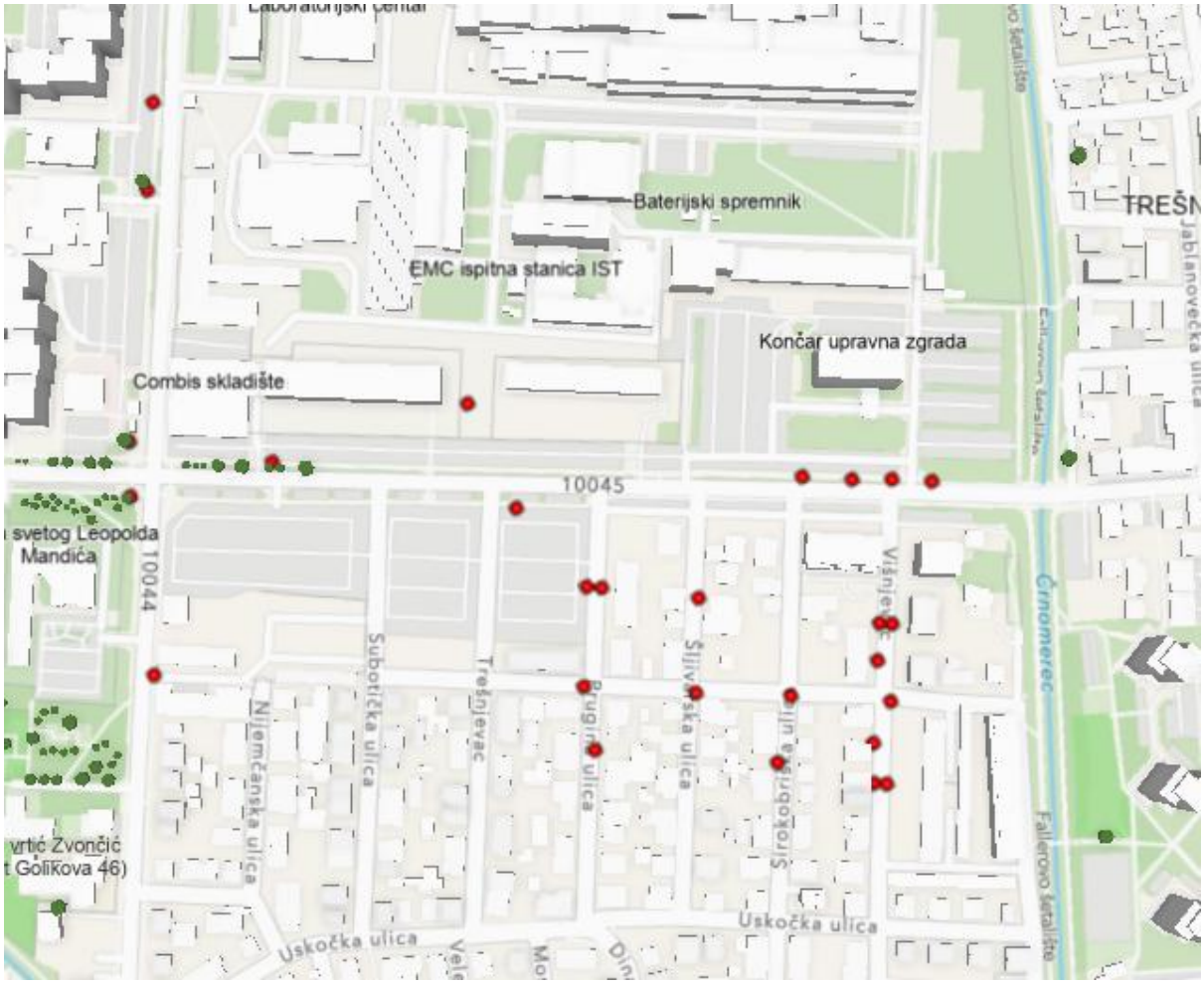


Image 4 Points in the Field Maps

Besides the work I also had the meeting with my supervisor, where we talked about progress and new steps. We also decided to have presentation in following weeks with executives for them to check on my work. We wanted to see if they also had some ideas in what direction should we go next and are we even on the right path. After I returned I crated the presentation but I also decided to make a videos for it to present the workflow in the full form. When I took the all videos I styled them and put them on the presentation.

While I was preparing the presentation I worked on the previously taken data, where I concluded that Scaniverse application is better for usage because it has coordinate system within itself and because of that the analyses is very easier. I concluded that the CloudCompare software is only best for using in the alignment and the cleaning the LAS files. This outcome was created because I also wanted to see if we can made cubes there and put them in ArcGIS. The makeage of cubes was possible but it needed a lot of work when was uploaded to the ArcGIS and then I decided that this way is more work then just create them in the ArcGIS.

5. Week (27.07.2026.-31.07.2026.)

In week five I decided to check for the online link for the Zagreb DOF (digital orthophoto). I found the data on the ZG portal and uploaded it on my project in ArcGIS. With the DOF I could map the manholes better. I concluded that the DOF is good but not perfect because of the resolutions, shades, trees. Then I combined the mapping with taken coordinates from survey and DOF. I figured that the coordinates are not so correct because it was taken with phone which had the accuracy of the 0 to 10 m correctness. I crated the features for all created and mapped manholes and then I created for all the attachment tables. The createage of the attachments table was to made a relationship between the features and LAS files. For the attachments I needed to created new excel table with paths of the LAS files. The attachments was made because the standard relationship is based on the tables which LAS files did not have. With attachment I got all the properties off LAS files. I documented everything and updated the presentation. I send the e-mail where I was asking for the time of meeting and I send the presentation and documentation. I got the meeting date for that friday and I was preparing for it. In the preparation period I was reading the legal documents about the true measurements of telecommunication manholes. I also find out how to open 3D scanning application within the Field Maps application. I learned that I need to use deep linking method for connection. This founding resulted in the first step of the automatization. Beside the learning new staff I cleaned the map, I put new symbology's and I went to measure new manholes. I also started the Proof of Work documentation (Image 5).

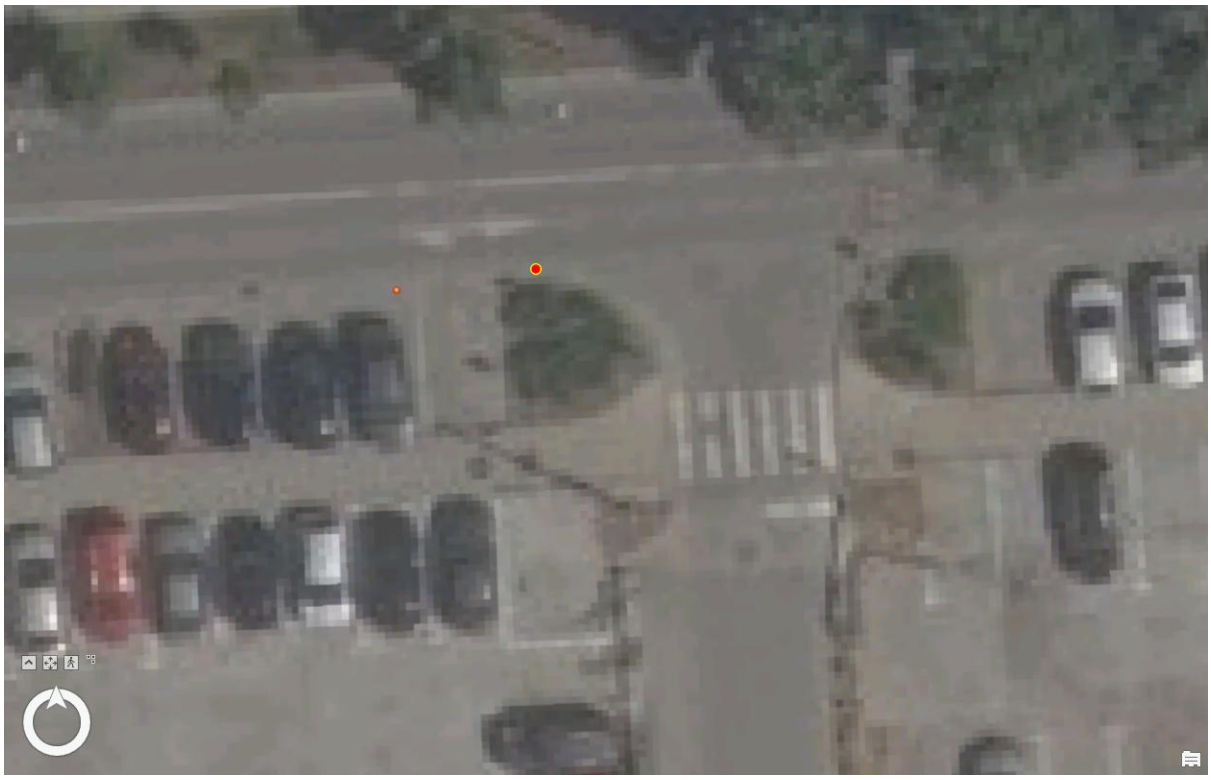


Image 5 DOF Zagreb

Also, in this week my supervisors provided me with iPhone 17 Pro mobile phone, where I will made a survey and see the difference between the two iPhones.

At the end of this week (Friday) I went on the field to try the new phone that I got. In my analysis I saw that the accuracy was far more better then the accuracy on the old phone. The GPS accuracy was within the 1m while the old one was within 5 m. The gotten accuracy was still not good enough as it should but it is very much better then previous one. Afte the scanning took place I prepared everything new and old for the presentation I had that day with my supervisor. In the meeting I presented everything that I already made, they told me what are they thinking, we discussed on the new ideas and they provided me with the materials that will probably help me in the execution of the tasks. After the meeting I watched the video they give me as a reference (Image 6).

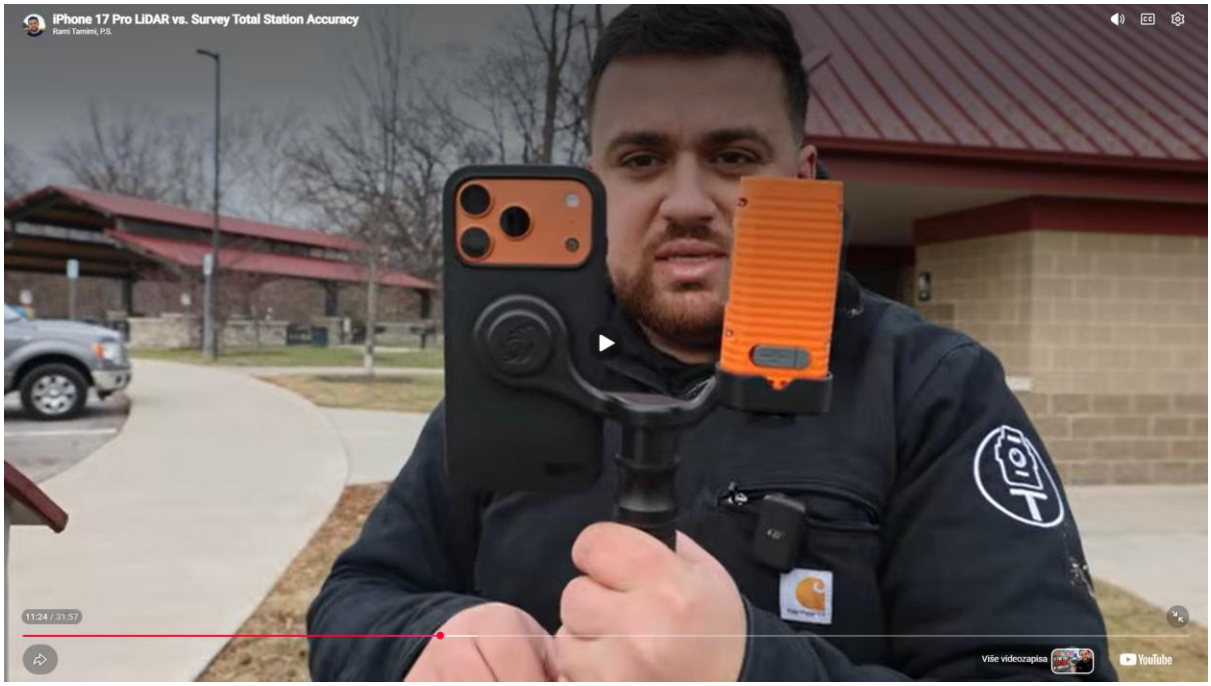


Image 6 Video

6. Week (03.08.2026.-07.08.2026.)

In this week I was dealing with the comments and ideas that I got on the meeting from the last week. On the meeting I got some scripts they worked on as a reference for the theory of the automatization, I needed to provide them with. They gave me a web-page where I can check the current status on the construction works in Zagreb and last thing I got was the already mentioned video where I needed to check the RTK device.

First thing I did was checking on the RTK devices. That was needed to be done because we discussed that we should buy one so we can get better accuracy then one that was provided with mobile phones. After checking of the devices I worked on the scripts that was provided to see what is it and can they be implemented as the parts of the automatization. I found out that automatization is possible but it is needed to be created as it's own project. The automatization of such tasks needs to be done

as the serious programming work, but the provided script is a result of one part of the automatization and it can be changed so that it can execute even more than now.

Besides the checking on the automatization I also finished the table of the properties of devices I used in the field surveying. Also, I took some time and I cleaned all of the ArcGIS projects (maps) I had. I found the problem in the LAS files, usually in the ArcGIS when we put the LAS files inside they has a red bounding box but after some time my LAS files become grey, they had grey bounding box. I find out that the meaning behind this is that my current paths to my original LAS files was invalid for some reason. The solution for this problems was changing the paths to original ones. After change was done they returned to red color. The red color indicated the presence of the points in LAS file which means that I could see the points within the project itself.

After setting every problem, I was trying to find out how to connect the pop-ups of features into one. The reason behind this was that I wanted to made a one pop-up for all feature classes that was actually based on the same feature. Also, I was trying to create tables out of the pop-ups to join them in that way but I am still figuring it out.

In this week I also prepared two surveys that will take place. Based on the web-page information and information form the people I learnt that the construction works on the gas and water pipeline was taking place in some areas in Zagreb. Since we needed for the research any type of underground infrastructure I took them as the reference. I found out that one of them was near the office and I took some time to go there to check if I can survey something but the problem was that the infrastructure was already covered. I returned to the office and I kept working on the preparations for the other two locations. Besides the prepartions, I took some time to create the metadata for all the layers I had.

At the end I was trying to figure out how to project LAS files from one coordinate system to other. The geoprocessing tool for this was called Project LAS (Image 7), in the tool we need to put our LAS file, the coordinate system we wanted to project to and the folder where our new LAS file will take place. After the running of it new file was created in the folder. We put the new file in the project and we compared the properties of the new and old files. In the properties we could see that the coordinate system is indeed changed also there we could find the extant which was our control did it really projection went trough.

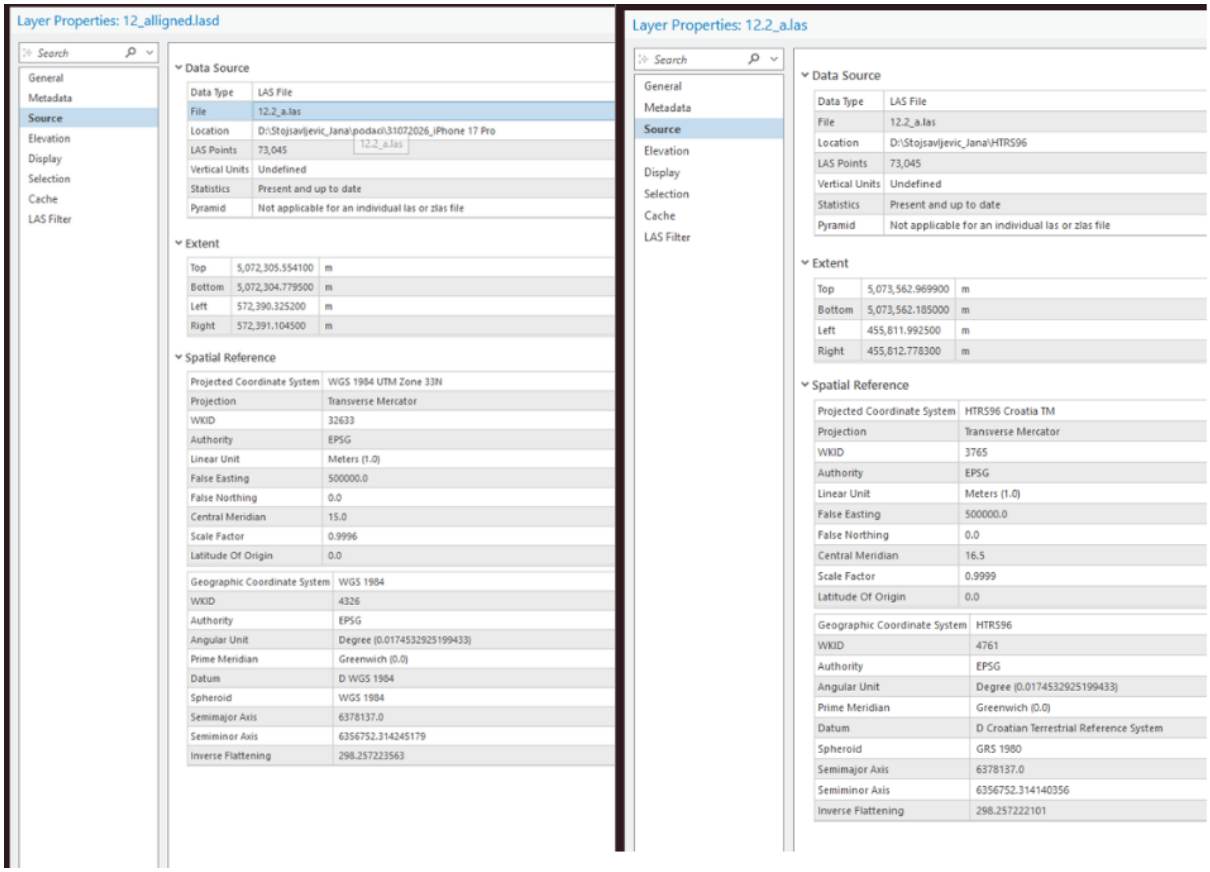


Image 7 Projection

I also created new project in the ArcGIS Pro and I created the new feature layers as the preparation for new data and I prepared for the worst case scenario if every infrastructure would be already covered on the web-pages I already mention there was also planned works and I found new locations that will go in the reconstruction.

With everything I also worked on the Proof of Work document.

7. Week (10.08.2026.-14.08.2026.)

On the seventh week of my internship I was trying to find the open trench for executing the survey on underground infrastructure. This was needed to be done because that was the next step in our research project. But there was problem in the execution of such task because all of the works that was on the underground infrastructure within the city was already done or in the last phase of works which was not good for our project. After some time of researching on the problem I found the dry stream bed (Image 8) near the office, I asked my supervisor should I then take a scan of it insted since we could not find anything else. My supervisor told me that I can take a scan of it since we need something that has approximately same shape that will help us research further.

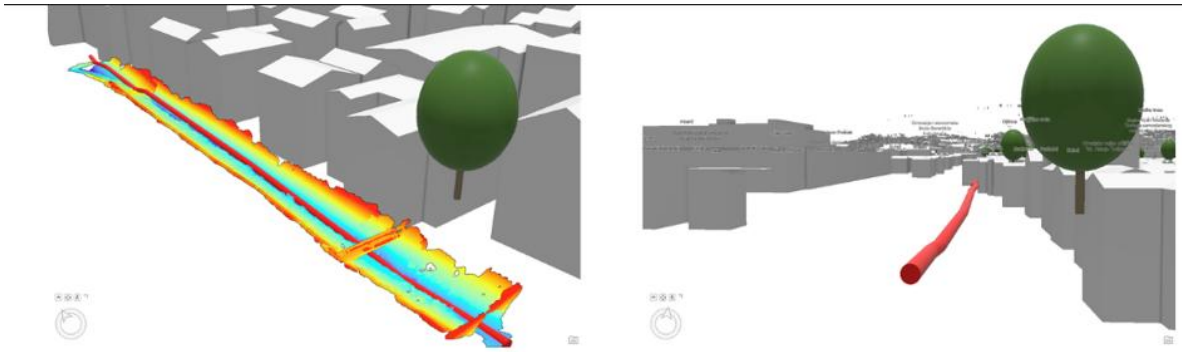


Image 8 Stream bed

I prepared everything for the measurements, I inspected the terrain I made a map and next day I went on the field where I performed the surveys. After the surveys were done I came back to the office to do the analysis on them. I had a hard time to align the scans because whole stream bed was executed into three scans which was needed to align and join. I executed the joints and alignment eventually and I figured out that next time I need to be aware of the surroundings to execute aligning far more quicker.

After the execution of alignment I inserted everything into the ArcGIS Pro were I made all of the next analysis. Also I decided to change the symbology of the line into the tube, because I wanted to made an example how the infrastructure should look like. Since I took the scans from both phones that I have I also made a comparison between them. In the second half of the week I decided to do more of the automatization and I worked on the automatization of the alignment (Image 9). I found out that most of the parts can be automated while the alignment by itself can not. The reason for it was that I had reference points and LAS file that need to be combined. I also worked on the attribute tables (Image 12) manually and on the final Proof of Work documentation where I put everything that I was working on up until now. Since I finished almost everything that we settled on the meeting (at least the thing I could finished) I also decided to gave everything to my supervisor to see what else can it be done. Since I started with the automatization at least the some research state of code I wanted to check should I keep going in that direction and in what direction I should go next.

Image 9 CloudCompare CLI

Beside the technical part of it I also was finishing the metadata for all of my layers that I had. Also I decided to delete layers that I did not have and did not work anymore. Also I made a list of all the features we need in ArcGIS once the research phase is completed. I also made them in the ArcGIS Pro.

I was also checking if the models are measurable as the point ones was and I found out that the models are indeed measurable. The measurements went good becasue the differences was not so big. But also all of the differences that was in the model we could say that was because of the alignment process there was some uncertainties.

8. Week(17.08.2026.-21.08.2026.)

On this week, I started with the consultations with my supervisor because I was stuck with the work, meaning I finished everything we talked about and could not think of anything to do anymore. My supervisor provided me with guidance and we decided to check can we determine the objects within the trench, meaning could we figured out the pipes or other objects just from LAS point cloud.

Since in previous trench we did not have the object we decided to took two days to go back on the field and took the scan of my trench in my yard (Sv. Ivan Zelina). The trench was made because we had a broken water pipe that was needed fixing. Meanwhile, my father also helped me to go to another construction site where he was working and where was one more trench (HRT). My father needed to help me because the construction site was guarded and I could not enter it withought announcement first but since he was working there he could help me enter. Between scanning on two different sites I also found public construction site where the city just started

reconstruction of gas pipes (Ivana Brlić Mažuranić street) so I took opportunity and scan that too. When I had all of the scans I came back to the office (Image 10).

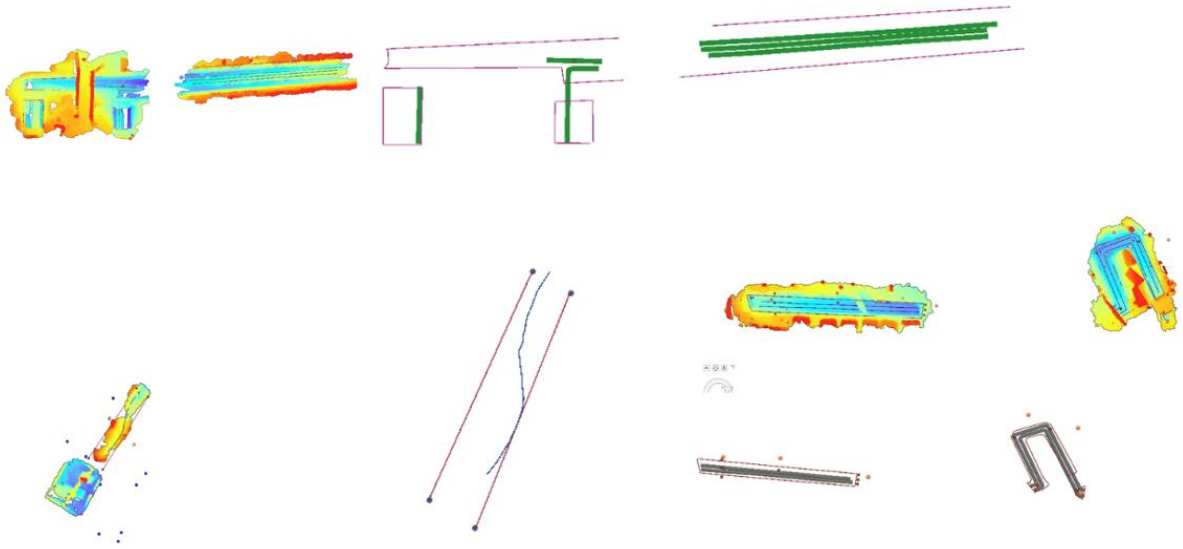


Image 10 Trenches

In the office I downloaded all of the data and I started to align it and convert it to a LAS files. Firstly I converted and aligned all of the HRT and Sv. Ivan Zelina trenches with the reference points I made before. After the alignment I inputed everything in the ArcGIS Pro, after finishing with the first two construction sites, I worked on the last one that was in the Ivana Brlić Mažuranić street in Zagreb. I also put that one in the ArcGIS Pro and I started to analyse them.

9. Week(24.08.2026.-28.08.2026.)

On the last week of my internship I was making the final presentation for my supervisor and executives, I finished the analyse of the trenches I sitll had and I started to made an atribute line object table (Image 12). After all of that I rewrite Proof of Work document and I putted everything new in it. Troughtout all of the weeks I also worked on the Work log where I keeped the track of project (Image 11).

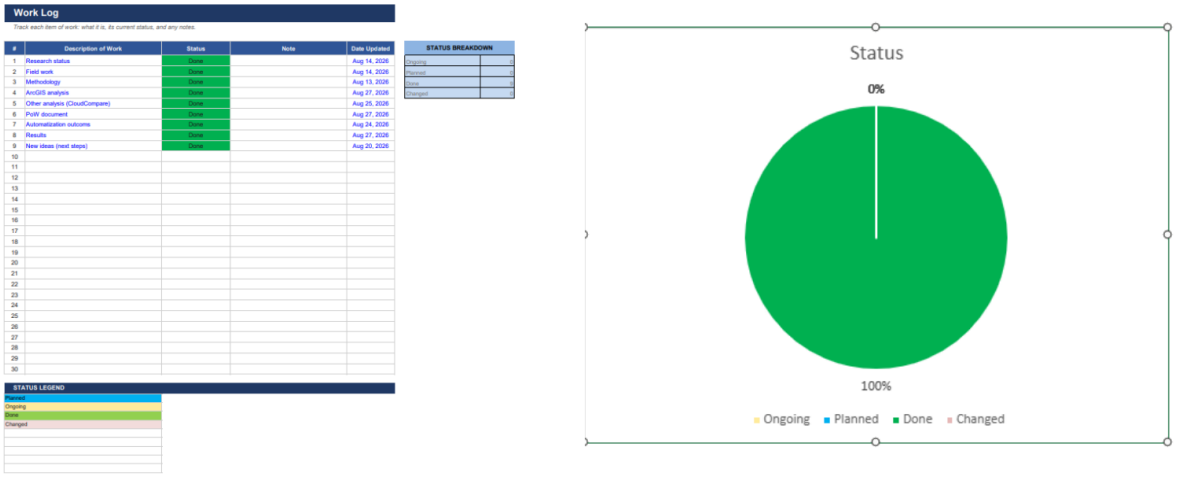
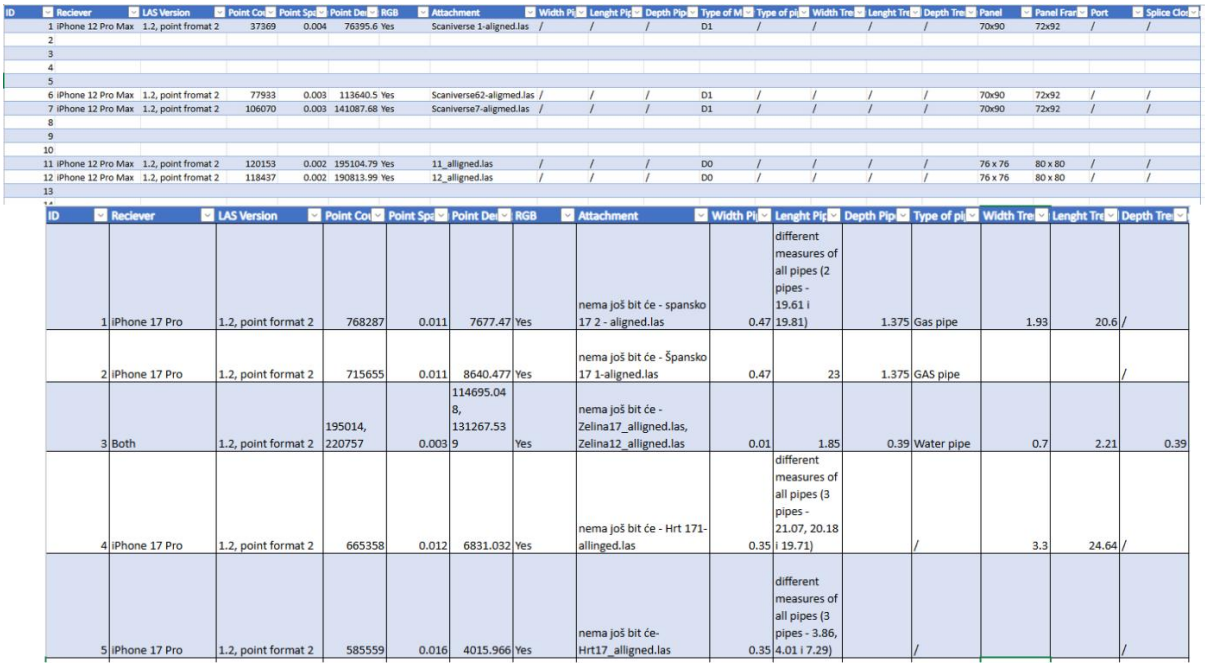


Image 11 Work Log

At last days, I started preparing the project folder to give out to my supervisor which I finished the day after. On my last day I had presentation and reflectens on my work, me and my supervisor also worked on the comfiramtion documentation that he needed to provide me with.



ID	Reciever	LAS Version	Point Co	Point Sp	Point De	RGB	Attachment	Width Pi	Lenght Pi	Depth Pip	Type of M	Type of pi	Width Tre	Lenght Tr	Depth Tre	Panel	Panel Fra	Port	Splice Clo
1	iPhone 12 Pro Max	1.2, point fromat 2	37369	0.004	76395.6	Yes	Scaniverse 1-aligned.las	/	/	/	D1	/	/	/	/	70x90	72x92	/	/
2																			
3																			
4																			
5																			
6	iPhone 12 Pro Max	1.2, point fromat 2	77933	0.003	113640.5	Yes	Scaniverse62-aligmed.las	/	/	/	D1	/	/	/	/	70x90	72x92	/	/
7	iPhone 12 Pro Max	1.2, point fromat 2	106070	0.003	141087.68	Yes	Scaniverse7-aligmed.las	/	/	/	D1	/	/	/	/	70x90	72x92	/	/
8																			
9																			
10																			
11	iPhone 12 Pro Max	1.2, point fromat 2	120153	0.002	195104.79	Yes	11_alligned.las	/	/	/	D0	/	/	/	/	76 x 76	80 x 80	/	/
12	iPhone 12 Pro Max	1.2, point fromat 2	118437	0.002	190813.99	Yes	12_alligned.las	/	/	/	D0	/	/	/	/	76 x 76	80 x 80	/	/
13																			

ID	Reciever	LAS Version	Point Co	Point Sp	Point De	RGB	Attachment	Width Pi	Lenght Pi	Depth Pip	Type of pi	Width Tre	Lenght Tr	Depth Tre
1	iPhone 17 Pro	1.2, point format 2	768287	0.011	7677.47	Yes	nema još bit će - spansko 17 2 - aligned.las	0.47	different measures of all pipes (2 pipes - 19.61 i 19.81)	1.375	Gas pipe	1.93	20.6	/
2	iPhone 17 Pro	1.2, point format 2	715655	0.011	8640.477	Yes	nema još bit će - Špansko 17 1-aligned.las	0.47	23	1.375	GAS pipe			/
3	Both	1.2, point format 2	195014, 220757	0.003	114695.048, 131267.539	Yes	nema još bit će - Zelina17_alligned.las, Zelina12_alligned.las	0.01	1.85	0.39	Water pipe	0.7	2.21	0.39
4	iPhone 17 Pro	1.2, point format 2	665358	0.012	6831.032	Yes	nema još bit će - Hrt 171-allinged.las	0.35	different measures of all pipes (3 pipes - 21.07, 20.18 i 19.71)		/	3.3	24.64	/
5	iPhone 17 Pro	1.2, point format 2	585559	0.016	4015.966	Yes	nema još bit će-Hrt17_alligned.las	0.35	different measures of all pipes (3 pipes - 3.86, 4.01 i 7.29)		/			/

Image 12 Attribute tables

Self evaluation and reflection

Through this internship I learned a lot about 3D applications, GIS systems and analyzing the data. I gained new and tightened old abilities that I had. I have experienced the work environment and learned a lot of communication and presentation skills. I learned about patience and good time management. I challenged my project management skills and I also learned or even better, I pushed myself in asking for help when I needed it and questions when I had it. In the past, that liability

would be hard for me because I always thought that if I asked something stupid or said something that I did not know, people would laugh at me. But throughout this internship I learned that I should not be scared of not knowing something and asking. I learned that all the new knowledge that someone is providing you with is happy that it can share what he/she knows.

I am very proud of myself that I learned new things, and I personally think that I did a pretty good job. I gave everything that I had and more. I am happy about the outcome and I hope that I will have the opportunity to work with this team again.

Recommendations for future interns

For future interns, interning at this or any other company, I would say give everything you have. Do not be scared to ask or learn, because we learn throughout our whole life. Do not be worried if you learn slower than others, as long as you try and work hard. It does not matter if you learn it in 2, 3 or 5 days. Be patient and expect new inputs that someone will provide you with. Inputs are here for help, not for criticizing. Do not forget to have fun and keep positive energy.

Conclusion

In conclusion, I finished all the tasks that were given to me. I also did a bit more than expected. I loved working at the company and I would like to work more with them if I had the chance in the feature. I learned a lot and experienced a lot. I think that these types of internships are a very good start in the professional world.

References

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JANA STOJSAVLJEVIĆ

INTERNSHIP COMPLETION REPORT

Student	Jana Stojsavljević
Study Programme	Copernicus Master in Digital Earth, Paris-Lodron University Salzburg, Université de Bretagne Sud, and Palacký University Olomouc
Host Institution	GDi Ensemble Global LLC
Internship Location	Matka Baštijana 52a, Zagreb, Croatia
Internship Period	2 July 2026 to 27 August 2026 (8 weeks)
Position	GIS and LiDAR Technology Intern, GDi Ensemble OSS Network Roll-Out Manager
Supervisor / Mentor	Antonio Antičević, Senior OSS Specialist

1 Purpose of this report

I'm writing this as Jana's mentor to confirm that she completed her eight-week internship at GDi Ensemble Global LLC and to summarize what she actually worked on, what she produced, and how she performed. The internship confirmation letter signed back in June set out the plan; this report is meant to close the loop and give the university a real picture of how it went, not just that it happened.

2 Background and objectives

Jana joined us through her Copernicus Master in Digital Earth programme. Her assignment was tied to a question we've been circling internally for a while: can mobile phones with built-in LiDAR sensors replace, or at least usefully supplement, traditional surveying when we need to verify that underground telecom infrastructure (manholes, cable ducts, trenches) has been built the way it was designed. This is not an abstract exercise for us. Proof-of-work verification is part of the workflow in our GDi Ensemble OSS Network Roll-Out Manager product, and anything that makes that verification faster or cheaper in the field has real value for our clients.

Rather than hand her a narrow, fully pre-scoped task, we gave her a research brief: use consumer LiDAR-capable phones and free or low-cost scanning apps, work out which combination of tools produces usable, measurable 3D data, and build a practical pipeline from a field scan to a georeferenced, measurable feature in ArcGIS Pro. How she got there was largely up to her, which is the point of this kind of internship.

It's probably worth explaining briefly what GDi Ensemble does, for anyone reading this outside the company. We build GIS-based operational support systems for telecom, utility and infrastructure operators, on top of Esri's ArcGIS technology, and the GDi Ensemble OSS platform is used by network operators to plan, build and manage their infrastructure. Jana's project sat inside that world: a genuinely open question about a tool we don't currently use, evaluated with the same rigor we'd apply to any internal proof of concept.

3 What she actually did

She logged 320 working hours over the two months, in line with the programme's requirement, and kept a weekly work log throughout, which is what most of this summary is reconstructed from.

Weeks 1 to 2: getting oriented

The first two weeks went into installing tools and mapping out the landscape. She went through the scanning apps available on iOS and Android (Scaniverse, SiteScape and Polycam) and compared what each one exports: PLY, E57, FBX, OBJ, GLB, LAS, PTS, XYZ, USDZ, among others, and which of these ArcGIS Pro can actually work with. She also worked out the commercial side of each app (Scaniverse and SiteScape are free to scan with,

Polycam charges for exports past ten captures), which mattered for deciding what we could realistically recommend later. Alongside that she installed and started learning ArcGIS Pro, ArcGIS Online, Field Maps, Survey123 and CloudCompare, none of which she had hands-on experience with before starting.

Weeks 2 to 4: first scans and the alignment problem

Once she had a working setup, she scanned a manhole cover on Marijana Baštijana street. The scan landed roughly in the right place, but the object came into ArcGIS Pro rotated incorrectly. Her first assumption was that the app was at fault, so she reran the same test under different conditions on Frana Kušana street and got a clean result. Comparing the two, she worked out that the issue wasn't the app or a coordinate-system conversion problem. It was the scanning conditions at the first site: more traffic, taller buildings, and trees interfering with the sensor. That's a reasonable bit of independent troubleshooting for someone two weeks into these tools.

From there she spent real time on the alignment workflow itself: bringing point clouds into CloudCompare, pulling reference points off Zagreb's official orthophoto (DOF), and aligning scans by hand before exporting to LAS for use in ArcGIS. She noted, correctly, that reference points placed by eye without a real GNSS source drift once checked against the orthophoto, and once she started using DOF-derived reference points consistently the alignment error dropped from roughly 0.20 m to around 0.05 m. She flagged this kind of limitation honestly in her working notes rather than glossing over it, which I appreciated.

Weeks 4 to 6: fieldwork

This stretch was harder logistically, mostly because we don't get to choose when a telecom trench happens to be open near us. Jana had to be resourceful. She used the City of Zagreb's public works tracker to identify active reconstruction sites, scanned a dried-up riverbed as a stand-in for a trench when nothing better was available, and, when a water pipe happened to burst at her family's weekend property near Sv. Ivan Zelina, used the resulting open trench as an actual field scan target. She also got access to a genuine telecom trench at HRT through a personal contact. None of that was in the original plan; she arranged it herself.

During the same period she surveyed construction sites at Vukomerec street, Selska street, and Ivana Brlić Mažuranić street (Špansko), with mixed results. A couple of sites were paved over before she could get there, which is a normal risk of this kind of fieldwork and not something either of us could have prevented.

On 30 July we gave her a second test device, an iPhone 17 Pro, so she could compare LiDAR performance against the iPhone 12 Pro Max she had been using up to that point. The newer phone produced noticeably cleaner, denser point clouds, especially in the Špansko trench scans, which ended up being her strongest dataset for the analysis that followed.

Weeks 6 to 8: analysis, automation, and write-up

In the final stretch she pulled everything together. She built 3D feature classes in ArcGIS Pro for the manholes and trenches, with separate symbology for open and closed manhole covers and pipe geometry derived from the line features, and ran her measurements against the dimension ranges set out in the Croatian regulation on cable duct construction (concrete shafts roughly 60 to 110 cm wide and 80 to 100 cm deep; plastic shafts of similar width; mini-shafts down to 30 cm). Where her measured deviations were small, a few centimeters in length, width or depth, she attributed them correctly to the precision of manual point-picking rather than a flaw in the method.

She also looked into automation, which was more of a stretch goal than something we expected her to fully solve in eight weeks. Going in, there was already a partial ArcGIS CLI script that our colleague Vjekoslav Aleksić had written earlier. Jana wrote a new script of her own for the CloudCompare side, covering data import, cleanup and export, and got real use out of Claude.ai while working through parts of it. Both scripts still need refining before they cover a full pipeline end to end. She worked out, correctly, that full automation is blocked less by technical difficulty and more by the fact that Esri's Field Maps and Survey123 don't currently support launching a third-party scanning app and getting data back automatically. She tested deep linking as a partial workaround: it works through Field Maps' info field, but not through Survey123, which only accepts standard http links for that purpose. She also worked out a way to attach LAS files to ArcGIS feature classes using match tables and the Enable/Add Attachments tools, since LAS datasets don't carry their own attribute tables and a direct relationship class wasn't possible.

She closed out the internship by writing up her Proof of Work document, cleaning up her working notes, writing metadata for the layers she published to ArcGIS Online, and preparing a final presentation for the team.

4 Results and outputs

By the end of the internship she had produced:

- A documented, working pipeline for turning a mobile LiDAR scan into a georeferenced, measurable 3D feature in ArcGIS Pro
- A practical comparison of Scaniverse, SiteScape and Polycam for this use case, with a clear recommendation: Scaniverse, mainly because its built-in coordinate system cuts the alignment work down significantly compared to SiteScape
- Scanned and processed data for manholes and trenches across five sites in Zagreb, plus the Sv. Ivan Zelina site, captured with two different devices for comparison
- ArcGIS Online layers with proper symbology for open and closed manhole covers, published with metadata for the rest of the team to reuse
- A working log kept throughout the internship, which made it easy to see what she had tried, what worked, and what didn't
- A formal Proof of Work document (v1.0) summarizing the goals, methodology, results and next steps of the research

5 Challenges and how she handled them

The single biggest constraint on this internship was access to open trenches. We can't schedule construction work around a research project, and more than once a site she was planning to scan got backfilled or paved before she reached it. She responded to that by widening her search for substitutes rather than waiting it out, which is exactly the right instinct for fieldwork like this.

On the technical side, GPS accuracy on a standard phone came up as a recurring limitation, typically 1 to 10 meters off and around 5 meters in most of her measurements against the Zagreb orthophoto. She looked into what a professional GNSS receiver would add here, including reviewing a comparison video on iPhone 17 Pro LiDAR versus a survey total station and a Bad Elf GNSS receiver, and flagged that the company may want to test a proper RTK device in future work rather than relying on phone GPS. That's a sound recommendation and one we'll likely follow up on.

She also ran into a case early on where she wasn't sure whether a rotation error came from the scanning app or from ArcGIS Pro's coordinate conversion. Rather than guessing, she reran the test with the original coordinate system preserved and used the comparison to isolate the actual cause. I'd rather see that kind of controlled re-test than a quick guess, and it's a habit worth keeping.

6 Skills and competencies gained

Jana came in with a solid academic GIS background but limited hands-on time with the specific tools we use day to day. Over eight weeks she got genuinely comfortable with ArcGIS Pro and ArcGIS Online, including geoprocessing tools she hadn't used before (Create LAS Dataset, Project LAS, Calculate Geometry Attributes, Enable Attachments and Add Attachments) and with Field Maps and Survey123 for field data collection. She learned CloudCompare essentially from scratch, including point cloud alignment, cleanup and the Global Shift handling that trips up a lot of first-time users. She also built a working, practical understanding of coordinate systems, going from not really thinking about WGS84 UTM 33N versus HTRS96/TM to catching coordinate-system mismatches herself.

Beyond the individual tools, she got real exposure to how a telecom infrastructure verification workflow needs to work in the field, not just on paper, and to writing technical documentation that someone else on the team can actually pick up and follow.

It's also worth mentioning the less technical side of this. She worked mostly independently, which means she had to manage her own schedule around fieldwork that depended on things outside her control (open trenches, weather, other people's construction timelines) and coordinate with me on what to prioritize when a planned site fell through. That's a real project-management skill, not just a GIS one, and she handled it without much hand-holding from me.

7 My assessment

Jana was reliable and easy to work with. She showed up prepared, asked good questions when she was genuinely stuck instead of guessing, and was honest in her notes about what didn't work, which I value more than a write-up that only shows the successes. The fieldwork limitations this summer were mostly outside her control, and she handled them well by finding her own workarounds rather than waiting for us to hand her a solved problem.

If I had one piece of feedback, it would be to build in more time for the automation side earlier on, since it turned out to be a bigger topic than either of us expected going in. That's a scoping note for future internships on our side, not a criticism of her work.

I'd be glad to have her back for a longer engagement if the opportunity comes up, and I'm confirming that she completed the internship in full and met the objectives set out at the start.

8 Confirmation

I confirm that Jana Stojsavljević completed an eight-week internship at GDi Ensemble Global LLC, from 2 July to 27 August 2026, in the position of GIS and LiDAR Technology Intern, under my supervision, that she logged the full 320 required working hours, and that the work summarized above was carried out to my satisfaction.

GDi Ensemble Global LLC
www.ensembleoss.com

INTERNSHIP COMPLETION CERTIFICATE

Confirmation of Completed Internship Activities

Student: Jana Stojsavljević

Study Programme: Copernicus Master in Digital Earth

University / Institution: Joint Master 'Copernicus Master in Digital Earth' at Paris-Lodron University Salzburg, University of South Brittany, and Palacký University Olomouc

Internship Host Institution: GDi Ensemble Global LLC

Internship Location: Matka Baštijana 52a, Zagreb, Croatia

Internship Position: GIS and LiDAR Technology Intern – GDi Ensemble OSS Network Roll-Out Manager

Internship Period: 2 July 2026 – 27 August 2026 (8 weeks)

Internship Supervisor: Antonio Antičević, Senior OSS Specialist, GDi Ensemble Global LLC

Summary of Completed Work

During the internship, the student researched and implemented the use of LiDAR technologies within the GDi Ensemble OSS Network Roll-Out Manager solution. Work included capturing high-resolution LiDAR imagery and spatial data of telecommunication infrastructure using mobile devices and applications (Scaniverse, SiteScape), field data collection using Field Maps and Survey123, alignment and processing of point-cloud data in CloudCompare, 3D feature modelling and analysis of telecommunication manholes and infrastructure trenches in Esri ArcGIS Pro, preparation of initial process-automation scripts, and the preparation of the accompanying Proof of Work documentation "LiDAR Scanning of Telecommunication Manholes Using Mobile Phones and Their Analysis Using ArcGIS Pro Software." A detailed description of the internship activities, methodology, work log, and results is provided in the preceding sections of this report.

Certification

I, the undersigned Internship Supervisor, hereby confirm that the above-named student has satisfactorily completed the internship activities described in this document.

For GDi Ensemble Global LLC (Internship Supervisor):

Name: Antonio Antičević

Position: Senior OSS Specialist

Signature: _____

Date: 27.08.2026

1

GDi Effective Solutions
GDi Ensemble Global d.o.o.

Student:

Name: Jana Stojsavljević

Signature: _____

Date: 27.08.2026

GDi Ensemble Global LLC
www.ensembleoss.com

CONFIRMATION OF WORKING HOURS

Employee Timesheet — July, August 2026

Name and surname of employee: Jana Stojsavljević **Supervisor:** Antonio Antičević

July	Week 1 (29.06-03.07.2026)		Week 2 (06.07-10.07.2026)		Week 3 (13.07-17.07.2026)		Week 4 (20.07-24.07.2026)		Week 5 (27.07-31.07.2026)	
	Reg.	OT	Reg.	OT	Reg.	OT	Reg.	OT	Reg.	OT
Monday	0	0	8	0	8	0	8	0	8	0
Tuesday	0	0	8	0	8	0	8	0	8	0
Wednesday	0	0	8	0	8	0	8	0	8	0
Thursday	8	0	8	0	8	0	8	0	8	0
Friday	8	0	8	0	8	0	8	0	8	0
Saturday	0	0	0	0	0	0	0	0	0	0
Sunday	0	0	0	0	0	0	0	0	0	0
Total per week	**16**	**0**	**40**	**0**	**40**	**0**	**40**	**0**	**40**	**0**

July Total: Regular Working Hours	176	July Total: Overtime Work	0

August	Week 1 (03.08-07.08.2026)		Week 2 (10.08-14.08.2026)		Week 3 (17.08-21.08.2026)		Week 4 (24.08-28.08.2026)		Week 5	
	Reg.	OT	Reg.	OT	Reg.	OT	Reg.	OT	Reg.	OT
Monday	8	0	8	0	8	0	8	0		0
Tuesday	8	0	8	0	8	0	8	0		0
Wednesday	0	0	8	0	8	0	8	0		0
Thursday	8	0	8	0	8	0	0	0		0
Friday	8	0	8	0	8	0	0	0		0
Saturday	0	0	0	0	0	0	0	0		0
Sunday	0	0	0	0	0	0	0	0		0
Total per week	**32**	**0**	**40**	**0**	**40**	**0**	**32**	**0**	**0**	**0**

August Total: Regular Working Hours	144	August Total: Overtime Work	0

Mandatory working hours: 320 Regular working hours: 320 Overtime hours: 0 **Total: 320**

Certification

I, the undersigned Internship Supervisor, hereby confirm that the working hours recorded above are accurate and that the student has fulfilled the required number of working hours for this internship.

For GDi Ensemble Global LLC (Internship Supervisor):

Name: Antonio Antičević

Position: Senior OSS Specialist

Signature:

Date: 27.08.2026

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