

Presented at the FIG Working Week 2019
April 22-26, 2019 in Hanoi, Vietnam



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"Geospatial Information for a Smarter Life
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The “uberization” of the GNSS Positioning Infrastructure

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1. Uberization

- **Uberize** or **Uberise** ('u:bə ,raɪz) verb (transitive) to subject (an industry) to a business model in which **services are offered on demand through direct contact between a customer and a supplier, usually via mobile technology.**
- **Byword for “disruption” of conventional market/service; bypassing regulators, gatekeepers, and standards bodies; taking advantage of technological advances; using new Business Plans built on collaborative relationships to facilitate trusted transactions.**



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2. Advances in GNSS Equipment, etc

- The price of GNSS chipsets, and associated OEM boards, **has decreased dramatically**.
- Hardware has increased tracking and measurement processing capability, and nowadays have **multi-constellation** (GPS, Galileo, GLONASS, BeiDou, and others) and **multi-frequency** (at least dual-frequency, and sometimes triple-frequency) tracking capability.
- GNSS receivers in many **form factors**, highly portable, including becoming “wearable”.
- **Plus** ICT technological developments, inc **Cloud, AI, block-chain, 5G**.



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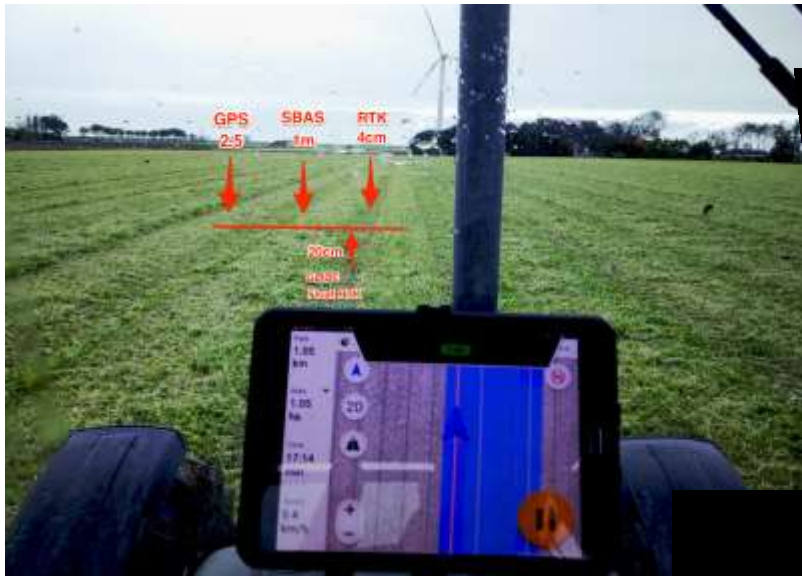




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3. Local & Regional Positioning Infrastructure



- To operate in **high precision (differential) mode**, GNSS receivers **must receive and process measurements and corrections** from a single reference station (**single-base RTK**), or from a GNSS network RTK server (**N-RTK**).
- This is the mode of operation for professional users over several decades.
- Many CORS streaming data for free over the Web.
- **New mass market users may be reluctant to “subscribe” to RTK services ... purchase value-added services as required.**

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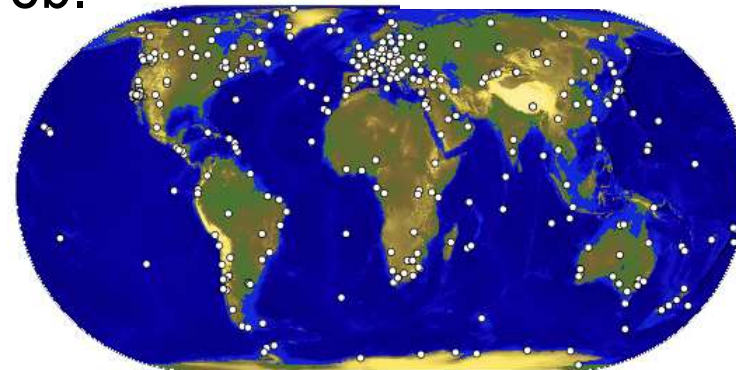
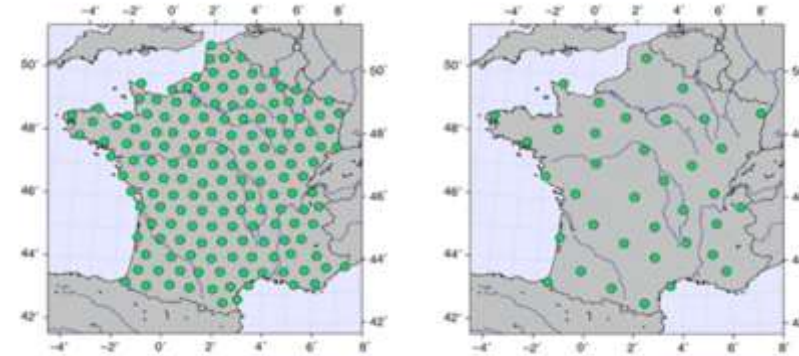
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4. Global Positioning Infrastructure

- **Precise Point Positioning (PPP)** and PPP with Ambiguity Resolution (PPP-AR) have advantage of requiring significantly **reduced number of CORS to provide wide coverage.**
- Many CORS streaming data for free over the Web.
- Hence... barrier of entry for new **Service Providers** is significantly lowered.
- New mass market users of high precision positioning services **do not need to invest in GNSS network infrastructure.**



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Marketplace (or "App Store") of available value-added services that can be accessed via the Cloud, *for example* ...

Where is the surveying area ?
What GNSS networks are available here ?
Use navigation mode ...

Let's start the job and subscribe for
2cm accuracy at 99% confidence
level in the local datum

I need **DGNSS** accuracy
for verifying the area where
my survey must be
conducted! Subscribe for
1m accuracy & A-GNSS
service.

Job done ... forward all
results to my office for
integration into the
customer's Data Base ...

RIZOS, C., & CRANENBROECK, J.van (2006). Alternatives to current GPS-RTK services. 19th Int. Tech. Meeting of the Satellite Division of the U.S. Inst. of Navigation, Fort Worth, Texas, USA, 26-29 September, 1219-1225.

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5. GNSS Positioning Infrastructure Paradigm Shift

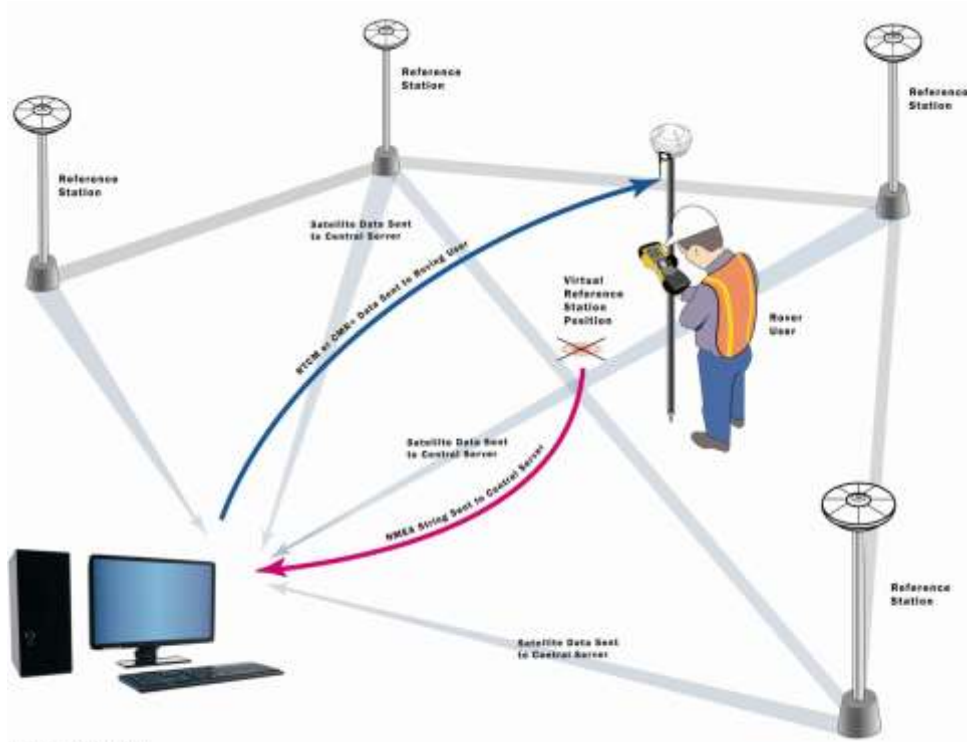


image courtesy of Trimble

- Currently there is a clear distinction *between* "base/reference" and "rover" receivers ...
- And *between* the **infrastructure** (static GNSS CORS network) and **users** (mobile & applications-oriented receivers) ...
- *And between* those who are using high precision (professionals) and others ...

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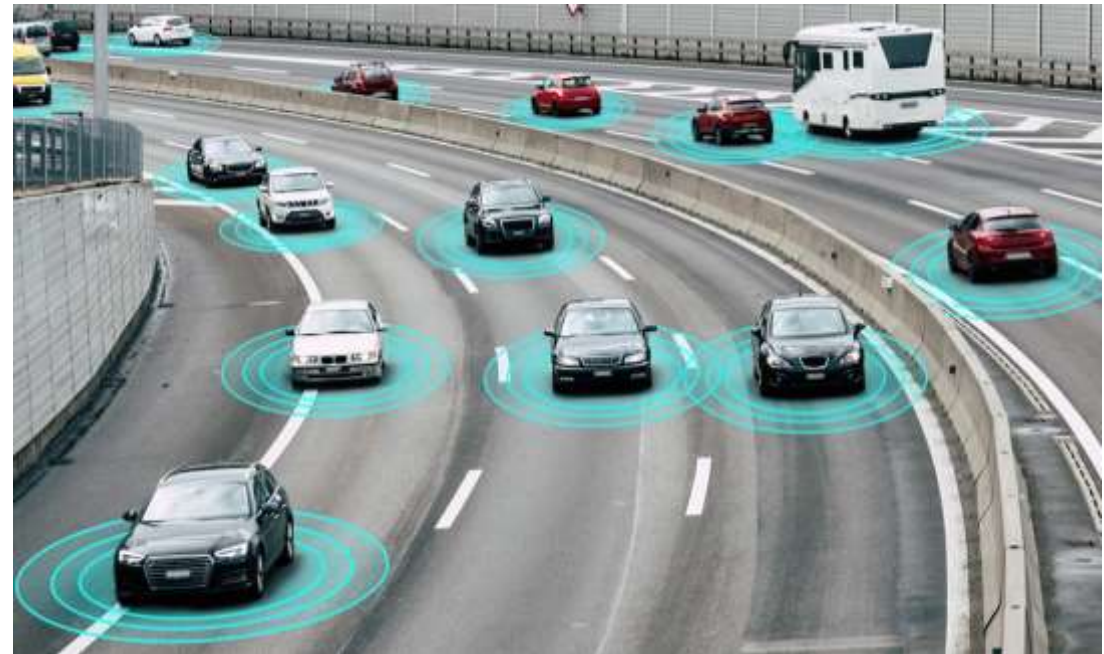
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6. GNSS Collaborative Positioning – “RTK Mesh[©]”

- Any GNSS receiver will be connected to the Cloud and can participate in a **Collaborative Positioning** scheme.
- Differentiation would be according to real-time status (e.g. RTK-fixed or not).
- Continuous communications between nodes, **exchanging measurements, corrections, solutions, making new measurements, etc.**
- Other configurations possible ... see *later slide*.



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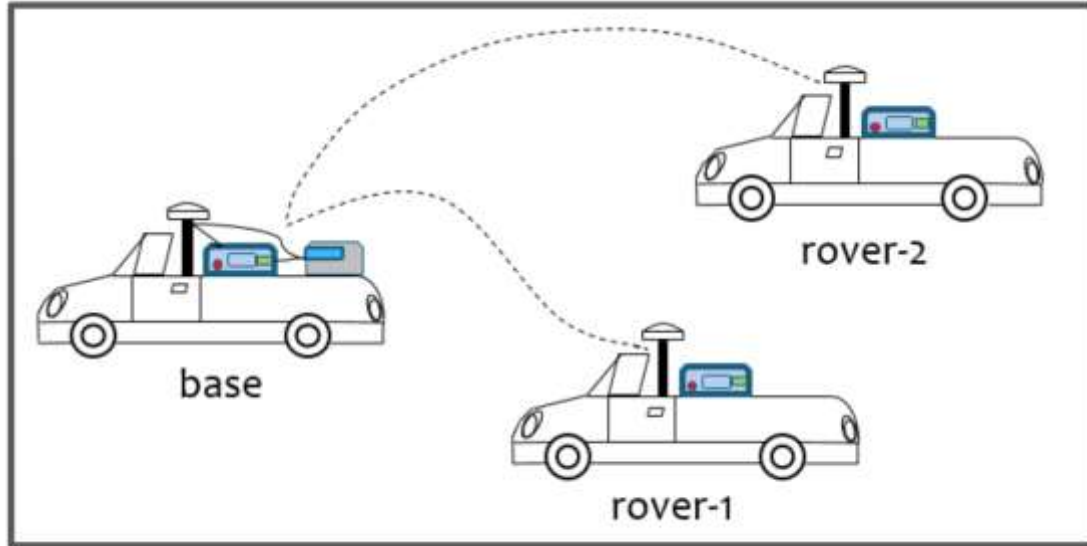




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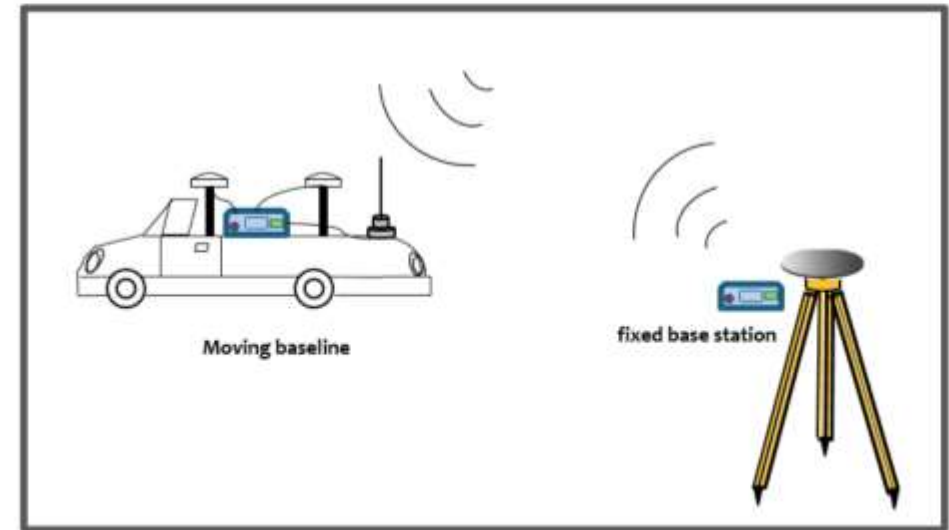
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The dynamic base station is similar to the normal RTK which can provide centimeter-level accuracy position. Corrections can be sent between the dynamic base and rover receivers, where the dynamic base receives the corrections from the fixed base station, which in turn can send corrections to the rover. In addition, the dynamic base station transmits the carrier phase and pseudorange observations to the rover station for attitude determination. The commands of this application must be used to allow the base to transmit messages without a fixed position.

Dynamic base station is a rover RTK that is sharing measurements and corrections with other rovers

This is the RTK MESH concept !



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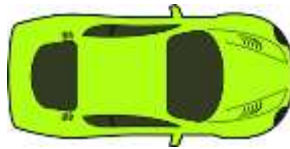
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Dynamic BASE using PPP-AR (convergence)

Vehicle stopped at traffic lights is BASE

Moving vehicles
are ROVERS



Vehicles
parked
are
BASES



Vehicle : ROVER

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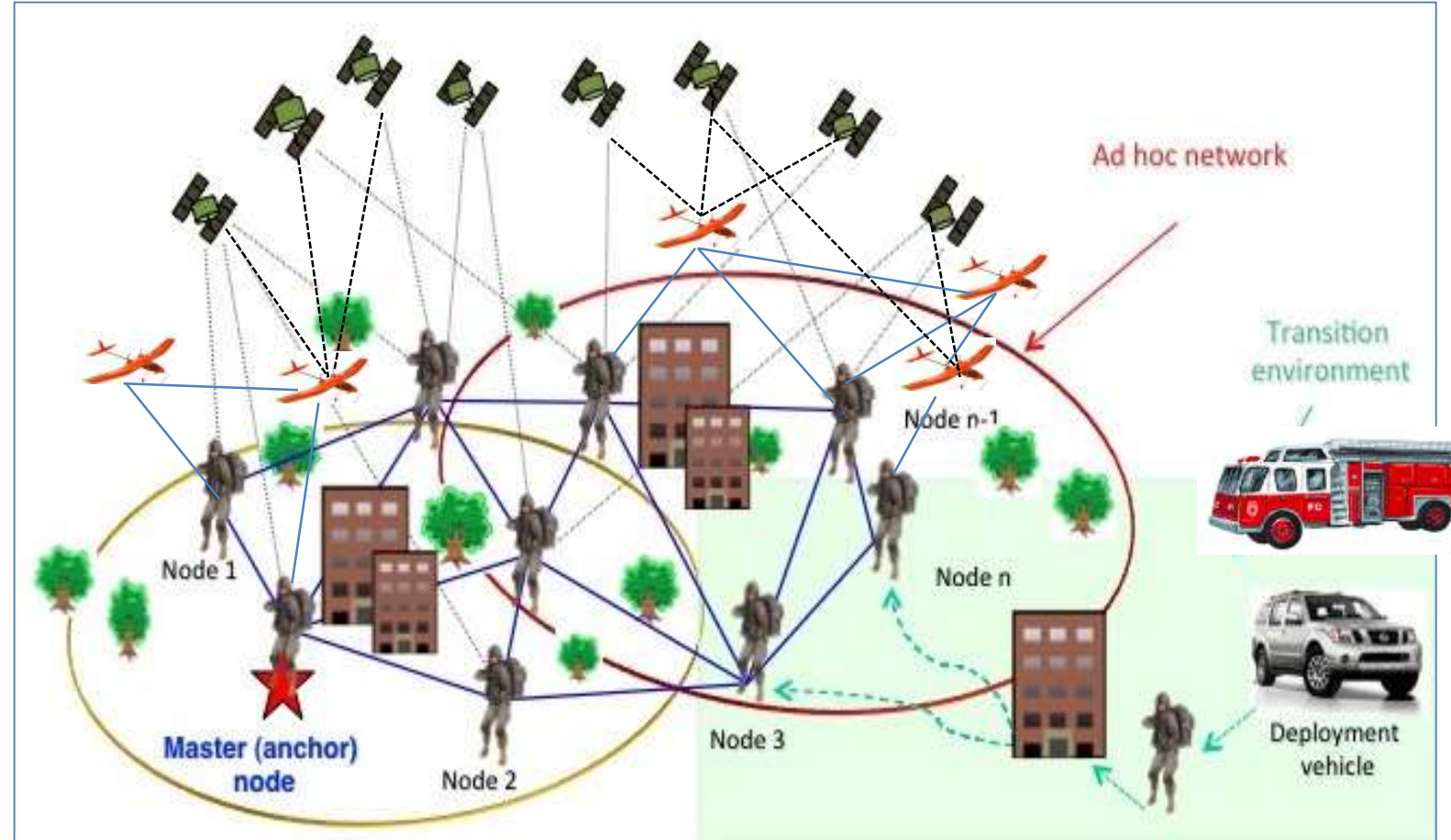
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- Emergency crew, soldiers, UAVs, vehicles, etc.
- All platforms *may* have ranging capability and *may* be time synchronised.
- Combine elements of PPP and DGNSS, and even *inter-node ranging*.
- Allows for better and more robust PNT of a *network* of users in **GNSS-challenged environments**.



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Acknowledgements: Brzezinska & Toth, OSU, 2014



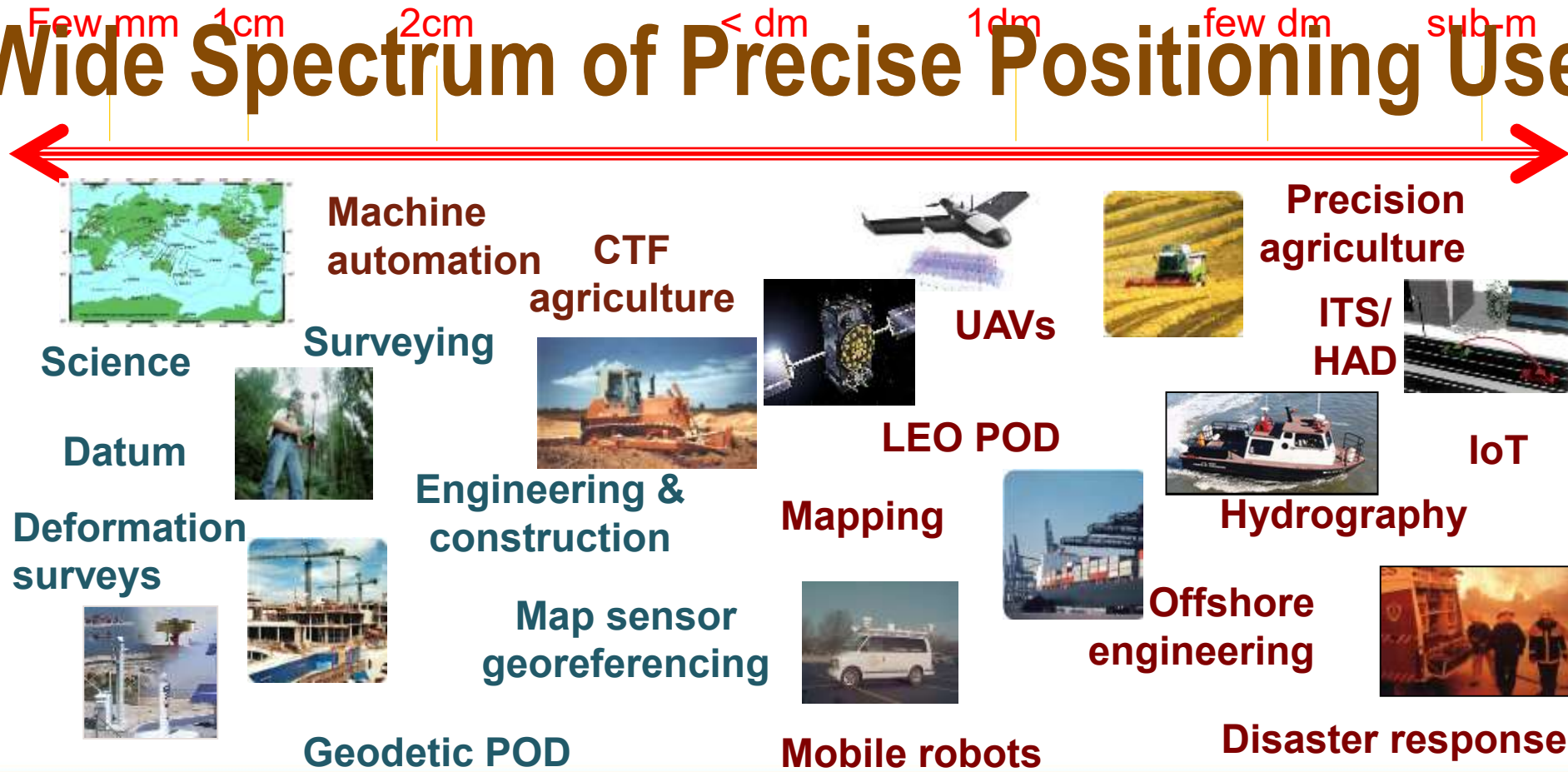
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7. Wide Spectrum of Precise Positioning Users



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- The positioning need no longer to be computed on the user receiver ... *instead delivered through Cloud applications.*
- “Positioning as a Service” (PaaS)... *available from a range of SPs.*
- Lower cost GNSS receivers and PNT platforms can be used.
- Continuous, reliable wireless communications, e.g. 5G.
- Open to different platforms and users.



- “Dynamic” GNSS augmentation network.
- “Dynamic” market offering range of PNT services
- New algorithms for CP needed.
- Unlimited (“cross-border”) coverage.
- Not just positioning services.

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8. Role of Governments and Agencies

- To date Positioning Infrastructures have been developed *for professionals by professionals* ... **new users wanting “value-added” (e.g. accuracy) positioning may prefer services with Business Plans such as those of Uber and AirBnB.**
- The role of Governments and Agencies *may* be severely reduced with respect to such BPs ... provide **monitoring, datum, validation, integrity, etc ... services.**
- Technological developments *will* **enable** innovative Positioning services.

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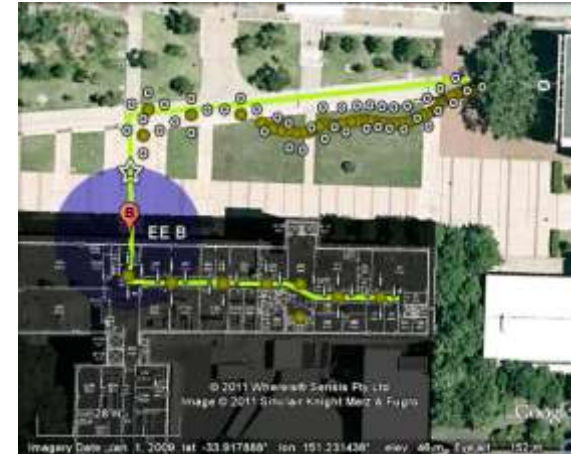
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9. GNSS+

- GNSS is **vulnerable**, and **unavailable** in certain environments ... **new PP technologies needed indoors, in urban areas, for high-integrity apps.**
- PNT **integrity** estimate is another type of value-added service ... **accuracy not the only measure of "value"**.
- GNSS is the **cornerstone** of Positioning Infrastructures ... **but we also need multi-sensor PNT solutions.**
- **Automation** applications will drive development of "ubiquitous" positioning services ... **further "uberizing" PIs.**



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Concluding Remarks

- The paradigm shift for GNSS Positioning Infrastructures likely to be the result of a **new class of user**, perhaps from market segments such as *Industry 4.0, IoT, autonomous vehicles, etc.*, (or *new warfighting scenarios*).
- Cloud services (supported by AI, block-chain fintech, high bandwidth telecoms, etc) could **monetise** available GNSS receivers (e.g. high accuracy, user status, interconnectivity) for the benefit of many other users **in ways not yet obvious**.
- New algorithms, new systems, new technologies and new BPs will be developed to provide new PNT services ... **hence expect disruption to traditional PI approaches**.

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Thank you very for your attention
Cảm ơn bạn rất nhiều sự chú ý của bạn

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