
Leica
Geosystems
Our GNSS Journey

In 2000 I started as a photogrammetrist!

For 12 years I worked with aerial photos

This shaped my future in geo-spatial

In 2012 I changed jobs to work in Laser Scanning

Then in 2013 I was into mining! For 2 years,

I worked closely with Geotechnical Engineers

Multiple constellations are enhancing GNSS capabilities for everybody

By 2019, this is forecast to

“ The introduction of Global Navigation Satellite Systems (GNSS) into surveying remains the most significant improvement experienced by the profession in recent memory — and will remain the core tool for surveyors. ”

European GNSS Agency (GSA)

used around the globe,
with 3.6 bln GNSS devices
in use in 2014.

GNSS today? About 85 FOC satellites

Galileo and BeiDou agencies are 100% committed to finish their constellation by 2020

31

GPS:
The first GNSS, fully operational since 1995, is managed by the US Department of Defense

24

GLONASS:
The Russian GNSS, completed in 1995 and fully operational since 2011, is managed by the Russian Aerospace Defence Forces

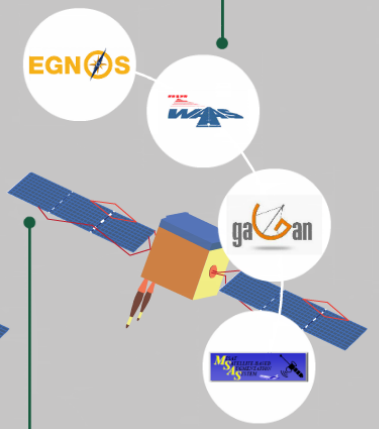
9

Galileo:
Europe's GNSS, currently under development as the only civil GNSS, is owned and managed by the European Union

21

BeiDou (COMPASS):
The Chinese GNSS, set to supersede the COMPASS regional system operating since 2000, is managed by the governmental China Satellite Navigation Office

Satellite- Based
ntation Systems



EGNOS (Europe)
WAAS (North America)
GAGAN (India)
MSAS (Japan)

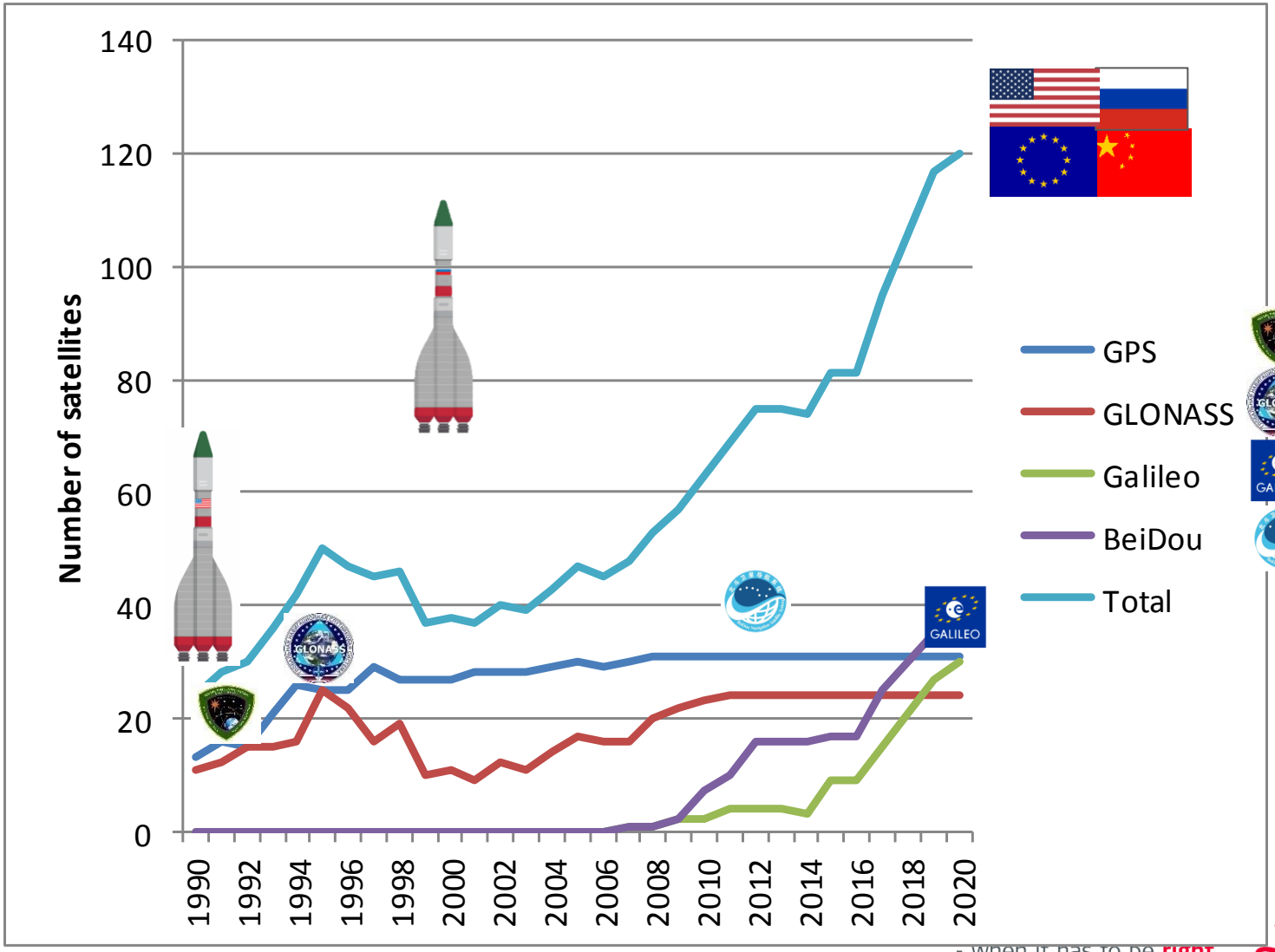
2016 named “The Year of Galileo”

The Munich Satellite Navigation Summit named 2016 as “The Year of Galileo.”

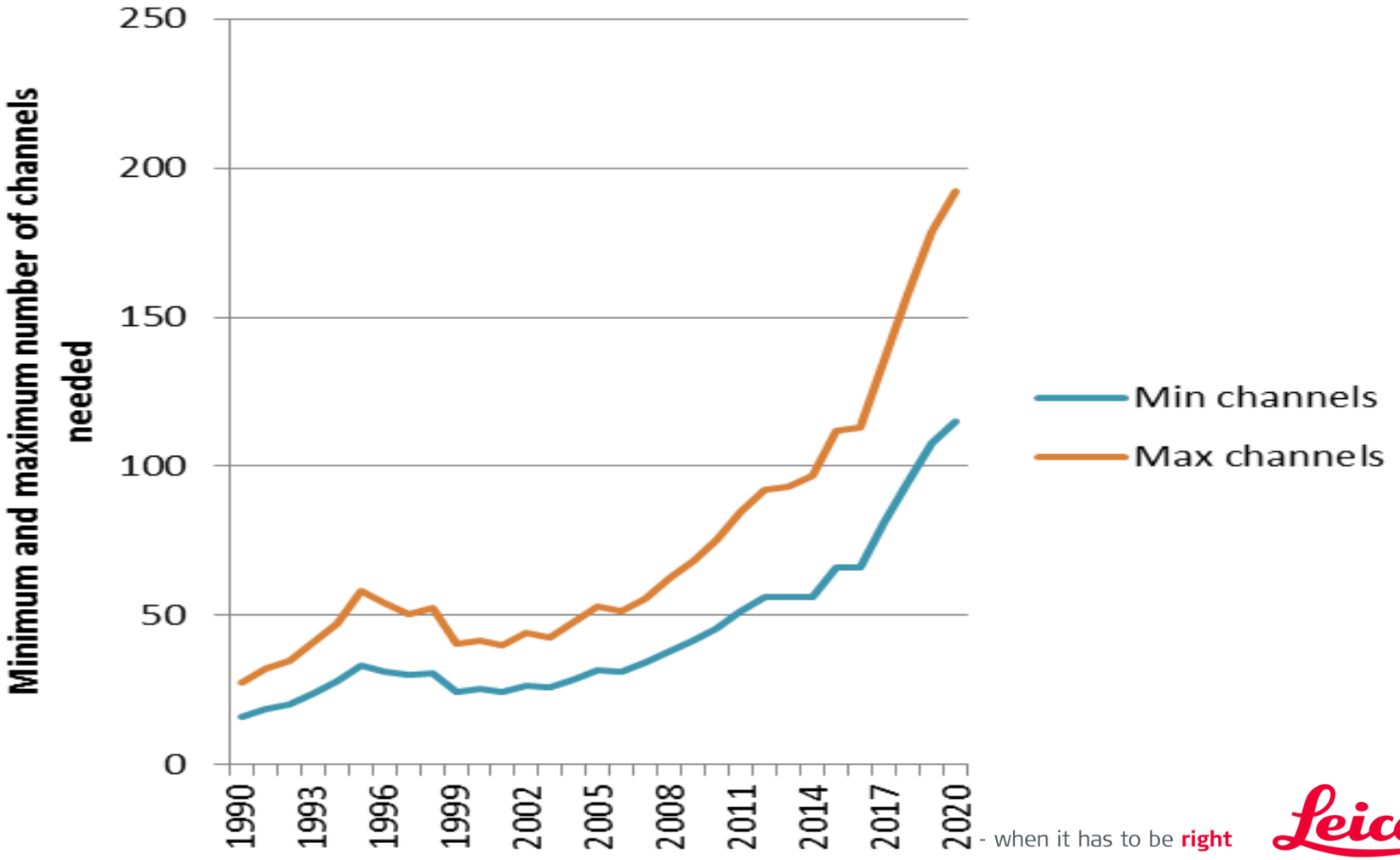
12 Galileo satellites are currently in orbit, with 4 launches in November and anticipated global coverage increasing by 2020.

Bringing the Internet of Things (IoT) and digital infrastructure in general, and the emphasis of better accuracy and availability of the European GNSS, especially in urban-canyon and tree covered environments.

Total GNSS satellites will rise to over 120 by 2020



If we want to benefit from the modernisation of GNSS, a larger amount of channels are needed.



Leica’s commitment to GNSS innovation

Now we have true Multi-frequency, multi-constellation 555 Channels

Multi-frequency, multi-constellation

Performance improvement

real time

RTK-GPS

on even in

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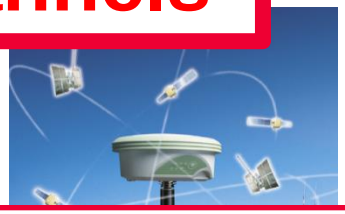


The European GNSS agency reported that the use of additional satellites improves the overall performance of the service in terms of reliability, The Time To First Fix (TTFF) and availability.

A vast majority (more than 85%) of GNSS devices offered today use a minimum of two constellations, 40% of receivers support four.

What are the drivers for GNSS developments

I. More precise positions - reduce limitation due to obstructions

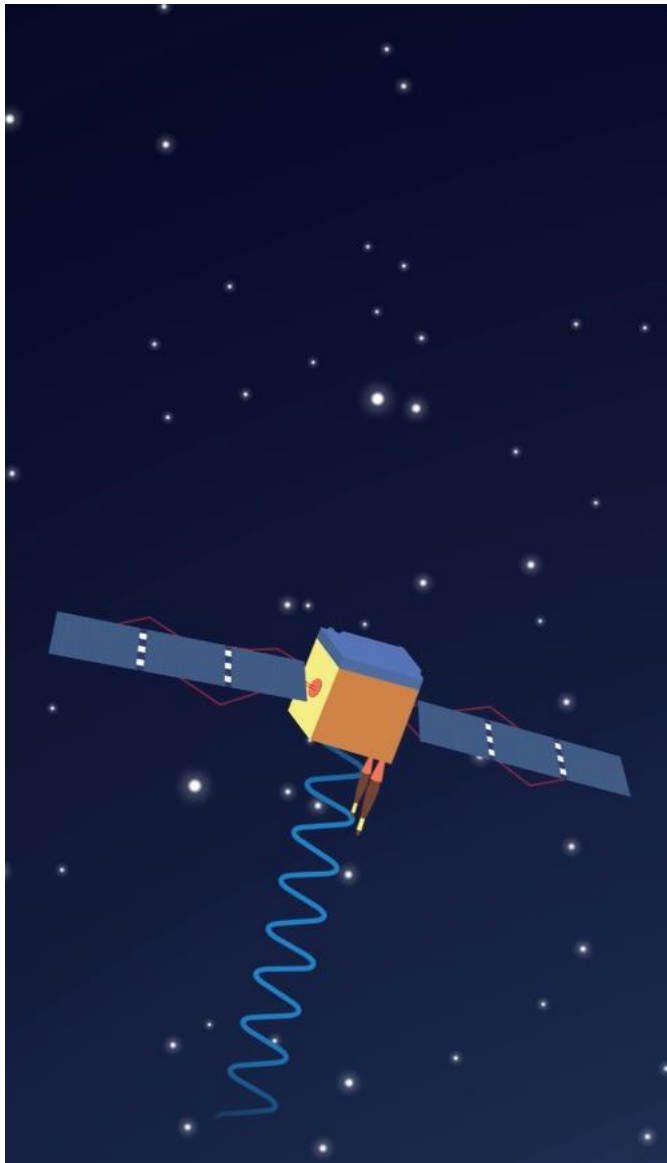
- E.g. forest, urban canyon, partly overhead coverage

II. More precise position – utilising new signals and signal compatibility

- New signals & constellations (GPS L5, GLONASS L3, BeiDou, Galileo, QZSS signals)

III. More precise positions - reduce interruptions due to unstable RTK link

- Overcome weak cellular link, short UHF radio range



Technology should work for us – not the o

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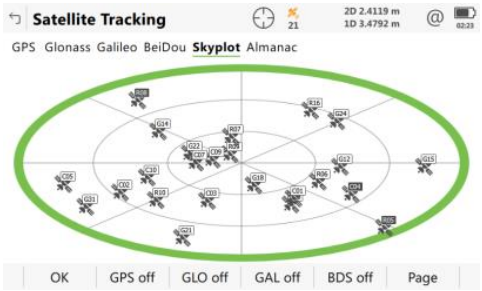
SELF LEARNNG TECHNOLOGY

More GNSS signals bring more challenges

- More measurements → more noise
- More measurements → more choice



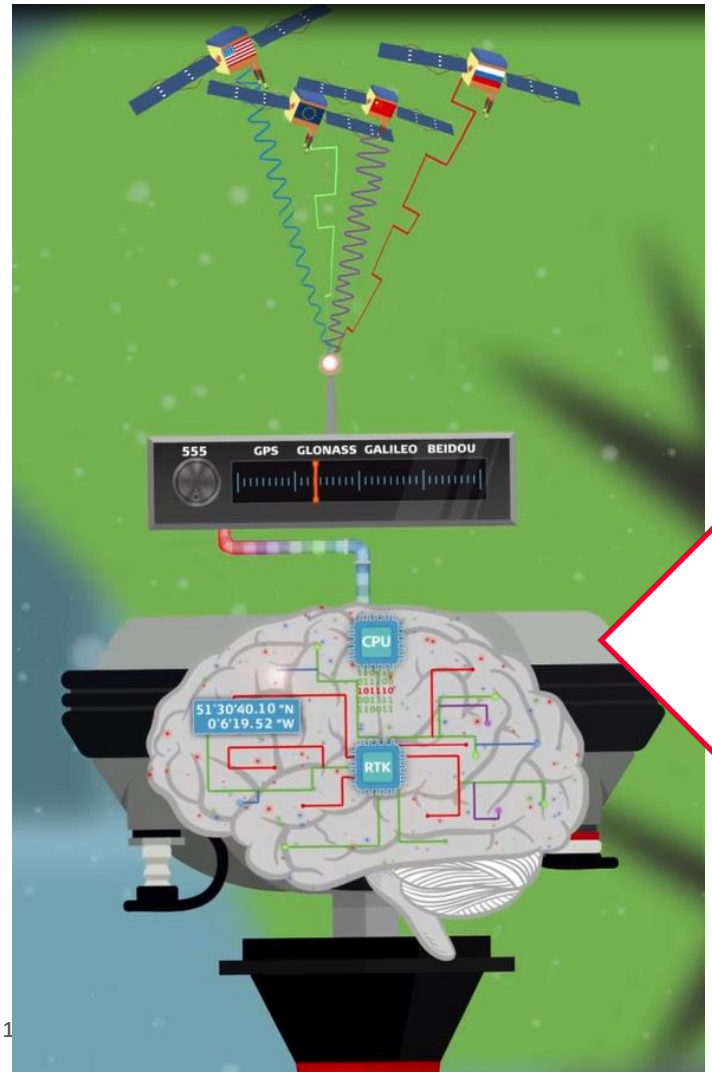
A modern GNSS receiver needs:

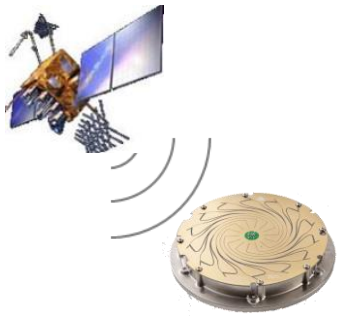
- To be smarter to select the right from the wrong signals
- More processing power
- Benefit from augmentation PPP services to bridge RTK outages
- To adopt and learn from predominant conditions

A next generation GNSS receiver has to be **self learning**

Geosystems

Another milestone of high precision GNSS





Antenna tracks analogue signals

0110001001
0101011101
0111001101

The intelligent use of all signals of all GNSS systems

A powerful 555 channel engine tracking all signals

New engines working in harmony

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Leica Geosystems

Combination of smart signal selection

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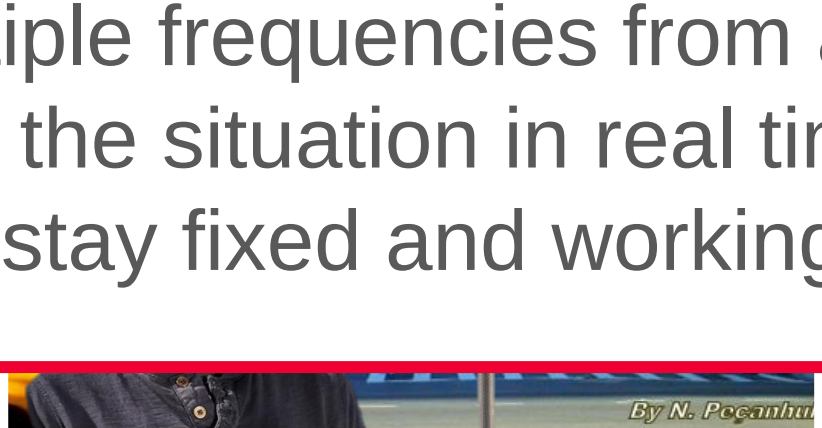
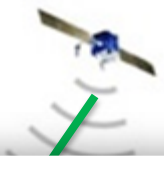
The more signals that can be simultaneously received and the higher the receiver sensitivity, the higher the level of measurement noise.

With a dynamically adjusting receiver that selects the best signals and retrieves the best of multiple frequencies from all GNSS systems for the situation in real time, we continue to stay fixed and working.

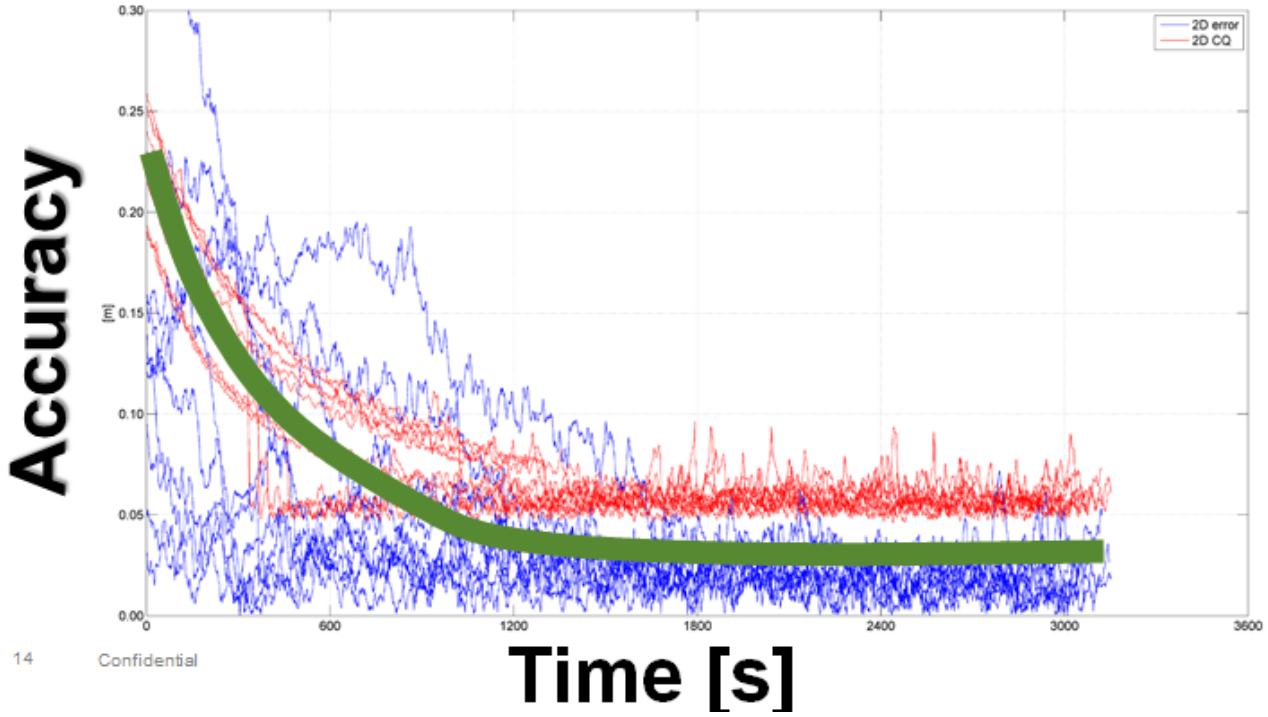


Precise Point Positioning (PPP) bridging RTK with



Precise point positioning (PPP) and convergence time

- Modern algorithms allow cm-level positioning within several minutes
- Modern receivers have L-band tracking integrated and do not require an RTK link
- Works fully remotely and can be a backup solution for RTK



Accuracy

The future for surveyors and GNSS?

Sensor fusion with high precision GNSS is the next generation