FIG WORKING WEEK 2023
28 May - 1 June 2023 Orlando Florida USA
Protecting Our World, Conquering New Frontiers

Automated IoT GNSS Monitoring Service

kurloo

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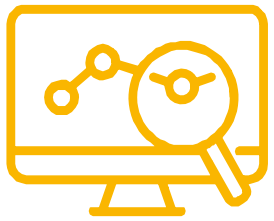
Organized By NSPS FIG INTERNATIONAL FEDERATION OF SURVEYORS

Paper 12331 | Session TS03G | 2023-05-29

Diamond Sponsors esri THE SCIENCE OF WHERE Trimble

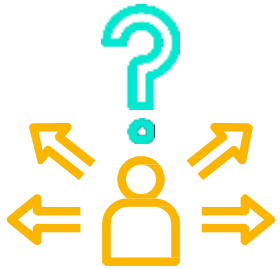
Motivation

Buildings, structures and ground surfaces move all the time



Frequent monitoring is important to assess safety and stability

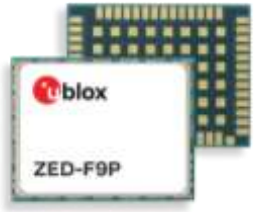
The current process of monitoring is complicated, expensive and in some cases, a safety risk



Asset and infrastructure managers need to know their assets are safe at any time

So, we invented **Kurloo** to help manage risk using **precise positioning**- more simply and economically than ever before

Opportunity



Low cost GNSS chips

Cloud computing

Low power integrated modems

Solar & battery technology

Advanced manufacturing processes

The Goal

Make precise positioning more accessible, to more people, in more places, more often.

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- ✓ **Low unit cost positioning device (mass deployable)**
- ✓ **Compact and simple to install and operate**
- ✓ **Remotely operated and configurable**
- ✓ **Accuracy XYZ displacement daily at 2-5mm daily (relative precision)**
- ✓ **Unlimited 24h online access to results**
- ✓ **Fully automated processing**

Collaboration

QUT Queensland University of Technology

monitum™ POWERED BY landsolution

imcrc

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3.5 years

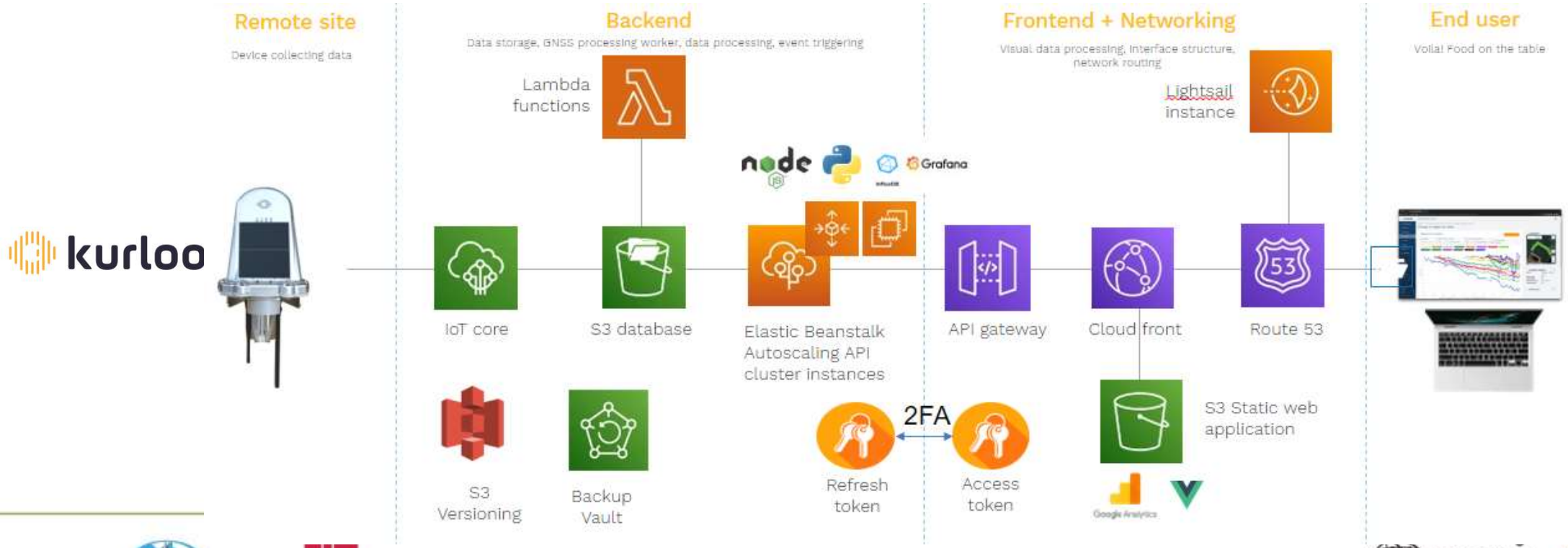
$4.5 AUD million R&D

https://www.imcrc.org/case-study-monitum/

Part A - Smart Positioning Device Features

- Fully integrated, compact, lightweight, IP67 rated
- Solar powered, battery life 14 days without charge
- Integrated GNSS chipset and Antenna (no cables)
- Remote Operation, over-the-air firmware upgrades
- Integrated smart environmental, accelerometer and ground level sensors

Part B – Scalable Automated Processing Cloud Computing Platform



Part C – Accessible Business Model

- Low entry cost
- Pay for what you use (per month)
- 3 - tiered Monthly Pricing Models (Hardware, Software and Support)

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GNSS Specifications

	Monitoring Device	Reference Device
Constellation	GPS Galileo BeiDou QZSS	GPS Galileo BeiDou QZSS GLONASS
Signal tracking	L1 of supported satellites	L1, L2, E5b of supported satellites
GNSS Antenna	Single-band helical antenna	Dual-band helical antenna

→ Horizontal Accuracy

2mm + 0.5ppm RMS*

↑ Vertical Accuracy

3mm + 1.0ppm RMS*

Daily / scalable to multiple readings per day latency

* GNSS Baseline length up to 1km

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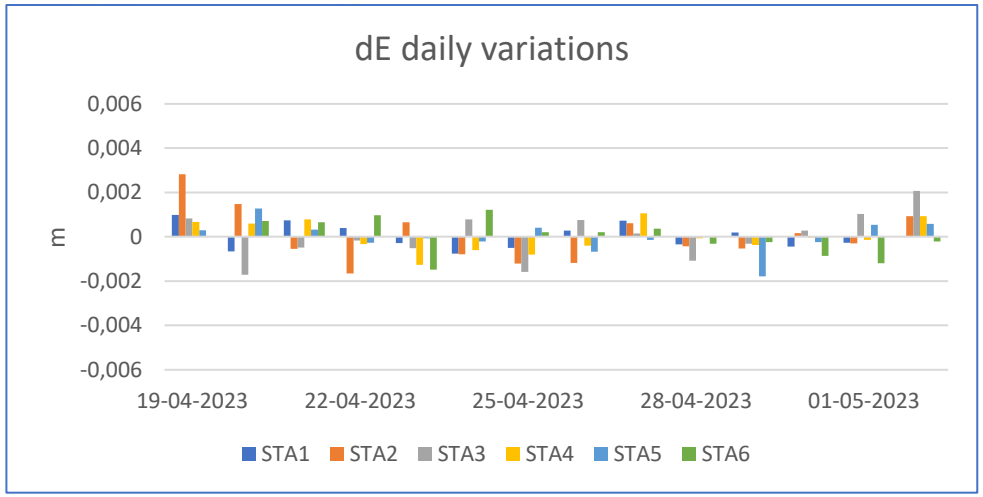
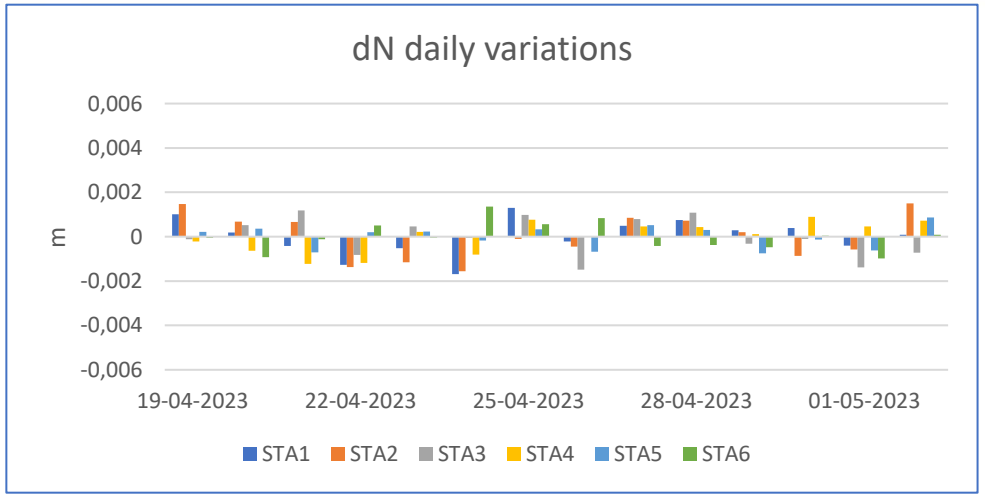
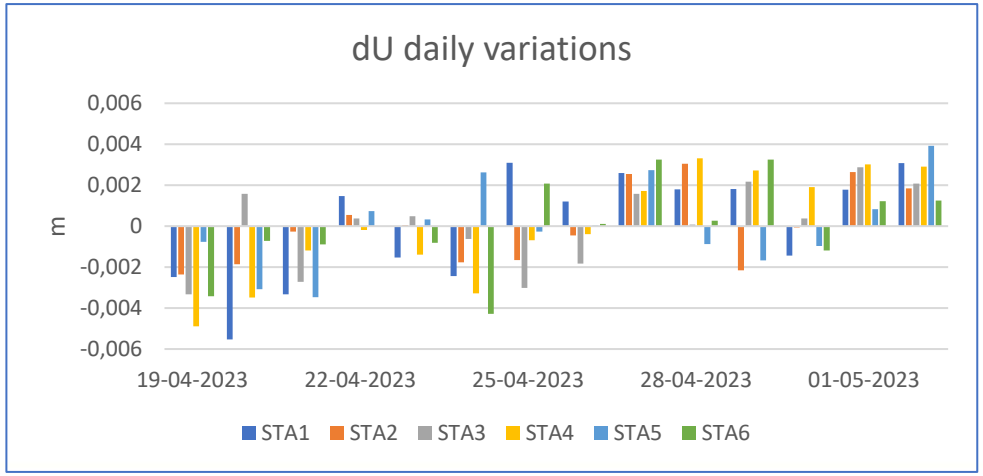
Test Case
EDM Calibration Range
Leyburn QLD







Station ID	Baseline Length (m)	L1 SNR (dB)	Repeatability (mm)		
			E	N	U
STA1	1082.912	40.05	0.5	0.8	2.6
STA2	1052.954	37.63	1.2	1.0	1.8
STA3	902.5	37.68	1.0	0.9	2.0
STA4	631.754	39.52	0.7	0.7	2.6
STA5	300.836	39.57	0.7	0.5	2.0
STA6	90.252	39.76	0.8	0.6	2.1

Legal Traceability of Length for Electronic Distance Measurement (EDM) Equipment

LAB	=	Kurloo Derived baseline length : SQRT(dE^2+dN^2)
REF	=	QLD Department of Natural Resources, Mines & Energy (NATA Accreditation No. 15032)
U_{LAB}	=	$2.45*(SQRT(\sigma_E^2+\sigma_N^2))$mm
U_{REF}	=	± (0.5 + 1.3 ppm) mm
E_N	=	$(LAB - REF)/\sqrt{U_{LAB}^2 + U_{REF}^2}$

E_N= ISO Guide to the expression of Uncertainty (<1 satisfactory)

Additional uncertainty to be added if baseline monuments suspected of movement 0.0020 m

Line	LAB (m)	U_{LAB} (m)	REF (m)	U_{REF} (m)	DIFF (m)	E_N	Result
7-1	1082.9130	0.00231	1082.9120	0.00191	0.0010	0.278	Satisfactory
7-2	1052.9600	0.00383	1052.9540	0.00187	0.0060	1.275	Unsatisfactory
7-3	902.5010	0.00330	902.5000	0.00167	0.0010	0.238	Satisfactory
7-4	631.7570	0.00274	631.7540	0.00132	0.0030	0.824	Satisfactory
7-5	300.8390	0.00224	300.8360	0.00089	0.0030	0.957	Satisfactory
7-6	90.2563	0.00259	90.2530	0.00062	0.0033	0.992	Satisfactory

Note: Line 7-2 Unsatisfactory due to higher multipath in monitoring device location compared to other devices

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Use Case
Slope Stability
Froggy Beach
QLD

Site:

Froggy Beach, Gold Coast, Australia
A popular beachside tourist destination.

Problem:

- Significant ductile creep above the beach.
- Cracking and movement in the footpath above slope
- Movement observed in boardwalk down to the beach

Issues:

- Public safety risk
- Negative impact on public space and nearby historic areas

Solution:

Kurloo GNSS devices were installed to monitor the 3D mm relative displacement of the slope on a daily frequency (4D) – (X,Y,Z and Time)

Corresponding daily Bureau of Meteorology (BoM) rainfall data fed automatically into the Kurloo Nest (online processing platform) to allow simple analysis of the relative displacement to rainfall.

Results:

With over 2 years of frequent monitoring data, the slope behavior clearly exhibits slips where daily rainfall exceed 50mm. Other trends are noticeable where expansion and contraction occurs during lesser rainfall and drier periods. This can be at times up to several cm.

Benefits:

Daily readings from Kurloo highlight the relationship of rainfall and displacement, which would not have been apparent with infrequent manual monitoring surveying.

- ✓ Faster response times
- ✓ Quantifiable results to act upon
- ✓ Improved maintenance planning
- ✓ Justification of remediation expenditure

Fig 1 : Kurloo **daily** monitoring frequency

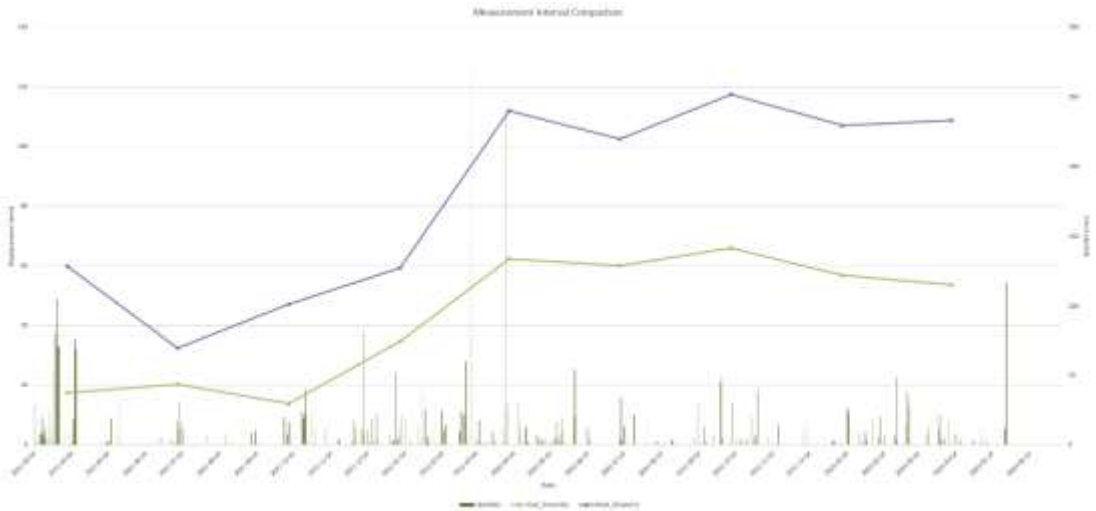

Fig 2 : Comparison to routine 3D displacement manual survey measurement **every 3 months**

What new frontiers can Kurloo conquer?

Mining
Tailing Dams
Site Stability & safety

Rail
Slope & Track Stability
Bridge abutments

New Construction
Risk Management
Slope Stability -
during & post construction

Roads
Slope stability
Embankments
Bridge abutments
Erosion

Dams
Displacement monitoring
Slope stability
Critical infrastructure

Ports and Airports
Settlement monitoring
Land reclamation
Sea walls and infrastructure


Mt Bogong, VIC
Australia
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Summary

How Kurloo can Protect our World and Conquer New Frontiers..

- ✓ Complementary technologies are making precise positioning more accessible
- ✓ Further enhancement of Kurloo Technology can be made for scientific and research applications.
- ✓ Making precise positioning more accessible advances greater possibility for scientific discovery.
- ✓ Collaboration will further enhance accessibility to positioning infrastructure in the developing world!

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Contact Us

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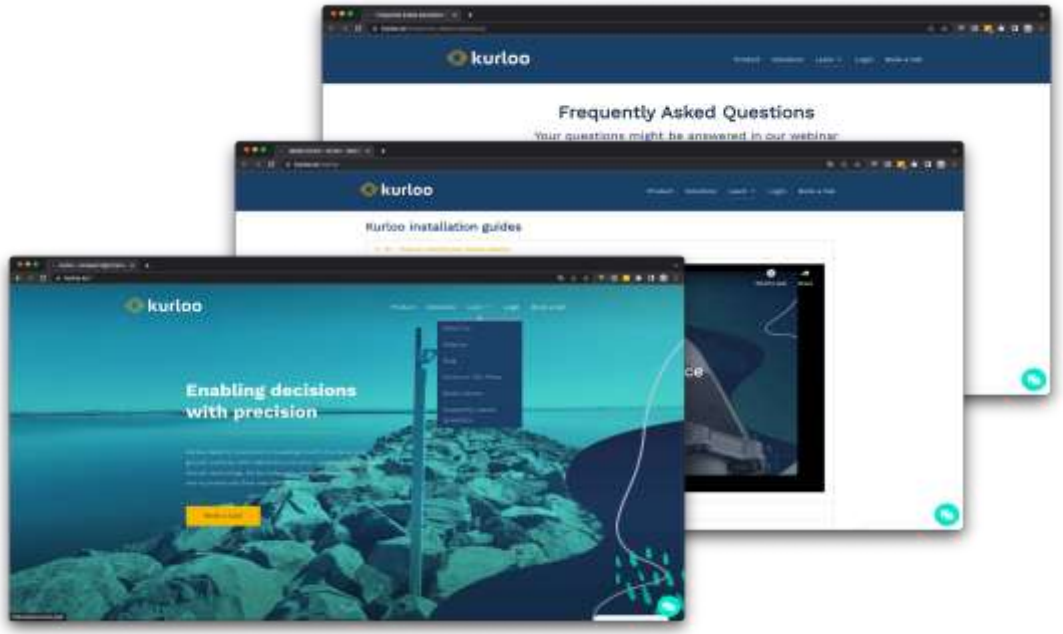

Find out more at
https://www.kurloo.io/

Or book a sales call
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