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INTERGEO
WISSEN UND HANDELN FÜR DIE ERDE

High precision GNSS – and the value of more satellites

Bernhard Richter, GNSS Business Director

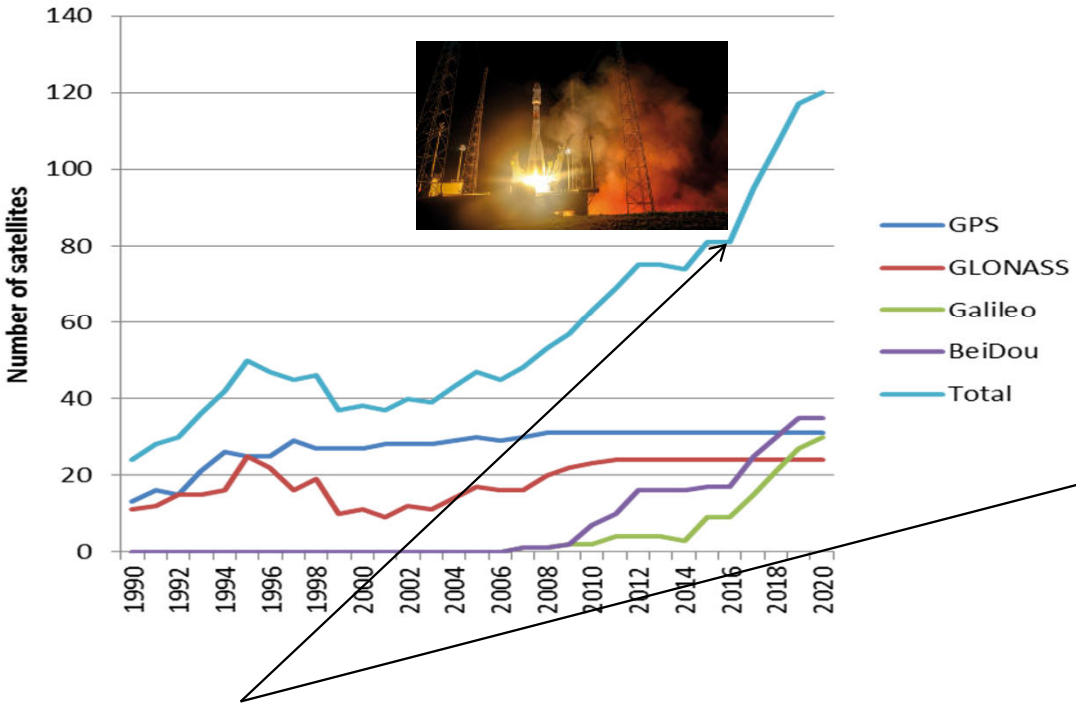
11, October, 2016

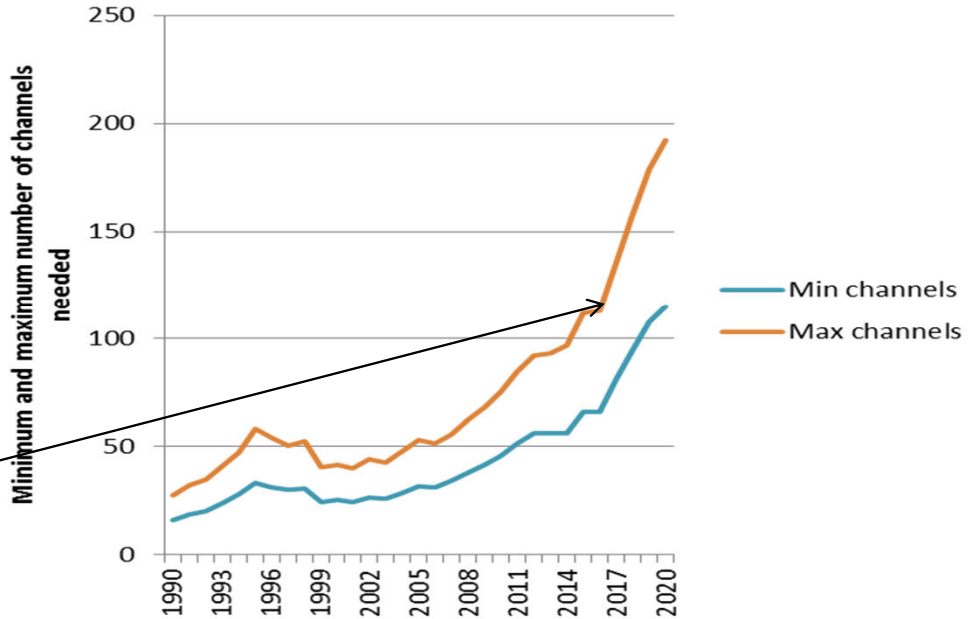
- when it has to be right

Leica Geosystems

part of HEXAGON

Development of GNSS over 25 years





- Only now multi constellation truly benefits RTK
- Galileo and BeiDou agencies are committed to finish constellation by 2020. Budgets are agreed.

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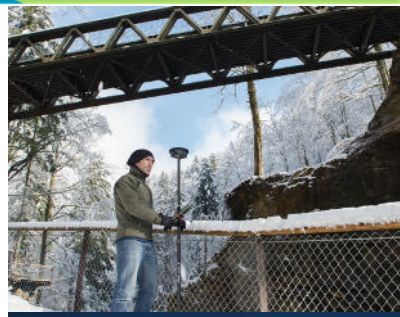
Drivers for GNSS developments

I. More precise positions - reduce limitation due to obstructions
   - E.g. urban canyon, partly overhead coverage, forest

II. More precise positions – utilizing new signals and signal compatibility
   - New signals & constellations (GPS L5, GLONASS L3, BeiDou, Galileo, QZSS)

III. More precise positions - reduce interruptions due to unstable RTK link
   - Overcome weak cellular link, short UHF radio range



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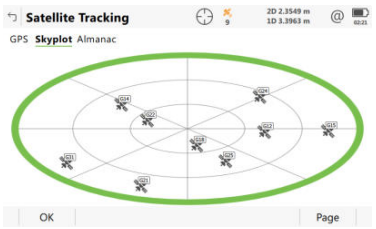
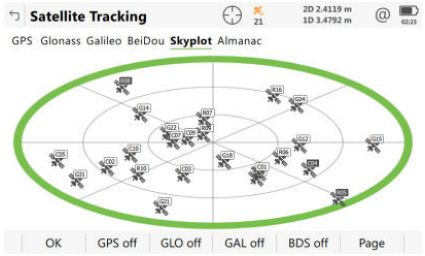
General situation

More GNSS signals bring more challenges

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



2006



2016

A modern GNSS receiver needs:

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

A next generation GNSS receiver has to be self-learning

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Leica GS16 – Self-learning GNSS with RTKplus and SmartLink

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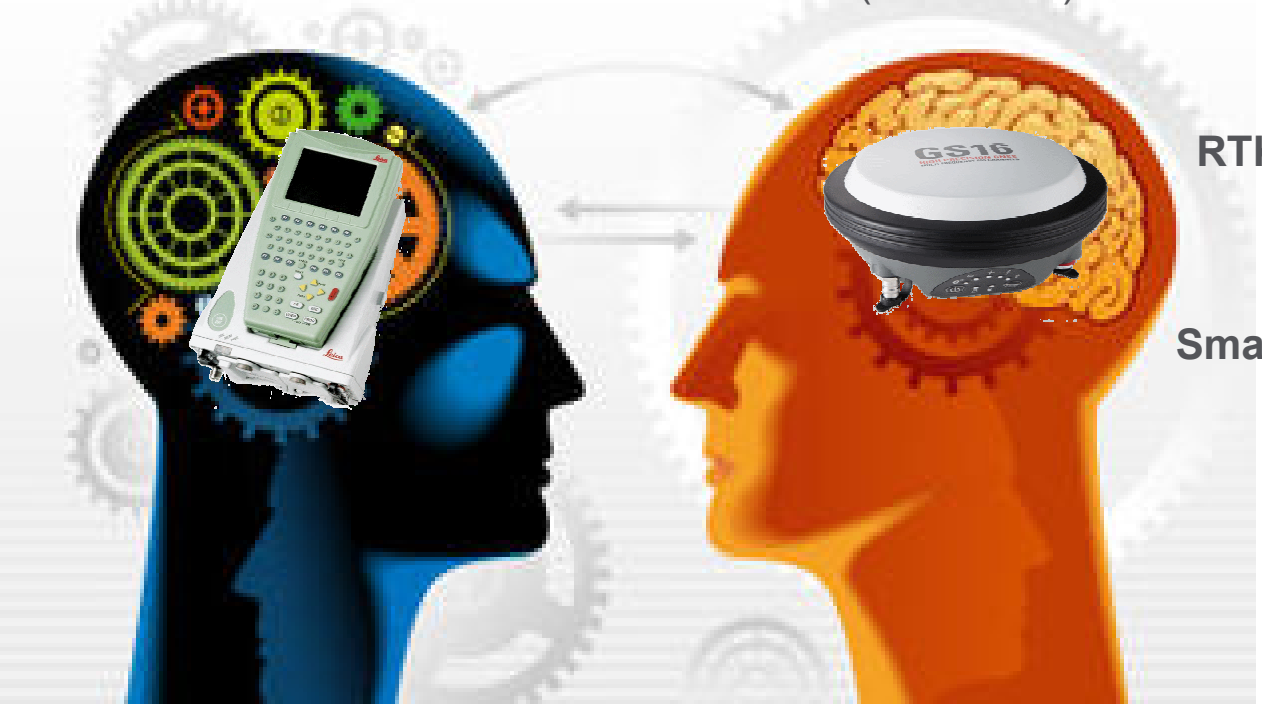
What is self-learning GNSS?

- Smart and adaptive selection of signals (RTKplus)
- Smart use of RTK corrections and PPP corrections (SmartLink)



RTKplus inside

SmartLink inside

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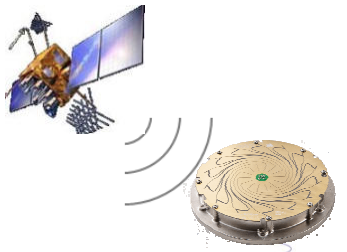
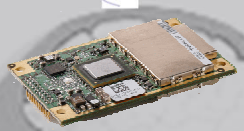
What is RTKplus?

- Like RTK but smarter
- The intelligent use of all signals of all GNSS systems
- A powerful 555 channel engine tracking all signals
- New engines working in harmony
- Ensuring a certain future
- Another milestone of high precision GNSS



Antenna tracks analogue signals



ME7 converts signal into binary measurements

RTK engine converts into coordinates

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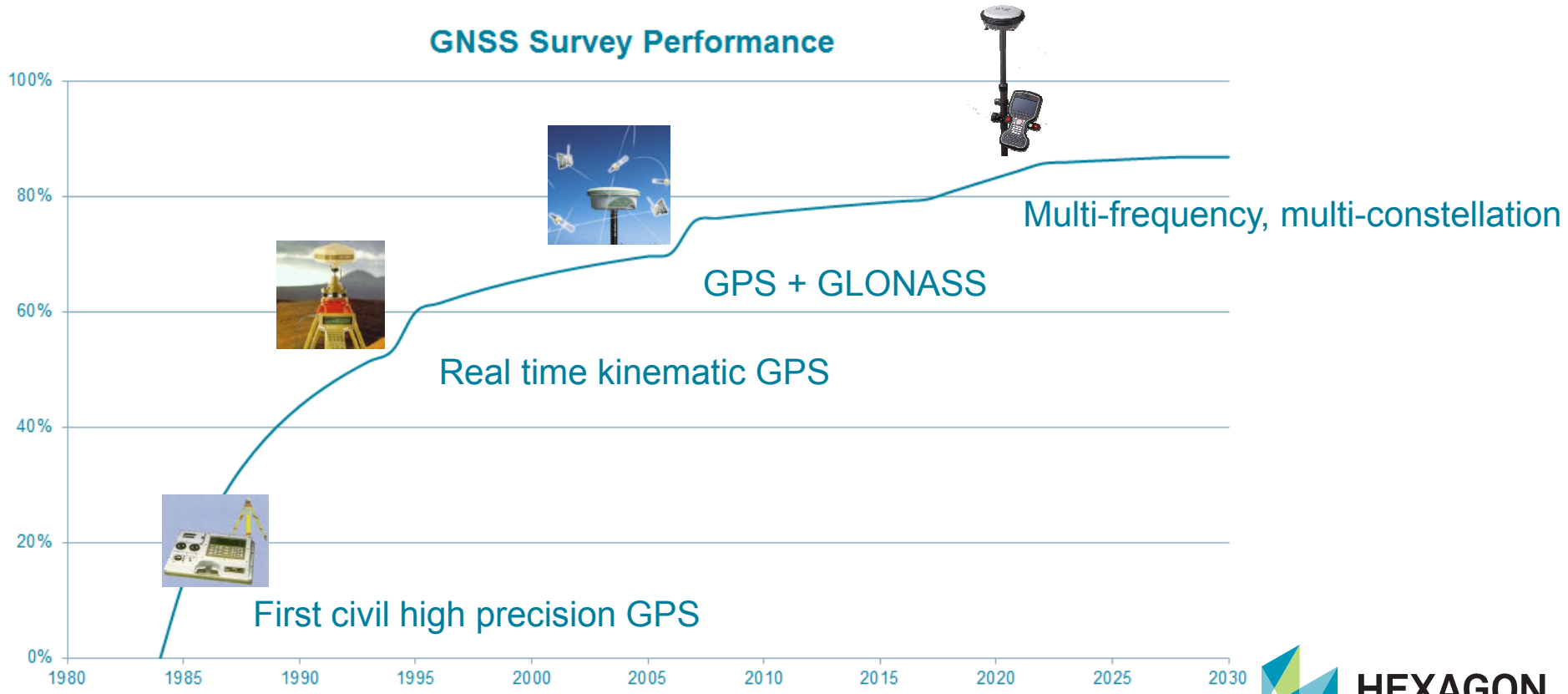
High Precision GNSS – Commodity or High Tech?

- Development and Milestones



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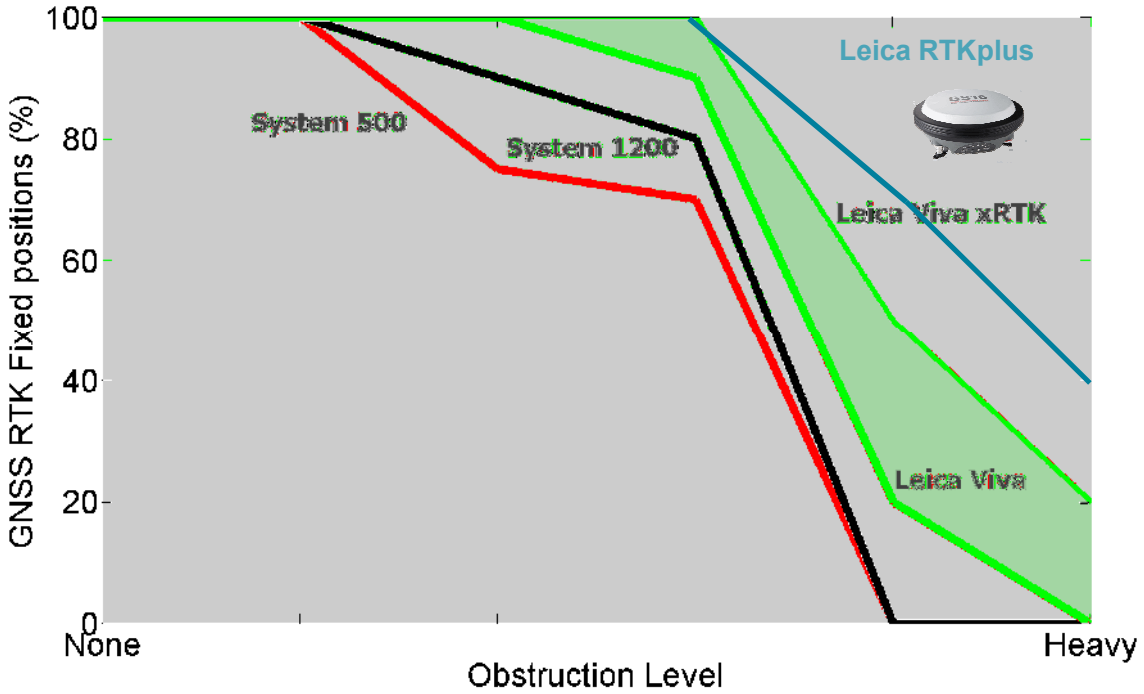
RTKplus pushes the boundaries in performance



Leica Viva RTKplus

2016 -

Leica Viva

2009 - 2016

GPS1200

2004 - 2009

GPS500

1999 - 2004

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A little recap - Drivers for GNSS developments

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

II. More precise position – utilizing new signals and signal compatibility
   - New signals & constellations (GPS L5, GLONASS L3, BeiDou, Galileo, QZSS)
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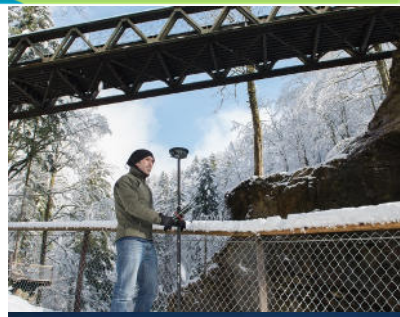

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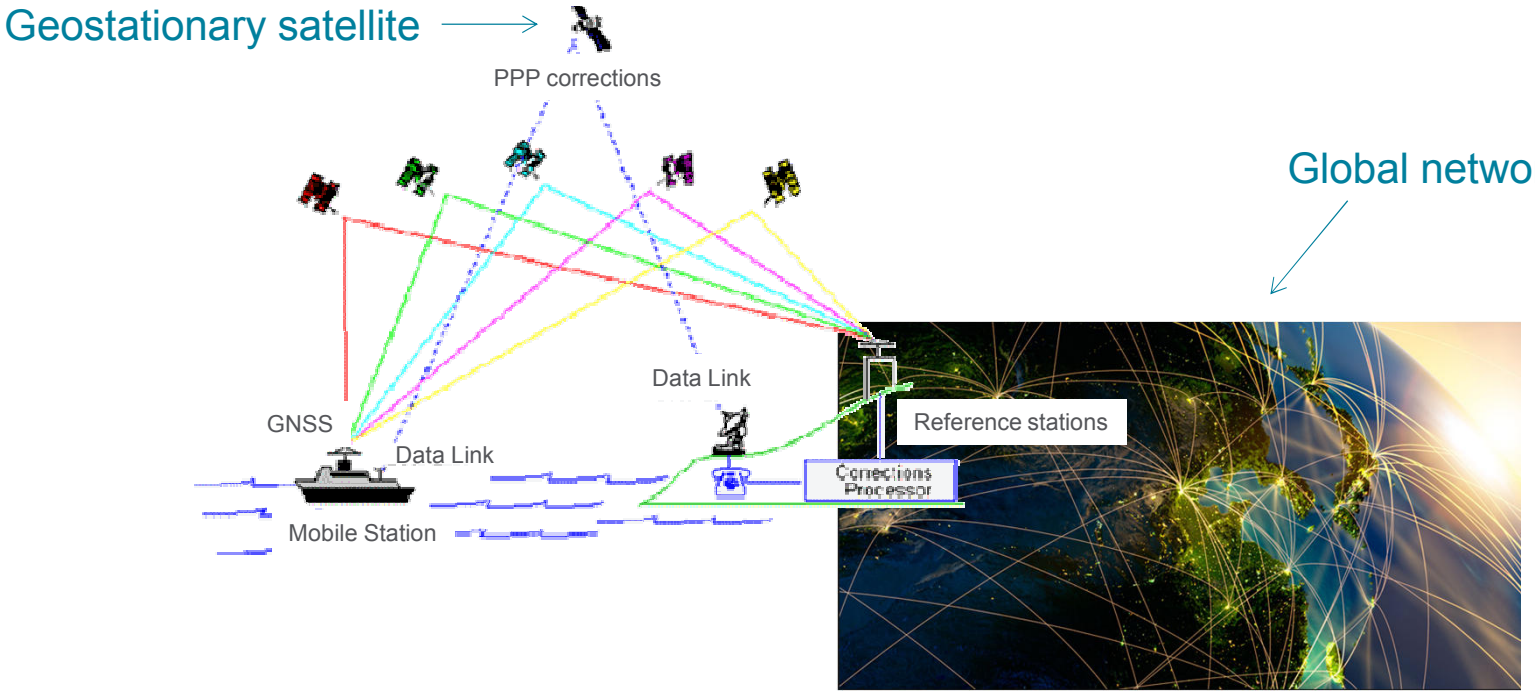
What is PPP and why can it improve a weak RTK link?



- Corrections are derived from a global network of base stations
- PPP service provides precise orbits and clocks and other errors (PPP corrections)
- Compact corrections are provided e.g. by a geostationary satellite

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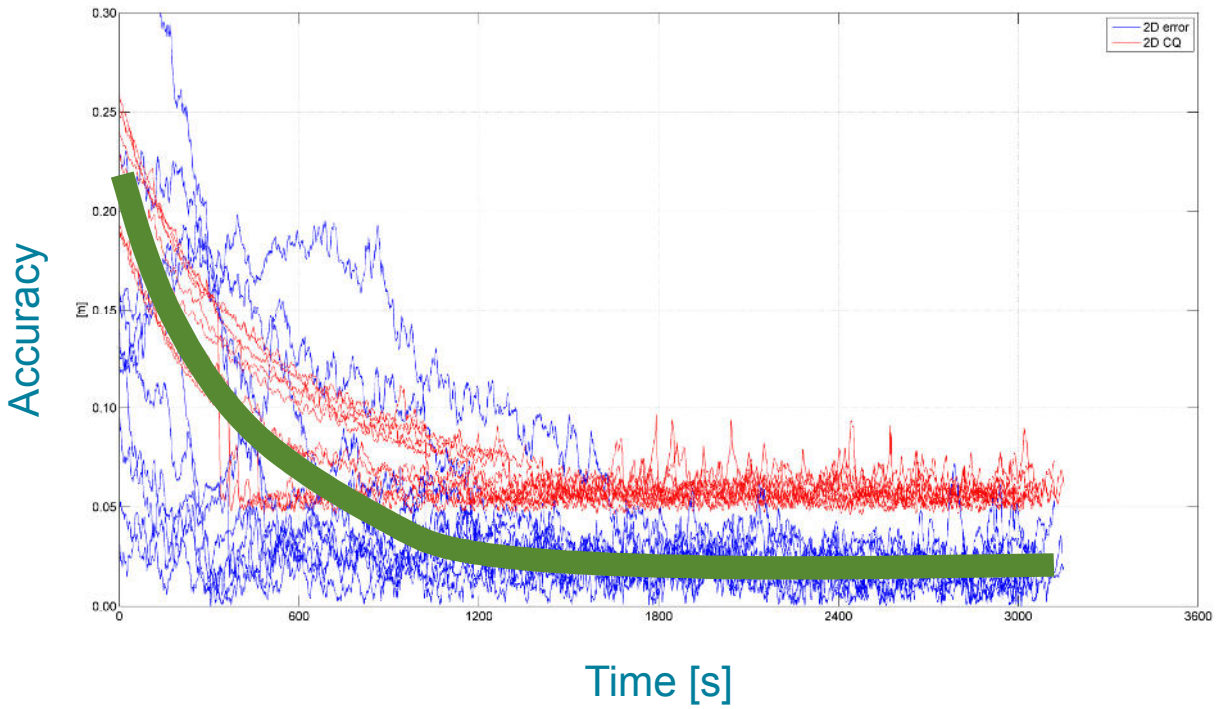
What is PPP and why can it improve a weak RTK link?

Precise point positioning (PPP) and convergence time

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



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What is SmartLink?

“SmartLink provides 3cm accuracy around the globe, everywhere, anywhere”

“SmartLink is more than just PPP - it is smarter”

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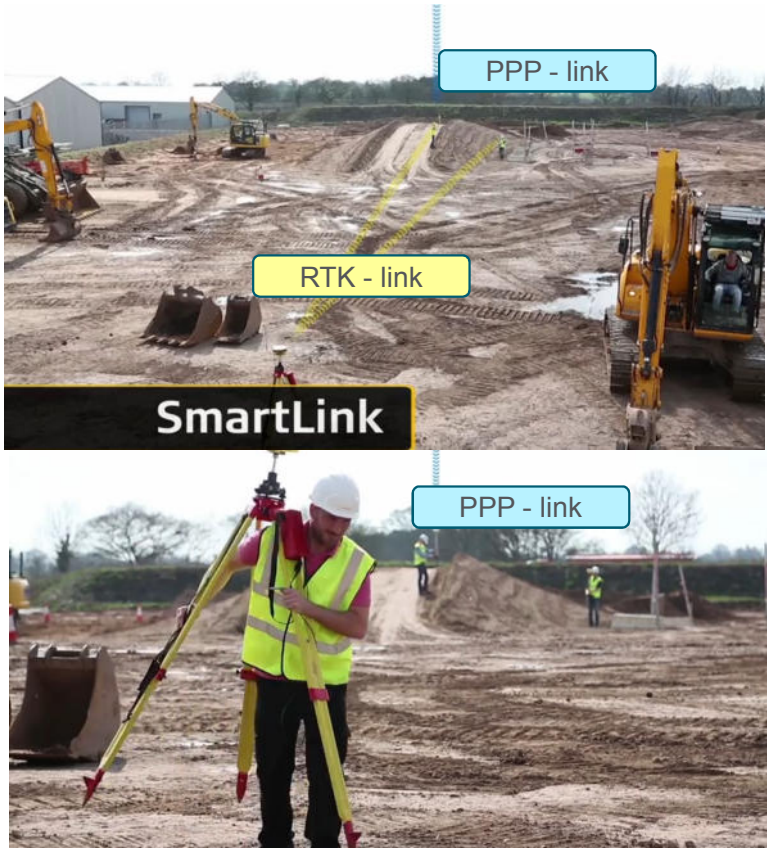
What is SmartLink?

SmartLink improves the connection

- GS16 runs two algorithmic tasks in parallel
  - RTK task
  - PPP task with ambiguity resolution
- SmartLink chooses the best link (RTK or PPP)
- Improves position robustness when RTK link is weak
- Works in any terrestrial reference frame (e.g. ETRF89)



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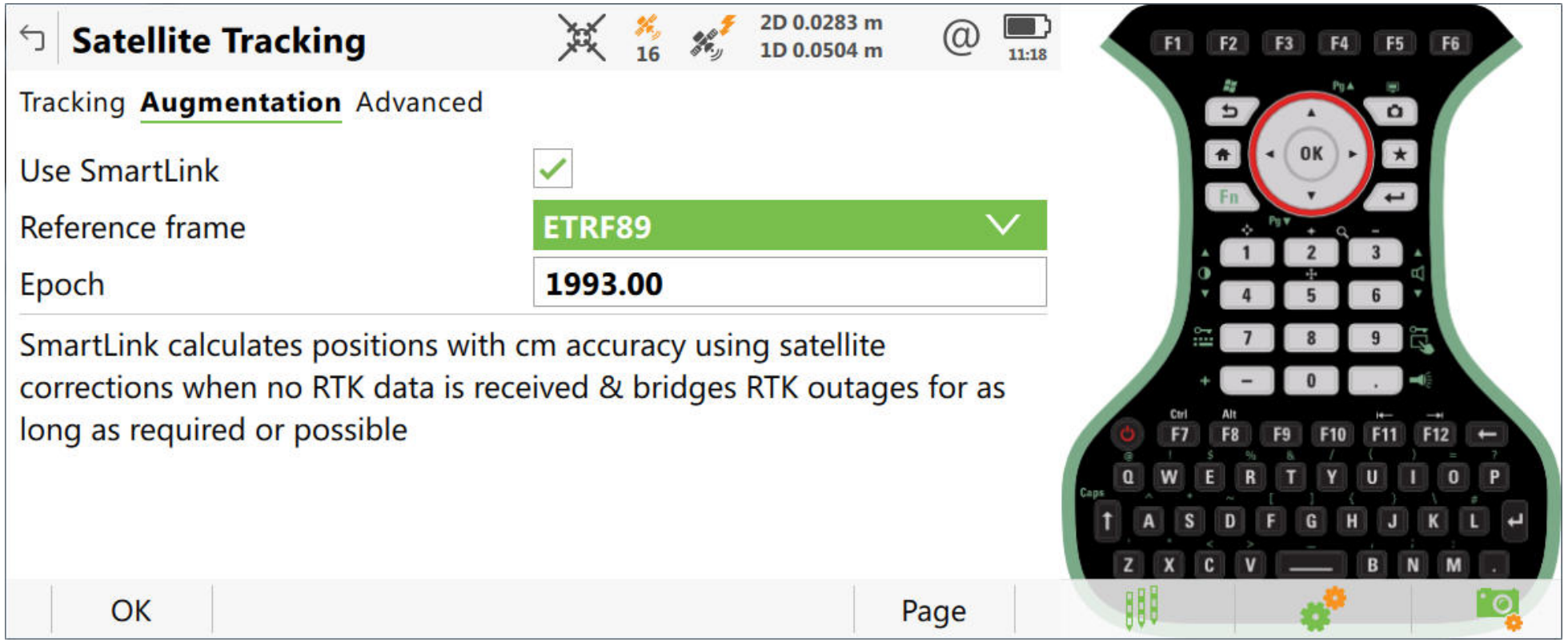

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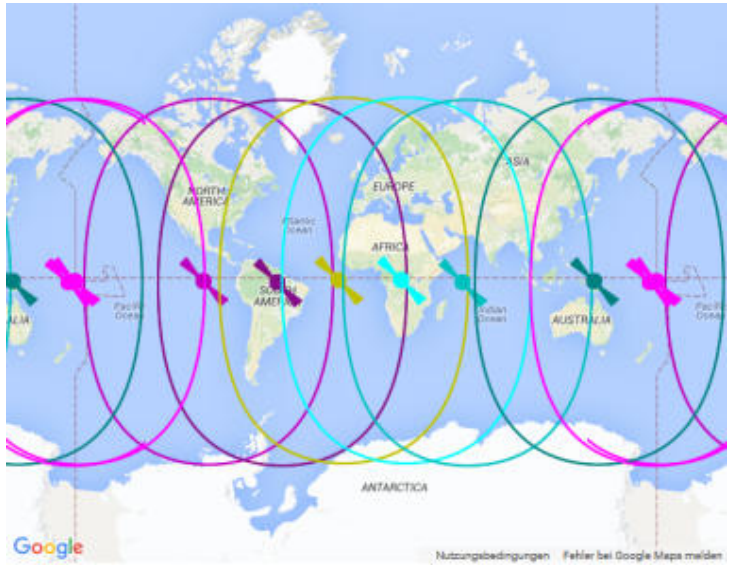
What is SmartLink?

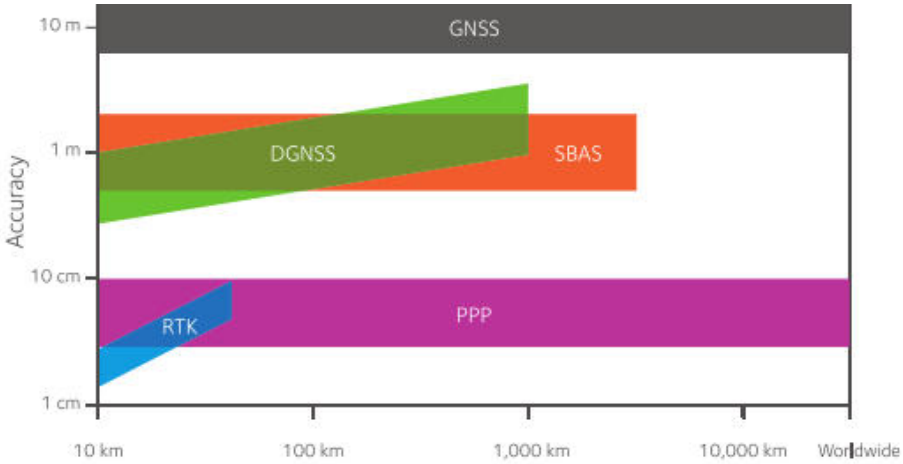
- Coverage and transmission
- SmartLink signal from 7 geostationary satellites
- L-band signal

65° N



65° S

- Solution accuracy relative to baseline length



Typically 3cm 2D accuracy

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First SmartLink Mountain

- The highest mountain of the England Scafell Pike has been surveyed with SmartLink.
- Please help an Austrian to get a more spectacular mountain to be surveyed with SmartLink – in the footsteps of George Everest

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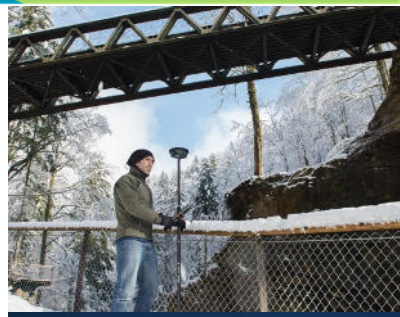

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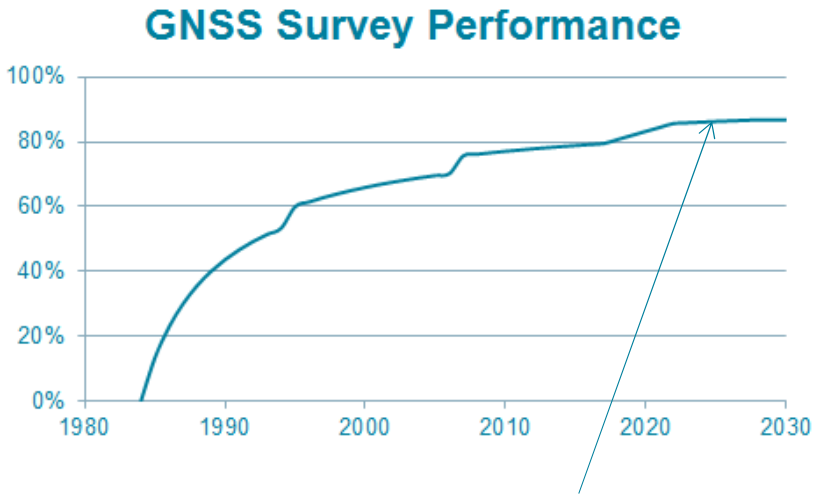
Outlook

- After 2020 following is expected
  - 4 global GNSS will be fully operating
  - Slow down in government spending and GNSS modernization due to high costs
  - Replacing strategy as satellites need to be withdrawn

- *"Is the GS16 the last GNSS receiver you will ever need?"*



Little foreseeable innovations purely from GNSS technology

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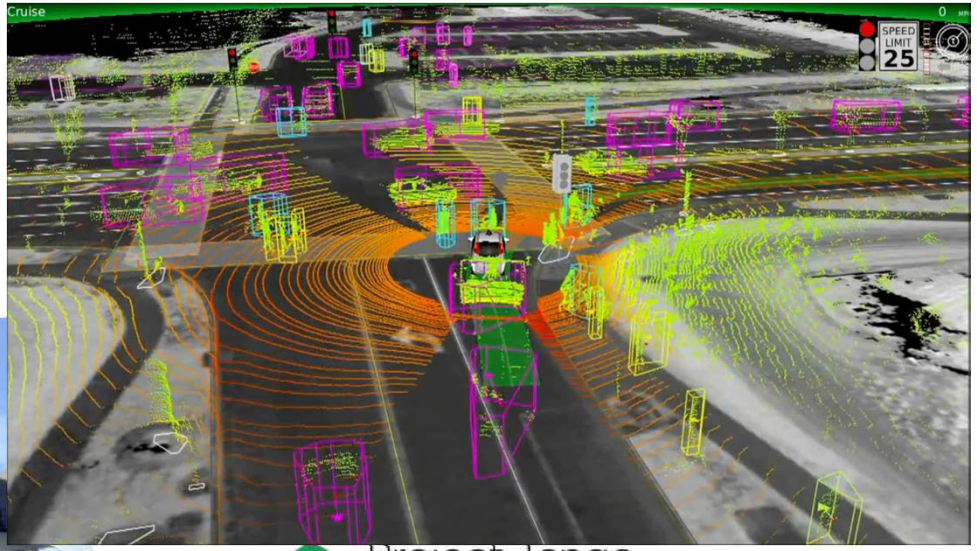
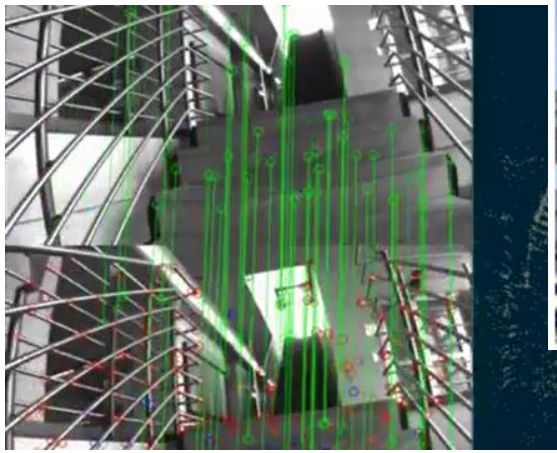
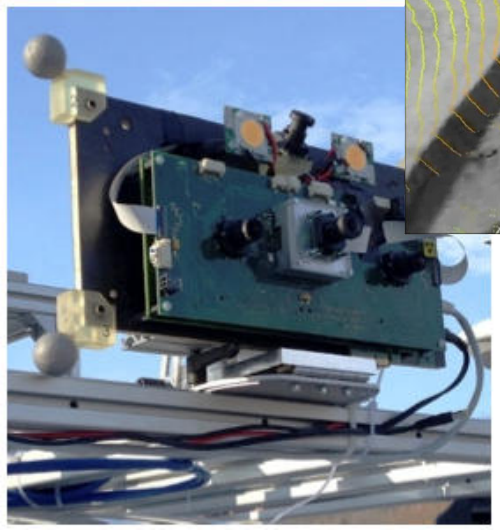
Outlook

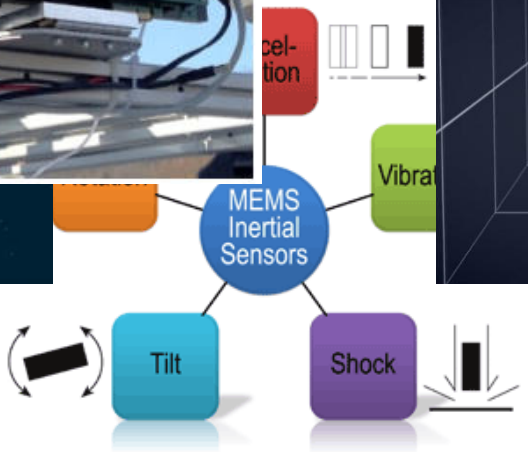
- Sensor fusion is the topic beyond 2020
  - High precision GNSS + aiding sensors



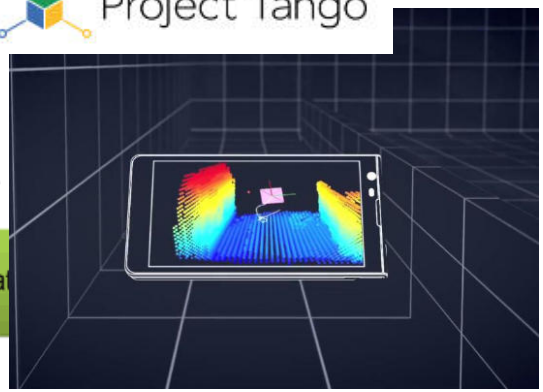
Visual inertial SLAM







Project Tango



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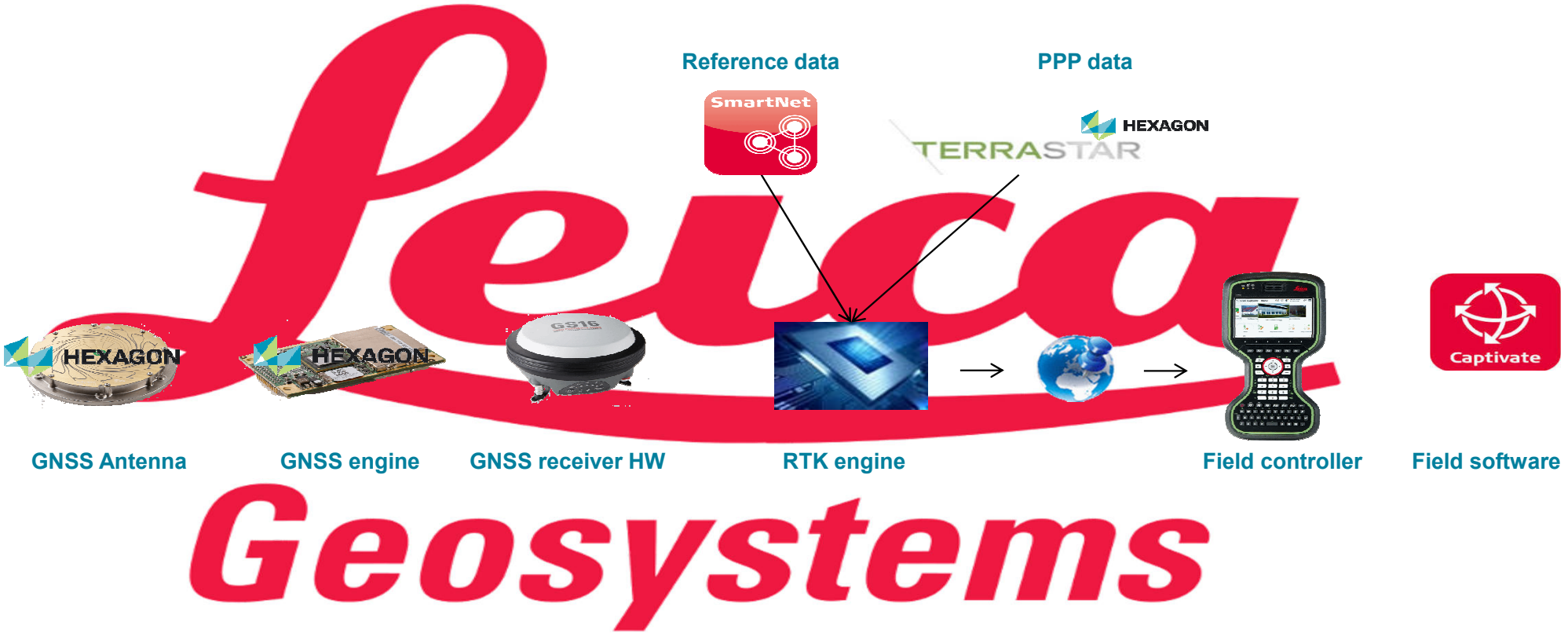
Hexagon – One company – One workflow



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The GS16 is the best GNSS high precision receiver Leica Geosystems ever built.

Bernhard Richter

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One day we will build an even better one, utilizing sensor fusion technologies.

Bernhard Richter

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