GS18 I: How GNSS with Visual Positioning Changes the Game for Surveyors

A Q&A with the Experts

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What if … ?

Asking “what if” removes limitations and barriers. It compels us to think creatively and challenge assumptions.

And so the question we are asking you to consider is:

“What if your GNSS RTK rover could see?”

Note: This document is based on a webinar presented Sept. 17, 2020. To view the full webinar, visit https://hxgn.biz/GS18questions.

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The reason we're asking this question is because of the **Leica GS18 I – the world's first GNSS RTK rover with integrated visual positioning technology**. The sensor fusion in the GS18 I allows you to measure hundreds of points in minutes, reach previously inaccessible points, and capture points from a safe distance, all with a remarkably simple workflow.

Essentially, the GS18 I GNSS RTK rover can see.

But what does this really mean for surveyors – for your business?

Our team of product managers and support engineers here in the US and Canada didn’t just speculate. They took the GS18 I out into the real world and put it to the test on several applications that have previously been limiting for GNSS.

This document walks through some of the most common questions we’ve received about the GS18 I and shares some of our own discoveries on the “what if” journey.

Subject Matter Experts

***Bob Kilburn** has a surveying background that encompasses many roles both in the field and office. He began his career as a Marine field artillery forward observer, then spent some time as a rod man and crew chief before moving into technology support and training for surveying equipment and software. Bob served as the Leica Geosystems survey sales and support representative in Wisconsin for the last five years and has recently taken on the role of product manager for the U.S. In this capacity, he is focused on listening to your ideas, needs, and challenges to help find solutions that make your job easier and more productive.*

***Ted Miller** is the software development product manager for Leica Geosystems in North America, where he has worked for the past 12 years. He focuses on helping professionals get the most out of their technology so they can be more successful in their business. Ted studied surveying at Ferris State University and has more than 15 years of surveying experience, including 3D modeling from photogrammetry.*

***Tim Kerr** has been directly involved in the surveying and mapping profession since 1970. He was awarded a B.S. in Surveying from Ferris State University in 1981 and an M.S. in Geodesy from Purdue University in 1984. He was licensed as a surveyor in the State of Michigan in 1983. Tim's career with Leica Geosystems Inc. (Wild Heerbrugg Instruments at the time) began in February of 1985. During his time with the company he has served in many capacities, including support, training, sales and product development. Today he serves as senior support engineer, where he applies his skills to helping surveyors maximize their technology investment.*

Bob Kilburn

Ted Miller

Tim Kerr

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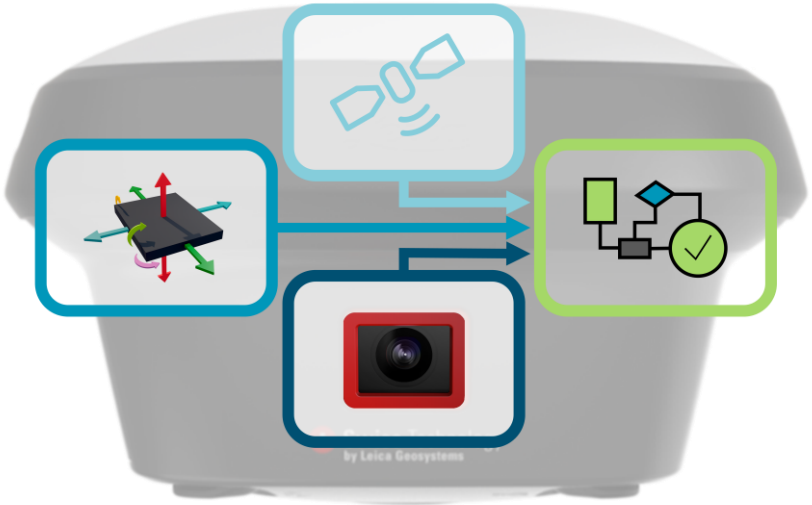
What is GNSS with visual positioning?

Merge Tech

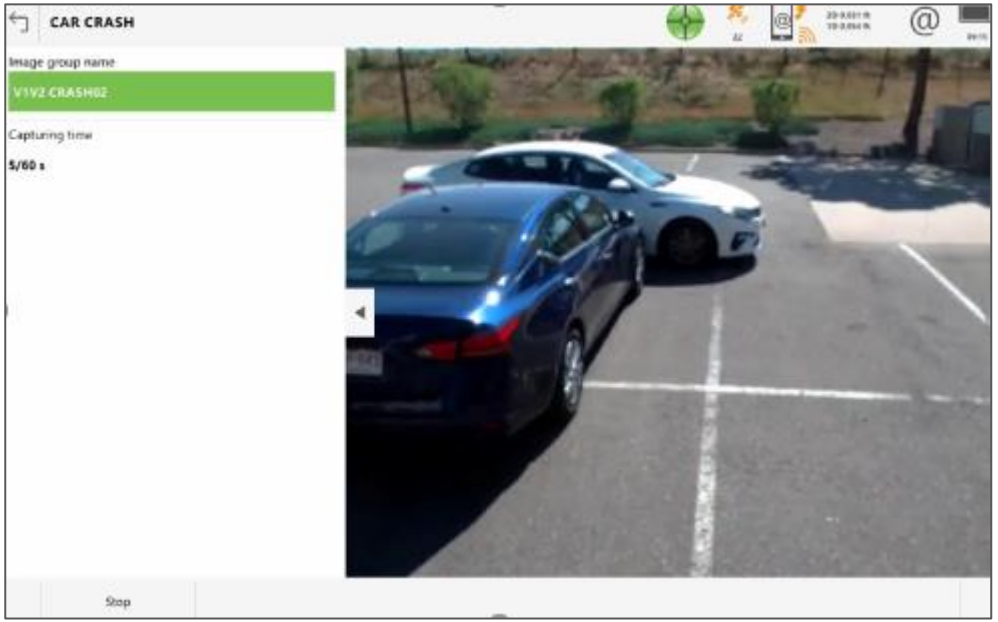
The visual positioning in the GS18 I is true sensor fusion, integrating:

- GNSS
- Inertial measurement unit (IMU)
- Imaging sensor
- Processing in the field in Leica Captivate, which enables points to be created and digitized in near real time, and in the office in Leica Infinity software.



Captivate GS Imaging – Capture Image Group

To capture an image group, simply start walking with the instrument. The GS18 I collects images at a rate of one image every half second.



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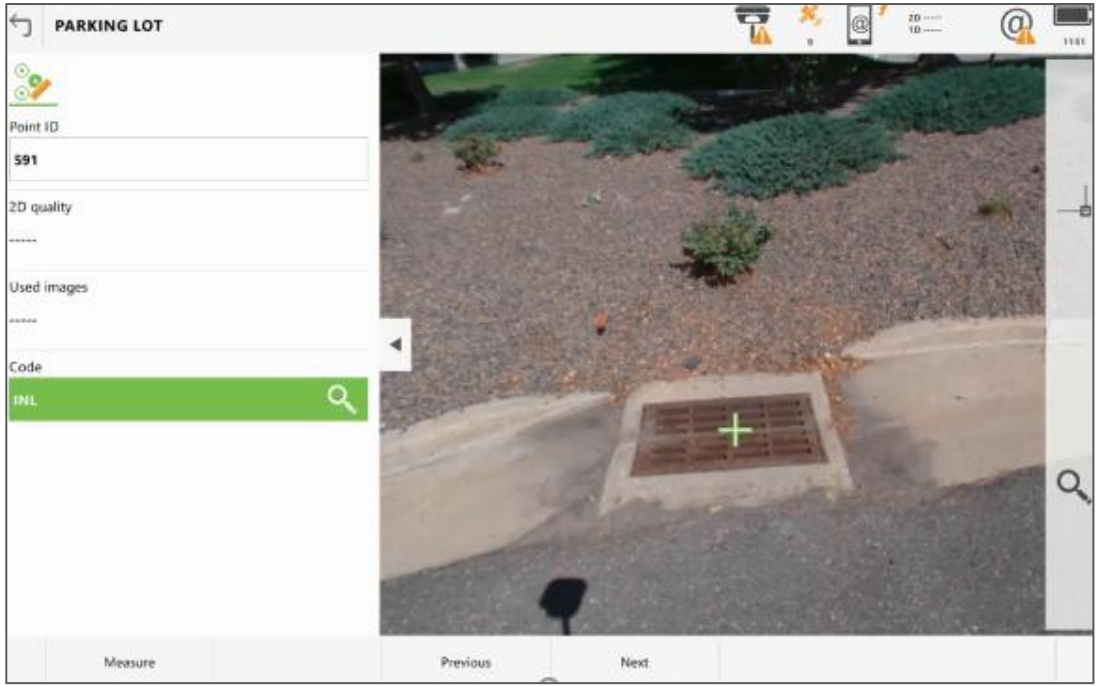
Captivate GS Imaging – Measure in Images

To measure a point or feature selection inside Captivate in the field, we go into the image group and move through until we find the image that has the feature we would like to select or create a point on. We can give it a code and point number. Then, we select that feature inside the image. We can move that selection to where we want it and tell it to measure. The software will give us the 3D quality and tell us how many images were used and whether it meets our predefined QC values.



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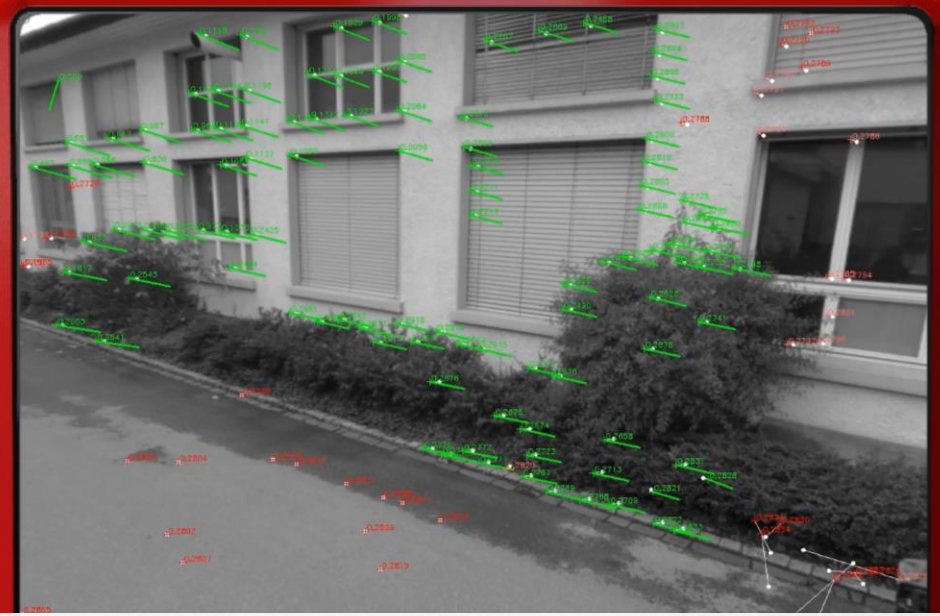
How is the GS18 I different from what has been available in the past?

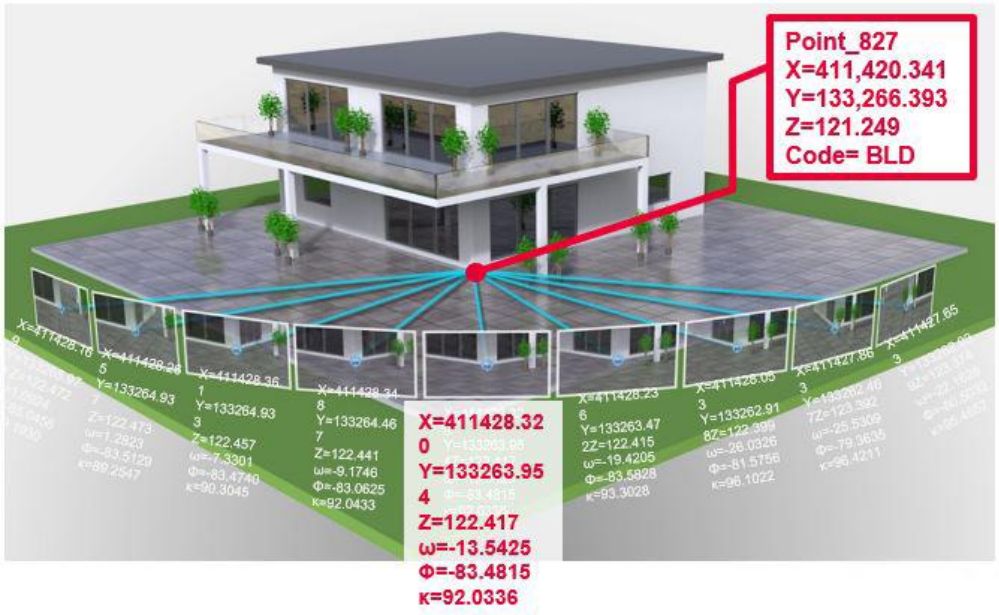


The difference is the true merge technology, or sensor fusion—the seamless integration of the IMU, GNSS and imaging sensor. Where previous imaging sensors have captured static images, the GS18 I provides a dynamic solution. This is similar to the visual inertial system (VIS) technology that is used in the Leica RTC360 laser scanner to position the sensor. With the GS18 I, the approach is used to automatically identify objects from one image to the next. Watch the video clip

Sensor Fusion for Survey-Grade Accuracy

The GS18 I captures images as we walk at a normal pace around an object. Because it combines an IMU with GNSS, it captures not only the X,Y,Z, but also the pitch, heave and roll. That allows us to position images with six degrees of accuracy. When we select a certain feature that we would like to measure, the software knows to select that same pixel or feature in other images, compute the intersection, and create an X,Y,Z at that point that we can also code separately.

As long as the object of capture is within the specified 2 to 10 meters from the instrument (approx. 6 to 30 feet), the 2D accuracy will be 2 to 4 centimeters, and the 3D accuracy will be 3 to 5 centimeters.



Is the GS18 I a replacement for LiDAR?

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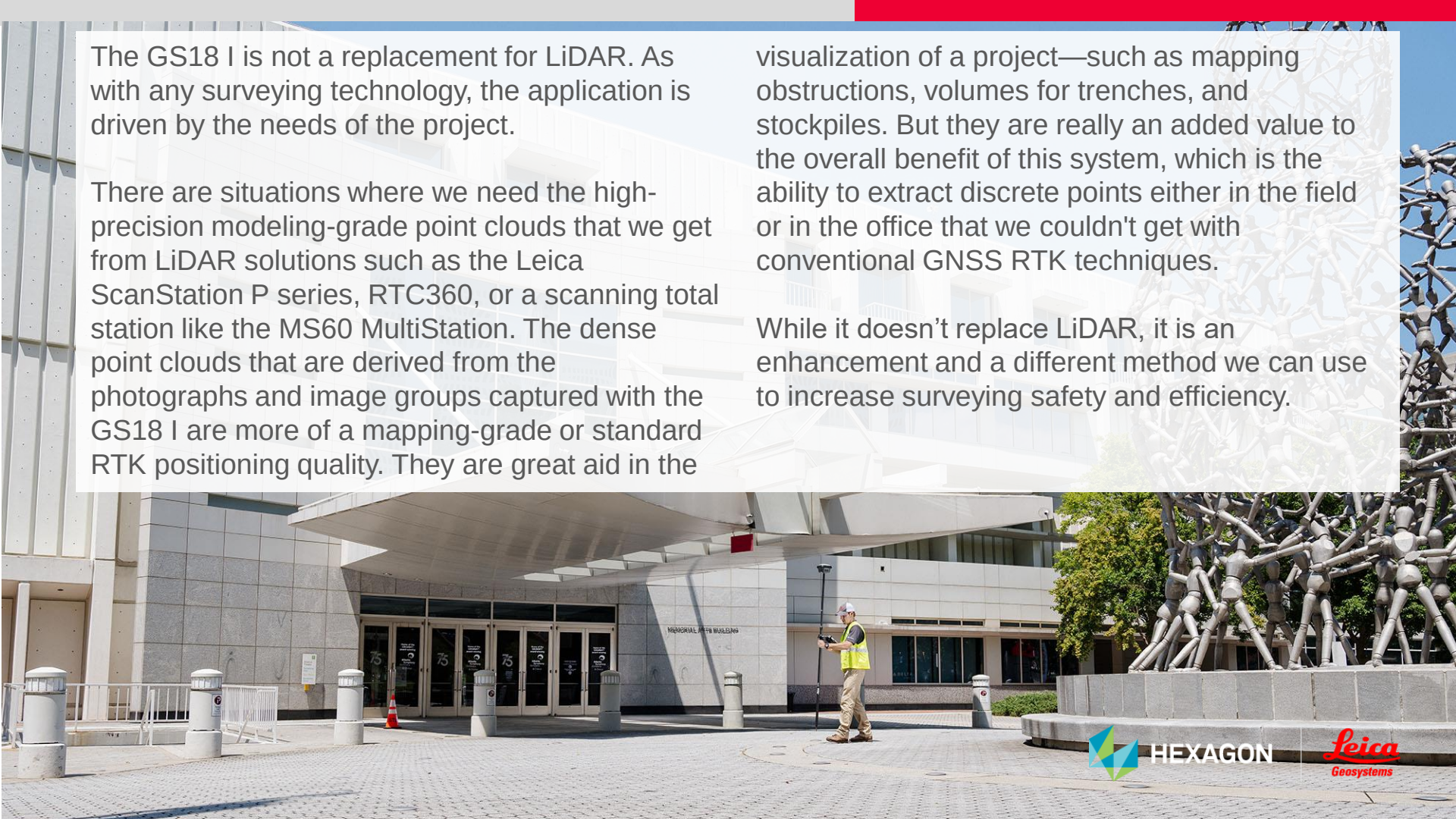
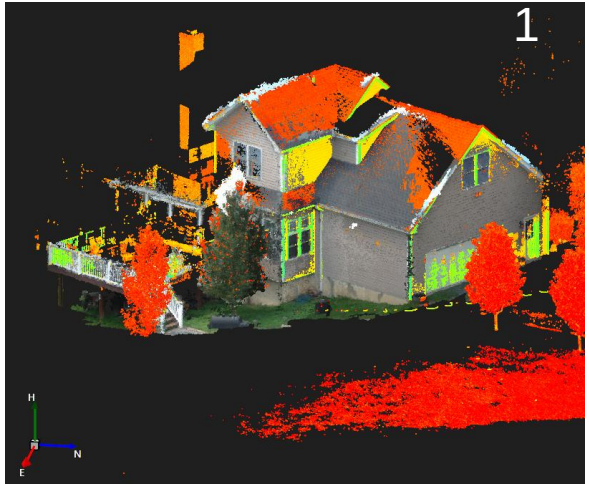
The GS18 I is not a replacement for LiDAR. As with any surveying technology, the application is driven by the needs of the project.

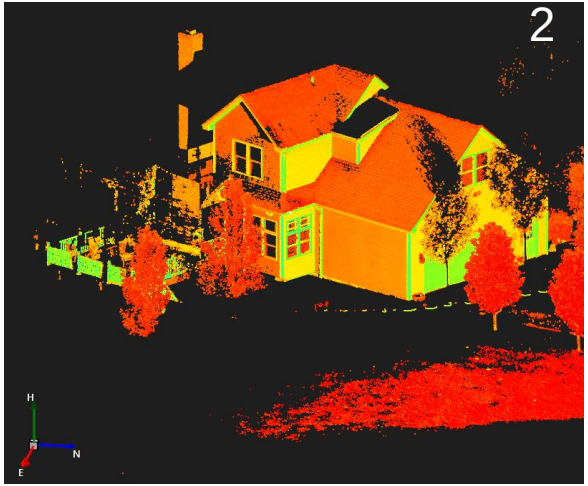
There are situations where we need the high-precision modeling-grade point clouds that we get from LiDAR solutions such as the Leica ScanStation P series, RTC360, or a scanning total station like the MS60 MultiStation. The dense point clouds that are derived from the photographs and image groups captured with the GS18 I are more of a mapping-grade or standard RTK positioning quality. They are great aid in the visualization of a project—such as mapping obstructions, volumes for trenches, and stockpiles. But they are really an added value to the overall benefit of this system, which is the ability to extract discrete points either in the field or in the office that we couldn't get with conventional GNSS RTK techniques.

While it doesn’t replace LiDAR, it is an enhancement and a different method we can use to increase surveying safety and efficiency.



GS18 I / MS60 Point Cloud Comparison





1. A point cloud from a GS18 I image group processed at full resolution.

2. A point cloud from an MS60 MultiStation. Note that this is a true LiDAR point cloud and is much sharper and crisper because it was captured at high precision rather than created from an image.

3. An overlay of the point cloud from both the GS18 I and MS60. Notice how this image shows the grass in the front that the LiDAR missed. Combining the two approaches provides a different perspective. As always, understanding the project requirements and deliverable is key to choosing the right solution.

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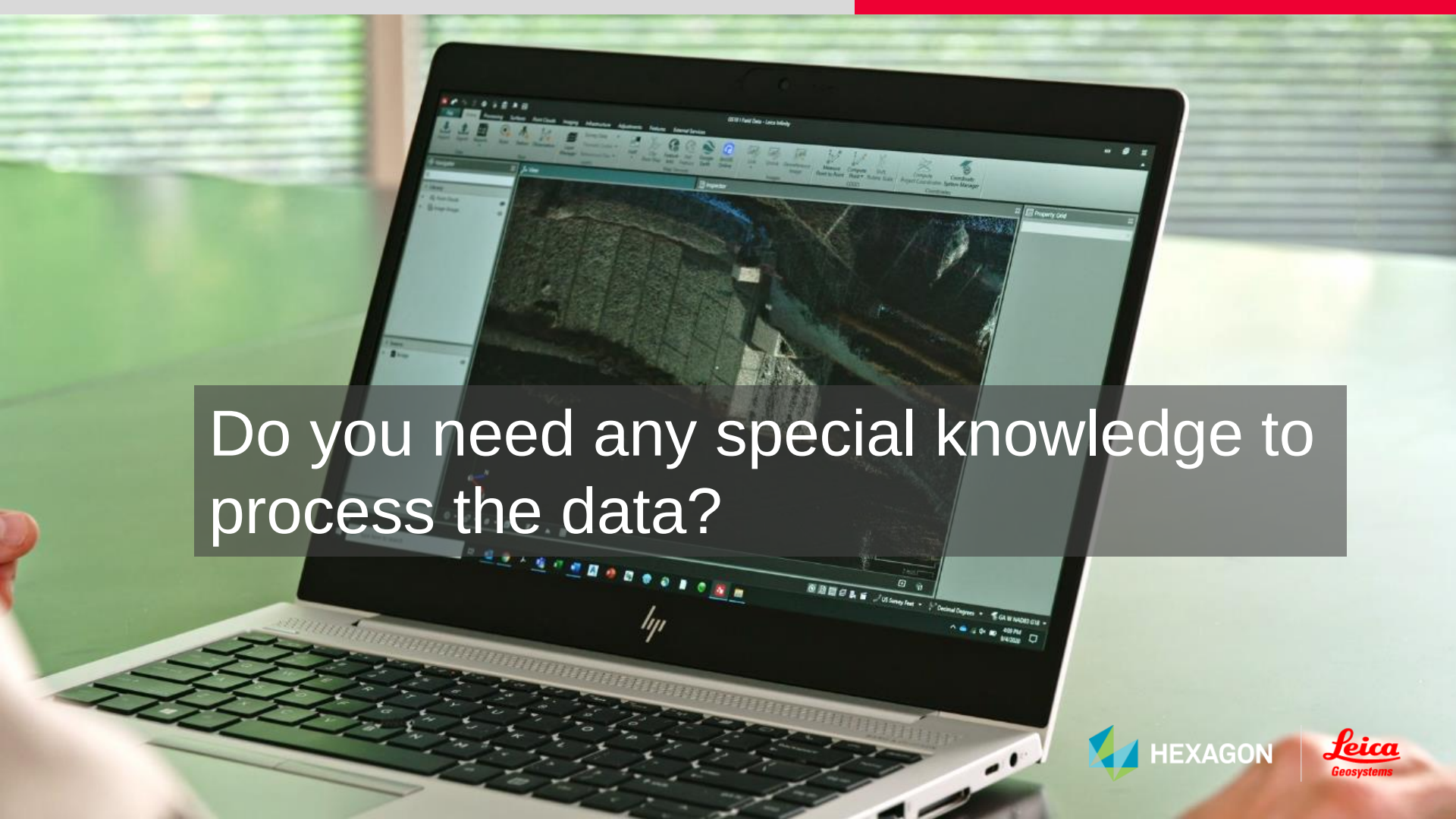
Do you need any special knowledge to process the data?
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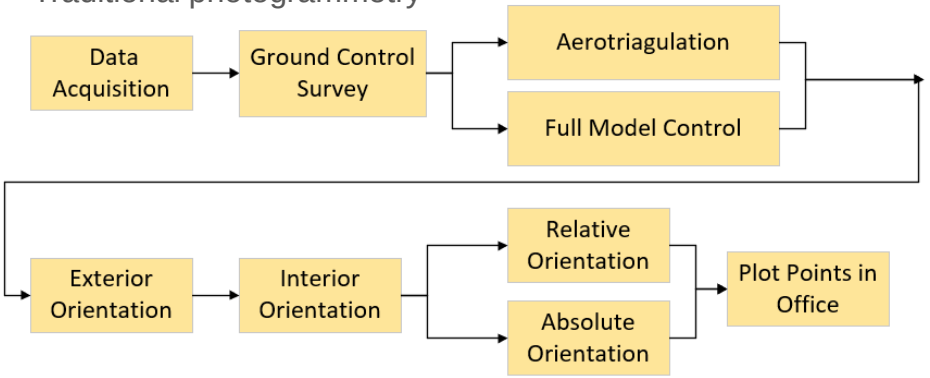
Simplifying Photogrammetry

While photogrammetry, in a broad sense, is just measuring points from a photo, the traditional computations and procedures needed to measure those points are quite complex. As you can see in the workflow chart on the right, the steps include introducing control as well orienting each photo so the points are in a common coordinate system. All of this has to be done before you can measure a single point and often requires the expertise of a specialist in the office.

With the GS18 I, the coordinate system of the image groups is already correct because of the integrated GNSS, and all the complex orientation computations are handled automatically inside the Captivate field software. This gives us the ability to immediately measure points from the images in the field in Captivate software or in the office in Infinity software with no extra time or special knowledge required.

Traditional photogrammetry

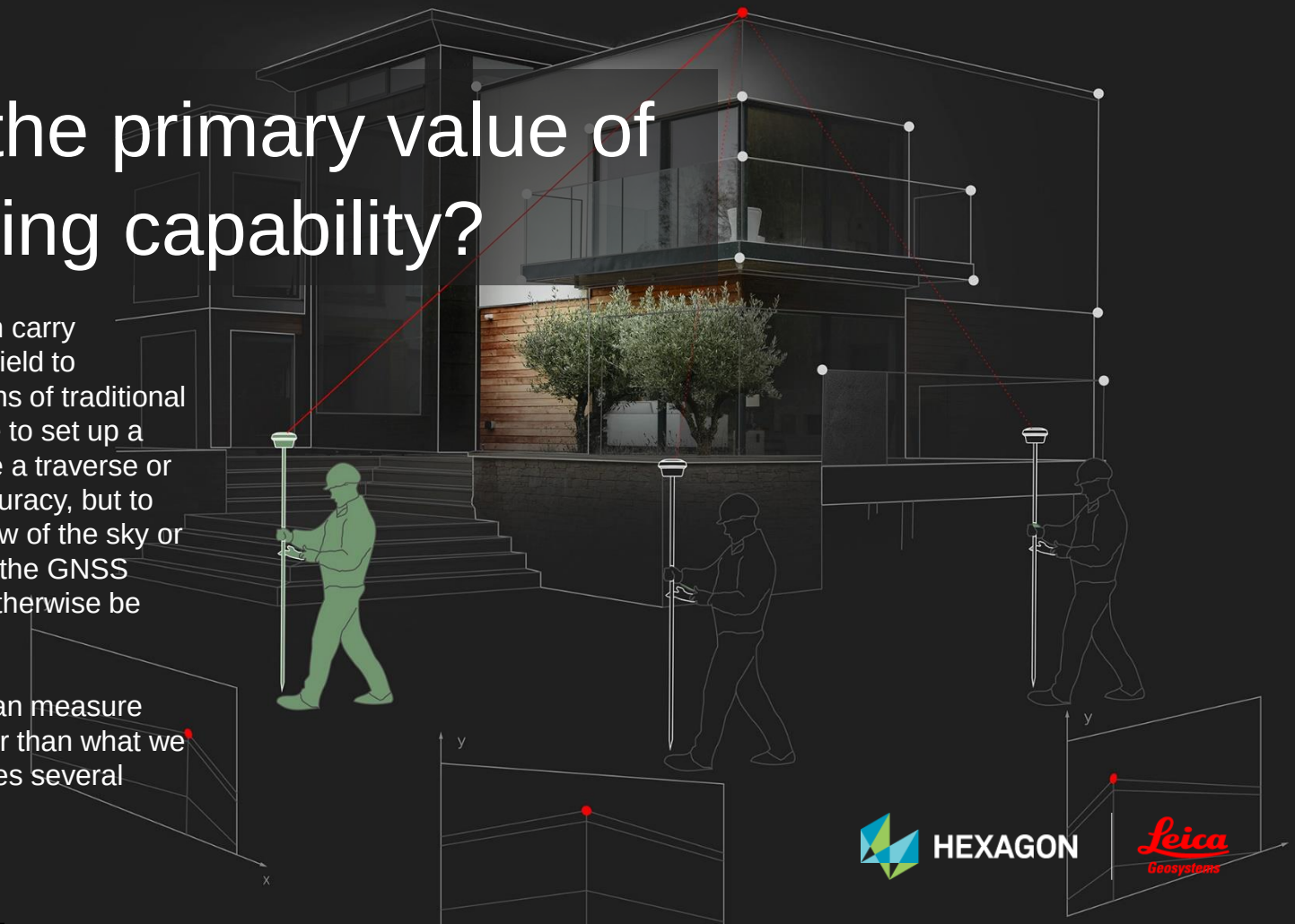


Photogrammetry in the GS18 I

What is the primary value of the imaging capability?

As surveyors, we often carry additional tools to the field to overcome the limitations of traditional GNSS. We might have to set up a robot—not to complete a traverse or achieve enhanced accuracy, but to overcome a limited view of the sky or something else where the GNSS measurement would otherwise be sufficient.

With the GS18 I, we can measure what we can see rather than what we can touch. This provides several important benefits.



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Measuring points that are physically unreachable:

- Compromises safety
- Demands time
- Demands additional measurement technologies

Visual positioning removes surveyors from hazardous situations, such as measuring near roadways or in ditches. With the GS18 I, the surveyor is no longer just outside the ditch but outside the fence. At the same time, he is able to capture more information because now he can use the images to create point clouds that can be used to measure and map any of the utilities in that ditch.

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Survey Grade Accuracy

Measuring points where the view to sky is limited:

- Demands time
- Demands additional measurement technologies
- Compromises accuracy

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Measuring single points where rich detail is required:

- Demands time
- Demands accurate documentation
- Is labor intensive

If we need to capture the building corner, is it the wooden façade, the stucco or the brick? Which one does the engineer need? Do we need to verify for an ALTA survey that the rise and run of the steps meets a municipal or building code, or do we need a high level of detail that can be used for additional engineering or architectural expansion? How much time do we take defining that and recording it in the field, and how do we record it?

With the imaging sensor in the GS18 I, we can record all this data easily as an image group, and the engineer can decide later what measurements are needed. That information can be extracted in the office without returning to the field.

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Trading off completeness of investigation vs. speed of clearing scene:

- Compromises safety
- Demands lots of experience
- Sometimes not possible

Public safety personnel need to thoroughly document an entire scene without missing evidence, but they need to be able to do it quickly so they can stay safe and get the road open faster. With the imaging capability of the GS18 I, they can capture an entire scene in minutes and get every detail from the imagery.

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Is the GS18 I a replacement for total stations?
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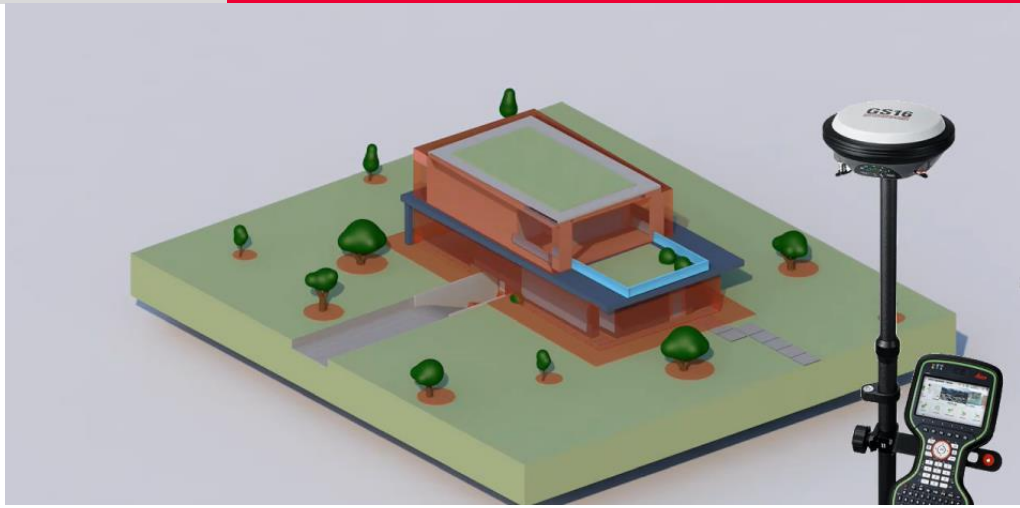
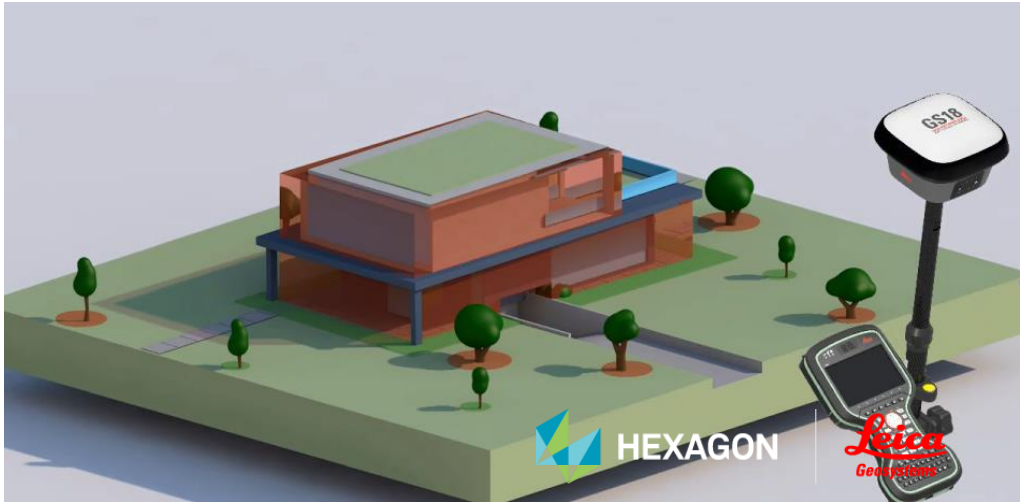
The key consideration is the level of precision needed for the project; a total station still yields a more precise result. However, there have always been situations where surveyors have had to use a total station simply to overcome the limitations of GNSS. If we needed to measure a building height, for example, even if we were in a good environment, we couldn't measure it with GNSS in the past because we couldn't touch that point with our pole. We would need to set two control points, take out our robot, set up the backsight, perform any other checks we needed to make sure we're on the coordinate reference frame, and then measure that discreet point to get one measurement.

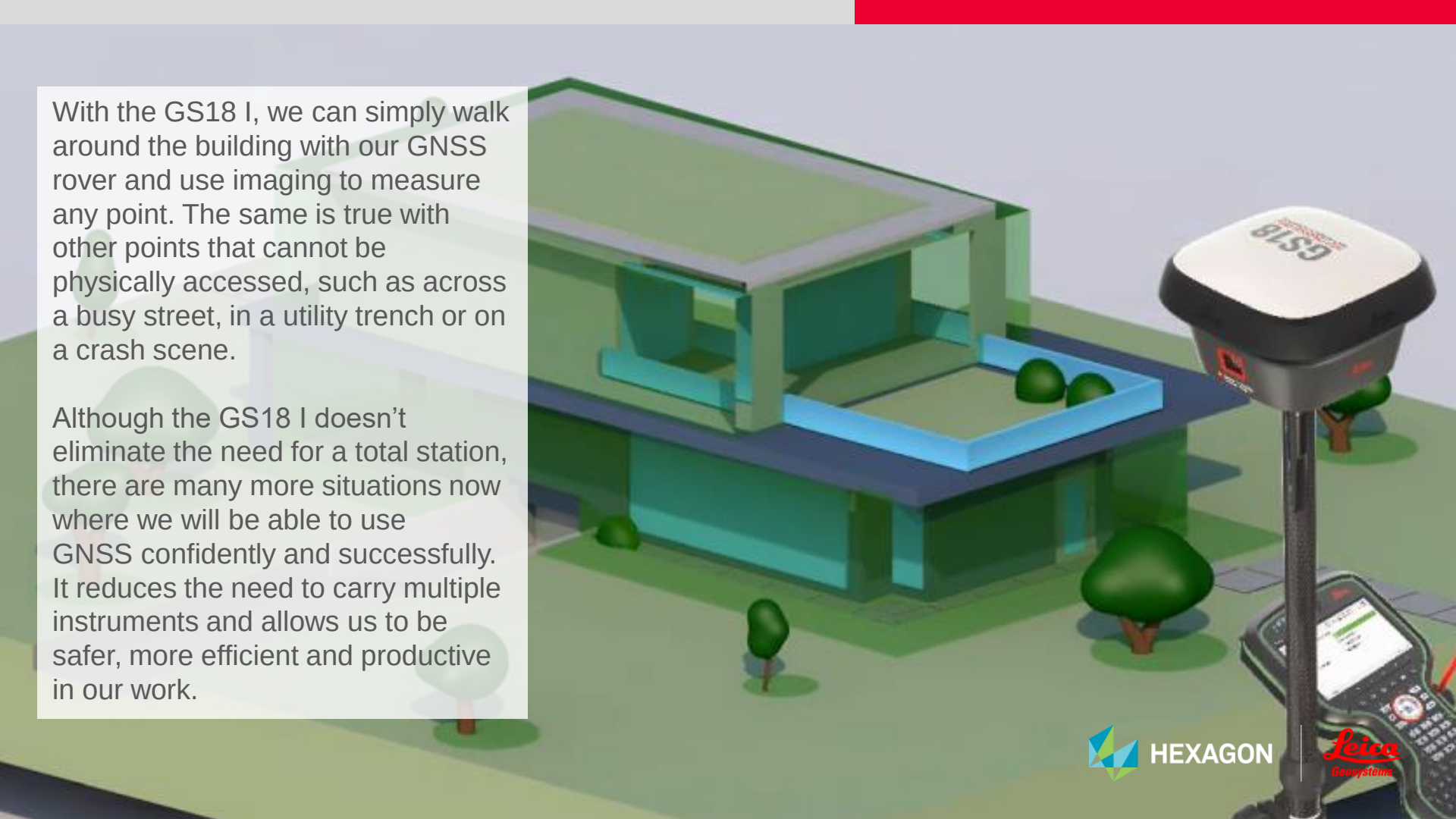
Adding an IMU to the GNSS sensor allowed us to get under the smaller trees and closer to the building through the ability to tilt the sensor but didn't remove all the obstacles.



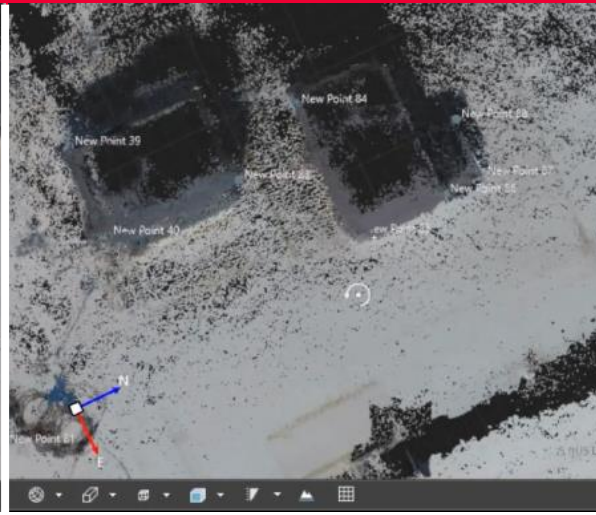


With the GS18 I, we can simply walk around the building with our GNSS rover and use imaging to measure any point. The same is true with other points that cannot be physically accessed, such as across a busy street, in a utility trench or on a crash scene.

Although the GS18 I doesn't eliminate the need for a total station, there are many more situations now where we will be able to use GNSS confidently and successfully. It reduces the need to carry multiple instruments and allows us to be safer, more efficient and productive in our work.




What opportunities does the GS18 I provide to deliver new services?



Watch the video clip

We've already touched on the examples of surveying a utility trench and a crash scene and the ability to document those situations much faster and safer.

Another potential opportunity is measuring and documenting rooftops with images for the design and construction of solar arrays. It is possible to do an as-built roof survey with drone technology, but flying a drone requires an FAA Part 107 certification, and a drone doesn't capture the oblique view. With the GS18 I, we can spend about 10 or 15 minutes walking the roof and then create a dense point cloud from the imagery in Infinity software (illustrated above). We can then digitize and measure single points, document the area, and use that data for the solar array design. We can also use the GS18 I along with a drone to fill in specific areas we might not be able to capture with the drone due to flight restrictions and other issues.

These are just a few of the possibilities.

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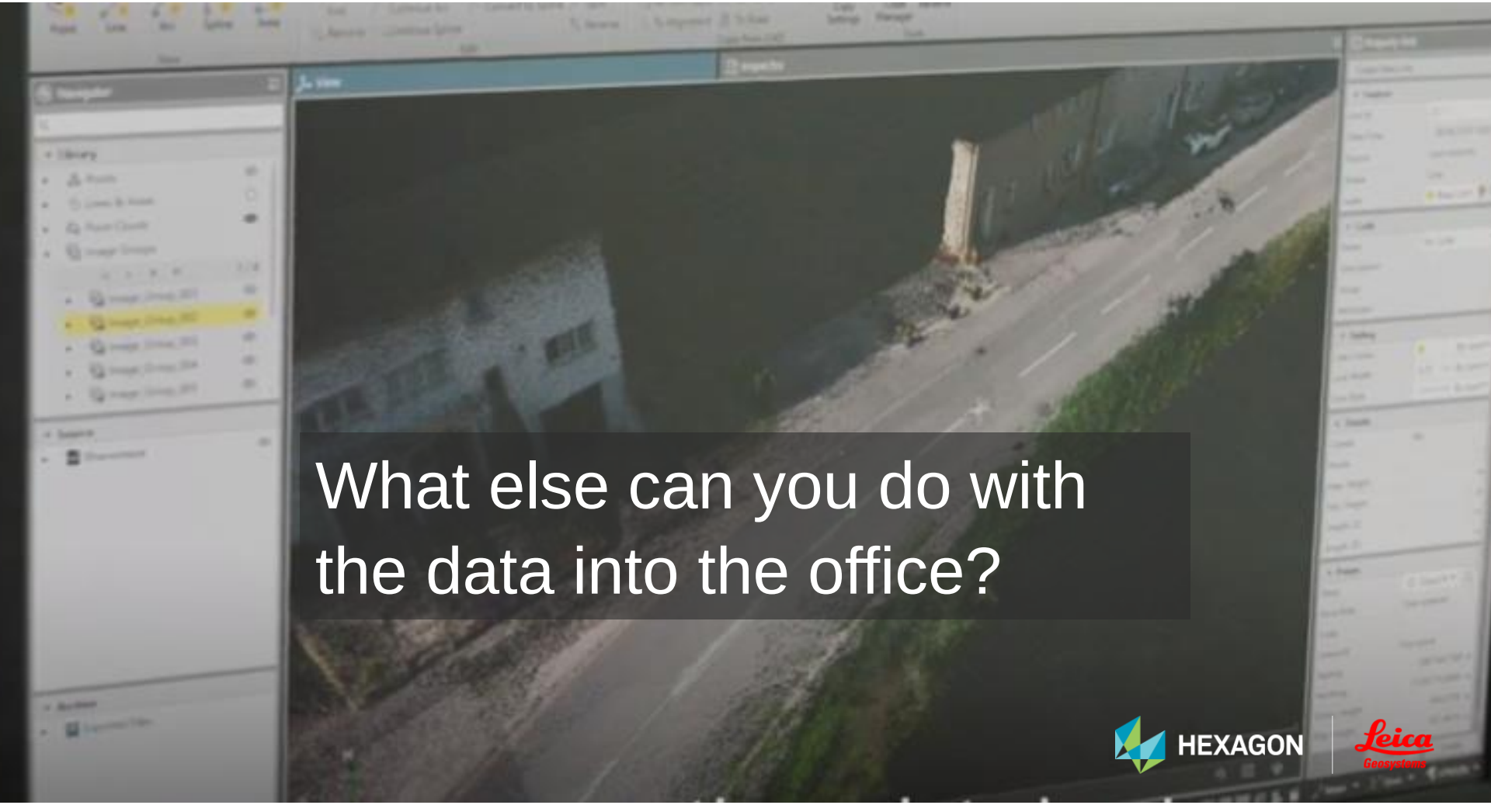
What else can you do with the data into the office?
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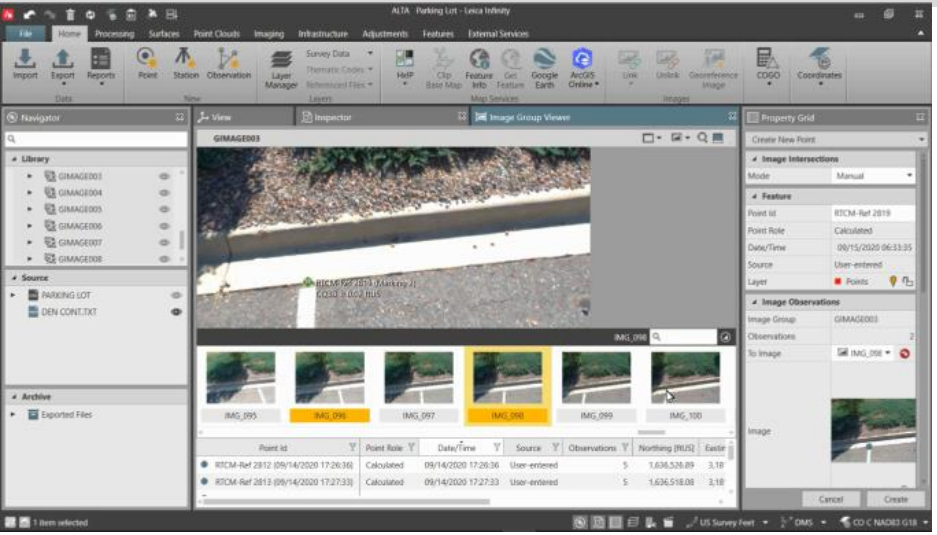

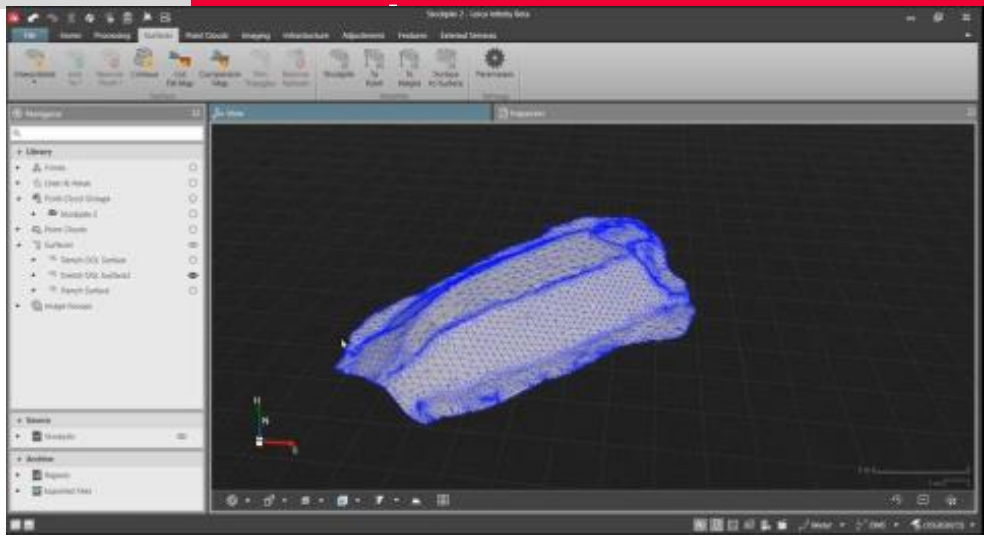

Watch the video clip

We don’t have to create a point cloud from the images. In fact, one of the most powerful capabilities of the GS18 I is creating discrete points from images. In the Infinity office software, we can scroll through the images until we find the feature that we'd like to digitize and zoom in—for example, the center of the paint line in the image on the left. When we select that point, the software looks at the images around the one that we just selected and computes the inverse and point with the coordinate quality displayed. We can also manually select the point from several different images, and the software will generate the 3D coordinate quality.

For applications such as surveying stockpiles, we can use image groups to create a digital terrain model (DTM) with surfaces and contours, and then generate reports for volumes and other measurements.

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Additional Q&A

Is the Infinity office software required with the GS18 I?
No, it is not. You can pick single points in the Captivate field software and export them to ASCII or another format. However, if you want to increase quality assurance/quality control and generate reports, Infinity is an easy way to do that. You can also use specific modules of Infinity to pick points from images captured from any Leica Geosystems sensor (the GS18 I, robotic total stations or the Aibot unmanned aircraft system/drone), combined data from multiple sensors, and create dense point clouds from images to generate stockpile volumes and other high-value deliverables. The GS18 I solution is scalable to meet the capabilities you need and the deliverables you need to provide to your clients.

How do the lighting conditions affect the visual positioning results of the GS18 I?
The imaging sensor must be able to see the feature that we're trying to extract. If we can't see it with our eyes, the imaging sensor won’t be able to see it. Lighting issues such as deep shadows or bright sunlight shining directly into the imaging sensor can adversely affect the image quality.

How do we know the accuracy of the image group captured with the GS18 I?
The system constantly measures 30 random points in every image with the visual positioning technology. When you process your image group, the Captivate field software takes into account the GNSS quality and IMU quality at the time the image is captured and displays that information as a component of the overall image group quality. You can choose to accept or decline that image group based on your quality parameters. This is all done in the field in real time, so you will always know the quality of individual measurements captured with the GS18 I.

Additional Q&A

How many images can be captured and stored with the GS18 I?
Each image group is limited to 60 seconds, but you can capture as many image groups as you need. The only limit is the space available on your data collector. In most cases, you should be able capture several days and possibly even weeks of data without having to worry about overloading your data collector. You can also add external storage if necessary.

Keep in mind that regularly downloading and backing up project data is a standard best practice. Captivate software stores your jobs to the \DBX folder of your SD card or internal memory. Each job is stored in its own \DBX sub folder using your job name followed by instrument ID and time/date information. This makes it easy to backup and remove projects from your data collector.

Does the GS18 I have tilt compensation?
Yes, the GS18 I has all the capabilities of the GS18 T tilt rover plus imaging. You can use the GS18 I for stakeout and topos, create points and lines, and do everything else that you've done in Captivate with the GS18 T, but now you also have the imaging capability to increase your safety, efficiency and data collection potential.

How far can the GS18 I be tilted?
Tilting more than 30 degrees creates slightly more potential for error in the IMU, but that will be displayed in your image group quality. The amount you can tilt the rover depends on the project and the accuracy required.

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What are the key takeaways?

The GS18 I enables you to:

- Increase safety
- Maximize efficiency
- Grow your business
- Mine the dataset to provide more value

Learn more about the GS18 I and get the spec sheet >

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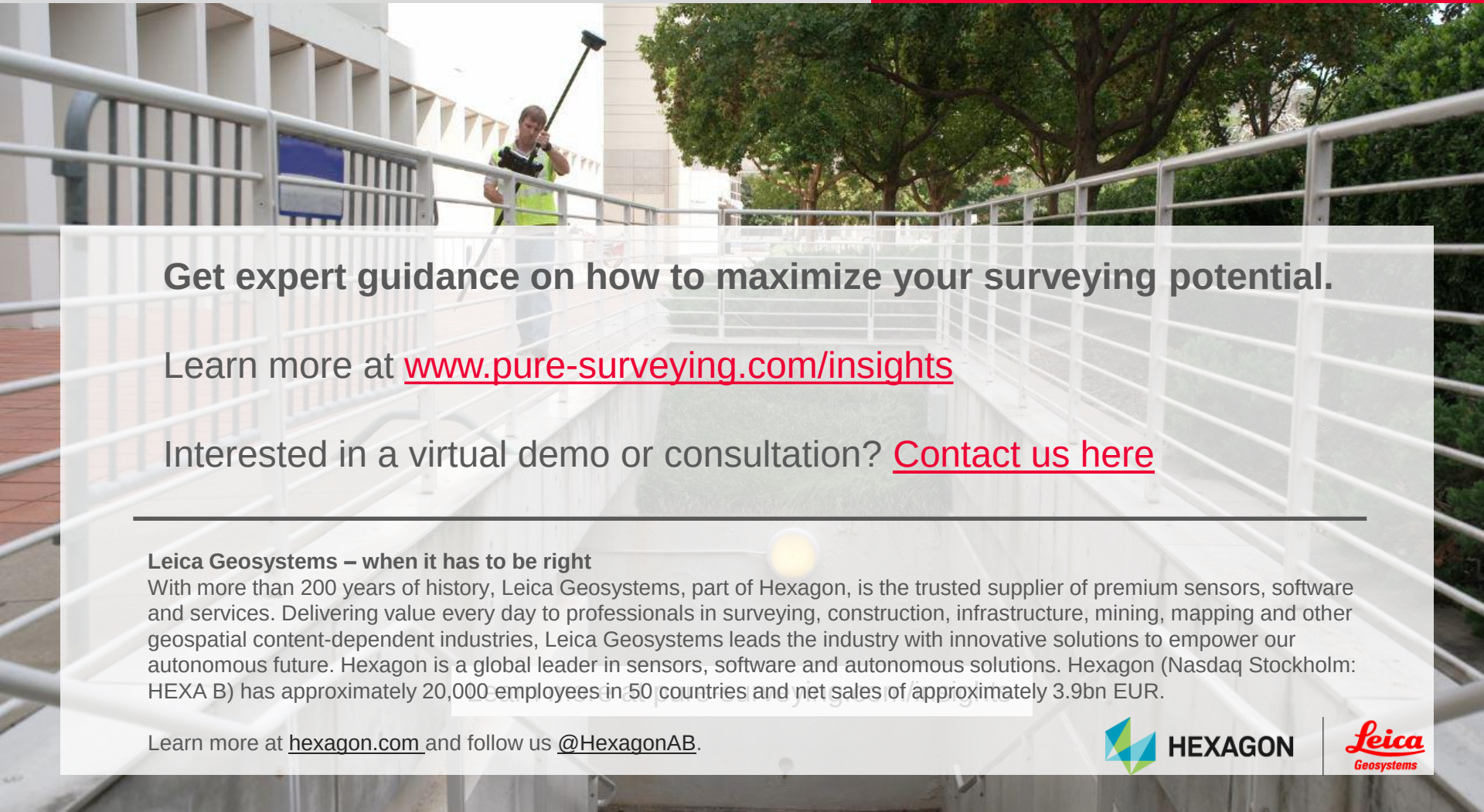

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