CanSLAM Circuit 2024

SLAM System Briefing

CanSLAMCircuit.org

Disclaimer

This report has been drafted for the followers and supporters of the CanSLAM Circuit, and are the opinions of the authors. The mission of the CanSLAM Circuit is one of growing the mobile mapping (MM) and simultaneous localization and mapping (SLAM) industries into effective and operationally fundamental tools of 21st century project reporting and documentation. The CanSLAM does not endorse the use or dissemination of this report or its associated data for any use beyond assessment of MM and SLAM systems or the development of their responsible and ethical downstream and support services.

The CanSLAM Circuit does not officially endorse or recommend systems disclosed within this report as all system or platform selection decisions are conditional upon a number of considerations well past 'generality' or 'general application.' Each device needs to be assessed based on the work at hand, and the environment and conditions placed on the project.

No data provided shall be used for any other purposes than those written above without the written consent of the scene (building/area) owner. Always consult with a knowledgeable geomatics professional prior to applying SLAM or MM technology on your projects!

Terms of Reference

Term	**Definition**
SLAMSO / SLAMSO23	Simultaneous Localization and Mapping Scan-Off of 2023. Precursor to the CanSLAM.
SLAM	Simultaneous Localization and Mapping
MM	Mobile mapping
LiDAR	Light detection and ranging
AI	Artificial Intelligence
SAIT	Southern Alberta Institute of Technology
GNSS	Global navigation satellite system(s)
GGE	Geodesy and Geomatics Engineering
Scene	The general area/object which is the primary focus of the scan
GoGeoExpo24	The National GoGeomatics Expo of 2024
NeRF	Neural Radiance Fields
SLAMSO	SLAM Scan-Off
Splat	Gaussian Splatting

Introduction

Knowledge: The First Step To Wisdom… and A.I.

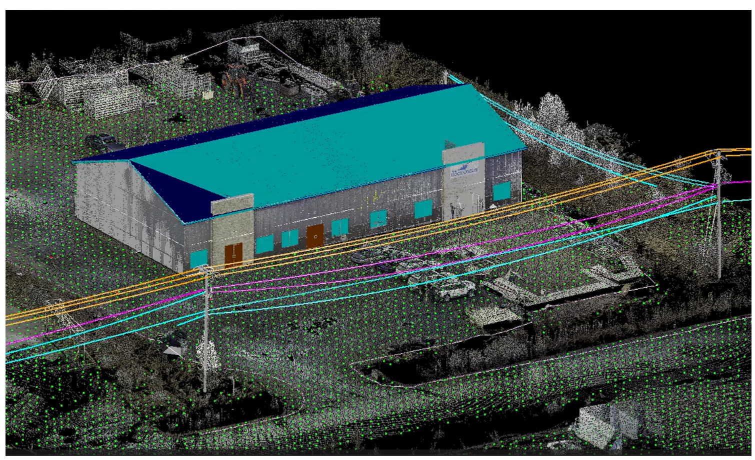
Information will always be critical to ambition. Knowing what exists, where, and its condition are the foundation for all responsible action and solid decision-making in the tangible world. The faster and more accurately the information can be collected, identified, analyzed, and distributed, the more control a user has. Planners, manufacturers, architects, construction managers, project managers, logistics professionals, utility providers, real estate professionals, tourism departments, accessibility advocates, emergency response personnel, archaeologists, airport administrators, asset managers… all those professions (and more) rely on 3D spatial data either as a commercial product, or as a critical component of their work. Significant time is spent every day collecting, verifying and making ready information for these professionals and their industries. What ‘things’ are where? What are their conditions? Does it fit [here]? Is [this] in the same place it was last time we looked? What’s the difference between the last time we were there and now? How much [material] will it take to [meet required demand]?

Historically, all this work involves one or a group of specialized professionals entering the space and taking direct observations, creating diagrams of the area, measuring critical lengths, noting critical areas of interest and documenting them to get ‘enough information’ to complete their task in a reasonable period of time. While this seems efficient, it gets less-so when each trade needs to repeat this process for different reasons, especially if safety onboarding and screening is required prior to participation, or security clearances need to be issued for every visit, or the remote nature of the site requires hours or days of travel to inspect.

So, what will happen to the world if we *dramatically* speed up reliable 3D spatial data collection and make a comprehensive product that can be visited virtually, shared, magnified, sliced, measured, modeled, or generally ‘pulled apart’ for information? What if you could have tens to hundreds of hours of work collected and made ready with a quick A.I . process and a few minutes of labour? What if we could find ways to quickly, convincingly, accurately, and automatically report progress to critical stakeholders, or items of interest or concern to project managers and project engineers? What if specialists were able to inspect dozens of locations a day without leaving home? How much cost savings would there be in travel, accommodation, change work orders, requests for information, site interruption and training, clearance & installation checks, permitting processes, mental/physical health effects and incidents, and others? How many phases would be saved from miscommunication issues and how many liability cases would be resolved quickly and definitively if we only kept track of what's where on a regular basis and not only *retained* that information, but centralized it and made it accessible to every required stakeholder at the appropriate time?

Mobile mapping (MM) and Simultaneous Localization and Mapping (SLAM) systems present themselves as modest instruments by which to 'measure and report,' but it's the *speed*, *comprehensiveness, and accuracy* of these solutions that are causing dramatic shifts in innovation across all the industries and professions mentioned above. These systems and the software solutions supporting them are all but promising entry level ease-of-use for outstanding professional products. But the potential for information gathering only *starts* at the collection of information and the creation of the 'map,' which in and of itself is currently being redefined. Once the data from these systems is reconstructed and put through computer vision and machine learning, the possibilities become endless over time.

Artificial intelligence (machine learning, computer vision, segmentation, etc) is one of the most exciting tools for geomatics in the modern era. The subjecting of all or some scanner data to computer analytic processes to help align the different data sources, identify targets & features, classify features, label and/or mark them, then provide additional information known as 'semantic information' (things like colour, material type, manufacturer, etc…) Through these processes, select computer programs are beginning to recognize the difference between a utility pole and a tree, a fire pull station from a light switch, the edge of pavement from a crack or the edge of the curb; severe structural wear from superficial markings. Every year, they become more 'aware' (or, adept at spotting features of interest,) more efficient, and have always been faster at their tasks than people. AI is here, it's growing, it's already impactful, collective learning is faster, and the tools to collect the information needed are not only here, they're improving and evolving year over year.



As exciting as this sounds, these systems are little known, even less understood, and persons researching these instruments and systems are either underwhelmed with the search results, overwhelmed with the *actual* number of units and choices available, or lack the knowledge/resources to properly assess the suitability of these devices for their operations. Does the instrument you found suit your needs? Will it work for your environment? Do you have time to test all the candidates? Are you sure you've found the one(s) best for you? Are the collection methods you're considering best for your intent? Which ones are compatible or complimentary? What's the difference between the two (or more) products that look exactly the same but you're told have differences? What support or extraction services already exist for your solution and its sensors? Will you have to develop an A.I. extraction solution, are there built-in tools that automatically fill the need, or is there a third party service already prepared to ingest those data sources on your behalf? What happens to your data after it's collected and is that a potential problem for you, your client, or their stakeholders?

The CanSLAM Circuit is your guide to the world of 'mobile mapping' (MM) and 'simultaneous localization and mapping' (SLAM) as they pertain to the built space and geomatic applications. Our goal is to empower our community with knowledge to leverage these documentation tools to their full potential. Together, we can cooperatively ensure the successful molding of this technology into the comprehensive, predictive, responsive, transparent, and accessible real-world tool this modern world needs.

Origin Story

Founded in January 2024, the CanSLAM Circuit was based on an identical event called the SLAM Scan-Off (SLAMSO) which was presented at the National GoGeomatics Expo 2023 (GoGeoExpo23). The SLAMSO was inspired by a comparative event hosted by the United States Institute of Building Documentation (USIBD) during Geo Week 2023.

In 2023 Alex Hill-Stosky, soon-to-be SLAMSO organizer and CanSLAM Co-Founder, attended Geo Week on behalf of Eagle Engineering & Consulting's reality capture department with simultaneous localization and mapping (SLAM) systems on his mind. Innovators from industries around the world are keeping their eye on the rapidly changing market that is "reality capture" because of how seemingly accurate and rapid these systems promise to be for all kinds of spatial documentation. Infrastructure projects, internal building documentation projects, incident investigations, remote site viewing/inspections, documenting project milestones and more, all are possible to be captured at inch-to-centimetre accuracy using tools that make detailed documentation as easy as walking. And to complement this, the data is presented in 'Google Street View' style and/or 'dollhouse' style for cost effective and intuitive review and measure, especially thanks to cloud viewing which makes large and/or complicated data sets readily available, and promise to fuse real-world function with machine control and optimization. SLAM systems today promise to not only meet the accuracy of today's current laser scanners, but also decrease collection time, make the process as flexible and dynamic as a person is, eliminate 'blind spots' in scanning, promise full situational flexibility, and make it as natural to use as a flashlight or flaming torch while potentially providing high definition photos and high-precision measurements every step of the way.

Reality Capture, or the 3D digitization ('scanning') of real world objects and places, is a newer discipline of measure and mapping but one that's *rapidly* changing with the continued advancements in computer processing speed/power/miniaturization and artificial intelligence (AI) processes, effectively combining high-precision measurement instruments with robotic navigation, interpretation and reaction. Naturally, computer vision also promises the unlocking of further value through the rapid and automatic recognition of objects and features inside of the spaces those sensors reconstruct, effectively having a computer 'understand, identify and locate' (aka 'map') objects or key definable features, determine their locations in 3D scene, label them, evaluate them (dimensions, 'colour,' orientation, position difference) and report their findings before a human even becomes involved. In parallel, advancements in 3D *representation* (to be distinguished from 3D *measure/modeling*) in the last five years has created gaussian splatting (splats) and Neural Radiance Field (NeRF) 3D scene rendering; high definition photogrammetric data processing techniques recreating previously unfathomable levels of detail with less data or effort than before. Geomatics, robotics, and the *gaming* industries are the largest drivers in these fields, leveraging the solutions into products or processes that are decreasing production times and/or costs dramatically and increasing effective situational awareness.

The CanSLAM is an organized response to the value potential of the current market and is set to be a touchstone for the future market of automatic mapping and data extraction.

These systems are relatively unadopted, have a lot of questions associated with them, and critical understanding of them is lacking. What systems are currently available? What are they capable of? What do they do? Do they perform as advertised? What do their specifications mean? Does it really meet or surpass the expectations of the only-recently-accepted stationary LiDAR scanners? What steps do you need to take to ensure a reliable product from them? What extra value can these scanners unlock? What are the flaws and common mistakes of these systems? What processes exist right now to unlock the value that I do collect?

In meeting GoGeomatics founder, Jonathan Murphy, at the same Geo Week 2023 event, Hill-Stosky was encouraged to pursue those questions and was introduced to Carina Butterworth of the Southern Alberta Institute of Technology (SAIT) and the two began to design the way forward. Soon the SLAMSO's pursuits began to draw the map for the CanSLAM, a means for bringing unbiased information to the consumers who stand to benefit most while providing empowering experiences for ambitious learners, and furthering data collection/dissemination for the development of A.I. data extraction processes.

What is the 'CanSLAM Circuit?'

The CanSLAM Circuit replaces the "SLAM Scan-Off" which preceded it in 2023. Expanded in scope from the SLAM Scan-Off, the CanSLAM Circuit is positioned to be the central hub for information regarding MM and SLAM scanners available for purchase in the market. Our initiative is defined by the following mission goals:

1) To introduce industry to mobile and SLAM scanners currently commercially available.
2) Encourage adoption of SLAM systems and relevant workflows to stimulate implementation.
3) Introduce implementers with considerations of adoption to maximize success.
4) Provide base data sets for those looking to develop or adopt these systems.
5) Bring SLAM manufacturers together to compare systems, evaluate performance, and foster collaboration.
6) Provide resources to promote downstream A.I. processes and integration.

We intend on pursuing these goals with a spirit of cooperation and ask post-secondary institutions, industry leaders, and volunteers to join us. Through these three branches we expect to bring knowledge, experience, and passion to the forefront of this initiative and inspire future industry innovators and leaders through awareness, experience and the sharing of knowledge.

We are working with post-secondary schools across Canada to establish 'test scenes,' or areas where the scanners of different manufacturers from across the globe can meet and scan a common data set to see how they perform against each other, but also against laser scans using more 'industry accepted' lidar collection methods like terrestrial static scanners. This is done for a number of reasons:

- Different geographic areas have different challenges.
- The industry potential allows for variance of scene type school-by-school depending on the local industries supported. For example, a forestry course could be built in British Columbia, Quebec or The Maritimes to test SLAM scanners for forest study applications; an energy production scene could be established in Alberta, Saskatchewan or Newfoundland; a warehouse or tower scene could be established in Ontario, etc…
- Retaining data sets from each system helps clients and consumers get a transparent impression of the product these systems put out.

The collective results of the CanSLAM tests and evaluations were to be made available for review and download at CanSLAMCircuit.org immediately after the presenting of results at each annual GoGeomatics Expo. However, the 2024 season failed to see manufacturer engagement match their initial enthusiasm for a second year in a row. As such, no results will be posted for the 2024 CanSLAM. It was determined the value of the CanSLAM'24 report will be in consumer empowerment, awareness of adoption considerations, general availability of commercially available units known to the CanSLAM, and a call to action for those wanting responsible and prosperous quantum shifts in infrastructure documentation and assessment.

While the GoGeomatics Expo is the premiere event, data and material from successful event years will be presented at conferences and functions throughout North America and across industry disciplines to evangelize the availability and suitability of reality capture today, and their downstream solutions, for those who stand to benefit.

What is ‘Mobile Mapping?’

Mobile mapping (MM) systems enable the collection of 3D spatial data for the purposes of mapping, digital rendering, asset condition assessment and measure, aiding in engineering or architectural assessment, drafting, or other spatially/dimensionally relevant information sourcing. Typically, this vehicle or marine-vessel-mounted tool is used for ‘horizontal infrastructure’ or projects with larger or elongated geographic footprints such as transit and transport corridors, bridges, utility and pipeline corridors, large plants and facilities, harbours, coastal infrastructure, canal channels, etc. It involves what can ultimately be described as a symphony of sensitive and high-precision, high-accuracy scientific instruments and processes, all brought together to bring rapid situational awareness.

Like a musical band or symphony orchestra, mobile mapping systems require synchronized timing and in-tune instruments to create a harmonious, agreeable, and ingestible product. Instruments like cameras and laser ranging arrays are carefully chosen to reinforce, compliment, or compensate for the performance of others. Improper choice, placement or balance of instrument can completely change ‘the way the song sounds’ (or, the scan quality) when it’s played back. Like a quality musical performance, a mobile mapping 3D scan is the coalescence of factors including the choice and placement of instruments; the ‘musician’ systems that operate them; the ‘conductor’ system that reads the music, assigns the tempo, and brings the instruments together; and even the composition of the venue itself is a critical consideration for the resulting quality and the effort required to achieve a harmonious product.

MM systems primarily rely on global navigation satellite systems (GNSS) like GPS to fix their position, confirm their travel path (trajectory,) and start the alignment process for parts of each scan that share spatial data (overlapping scans) or are constrained to fixed coordinates. But GPS positions alone are not enough; positional certainty can be degraded with reflected signals (multi-path,) and electromagnetic interference potential like electrical power gids, chain link fences, or our atmosphere and space weather, just to name a few! This only gets more true as the receiver in question enters ‘canyons’ here on the planet like roads in tall forests or in downtown urban centers. When standing alone, GNSS systems do not provide enough security against ‘confusion’ or poor signals to be reliable.

Even if GNSS operated in perfect conditions, it is incapable of recording satellite data for every single moment of collection; this means that you have ‘blip’ recordings of location. Like a person moving in a strobe light. Even if the signal is transmitted every second, there can be a lot of critical movement in the milliseconds between. So, how do we fill in the blanks?

To fill between these ‘blips’ of awareness in location, inertial measurement units (IMUs, or Inertial Navigation Systems, INS) are used in tandem with the GNSS systems to provide that extra directional/movement awareness and, by implication, interpolatable location information. In other words, it very much acts like your inner ear, helping the instrument not only understand ‘which way is up,’ but the magnitude and direction of inertial forces acting on it to get a sense for how it moved. If you stand in the dark with your eyes closed, you can still tell if you’re moving and which way is ‘up.’ If you don’t know what *exact* direction you’re facing, you can still estimate a *relative* path of travel based on how you moved from one pose to another, and with how your body (specifically, your head) moved as you attempted to navigate the space.

It should be noted, however, that IMU/INS instruments are also imperfect with a very good chance that the instrument records movements with a very small disagreement between the observed and real force/direction values. This lack of accuracy can seem small and insignificant (MAGNITUDE EXAMPLE) but accumulate instance-by-instance with each ‘instance’ being taken hundreds of times between GPS ‘blips.’ This is a problem because, much like walking in a room with your eyes closed; you can *assume* you’re walking in a straight line, but if your inner ear or nervous system fails to register any change that happens, or *exaggerates* feedback, your perceived path has potential to deviate greatly from your understood path, making it much more difficult to correctly ‘map’ your movement in your mind. The uncorrected perception only changes when you open your eyes and see you aren’t standing exactly where you’d intended, or other senses alert you to an object/temperature/sound that helps you determine your position in the environment.

What is SLAM?

Simultaneous Localization and Mapping (SLAM) is the solution to the question of “how do you get a robot to understand its position in an unknown environment as it tries to figure out what that environment looks like?” It involves a series of ‘estimate, observe, correct’ actions known as Kalman Filtering, and other algorithmic principles to use as many onboard instruments as possible to piece it all together.

Like people, SLAM depends on ‘spatial awareness,’ or comparison and perception methods for the physical dimensionality of a space, place or object in its environment in order to navigate that space. The machine can use image-or-lidar-detected geometries like planes (flat surfaces,) ‘edges’ of objects (corners,) targets, and other natural/artificial features within the environment itself to ‘track’ an instrument’s movement, and using those detected objects and features as the basis of navigating through the data to the next known area or object. Again, going back to that ‘dark room analogy,’ this aspect of mobile mapping is the ‘reach out,’ when you extend a hand to into the unknown darkness to find a familiar object. Because your arm is attached to your body you have a sense for how far away that object is from you when you find it. The geometry or *feel* of the object also helps you understand where you are based on the object and its relative location to other objects in the room.

To explain this, I offer this scenario: You are standing in that dimly lit room with a head injury. Because of this blow to the head, the world that you can see through the dark looks like it's not only fuzzy, it's moving 'in frames.' It's like you're blinking rapidly; your eyes are taking pictures instead of streaming video and, to top it off, sensor information is sometimes delayed! You stop moving, but your head reports movement for a fraction of a second longer thus tricking your body into thinking you still have to shift your weight to account for the movement, affecting the way you sway and stand… To try and compensate for this dim and blocky vision and your misreporting inner ear, you reach out with your arms trying to find a wall to follow or an object you can refer to if you get lost like a chair or a table. Eventually as you move around this room, you're going to figure out the layout and, soon, your lack of quality input doesn't matter as much regarding your understanding of the room. You've used your multiple walks around and familiar objects/sensations to 'map' the environment.

SLAM systems use similar (but less dramatic) methods of reconstruction to rebuild a 3D scene with laser data, image data, movement data (from inertial measurement units,) satellite positional data, ground markers, and anything else that developers can cleverly add as aspects to consider. The fundamental difference between our 'head injury' analogy and SLAM methodology is that our machines don't have 'head injuries,' they are computer science's best approximations or improvements on human function and considerations while navigating in a 3D space. It takes aggregate data from various systems and a variety of accuracies, then integrates them together into statistically harmonized perceptions of a space, using the result to evaluate its own quality and, as a result, adjust itself according to automatic or manual prompts. All with otherwise disjointed, aggregate data and (preferably,) in real time or in post-processing

SLAM technology promises to make 3D spatial reconstruction look convincing and accurate while taking most of the alignment process out of the hands of human operators, often providing a more convincing map faster.

Current Manufacturers

One goal of the CanSLAM Circuit is to introduce industry to as many mobile mapping and SLAM scanner manufacturers as possible. However, in order to strike a balance between “free advertising” for SLAM companies and the desire for *candid data* by which to compare systems, only SLAM and mobile mapping companies who have devices participating in the CanSLAM will be described in detail. Thus, to fulfill the goal of ‘simple introduction,’ we offer the following list of all currently identified SLAM Scanner manufacturers across the Globe. This list starts with descriptive profiles in order of CanSLAM enrolment, then transitions to non-descript listing of companies and available units.

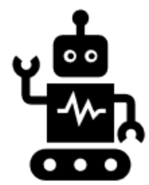
Please note the symbology below each company name to represent different **market ready/advertised** platform capabilities with each manufacturer. Due to the complexities of these systems and the number of available attachments, symbols are provided for ease of browsing but may not accurately reflect true functionality/readiness.

Mobile Mapping Options

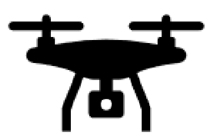
Torso Mount

Handheld

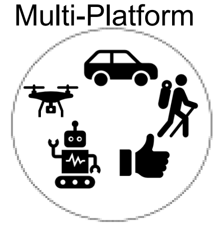
Robotic Mount



Aerial Mount



Multi-Platform



kudan.io

Can-SLAM 2024 Participant

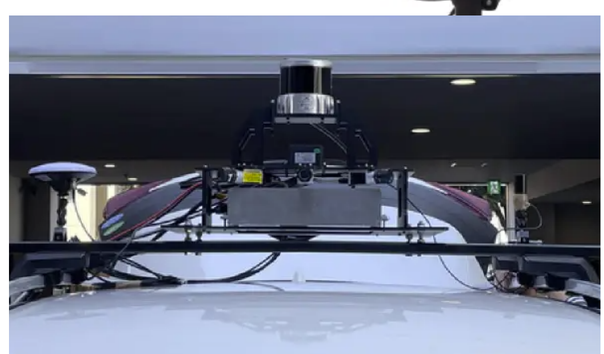
A Japanese-based software company with roots in Great Britain and offices in the USA, making it a ‘globe-spanning’ company. Kudan has partnered with companies such as XGrids (another SLAM company) and Inertial Labs to create custom SLAM platform solutions for various robotic, vehicle, or human-mounted applications.

Kudan’s ‘market-ready’ **Dev-Kit**s are examples of ‘ready-to-use’ mapping simplicity: a self-contained starting point for a Kudan-developed or privately developed solution. Their Dev-Kit, whether vehicle or hand-mounted, is a unit capable of self-calibration; scan monitoring; control point introduction/incorporation; on-board, on-the-spot post-processing, and an option to export the collected data. It is 100% self contained.

Kudan’s agnostic approach to technology allows for highly adaptable and upgradeable solution while keeping the data local and rapidly accessible. This means that the data you process does not leave the machine unless otherwise intended, and the license issued for data processing is perpetual with updates and support as paid services.

Kudan Dev-Kit (Handheld)

Price:~$25,000 USD (w. OSO-64 Lidar)
~$27,000 USD (w. OSO-128 Lidar)
PP Location: Onboard/Local Processing
PP Power: Medium (onboard mobile system)
Point Cloud Confidence: ~3cm
Visual Interface: 3D point cloud (Unadjusted)
On mobile phone
Notes: GNSS capable (+$1500 USD)



Kudan Dev-Kit (Mobile)
Not showcased

The CanSLAM Circuit would like to recognize KUDAN USA as a full participant in the CanSLAM Circuit 2024 and the first company to volunteer participation in this SLAM scanner evaluation in both years of its existence. KUDAN USA’s belief in an informed and engaged client base is evident, as their representative, Juan Wee, was exceptionally open and frank in his discussion with students from both the University of Calgary and Southern Alberta Institute of Technology (SAIT) as well as other CanSLAM volunteers. We thank them emphatically for their support and engagement with the geomatics community. May your sense of initiative spark prosperous innovation!

Leica Geosystems

as provided by **R-E-A-L.iT**

Can-SLAM 2024 Participant

While Leica is a Swiss company famous in the geospatial industry for the reliability and quality of their instruments, **R-E-A-L.iT** is a Canadian reality capture solutions company that brought Leica to the CanSLAM! While R-E-A-L.iT specializes in providing holistic reality capture strategies and solutions, Leica Geosystems are a significant part of their armoury, along with as many useful attachments, targets, and coding solutions as they found practical.

Leica Geosystems provides a number of mobile mapping and SLAM units with the TRK and BLK brands leading the charge, respectively. R-E-A-L.iT showcased the centerpiece of the BLK line of SLAM scanners; the **BLK2GO**, but also provides and rents many more of Leica's SLAM and mobile Mappers including the [**Reconfirm equipment**]

Leica BLK2GO (Handheld)

Price:~$70,000 CAD
PP Location: Local Processing Only
PP Power: Medium
Point Cloud Confidence: ~3cm
Visual Interface: 3D point cloud (Unadjusted)
On mobile phone
Notes: Many adaptors for many environments

Leica BLK2GO PLUSE (Handheld)
Not showcased

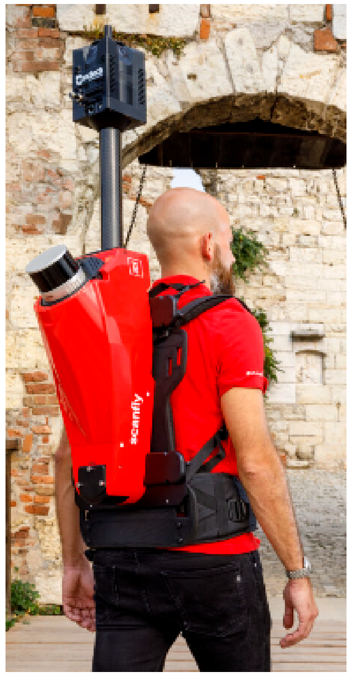
Leica BLK ARC (Robotic)
Not showcased

Leica BLK2FLY (interior/exterior Aerial)
Not showcased

Leica TRK100 (mobile mapper)
Not showcased

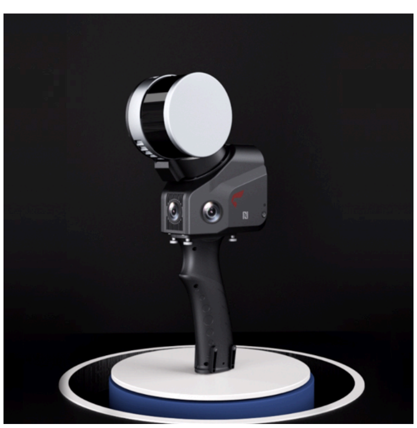
The CanSLAM Circuit recognizes R-E-A-L.iT as a full participant in the CanSLAM Circuit 2024 and the second company to volunteer participation in this SLAM scanner evaluation in both years of its existence. R-E-A-L.iT's engagement with these community events is a testament to the confidence in their solution strategy, no matter the challenge. We thank them emphatically for their support and engagement with the geomatics community. May your willingness to engage spark prosperous innovation!

3DT scanfly

EVO	PRO (similar to EVO)	DUO
		

scanfly.it

α-GEO

SLAM 100	SLAM R100	Lixel K1
		

alphageo.ai

AutoMap

TerrusM

VellusX

automap.io

CHCNAV

RS-10 (& RS-10(32))

Alpha3D-L (& Duo)

Alpha3D

CHCNAV.com

Hovermap

https://emesent.com/

eHLS1

eHLS2 (5 lidar variants?)

esurvey-gnss.com

exyn technologies

Nexys (Velodyne & Hesai versions)

exyn.com

FARO

Orbis

faro.com

FEIMA ROBOTICS

SLAM100

feimarobotics.com

FJDynamics

FJD Trion P1

FJD Trion S1

fjdynamics.com

GEOCUE

TrueView GO 116S & 132S

Mobile Platform

(compliant with 6 aerial scanners)

geocue.com

Geosun

GS100G

geosunlidar.com

GEXCEL
GEOMATICS & EXCELLENCE

HERON (4 variants)

heron.gexcel.it

GreenValley International

LiGrip O1 Lite

LiGrip H300

LiGrip H120

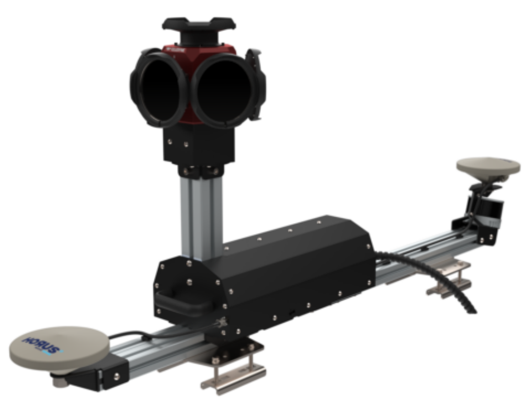
LiBackpack (DGC50H)

LiMobile m1

https://www.greenvalleyintl.com/

HORUS MAKE SENSE

Citymapper

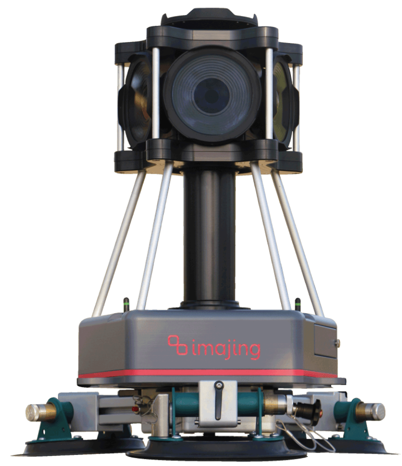


horus.nu

imajing

Imajbox3

Imajbox360



imajing.eu

looq

Q

Looq.ai

(Image via https://www.geoweeknews.com/blogs/looq-ai-suveying-gnss-imu-imagery-saas-photogrammetry)

LUXMODUS

[Proprietary?] (photo circa 2021)

luxmodus.com

(Image via https://energynow.ca/2021/06/energy-innovation-feature-who-is-lux-modus/)

Mosaic

Xplor

51

X

Viking

mosaic51.com

NavVis

VLX (1, 2 & 3 generation)

MLX

navvis.com

RIEGL®

VZ-600i

(Yep; not a mistake)

VMY-2

VMY-1

VMX-2HA

VMX-RAIL

VMQ-1HA

VMZ

http://www.riegl.com/

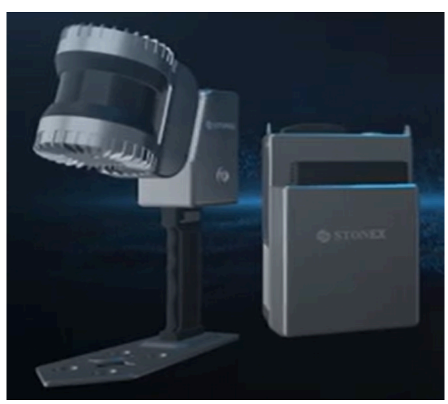
SATLAB GEOSOLUTIONS

Cygnus Lite | Cygnus 2 | Cygnus Handheld | Lixel X1

satlab.com.se

STONEX

X120GO | X70GO | XH120 | XVS vSLAM



www.stonex.it

TEE LABS

TeeScanner

http://teevr.com/en/

Trimble

MX50	MX9	MX90
		

geospatial.trimble.com

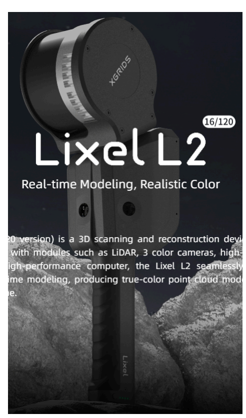
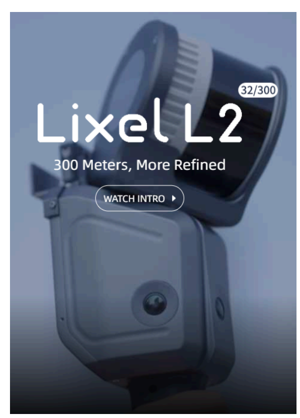
ViAmetris

MS96

viametris.com

SYMBO DUO

www.voxelmaps.com

Lixel L2 Pro	LixelKity K1	Lixel L2-16	Lixel L2-32
			

https://xgrids.com/

FlexScan 22 (with Imager 5016)

www.zofre.de

Considerations for Adoption

MM and SLAM systems and the scenes they collect are extremely unique, making it extremely difficult to generalize a list of suited devices, needed support equipment, or even 'what's better in what situations.' However, the following points are the *start* of a list of considerations a burgeoning SLAM or MM user may wish to ask themselves prior to committing to a purchase.

1) General Intended Use

Every environment is unique in size, atmospheric composition, access permissions and/or restrictions, accuracy requirements, safety permissions, radio and electromagnetic frequency tolerances, required levels of detail, permitted digital tools, physical and digital security protocols, etc. It's important to know what's being asked of the sensors, what types of environments they're designed for or can be leveraged to achieve better results.

2) Expectation vs Performance

Expectation is a dangerous thing when not established correctly. While companies have the responsibility to clearly define their scanners, their function, and the product they provide, the sales representatives might not fully grasp the functionality or, worse, misinterpret either a client's question or the instrument's capabilities. For example, 'moving around freely' with a SLAM device often does not include taking an elevator as a mode of transport, and some don't like auto-platforms like escalators or moving walkways.

Likewise, a purchaser may misinterpret performance metrics on a device and assume one functionality and receive another. For example; the lack of understanding that a '4k Camera' does indeed collect a great deal of information, but the resolution at a set distance will differ greatly even just considering 'planar' versus 'spherical' cameras. You might find you have to collect information from within one metre of the target object, rather than the expected ten metres.

It's important to get a comprehensive picture of a device's performance in its intended job environment prior to purchase or use. This may require extensive testing in 'worst case' or 'common strain' environments to get a sense for reliability in less-than-perfect conditions.

3) Ease of Use/Training

While training a person to use a SLAM or MM scanner can be relatively simple, it's the troubleshooting and data harmonization that comes after where knowledge and skill begin to take a greater roll. Some devices simply need to be turned on and started, other devices need a second before starting, others still have highly complicated processes that need to be followed to-the-letter if you're to hope for a successful product. Some instruments need to be treated with delicate care, not turning suddenly or quickly to give time for IMUs to register movement; others are designed to be used almost haphazardly and achieve similar results. Shut-down procedures are usually just as trivial as their start-up procedures, if not easier, but still have to be adhered to for the sake of mathematical certainty of closure and differencing the path of travel in a forwards/backwards direction for analytics on confidence an dquality.

Ease of post-processing training is also a consideration. Are your technicians going to be calling into the manufacturer's help line regularly, looking for help? Do your crews have a good enough understanding of the technology to apply it correctly? What procedures will you have to create to accommodate this device and the data it produces?

Proper maintenance and *treatment* of the system will also be critical topics of discussion. How forgiving are these instruments to mishandling? Is a 'bump' something it's not allowed to endure, or is the system forgiving to instrument change/abuse? If not, you may have to re-evaluate either the device being proposed, or who's using these instruments based on their physical capability, spatial awareness, and ability to handle the devices efficiently and effectively.

4) Camera Suitability

Cameras are one of the more simple-sounding attachments you could put onto a device, but they require a great deal of forethought and consideration prior to coming to a decision. They are an integral part of most SLAM systems and compliments LiDAR collection through providing colourization values for the point cloud, but also for providing human beings with better-than-point-cloud resolution of real-world places and objects so that smaller details that are missed by the lidar can still be seen and leveraged.

Resolution, frame rate, dynamic (exposure) range, and lens type all have critical impact on the quality of a camera. High resolution means higher details, but higher detailed images require more data for the same sized area, increasing operational costs on collection, processing, and storage. But they also collect finer details, making some SLAM systems more effective than others at condition assessment; others still use lower resolution cameras specifically because their SLAM algorithms work more reliably at building 3D models with lower resolution images.

SLAM units are ideal for collecting images on the run, but you'll need to test the cameras thoroughly to ensure you're going to get the resolution of image that you were expecting from the distance you intend; otherwise you might be disappointed by the in-field results. Likewise, areas of dramatic change to light could cause visibility issues. Ask your vendor how quickly the cameras adapt to a dramatic change in light, and if there's any way to review and adjust the camera sensitivity during collection or after the fact, either in bulk or with select images..

5) Dimensions (Travel & Carry)

For mobile mapping and SLAM scanning, it's not just about 'fitting it on the roof' or 'having someone carry it.' This equipment can cover a large amount of ground very quickly, but in and out *fast* doesn't necessarily equate to 'in and out *easily*,' making logistics, utility and weight as much a consideration as time, range and accuracy.

Modern SLAM scanners are highly flexible devices, operationally, and often have diverse, augmenting attachments or methods of use that can accommodate a great deal of complex sites and data collection techniques. It's important to know if the devices used will not only perform but be ergonomically safe, *agreeable* to carry and small/nimble enough to be wieldy in the space, especially over the intended periods of time, and securely fit with any other supplies or equipment you're transporting. Of course, if you're not transporting it or using it, you're storing it; which has its own challenges, especially if the equipment is to be moved around a lot of work sites or wide geographic areas.

Mobile mapping units need to be positioned on their utilizing vehicle according to design specification tolerances and according to scan requirements. Depending on the scanner, setting the device too far forward or backward puts the vehicle into the scan, potentially blocking critical parts of your scene. Having the scanner positioned too low to the ground may limit overhead height restrictions, but it has the potential to create a myriad of other issues mostly to do with limiting the laser's perspective and effective incident angle range. While tall vehicles and trucks will provide a higher perspective, they also tend to be less wieldy in urban areas or other environments that sometimes require tight maneuvering; taller vehicles may also have scans blocked by medium-height objects in the environment.

One of the most nerve wracking experiences for a field crew is using equipment for the first time after unsupervised transport like airline travel or ground delivery. Airline undercarriage cargo ('checked bags') can often be damaged, lost, or stolen during transport (especially -seemingly- in Canada.) Naturally, some recent-gen handheld and backpack SLAM scanners are small enough to be stored in a carry-on bag or backpack-like case, making air travel less anxiety-inducing. However, this isn't a universal truth; many of the higher-precision instruments and older generation models fit into luggage-size cases. While this example focuses primarily on air travel, the same risks exist when using any other freight service. Ultimately, the only way to know for sure that the equipment has not been damaged by rough transport practice is through shock indicator stickers that can be attached to the inside of the case.

With mobile mapping or a 'full equipment loadout,' (bringing various equipment to satisfy various perspectives and accuracies) it's more expensive to find vehicles to carry gear with larger boxes, but buying the wrong one could also cost you production time. Consideration should be made on whether the device fits into the 'field kit' you intend for your crew in both function *and* available space; and you should always be averse to taking your field crew's leg room…

There is also the question of peripheral or 'support' devices that either enable collection through control establishment or collecting extra-sensory data (sound sensors, light sensors, signal strength detectors, RFID readers, etc) which have their own associated components and transport dimensions/requirements

6) Weight (Travel & Carry)

No matter the method of transport, larger and heavier parcels tend to cost more to move. Plus, once the unit is where you need it to be, you still need to transport it around the local area.

Weight of a mobile mapping or SLAM scanner can mean the difference between success and failure. While, in theory, you could get people to carry a 50-200 lbs (22-90 kg) mobile mapper on a stretcher or litter through a site to document it, it would be far easier to use a 3-10 lbs (1.3-4 kg) SLAM scanner, plus you'd probably cover more ground in less time with far less risk.

Ergonomics cannot be understated. 'Heavy' is generally frowned upon in reality capture as mobile mappers can be hazardous to mount and vessel-restrictive if of substantial weight, and SLAM scanners need to be light in order to be carried farther, longer, or to be flexible enough to serve as a 'multi-platform,' or a sensor that can readily be adapted to function as a hand scanner, backpack, drone, robot navigation instrument, and/or mobile mapper. Of course, ergonomic and multi-platform suitability also means peripheral devices, or 'attachments,' that enable that comfort or flexibility. With those attachments comes weight and dimension which, again, are not just part of your financial cost analysis, but your *movement* cost analysis.

7) Durability/Flexibility of Function

When it comes to durability, these systems and their supporting solutions can be designed to fit a near-infinite number of applications. If the space being scanned is more rugged, like a mine or forest, or that the environment is harsher, like a forge or volcano's edge, then the system must be designed for (or, at least, temporarily resistant to) those environments. Waterproofing, temperature requirements, EM/RF transmission and resistance tolerances,, and structural stability of the unit are essential in determining if it is the right tool for the job. Not all SLAM or even mobile mapping units are water resistant, making surprise precipitation catastrophic! Images don't always transition to changing light intensity (like going in/out of a building) as quickly as a user moves, affecting in/out/transition collection times. With knowing what environments the unit can operate in, and how quickly the instrument responds to commands or auto-transitions, it is easier to determine which scanner you need for your company's purposes, and to understand where your failure points will start from an environmental and procedural perspective.

'Flexibility' can be seen as the instrument's ability to adjust its perspective in any direction on the fly. While it's nice to have a sensor you can keep close to your body or mounted on your car, your ability to reverse or hold a hand-scanner upside down may be the deciding factor between a 'solid' arsenal item and a poor investment. However, 'flexibility' can also encompass different platforms to *get* those different perspectives. Does the device have the ability to be readily incorporated into another instrument? Can I attach my scanner to an aerial drone to get a birds eye view of the area or navigate a cave, mine or sinkhole that I'd rather not enter? Can I put it on a terrestrial robot if I think the area's too hazardous for human entry or if I want to make regular, systematic scans of the area?

Flexibility is also a good indicator as to if you need one scanner or multiple scanners to cover your client's needs. While more of one scanner is a luxury, it may be very much essential that other devices accompany your mobile mapping or SLAM solution. Multi-platform adaptability (section 10) may be a solution in limiting the number of different scanners required, but this will always depend on your project requirements.

8) Operational Temperature Ranges

As mentioned in Durability/Flexibility of Function, the operational temperature range is important to understand. If the system is operating in temperatures too cold or too high for its intended design it may slow down (affecting instrument synchronicity,) stop entirely, not turn on, and/or become damaged from frost, condensate, or warping/strain from adverse application of hot or cold.

Of course, when using lidar, standard laser measurement rules apply. Temperature (and pressure) can play a non-trivial role in the proper determination of laser range in any environment.

9) Battery Hot-Swap capabilities

Knowing how long your unit will last is a critical component to your collection. Stopping a recording and shutting down a unit so that you can swap the batteries is a cost to collection time and an added frustration for your field crews. While infinite operation time is preferred, realistic expectations can put your instrument's operation between 40 minutes and 13 hours. However, some mobile mapping units feed directly into the power system of their host car or marine platform. If supplied/generated power is not an option, and time is of the essence, you'll be interested to know how long the batteries last and if you can exchange them without shutting down the instrument (known as hot-swapping.)

You'll also want to know how long it takes to charge any batteries you get as this helps you determine how many batteries you'll go through before the next charging battery is ready.

10) Multi-Platform Adaptability

I don't think there's a single surveyor, engineer, or manager that doesn't wish there was 'one tool to do it all.' Unfortunately, SLAM scanners may not have the ability to reach that level of uniform adaptability and trust, but it doesn't stop companies from coming close. Aerial systems provide the best vantage point and accessibility to complicated work areas, but mobile systems are able to move at equally impressive speeds for incredible distances and aren't restricted by airspace. Stationary and personal/robotic scanners provide coverage to 'blind spot' areas, more complicated environments, and areas where GNSS fails or becomes unreliable, rendering mobile mapping ineffective. This means that, despite one's desire to drive a car through a building, it's better suited to a torso-mounted hand scanner. As fun and economical as it would be to then dangle that person off a crane along the side of a building to scan it, that's better suited to the aerial attachment for the hand scanner.

It is critical to note that, just because a system has multi-platform capabilities it doesn't mean that it has *smooth* multi-platform capabilities. A system needs to recalibrate depending on who's operating the system and how; a human walking and a human driving have different predictable behaviors to a robot flying, rolling, or cyber-dog-walking their way across the worksite. Sometimes the multi-platform scanner has to be stopped, then the instrument recalibrated to the new movement behavior. This means an operator may have to shut down recording, then start a new recording session under a new perception/operation profile.

While multi-platform solutions sound ideal, it would again come down to project requirements and restrictions as to whether these solutions can be deployed and the platforms tested performance versus published performance.

11) Point Cloud Classification (categories & quality)

With the quickly advancing use of artificial intelligence (AI), classification has never been easier. Integrated sensors provide additional information to the point cloud allowing for a more accurate classification as the systems improve. If a scanner is used regularly on one type of project, the system may have the ability to learn from successive projects to identify particular features and classify the remaining point cloud. Being that these sensors contain more levels of data than just a point cloud, the software capabilities are an important aspect to consider when purchasing a new unit. The second question is also to ask, how much classification does your company require for the standard project?

12) Accepted Target Types

While you'd expect most SLAM and MM scanners to find and accept most checkerboard targets, you'd be surprised to learn that there are systems that do not accept these as targets at all. MM scanners often accept custom road markings (chevrons, for example) but some SLAM scanners require their own special targets and are not always (automatically) compatible with any others.

Target size is another critical consideration. If the target is too small, the noise around the target will drown out the intensity-based 'image' of it, rendering it invisible during cloud-to-cloud alignment.

13) Safety Rating

While one might not think it; these instruments may be sensitive to or generate certain types of electromagnetic (EM) or radio frequency (RF) interference. It's important to know what types of safety standards your device is compliant with, and what compliance standards are required on the project site prior to arrival.

Facilities such as energy production plants, data centers, airports, and other signal-sensitive facilities may insist on knowing your instrument's safety compliance performance.

14) Data Detection Range

Once again, 'how far do you want the system to detect' sounds like a silly question with the answer inevitably being 'as far as you can go!' Naturally, one would assume that 'how far you can go' equals 'laser effective range.' Unfortunately, the difference between 'detection range' and '*effective* detection range' depends greatly on the environment first, then a series of operational considerations.

For example, if you're on the side of the road with an MM device that can scan up to 350 metres away, one would expect information in a 700 metre swath with the instrument in the middle (350 metres on either side.) However, most scan lines from the road won't naturally extend more than 20-30 metres into a treeline. This isn't because of shoddy performance reporting; it's simply because there are enough trees and natural obstacles within this 20-30 metres to absorb the laser, thus rendering a ‘350 metre detection range impressive, yet pointless in this instance.

The next question that should be asked is this; can a laser measurement be trusted from [maximum laser range] away? From the sub-metre level, is the distance report correct? If not, at what distance from the sensor, or environmental condition, is ‘range’ no longer an effective selling point for what you’re trying to do?

Another consideration in ‘detection range’ is that, due to radial dispersion, the spaces between successive laser ‘shots’ increases the farther out from the source those laser shots go. This means that, from ten metres, a building or mast would be clearly visible via the point cloud; practically ‘painted with dots.’ However, at 200 metres away, there are less points hitting the building or mast, making the object a fainter shadow of itself. This makes object determination and detailed measure difficult if sparse enough, so keep ‘effectively close’ to your objects of interest. Of course, ‘effectively close’ depends on intention and instrument.

While not necessarily ‘range,’ the number of returns your laser is able to register for any one laser pulse also affects the amount of ‘things’ that are picked up in a scan. A scanner that only registers the first or last pulse it gets back only sees one ‘thing’ in that moment; but a laser that can track up to five or fifteen return pulses will pick up ‘more’ as each of the first five-to-fifteen objects that the light hits will be ‘seen’ in the scan.

15) Data Storage & Processing Capacity

A scanner’s only useful when it collects data. The effectiveness of that data is determined by a great number of factors, but capacity is a significant consideration for duration of scan and, therefore, a logistical concern for project completion time. If I am scanning hundreds of gigabytes worth of data but only have 128GB data stick, I know I’m not going to finish without at least filling the stick and will need either alternative storage or the ability to make that stick available again when needed.

Data storage capacity isn’t just about how much data you collect in the field or display on the front end, but how much data you create on the back end. Often, as a part of data ‘post-processing,’ field collected data is stored in super-condensed, proprietary information packets that need to be unzipped before being understood by any outside software. As such, between this and the data created for post-processing of the mission trajectory data itself, it’s not unusual for datasets to balloon 3-6 times their original size, depending on the required export types and the amount of information collected by the system. Without a proper data management strategy, companies looking to adopt SLAM and mobile mapping without first being accustomed to reality capture data may not fully grasp the volumes of data possible with these systems in a given year, let alone while sustaining operations over many.

While one would naturally assume ‘more information is good,’ having too many cameras, lasers, IMUs, or other sensors onboard a machine naturally complicates its operation and data capture processes and can greatly inflate post-processed data volumes. From data transfer to troubleshooting, a ‘simple’ machine can become a labyrinth of information and cross-referenced data, requiring knowledge of back-end processes to interpret and troubleshoot.

16) System Security

Data storage security is a paramount concern, especially when dealing with sensitive SLAM data. The risk of unauthorized access or data breaches can have severe consequences, including the compromise of sensitive scene information like centimetre-accurate room measurements and high-definition images of people, critical fixtures, sensitive documents, emergency response and critical infrastructure locations, etc. Tragically, rising security concerns across the globe also impact the future direction of this technology and its potential affects and/or effects on society. Like all valuable information systems, it is critical to implement robust security measures and maintain the relationship of integrity and trust placed upon us by our clients and the public at large, and to protect both SLAM/MM data and storage integrity throughout its lifecycle.

Cloud storage solutions offer scalability and accessibility, but they may also introduce vulnerabilities, and in some cases your knowledge of security breaches may be contingent on the provider informing you on their own schedule, despite what laws might be in place. Storing sensitive SLAM data locally can provide greater control and mitigate the risk of external breaches. However, local storage requires stringent physical security and robust access controls. Encryption, both in transit and while stored, is essential regardless of the storage location. Implementing strong encryption algorithms and key management practices adds a layer of protection against unauthorized access. If you’re not familiar with recommended security protocols, it is recommended to receive formal instruction from an institution in line with your industry. While ISO27001 specifically deals with information security management, resources could include buildingSMART Canada and it’s certified instructor companies; ‘The Committee: In Luce est Veritas’ a reality capture education and advocacy group; the Reality Capture Network (RCN); the Open Geospatial Consortium Group (OGC); CanBIM; the US National Institute of Standards and Technology (NIST,) or other knowledgeable and relevant bodies.

If data security is important to you, access controls should be strictly enforced. Regular security audits and vulnerability assessments can help identify and address potential weaknesses in the data storage infrastructure. By adopting a comprehensive approach to data storage security, organizations can safeguard sensitive SLAM data and maintain the confidentiality of critical information.

While the CanSLAM supports international trade and the development of co-beneficial relationships with foreign nations, regardless of geographic location, it should be noted that 'supporting trade…' does not imply '...at all costs' and service providers in Canada need to be cognizant not only of the companies with which they do business, but their responsibilities and liabilities should conflict deepen or worsen between us and their supply/service nations. Rising geopolitical tensions across the globe threaten economic and military conflict as nations and independent organizations blatantly and aggressively attempt to re-align global economic alliances, and attempt to economically or militarily 'squeeze' non-compliant countries including the United States and Canada. At the time of this report, Canada and India are facing off on the international stage with Canada accusing India's nationalist government of murdering Indian/Canadian citizens on Canadian soil, and India declaring Canada unsafe for its politicians and citizens, threatening economic tariffs and sanctions, thus threatening an increase of cost to those who outsource processes to or buy consumables from India. Some actors on the world stage, to their credit, seem content to stop at open war and continue to expand their influence by primarily economic means, and minor military 'events.' As 'rule of law' diplomacy and democratic institutions continue to erode, military tensions rise, and technology continues to change, countries are increasingly threatening hardship, conflict, and war for non-compliance to their wishes. While individuals and companies may wish to conduct business free of political control, this is not a reality, and everyone is subject to the ruling government of their region including their conflicts. Buying equipment from not-so-friendly countries in this climate opens your service, supply lines, and clients to the risks of foreign *or* domestic meddling including purposeful delay, penalizing tariffs, espionage, sabotage, or denial of supply or service (sanctions) until tensions are resolved.

17) Weather Resistance

Currently, the CanSLAM Circuit is located in Canada where the weather can change rapidly based on day, season, and location. Temperatures can vary from below -50C (-58F) in the arctic, or prairies in some cases, in the winter to nearly +50C (122F) in the summer. Humidity has a large impact on the quality of scans, depending on the design of the system. Is the system able to operate in various levels of humidity? What is the temperature limitation of the system? If an interior scan is being done, can the scanner work in a walkin freezer or oven to capture any required details? Rain and snow can also impact the final result, where onboard filtering is helpful in these cases. Different systems have different filtering methods which can improve the efficiency of the post-processing time if working in a precipitating environment.

18) General Site Area Coverage

As previously pointed out, range is a key aspect of what scanner manufacturers highlight as part of their value proposition, and it directly influences the area of coverage for a scanner at any given time. This consideration applies to all types of laser scanners, including SLAM systems. While SLAM systems generally have a shorter effective range compared to terrestrial laser scanners, understanding the area of coverage achievable from the trajectory of your scanner remains crucial when evaluating its suitability for specific projects. If your projects involve challenging terrains where walking access is limited, it is important to assess the scanner's capability to effectively capture the area of interest within its operational limits.

Rather than focusing solely on detection range, it is important to consider how well the scanner can comprehensively cover an entire site, particularly when dealing with obstacles or varied terrains. In scenarios where effective coverage of complex environments is needed, understanding both the recommended movement path of the scanner and its ability to collect consistent data across the site is essential. In some cases, the scanner's area of coverage may be limited or enhanced by the physical environment or the scanner's physical design. Therefore, evaluating the overall site area coverage capability, including considerations like line-of-sight limitations and point density, will help determine whether a scanner is the right fit for a given project.

It's also worth noting that this consideration can significantly impact the time required to complete scanning projects. The triangle of range, area of coverage, and time is a critical piece of the puzzle when evaluating the adoption of a scanner.

19) Dimensional vs Perceptual Fidelity

To oversimplify; this is a question of “do you want it for looking at, or are you trying to build something with it?” While some systems have begun to dramatically bridge the gap between photo-realistic 3D viewing and precision measure, most current systems provide you with a choice; ‘detailed’ and texturized 3D fidelity or precision measure.

An Engineer very much cares about the dimensional fidelity of an object, or how accurate the reported distances are that they measure. They don’t care how convincing the data *looks* from a “does it look ‘real world’” sense. As long as the measurement is accurate, they can tell the difference between critical objects or features in the scene, and they can measure them to the standard or confidence level required; how much “representation per millimetre” is never a desired metric.

Likewise, a game design, simulation process or loosely defined 'digital twin' may not necessarily care that a room is an inch-to-a-foot different in dimension from what's been recorded, or that a hallway doesn't 'bend' the way it does in the scan. For them, it's about rapid product and a quick turnaround to use rough dimensions and convincing representations (models, avatars, scenes, etc) to approximate the environment (simulate) for their clients.

In 2024, one company has actively begun selling precision lidar measure and high-visual-fidelity 3D export of its scanned environment using 'Gaussian Splatting' or "splats." While current performance is restricted to short range collection (less than 200 metres,) the AI methods used for this creation type are a well known 'game changer' in the industry, so the CanSLAM expects a multitude of these instruments to be available for showcasing next year (2025.)

20) Workflow Adaptation

The question for this characteristic is to ask if the system can be adapted to different ways of doing things. If a land boundary is to be included in the data, how adaptable is the unit to collecting that information? What if the land boundary survey is completed after the scan is done? Different companies also approach their workflows slightly differently. The workflow may change in the field or in the office, so how adaptable the SLAM scanner with corresponding software is to these changes will provide insight to the customer about how to work with the scanner. A tight workflow is sometimes best when a particular project requires it, but acknowledging this as a consideration is important for the one purchasing.

Ironically enough, SLAM scans can be used by LiDAR technicians to approximate the number of setups needed to complete a more high-precision scan (say, metrological or high-confidence machinery) and the equipment needed to support it. This limits the on-site time required

21) Maximum operational time

Battery life is always a contentious issue on any job. How long the battery lasts will dictate how big of a job it can be used on, but the operational time does not just include battery, it can also include onboard/cloud memory space, mechanical and thermal limitations, and others. This can also be dependent on environmental factors. Vehicle mounted devices will require a longer operational time than a handheld system. The key is to know the job size and area of required coverage so that you can decide on which SLAM scanner is the best tool. When the manufacturers design the scanners, this is an important consideration.

Conclusion

Despite opening its internal course on July 23, 2024, the CanSLAM was unsuccessful in having more than two commercially available SLAM scanners pass through the course before being closed for the season on October 10, 2024. The control network for the 2km mobile course was completed later in the year, causing mobile testing to be functionally delayed until the 2024-2025 season. As such, the CanSLAM feels it does not have enough information on individual market devices from either SLAM or MM systems to provide significant insight into the performance of the industry as a whole.

With this result, the value of the report was re-drafted to provide a brief exposé on SLAM technology available on the market, rather than showing scanner results for common scenes, and provide a call to action to the geomatics community.

With the greatly appreciated help of student volunteers, guided by industry volunteers, the CanSLAM has established a high-precision control network, georeferenced images and point clouds, and a framework for evaluation that incorporates student enrichment and scouting. We stand ready to begin evaluation of units through the SAIT Internal and External courses once it's established that the course itself is of interest to either manufacturers or the community at large.

Likewise, a historic site in Fredericton, New Brunswick, was identified as a willing to play host for a circuit scene for a single season (non-renewing,) but lack of local student interest and finances/resources for otherwise required operational expenses meant that this course was unable to be established by local industry volunteers for the 2023-2024 season.

Call to Action

With the ever expanding numbers of SLAM and MM scanners, the decision to purchase one or adopt these systems into their operations becomes overwhelming, and companies looking to innovate and revolutionize their industries need a jumping-off point in the face of so many options, so many considerations, and little understanding. Likewise, understanding of SLAM and MM breadth of function is critical to unlocking the functionality fundamental to your adoption goals. The CanSLAM Circuit has been designed to help those looking to adopt SLAM scanners into their environment by providing candid data from each individual scanner and making it available in one non-biased location, not just presented in 'evaluation of performance,' but candid samples of a tightly controlled area, and options to review alternatives. From here, companies and downstream developers can access the data with the understanding that the data is to be used strictly for SLAM and MM development, or the AI processes that support or enhance their collection, processing, rendering, and information extraction AI workflows.

The CanSLAM is designed to be the platform where industry can get a ‘snap shot’ of year-to-year system performance, functionality, and available AI tools or extensions, and has value to consumers, the community, and manufacturers alike.

Manufacturers:

The CanSLAM Circuit is here to help market your product and get the message about its performance and features for those interested in adoption. Two startup SLAM companies have already onboarded with the CanSLAM Circuit for the testing grounds of their product in 2025. Using the circuit, manufacturers are able to compare their product both with a high-precision data set and what is currently on the market. This allows them to identify and highlight the advantages of their systems and solutions, and what makes their SLAM unit stand out from others. Seeing what’s possible from other devices in the same scene is also a premium way to gauge comparative performance in various scenes and environments.

Community:

The CanSLAM Circuit is giving back to the community with freely downloadable information about SLAM scanners. This information has come through volunteerism and donations. To keep the CanSLAM Circuit operating, there is a need for resources - human, technical, and financial. The human resources are needed for point cloud validation, maintenance of the primary control points, outreach to manufacturers and sponsors, circuit administrators to assist manufacturers when they attend the circuit, analytics, and new circuit locations and design. Although there are a lot of jobs to complete, they generally are only a couple hours at a time. The exception is the new circuit design and placement, but the CanSLAM Circuit would prefer to engage students in completing the control surveys as capstone projects or internships. Another easy engagement for all in the community would be to ask manufacturers if they have participated in the CanSLAM Circuit before they purchase. As manufacturers hear more and more that the industry is looking to see what characteristics are exemplified by participating, it will encourage them to give the nearest circuit a try.

Technical resources include cloud storage and cloud analytics software. Point clouds require a significant amount of computer resources to handle and providing the sample point clouds, raw and post-processed information, and images to the world requires cloud storage. The donation of this would be essential in creating a fully beneficial circuit. Also, cloud analytic software for comparisons that can handle entire point clouds is currently a high and renewing financial cost. Because this software would only be used on a temporary basis when a manufacturer submits a point cloud from the circuit for review, the need for a permanent license is not required at this time.

Financial resources include volunteer incentives/opportunities and general financial sponsorship. Administrative costs of the webpage, current data storage, cost of circuit maintenance and equipment consumption, registering and maintaining registration as a business entity, and travel to present results to the community, and the requirement to rent equipment to supplement lack of pro-bono participation, average far greater than $10,000 CAD a year. Donations to cover these costs would keep the CanSLAM Circuit in business to provide these free datasets to everyone. Another cost would be to bring a student or students on as an intern to assist with outreach, circuit design, analytics, media editing, report formatting, and production of articles & educational material. Having a way to meaningfully compensate students for their engagement would bring additional interest into the program, allowing us to keep our desired educational pillar, teach the upcoming generation about the participating SLAM scanners, and find your next talented star. Ultimately, using students is a long term marketing approach as students provide value to the manufacturers by being able to recommend their products and solutions to others during discussions, troubleshooting, or leadership/innovation opportunities.

Overall, the CanSLAM Circuit provides a much needed resource to the geomatics community as well as value to manufacturers. As the industry grows and becomes more overwhelming, manufacturers will need to find a way to grow their businesses and consumers will need to find a way to know which scanner is the best option for their projects. The CanSLAM Circuit is willing to facilitate all this and more, but we need your engagement and support.

Closing Remarks

The CanSLAM Circuit would like to extend its greatest appreciation to GoGeomatics Canada and Eagle Engineering and Consulting for their support and encouragement of this undertaking, as well as the Southern Alberta Institute of Technology and it’s staff, student volunteers, and facilities management personnel for allowing this course to be established and maintained for the benefit of the geomatics community; continuing their proud tradition of pioneering engagement in development of the survey industry.

Kudan USA and R.E.A.L.iT should be highly lauded for their openness and confidence in their provided solutions, and we thank them greatly for their engagement. The CanSLAM is both grateful for their support and regretful that we were not able to honor their contributions as intended. Kudan USA and R.E.A.L.iT have supported the CanSLAM from its inception -both years- and both companies clearly demonstrated both enthusiastic confidence in their line of SLAM solutions and endorsement of the learning process required for responsible and informed SLAM adoption. They are truly industry Leaders.

We hope what was presented in this report proves to be of value in providing insight and understanding into the application of Mobile Mapping and Simultaneous Localization and

Mapping solutions currently available to the North American market, and SAIT stands ready for the coming season.

We'll see you at the National GoGeomatics Expo, 2025.

Thank You

The CanSLAM Circuit would like to thank all those who got involved in this year's initiative and the manufacturers that participated in scanning. Your efforts have been greatly appreciated, and you have helped bring significant information to the GoGeomatics Expo, regardless of the one year's outcome.

Student and Industry volunteers:

Ricky Mendoza, *SAIT Student*
Janice C, *SAIT Student*
Eunice Estonactoc, *SAIT Student*
Jesse Vanneste, *SAIT Instructor (Fortress Geomatics)*
Lance Hummel, *SAIT Instructor*
Victoria Desjardins, *SAIT Instructor*
Mack Kowalski, *LiDAholics, K&K*
Gabe Kettler, *LiDAholics, K&K*
Kailey Graves, AScT, *Underhill Geomatics*
Chimezie Azih, *Cansel*

Corporate and Organizational Entities:

Eagle Engineering & Consulting
Southern Alberta Institute of Technology (SAIT)
GoGeomatics Canada
Kudan USA
R-E-A-L.iT
The Committee
LiDAholics
University of New Brunswick