geo flex

Operator of new services to augment Global Navigation Satellite Systems

IncubAlliance
L'INCUBATEUR TECHNOLOGIQUE DU CAMPUS PARIS-SACLAY-ILE-DE-FRANCE

BOOSTER
SEINE ESPACE

GEOFLEX provides disruptive GNSS solutions

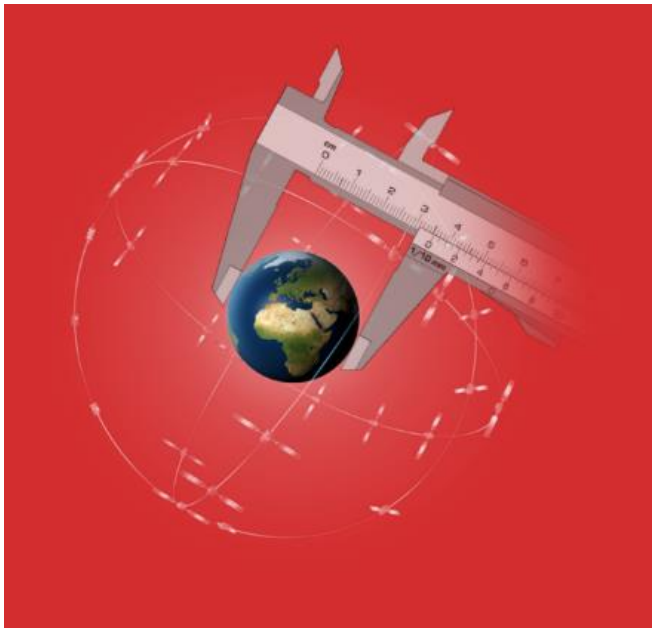
GEOFLEX is operator of new GNSS augmentation services to augment GNSS accuracy, integrity and continuity

GEOFLEX sold:

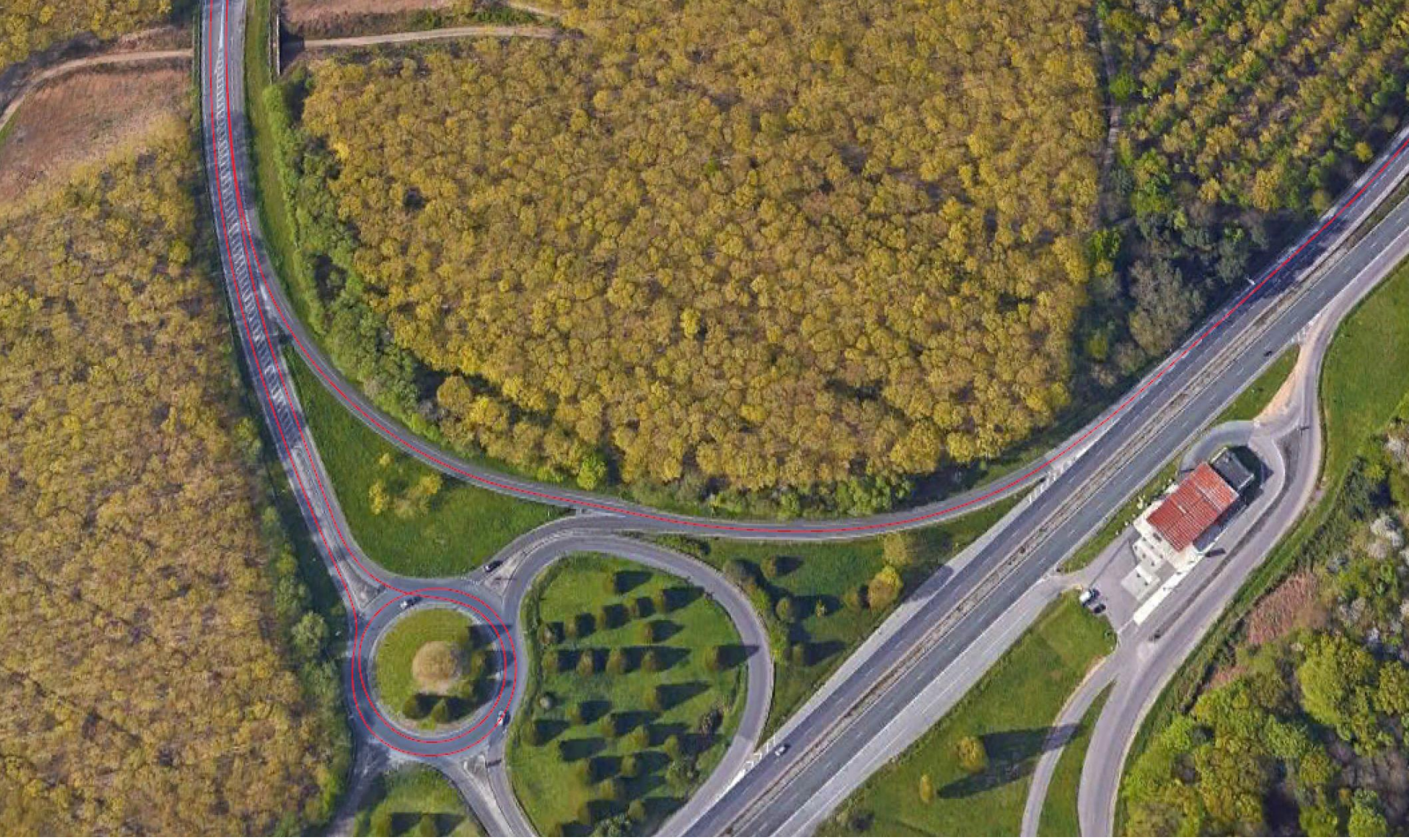
- Corrections data stream in an open format under subscriptions
- Optionally accompanied by HDK, SDK & Reference implementations

To provide simple, affordable, and state of the art solutions adapted to applicative integrators for:

- Positioning: Up to 4 cm (2D-95%), in real time, everywhere (worldwide, on lands, across seas, and in the air), all the time
- Time stamping: Few nanoseconds



cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES



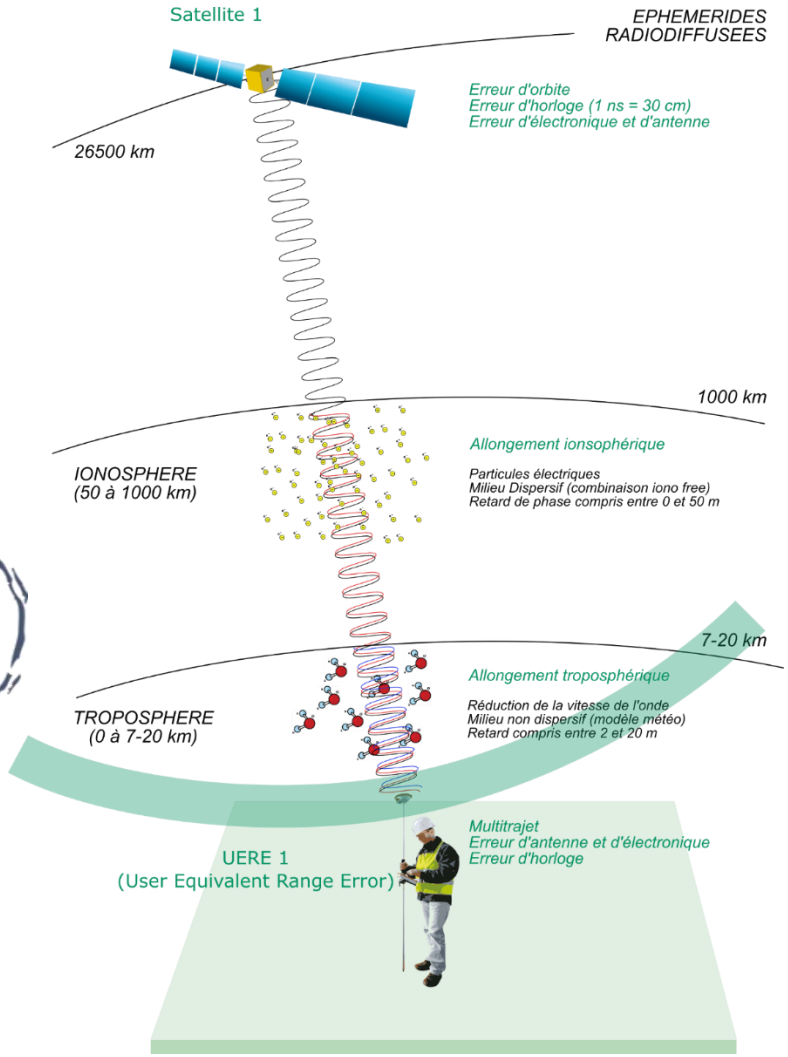
geo flex

How does it works ?

Errors affecting GNSS measurements

General principles of GNSS

- **User Equivalent Range Error:**
  - Satellites errors
    - Orbits errors
    - Clocks errors
    - Antenna phase center and electronic biases
  - Atmospheric errors
    - Ionospheric refraction
    - Tropospheric refraction
  - Multipaths
  - Receiver errors
    - Clocks errors
    - Antenna phase center and electronic biases



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Our Technology

<u>Precise Point Positioning (PPP):</u> Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- Sparse network (about 100 permanents stations around the world) to model in real time on central platforms orbits and clocks errors for all GNSS satellites
- Corrections are then transmit to the user's receiver by cellular (GPRS/UMTS) or SATCOM…
- … to be synchronize to measurements of the user's receiver to obtain a centimetric positioning after an initial convergence time from 30 to 5 minutes

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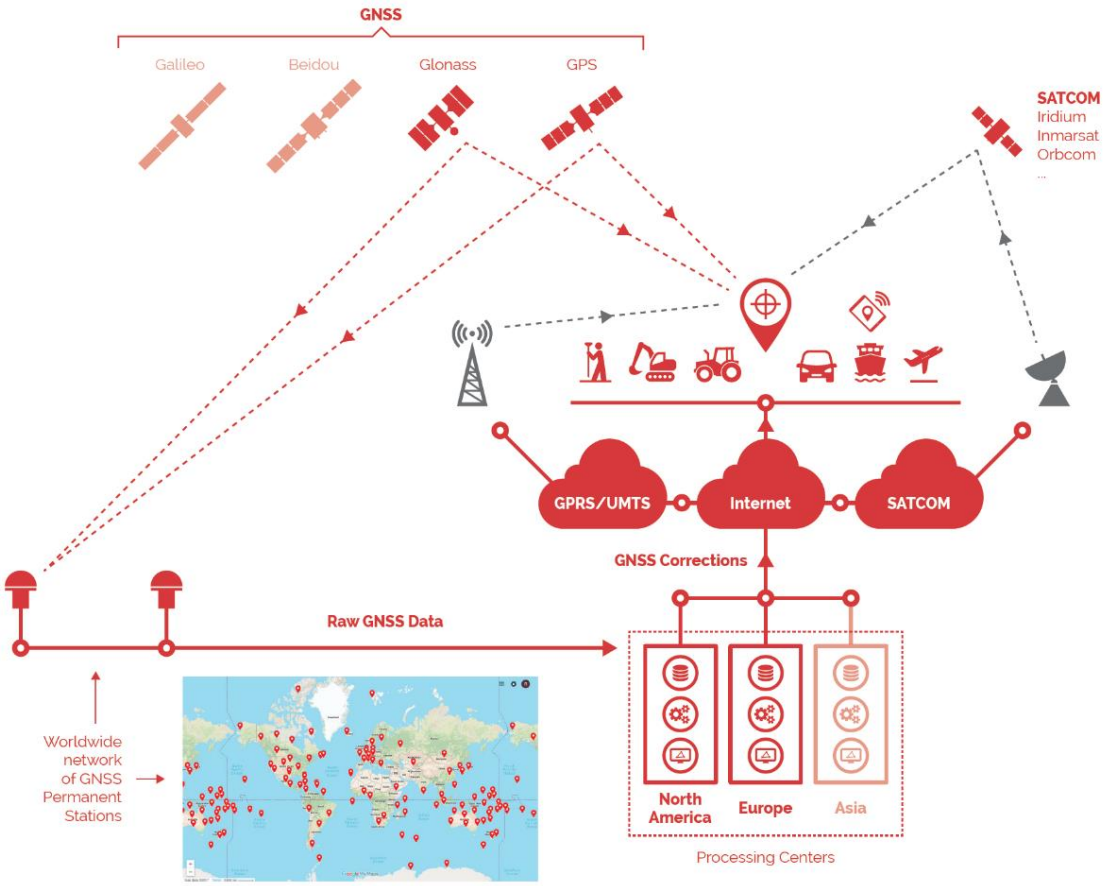
- 6 patents, join technical team with CNES

GEOFLEX provides disruptive GNSS solutions

<u>Precise Point Positioning (PPP):</u> Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach



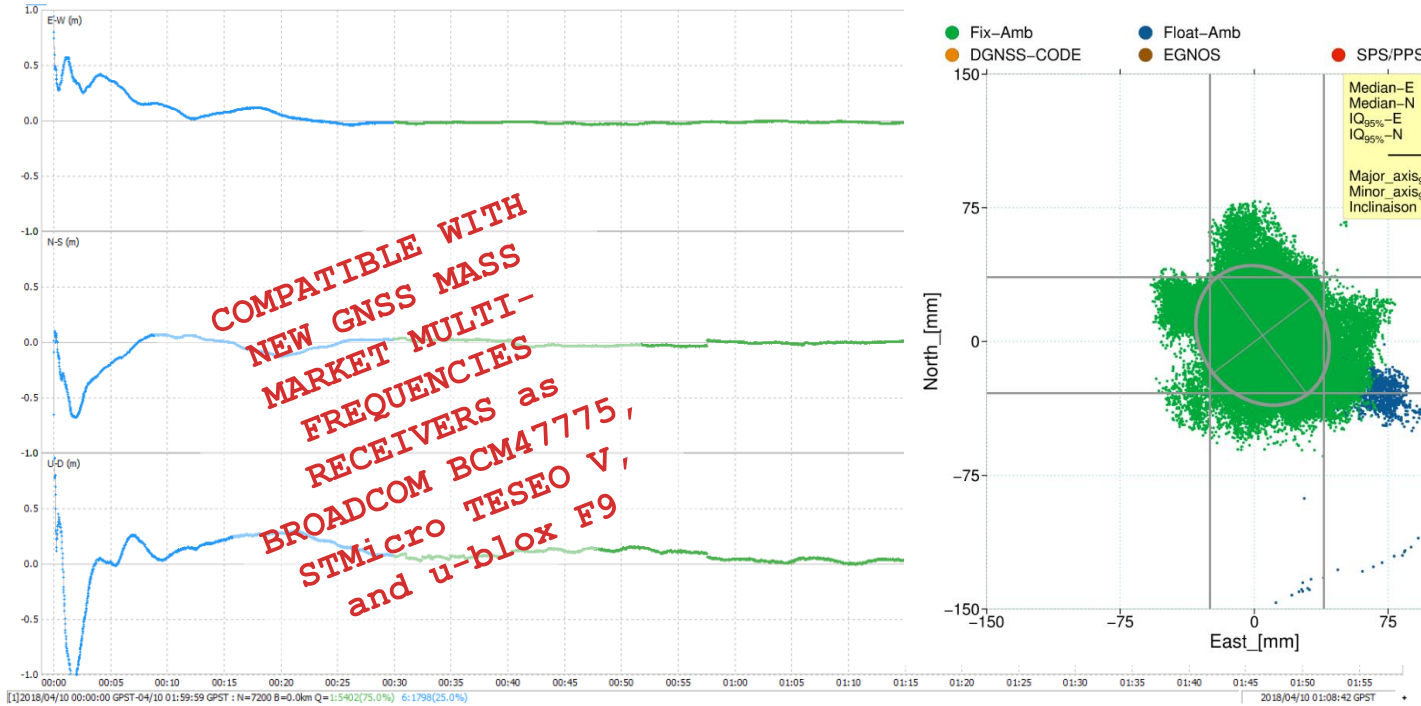
To provide a first level of services from only 1 satellite in downtown:

- To perform an hybrid multilateration with LIDAR and/or camera
- To constrain the drift of an IMU system

Our Technology

<u>Precise Point Positioning (PPP):</u> Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- <u>30 minutes of convergence</u> to reach an accuracy of 4 cm (2D-95%) = More than 68% of surveying points matching a 2 euros coin year after year (absolute precision) = PPP-IAR



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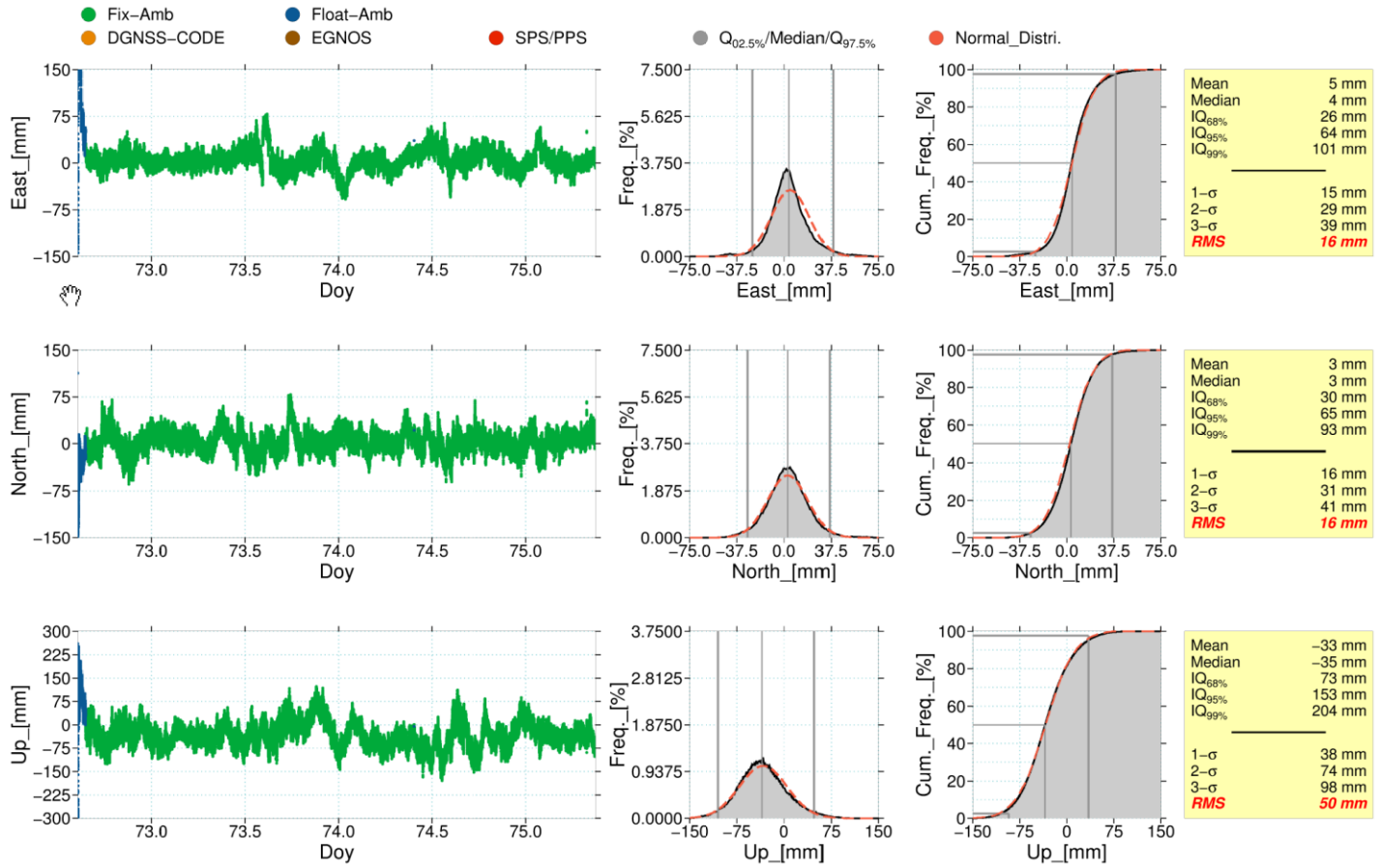

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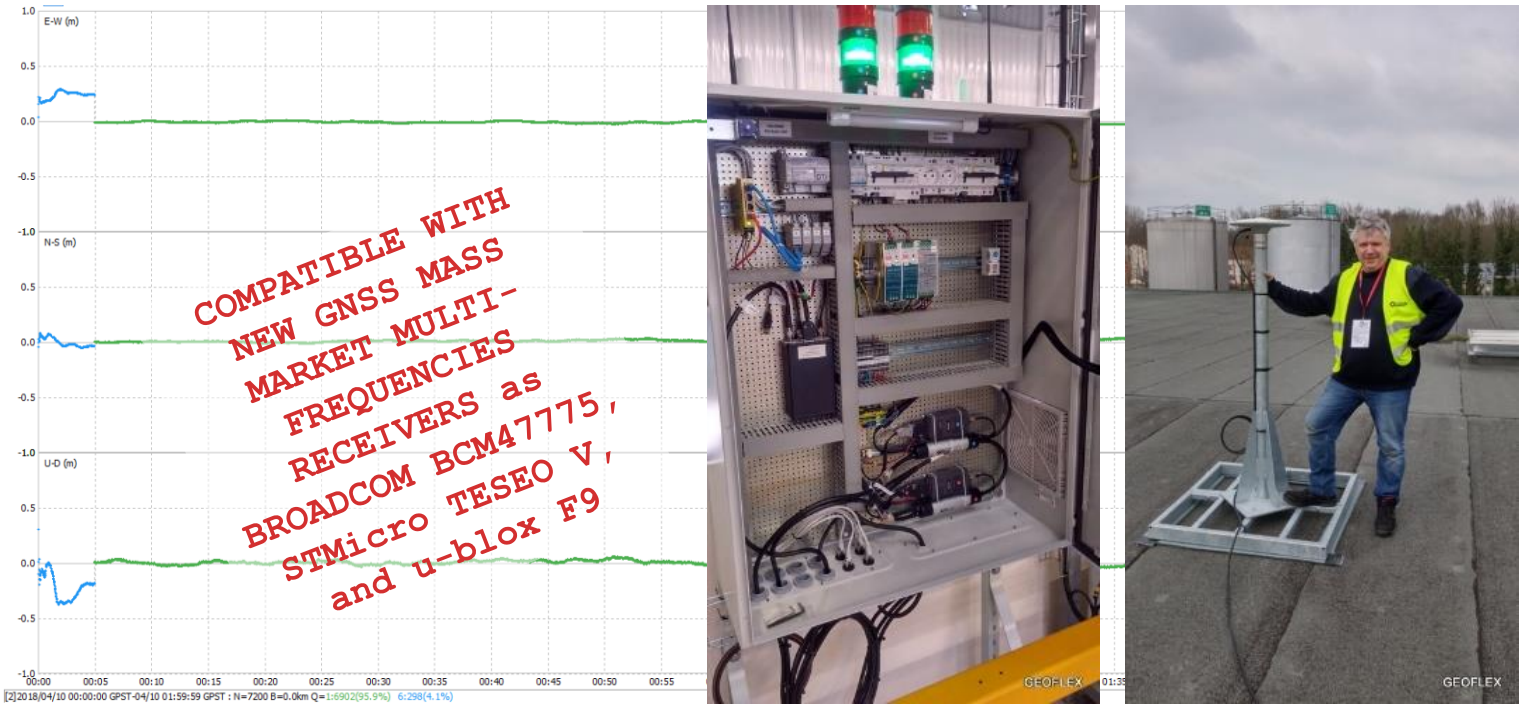
Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- 1 - 5 minutes of convergence using atmospheric refractions from a local "atmospheric base station" serving an area of interest with a radius up to 100 km ! = PPP-RTK



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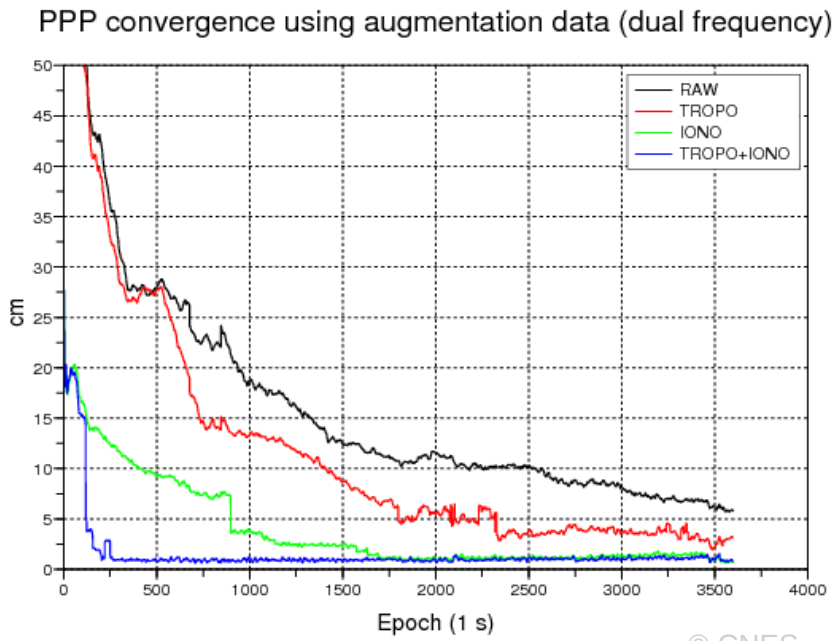
Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- **5 minutes of convergence by injecting in the computation good enough aprioris of atmospheric refractions from a « semi-dense » network of about 40 CORS for a country as France = PPP-RTK**



UNDER DEVELOPMENT
/
EXPERIMENTAL RESULTS

Our Technology

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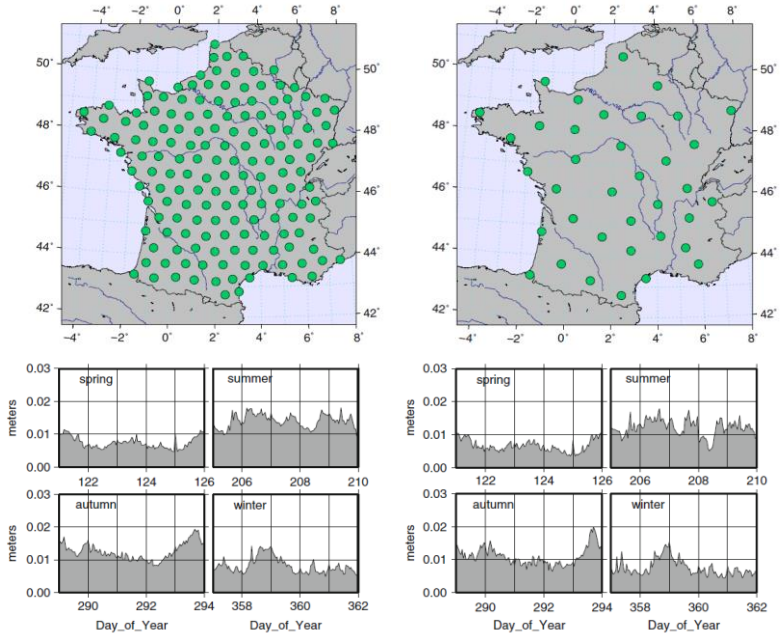


UNDER DEVELOPMENT
/
EXPERIMENTAL RESULTS

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real “Zero difference” approach

- **Tests in France:**

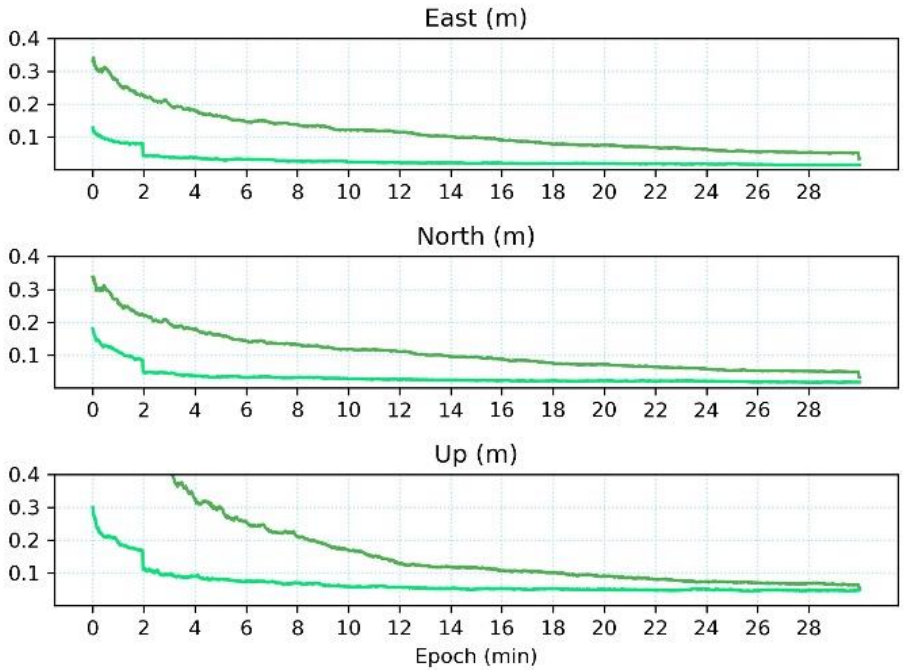
UNDER DEVELOPMENT / EXPERIMENTAL RESULTS

Bases atmo - mobile	0 – 10 km	10 – 30 km	30 – 60 km	60 – 100 km	100 – 150 km
Jours d’études	4 jours : 249/2017, 251/2017, 271/2017, 100/2018				
Nombre de mobiles	6				
Nombre de sessions	504	504	378	483	378
Durée des sessions	2h				

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- **Tests in France:**



60-100 km

UNDER DEVELOPMENT
/
EXPERIMENTAL RESULTS

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Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real “Zero difference” approach

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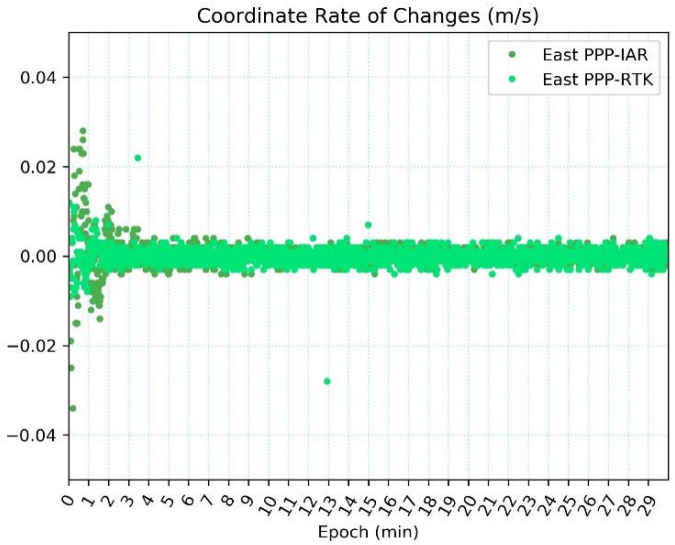
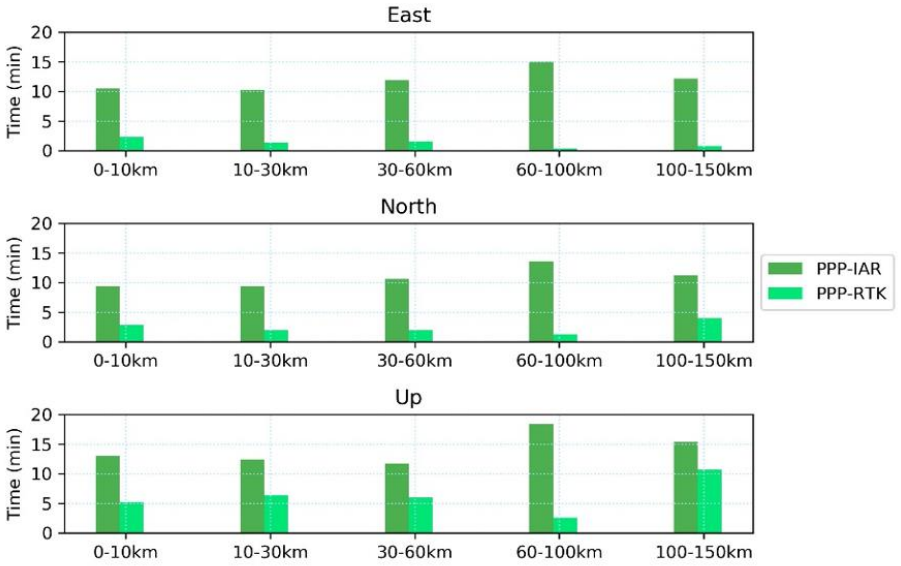




	Erreurs sur la position				Erreur glissante sur 5 min			
	Médiane		Percentile 68 %		Médiane		Percentile 68 %	
	PPP-IAR	PPP-RTK	PPP-IAR	PPP-RTK	PPP-IAR	PPP-RTK	PPP-IAR	PPP-RTK
Est	14′ 59″	0′ 21″	21′ 35″	1′ 58″	3′ 20″	0′ 40″	5′ 16″	2′ 4″
Nord	13′ 38″	1′ 12″	21′ 18″	1′ 58″	3′ 22″	1′ 28″	5′ 18″	2′ 46″
Hauteur	18′ 23″	2′ 36″	28′ 43″	14′ 15″	7′ 40″	2′ 14″	11′ 14″	6′ 58″

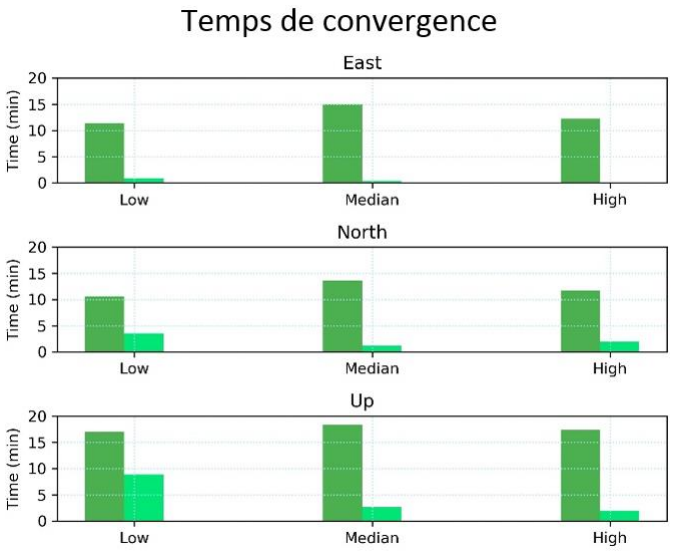
60-100 km

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real “Zero difference” approach

- **Tests in France:**

UNDER DEVELOPMENT
/
EXPERIMENTAL RESULTS

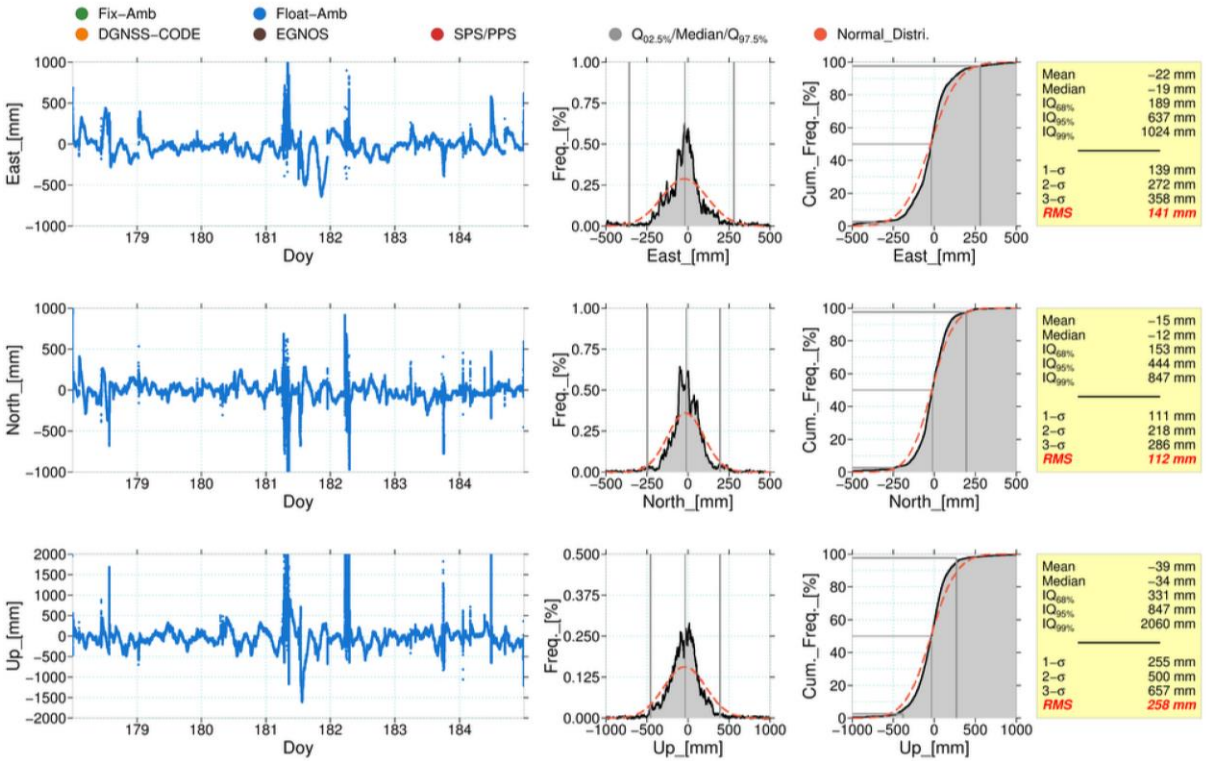


Activité ionosphérique	Faible	Moyenne	Forte
Jours d’étude	252/2017, 60/2018, 61/2018, 62/2018	249/2017, 251/2017, 271/2017, 100/2018	250/2017, 270/2017
Nombre de rover	6		
Nombre de session	474	483	189
Durée des sessions	2h		

Our Technology

<u>Precise Point Positioning (PPP):</u> Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- **With a such « semi-dense » network, we can significantly augment the performance of "L1 only" low-cost receivers**



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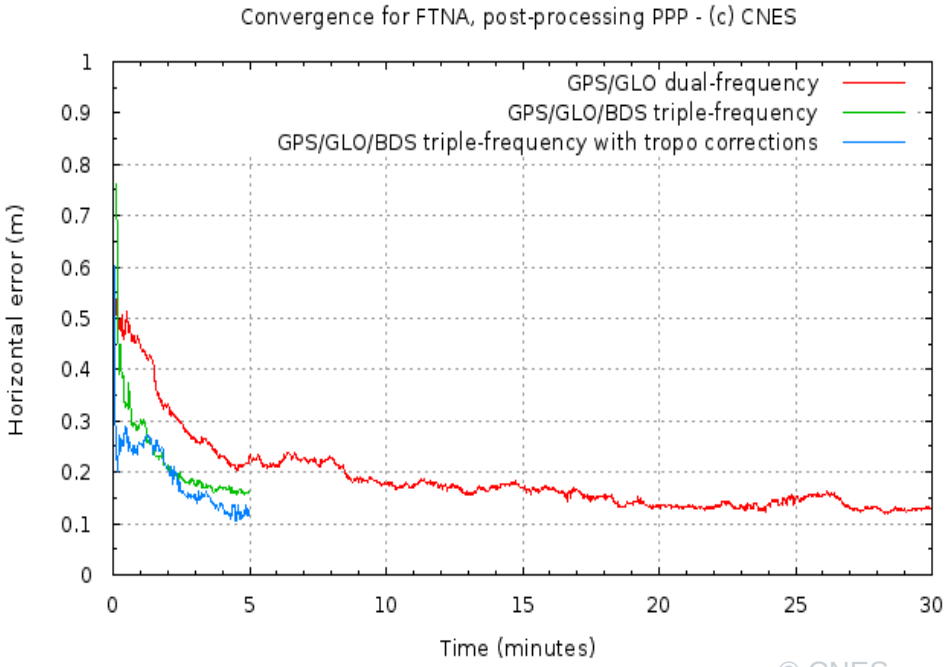
Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

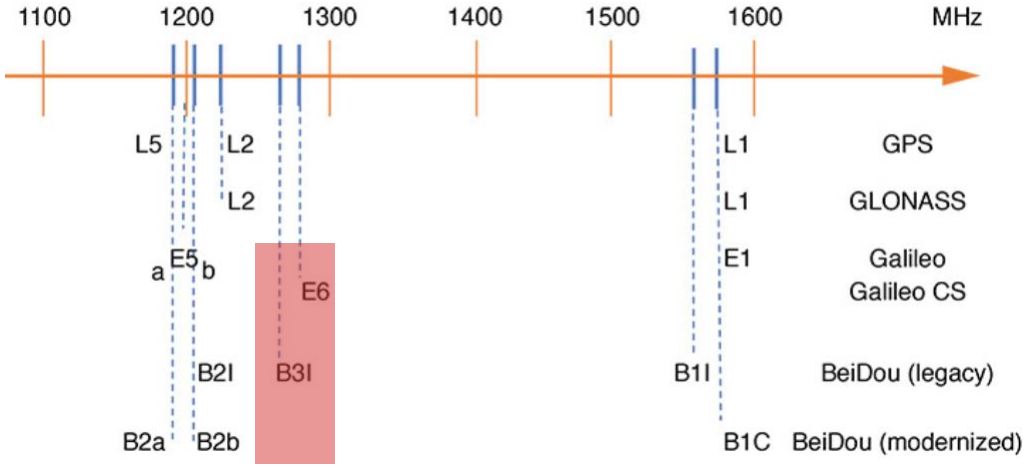
- Instantaneous precision of 20 cm and 10 cm after 5 minutes with tri-frequencies observations and an innovative worldwide model of ionospheric refractions = PPP-RTK



Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- Instantaneous precision of few centimeters with quadri-frequencies observations E1/E5a/E5b/E5/E6 since March 2018 = PPP-RTK



Constellation	Number of operational satellites on December 2018	Number of frequencies
GPS	12 Block IIF	3
BEIDOU	18 MEO 3S	5
GALILEO	20 FOC and 2 IOV	5

UNDER DEVELOPMENT / EXPERIMENTAL RESULTS

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

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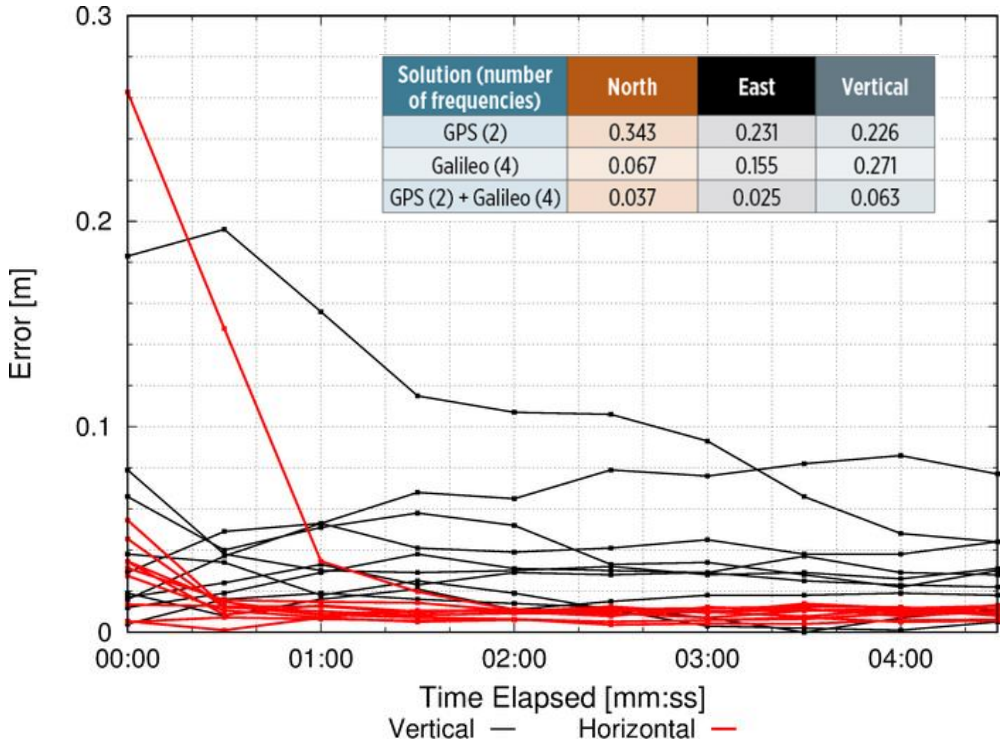
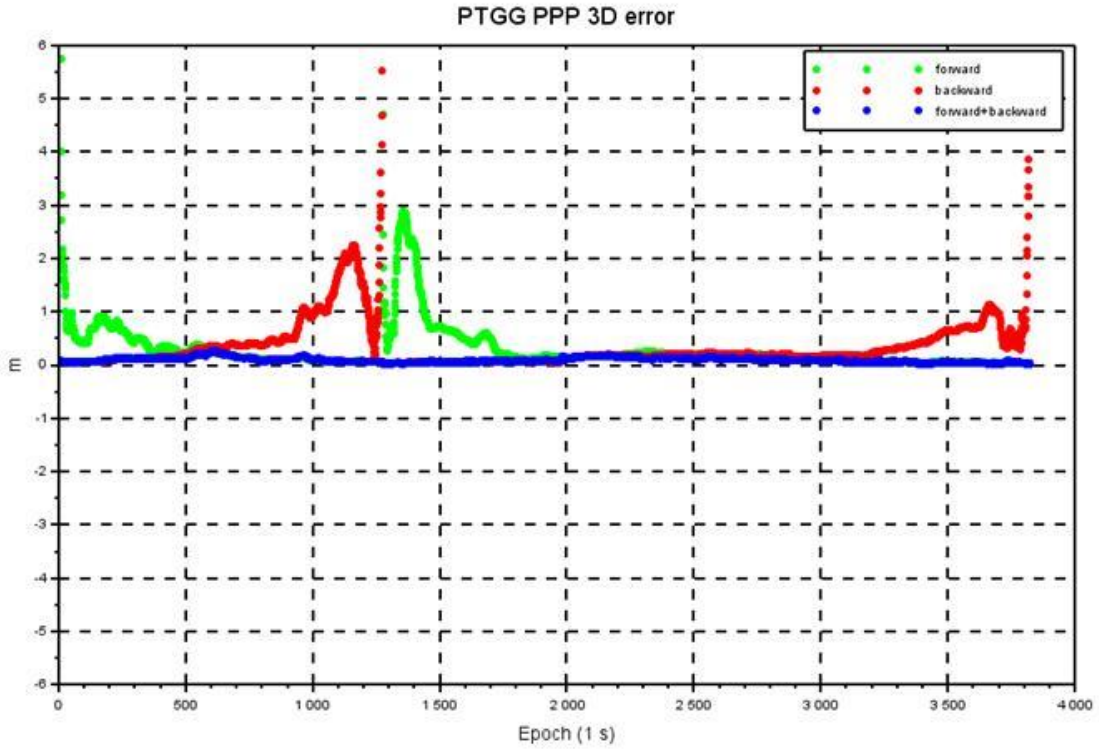


UNDER DEVELOPMENT / EXPERIMENTAL RESULTS

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

- In real time but also in post-processing in forward and backward mode

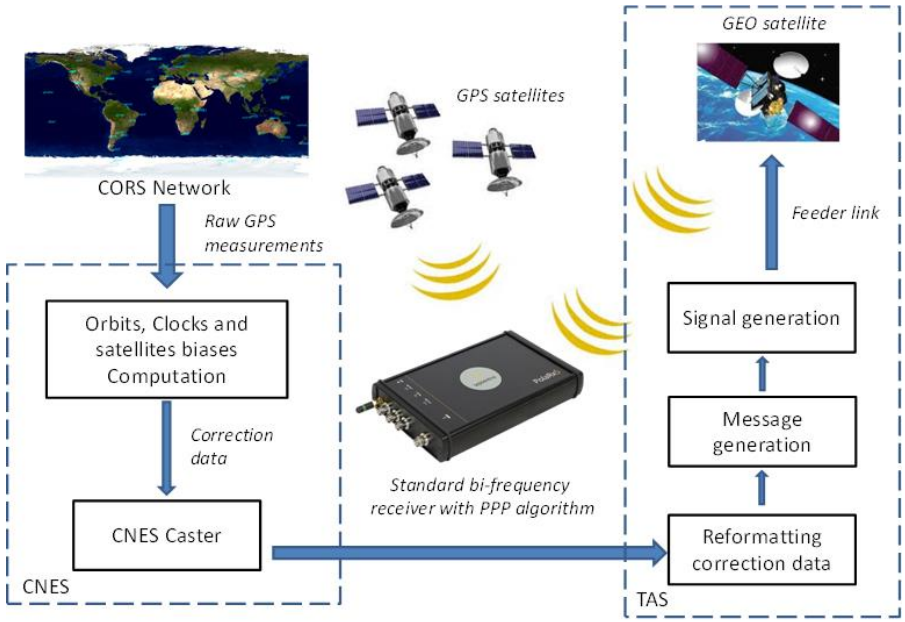


UNDER DEVELOPMENT
/
EXPERIMENTAL RESULTS

Our Technology

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements in a real "Zero difference" approach

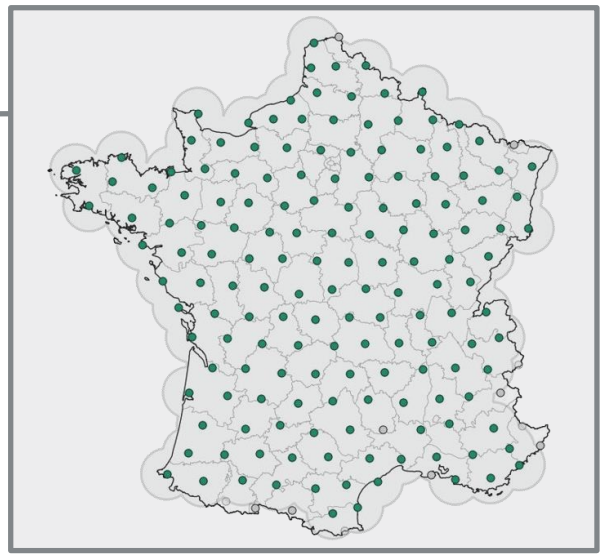
- ICD to broadcast corrections via SATCOM: SES ASTRA 5B GEO satellite CNES's experimentation (summer 2016) with a compressed streams from 5 000 to 100 bps to disseminate a Galileo type signal E5b



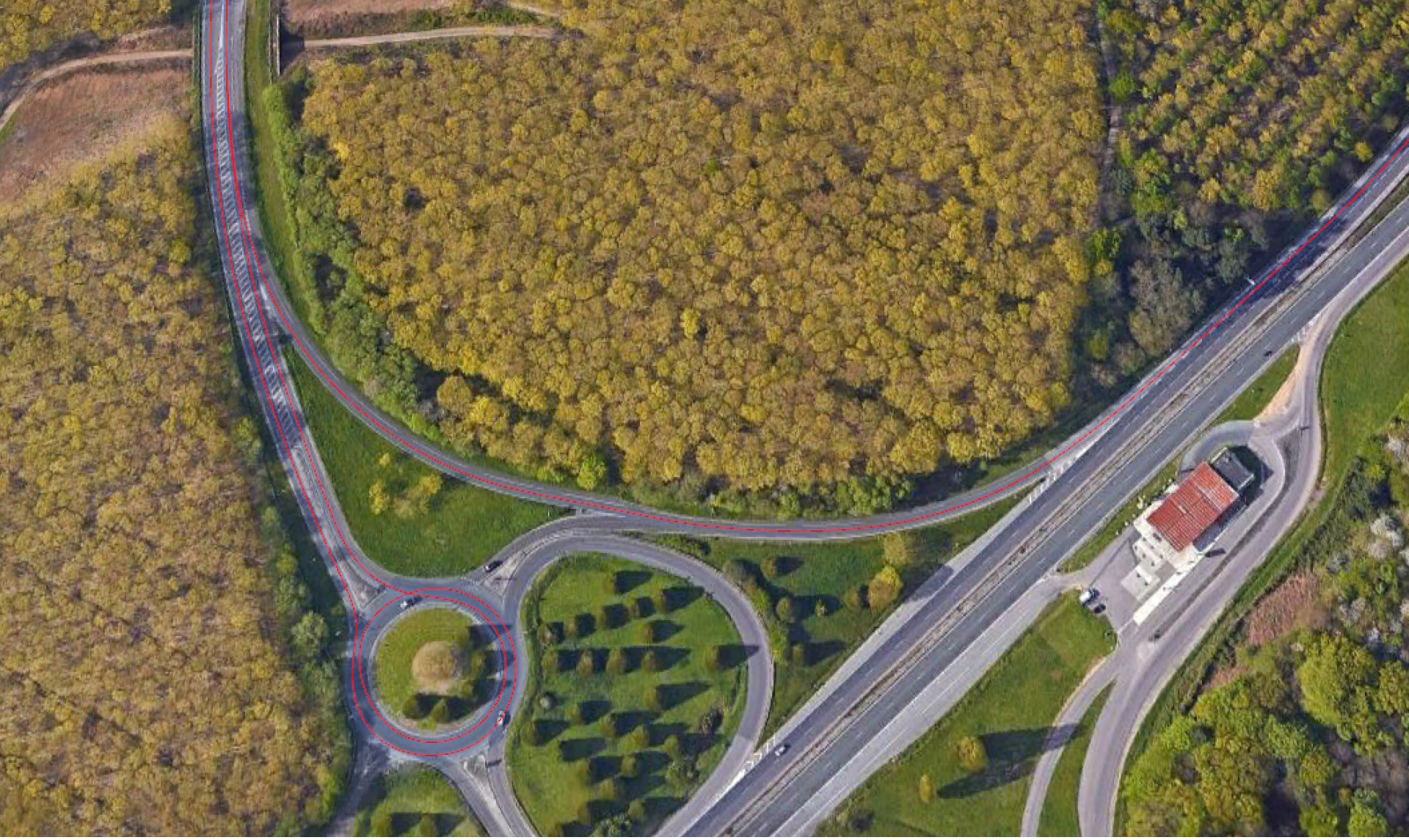
Radically different of others solutions

Others solutions as RTK/NRTK exists but:

- They are not scalable to worldwide operations with at least 200 reference stations for a country as France



- They doesn't allow the tight hybridization between GNSS and others sensors to ensure continuity and integrity



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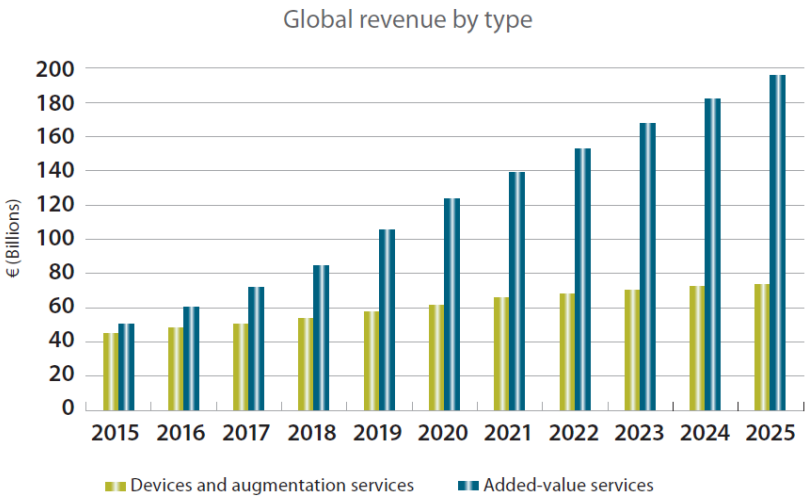
What are the downstream applicative chains ?

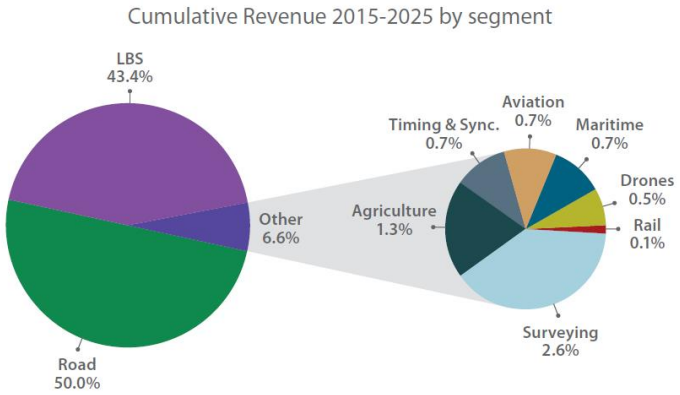
Diversified and very important markets

- **Geospatial**, **Construction**, **Agriculture** and **Transports** in link with dronification of activities
- **Location Based Services**

Diversified and very important markets

- **GNSS** market of **more than 100 billions of Euros in 2020**
- **GNSS augmentation** market of about **3 billions of Euros in 2020** with a compound annual growth of 6.36% between 2015 and 2020
- **In 2030, GNSS will impact 30% of the European GDP** (6% in 2015)

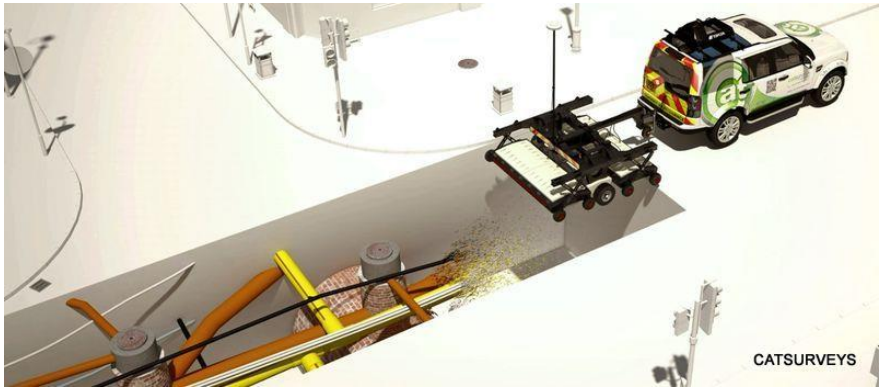




European
Global Navigation
Satellite Systems
Agency

Diversified and very important markets

- **GEOSPATIAL: Data georeferencing to pass from Information System to 4D/4.5D Geographical Information Systems (GIS)**
  - Topography, Cartography, GIS
  - Buried networks detection
  - Lidar & Photogrammetry
  - Remote sensing
  - Hydrographic survey & underwater imagery



Diversified and very important markets

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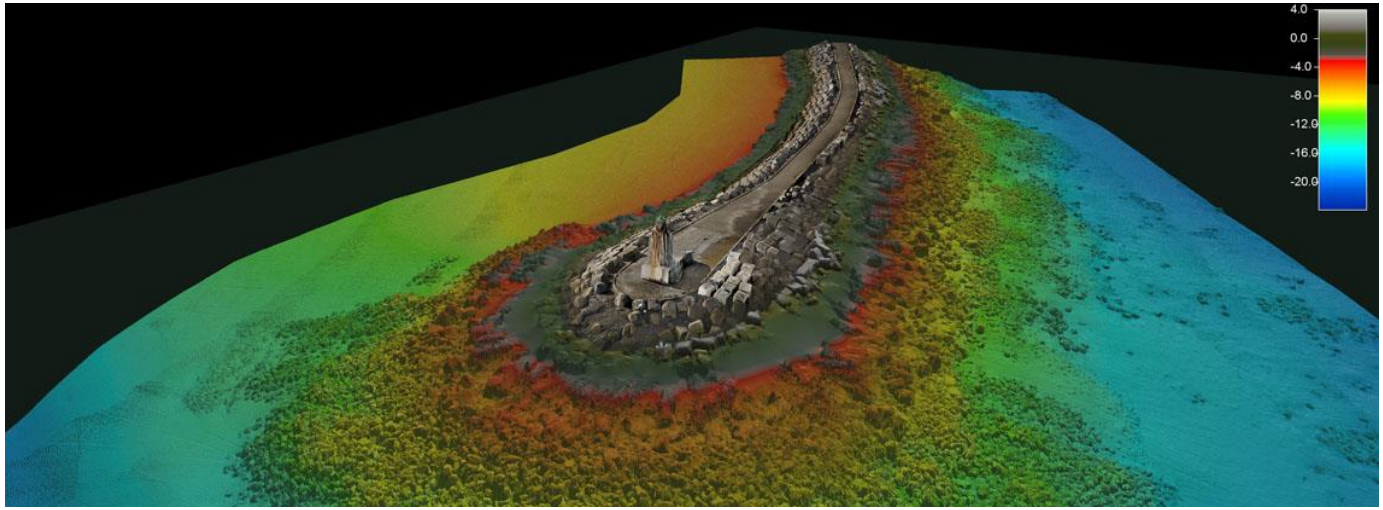
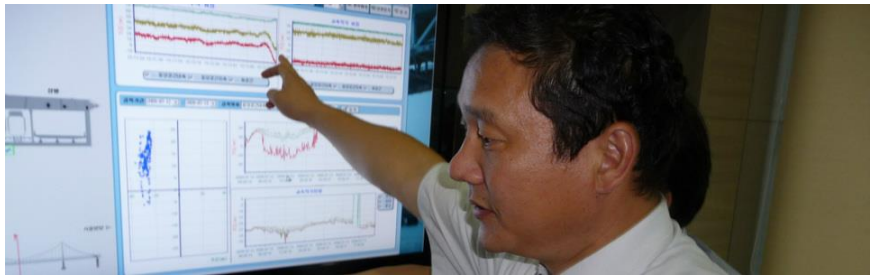


Diversified and very important markets

- **CONSTRUCTION: 4D/4.5D GIS as support for field activities automatization**
  - Machinery guidance
  - Structures stake-out
  - Control of verticality
  - Structure monitoring



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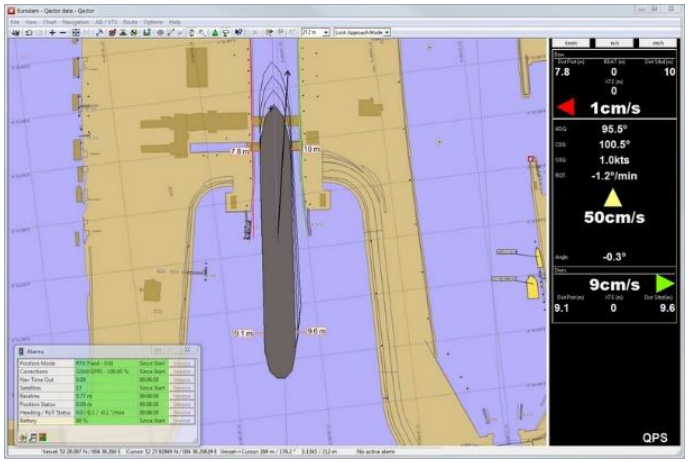
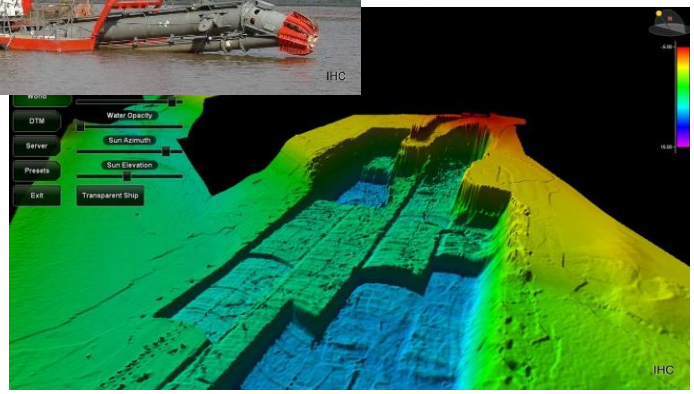
Diversified and very important markets

- **MARITIME AND FLUVIAL: 4D/4.5D GIS as support for field activities automatization**
  - Dredging
  - Navigation and docking
  - Dynamic positioning





Diversified and very important markets

- **AGRICULTURE: 4D/4.5D GIS as support for field activities automatization**
  - Steering & Auto-steering
  - Precision farming

Diversified and very important markets

- **AVIATION: 4D/4.5D GIS as support for field activities automatization**
  - Final approaches:
    - Procedures for satellite approaches « PNB LPV 200 »
    - 2016 in France = Suppression of half of the ILS (Instrument Landing Systems)
  - Aerial control of flying drones

Diversified and very important markets

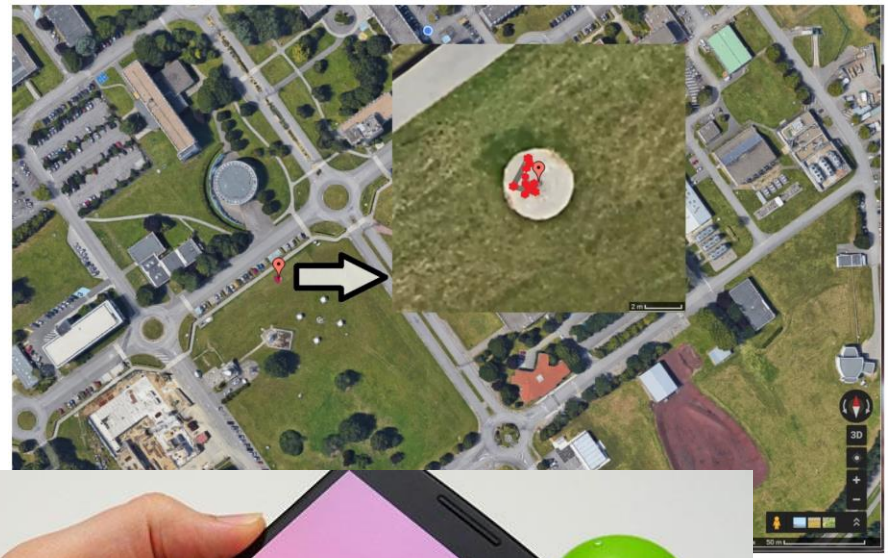
- **RAILWAY: 4D/4.5D GIS as support for field activities automatization**
  - Precise and robust localization to dematerialize of railway signaling
  - Autonomous train
  - Wagon tracking

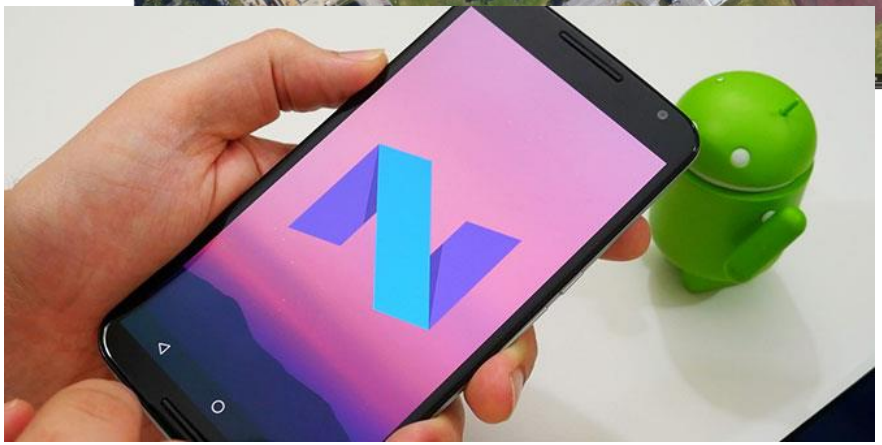
Diversified and very important markets

- **AUTOMOTIVE: 4D/4.5D GIS as support for field activities automatization**
  - Road navigation
  - ADAS (Advanced Driver Assistance Systems
  - Connected Vehicles
  - Autonomous Vehicles

Diversified and very important markets

- **LOCATION-BASED SERVICES (LBS): New mobility of people**
  - Navigation on smartphone and tablet
  - Transport multimodality
  - Collaborative mapping
  - Security and emergency services
  - Geomarketing
  - Sports and hobbies
  - Augmented reality

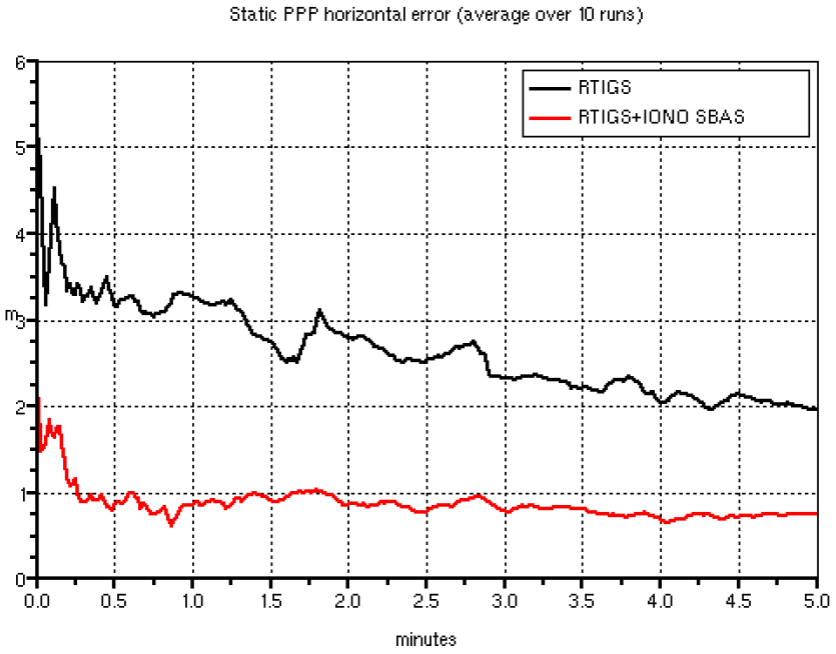




GÉOFLEX 100% compatible with Android N (Google)

Diversified and very important markets

- **LOCATION-BASED SERVICES** (LBS): New mobility of people



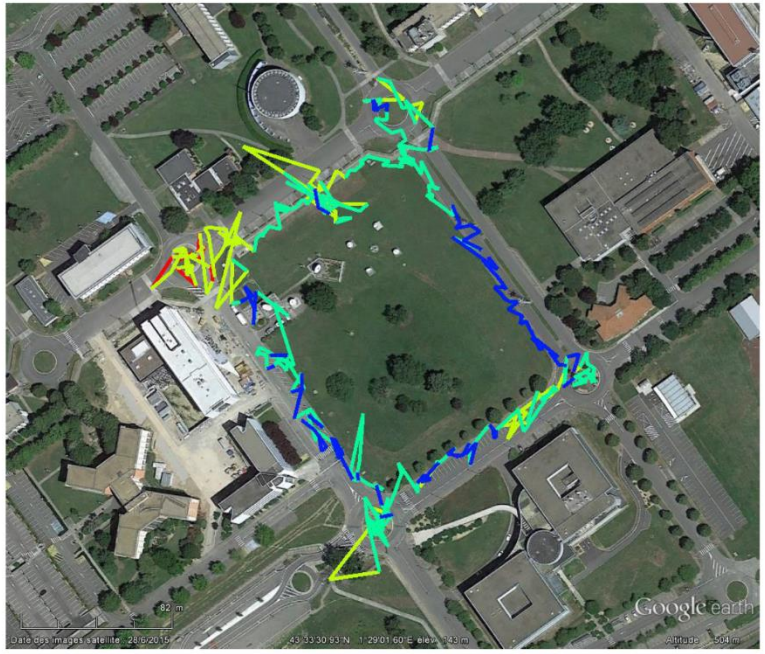
Diversified and very important markets

- **LOCATION-BASED SERVICES** (LBS): New mobility of people

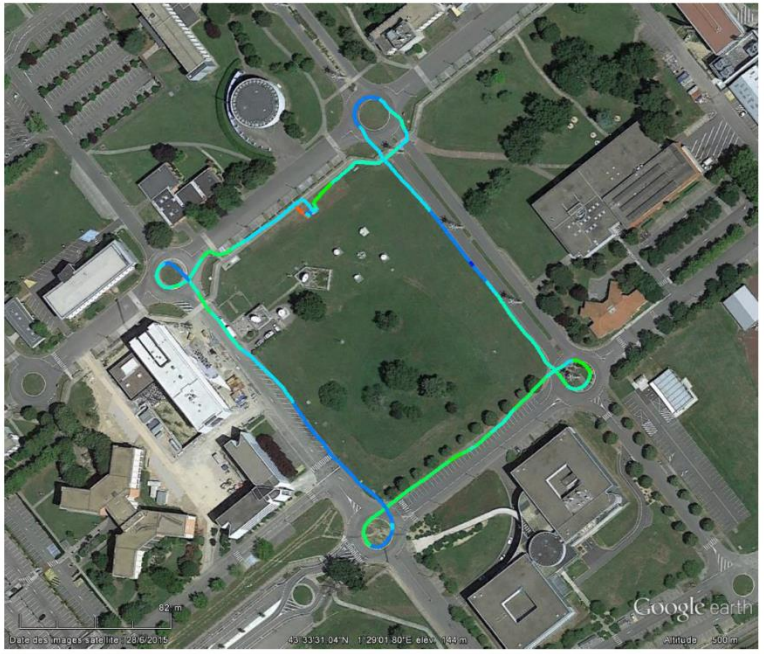
Smartphone Applications for Precise Point Positioning

cnes

PPP Wizlite: results in dynamic mode (pedestrian)



Rtklib PVT (GPS+GLO)



PPP Wizlite (GPS + GLO)

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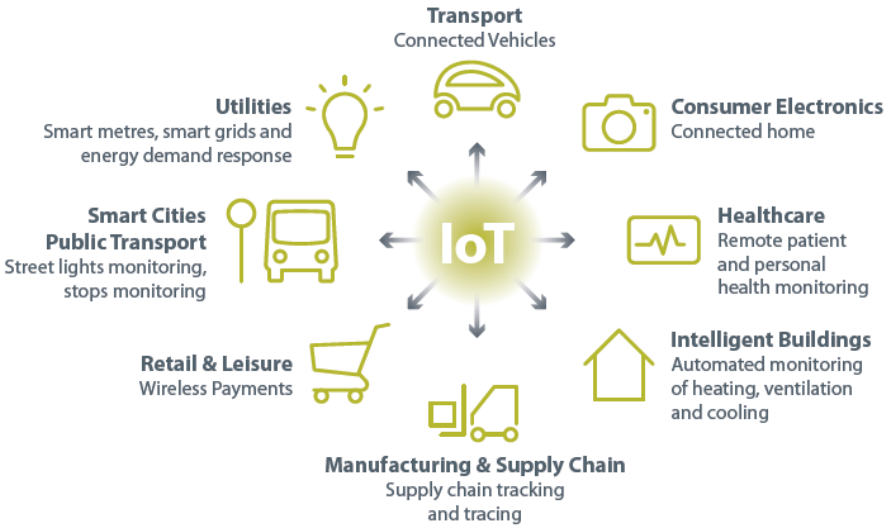
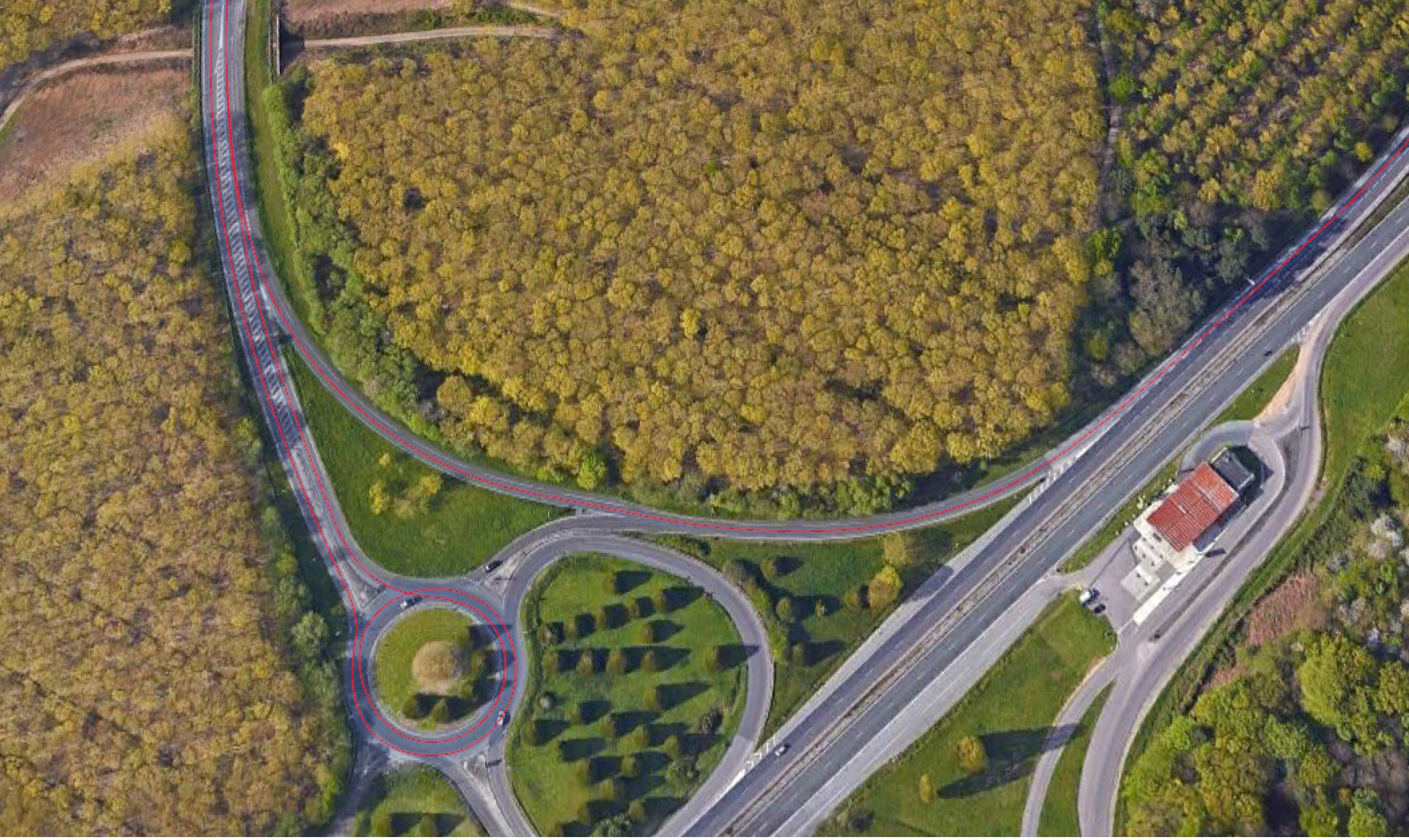
Diversified and very important markets

- **ASSETS TRACKING** (IoT): New mobility of goods and new interactions with humans

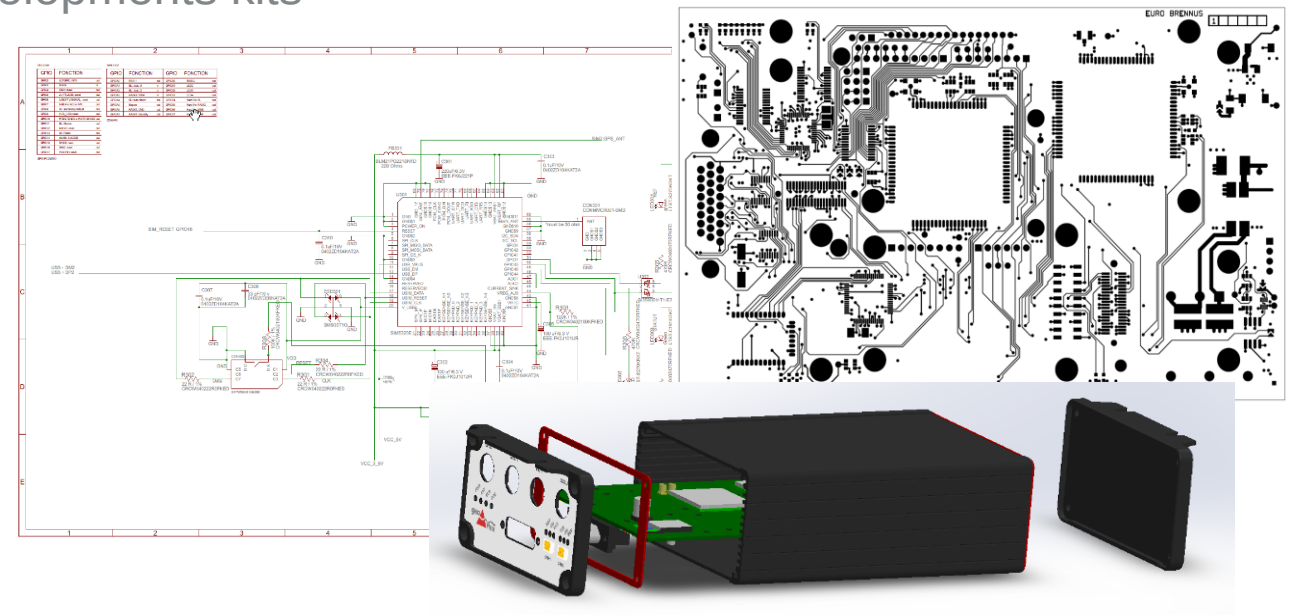




What is our strategy ?

Our Strategy / Singularity

- **Open model to mark our singularity:**
  - Sales of corrections through subscriptions in an interoperable format (RTCM3 SSR)
  - HDK/SDK enabling manufacturers, integrators and resellers to quickly create trade applications with a very high added value
  - GNSS BOX of augmentation services as reference implementations of those developments kits



Our Strategy / Singularity

- **Global concept of GNSS box of augmentation services:**
  - Configuration server
  - Firmware server
  - Logs servers
  - Management of remote access

Device:

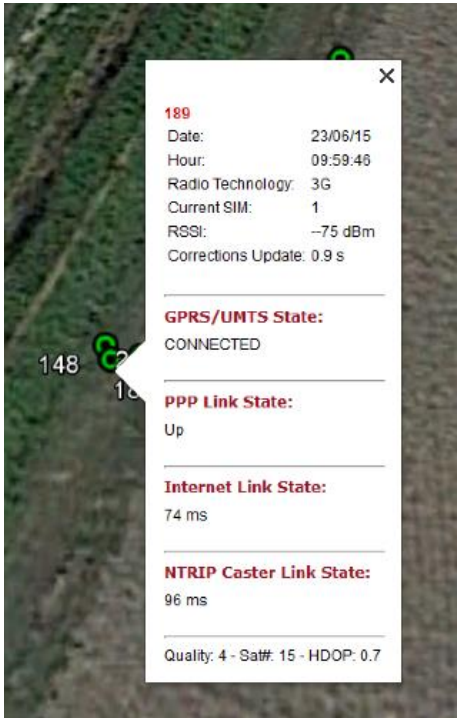
IMEI: 359998044121921

SIMs:

IMSI1	208011400524063
OPERATOR1	orange
APN1	orange.m2m.spec
IMSI2	208104289994424
OPERATOR2	sfr
APN2	m2minternet

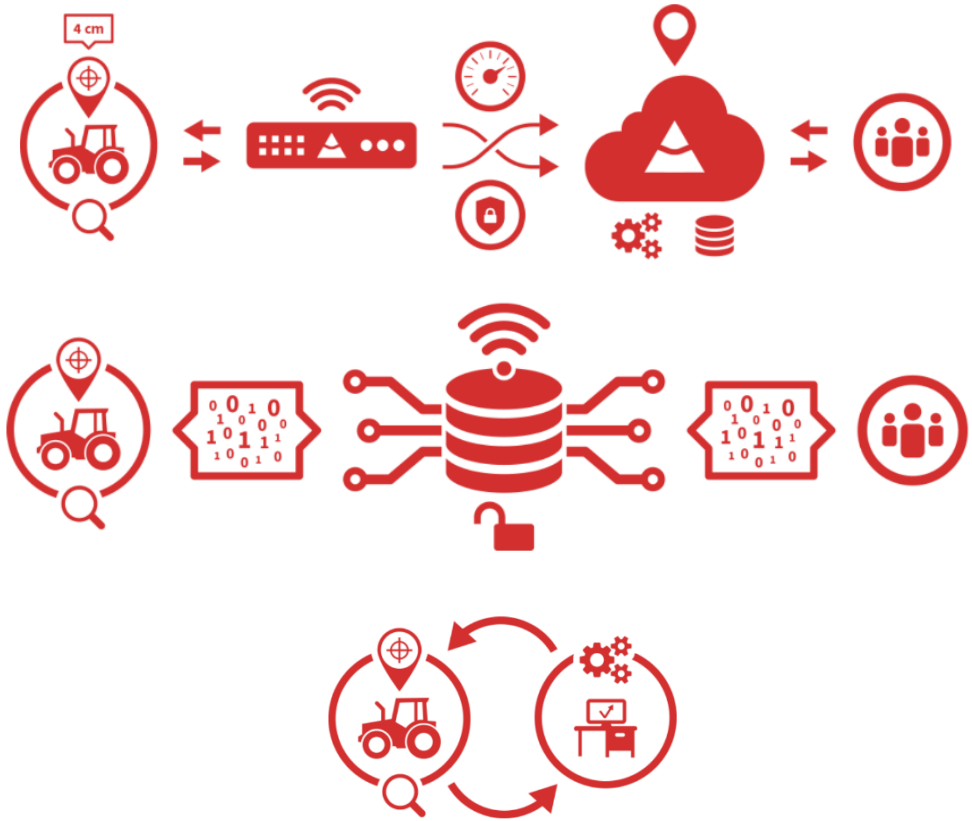
Tracks statistics:

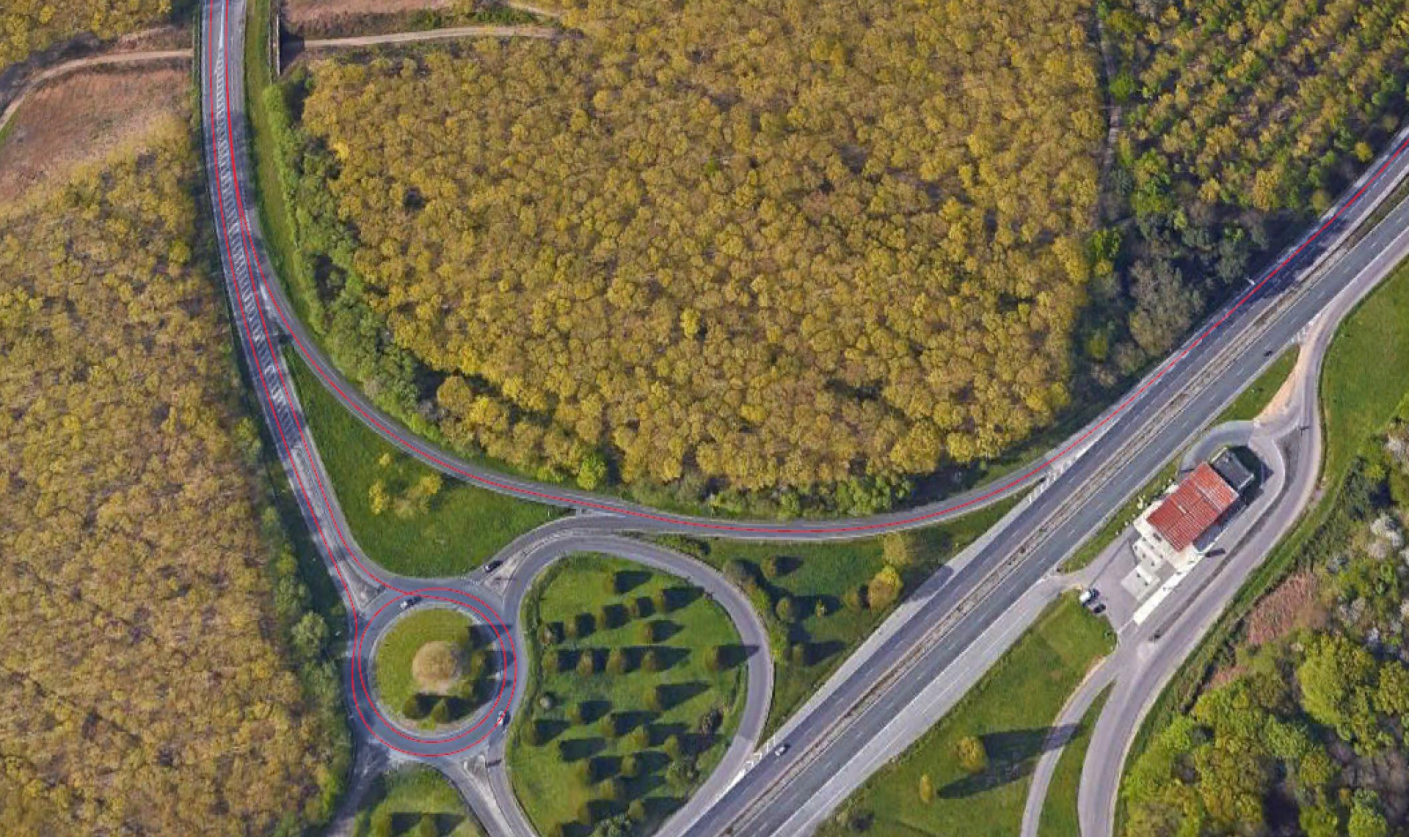
Date	23-06-2015
First epoch	08:29:42
Last epoch	10:02:19
Elapsed secondes	5557
Exported GNSS Points:	197
Interval Point (m)	50.000
Distance (km)	10540.4
Threshold:	45/30/15
Correction Quality:(under 45 s)	100.0 %
Correction Quality:(under 30 s)	99.5 %
Correction Quality:(under 15 s)	99.5 %
RTK Fix (4):	87.2 %
RTK Float (5):	1.0 %
NDGNSS Fix (2):	9.2 %
GNSS Fix (1):	2.6 %



Our Strategy / Singularity

- **Global concept of GNSS box of augmentation services:**
  - We provide a global open ecosystem to use GNSS augmentation in order to digitize the field activities of enterprise





geo flex

What are our solutions ?

Our Solutions

Precise Point Positioning (PPP): Model / estimate each error affecting GNSS measurements

Single-frequency PPP multi-GNSS	***RT-PPP-L1*** Accuracy of 80 cm Convergence of 30 minutes
Single-frequency PPP multi-GNSS + iono. SBAS	***RT-PPP-L1 "Fast and Precise"*** Accuracy of 50 cm Convergence of 1 minute
Dual-frequency PPP multi-GNSS with float ambiguities	***RT-PPP-L1/L2*** Accuracy of 10 cm Convergence of 30 minutes
Dual-frequency PPP multi-GNSS with fix ambiguities	***PPP-IAR*** Accuracy of 4 cm Convergence of 30 minutes
Tri-frequency PPP multi-GNSS with fix ambiguities	***PPP-RTK*** Accuracy of 2-4 cm Convergence of 5 minutes

Our Solutions

The THD box for « True High Definition »:

- From L1 GPS/GLO/GAL to L1/L2/L5 GPS/GLO/GAL/BEI dual-antennas
- WAAS / EGNOS
- DGNSS / N-DGNSS
- RTK / N-RTK
- PPP / PPP-AR / PPP-RTK
- PPS
- MARKER EVENT

GEOPOS / romain.legros@geoflex.fr / mobile: +33 7 83 30 96 86

Our Solutions

The THD box for « True High Definition »:

- **UHF Radio 430-450 MHz**
  - External and Internal
- **GPRS-UMTS**
  - Two internal modems
  - Multilink NTRIP Client
- **Satcom**
  - External INMARSAT–IRIDIUM etc.
  - Internal IRIDIUM to follow

9/36V

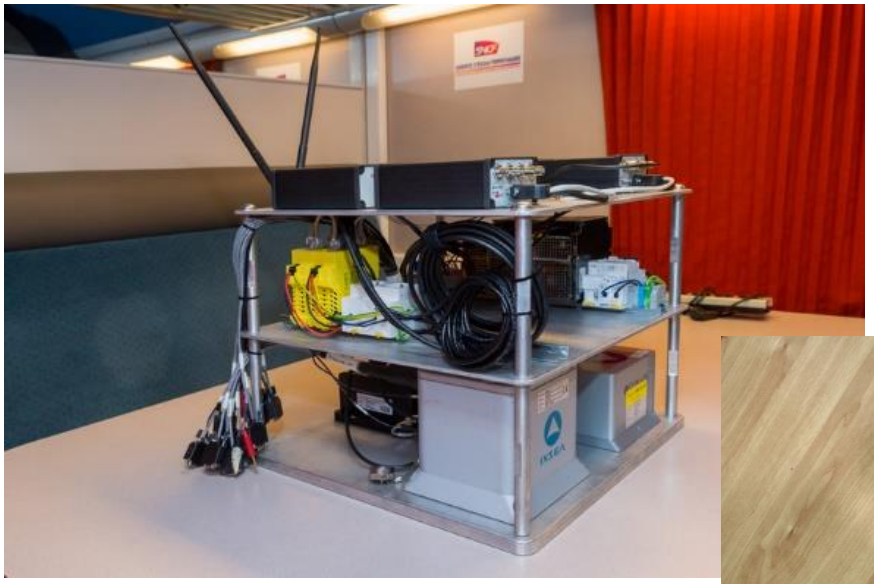
2 SERIAL, 1 USB, 1 BLUETOOTH

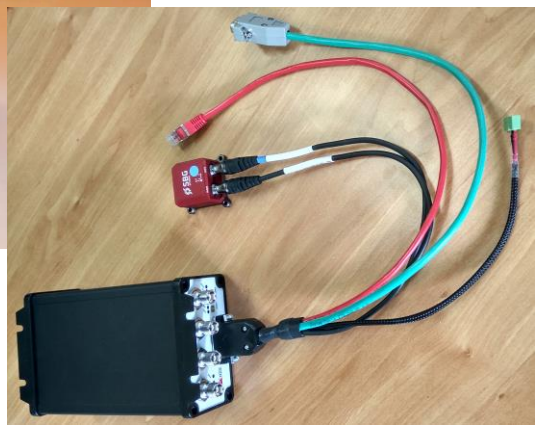
1 ETHERNET, 1 WIFI

Our Solutions

The THD box for « True High Definition »:

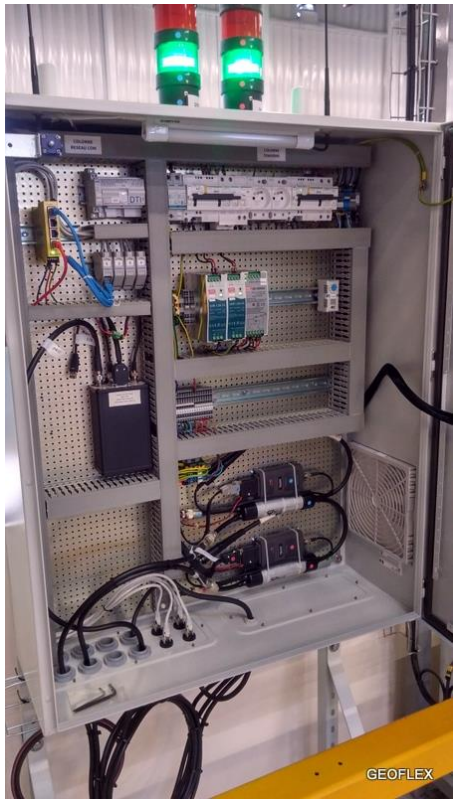
- Perfect Integration of the quadri-frequency GPS/GLO/GAL/BEI with the Inertial Measurement Unit from iXblue (URSA3 / ATLANS / PHINS) and SBG (ELLIPSE, EKINOX, APOGEE)





Our Solutions

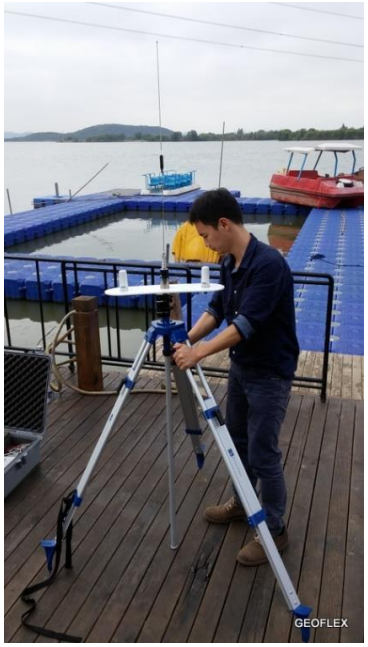
The THD box packaged in a GNSS CORS (Continuously Operating Reference Station): Full secured installation to meet industrial requirements



Our Solutions

The THD box packaged in an Auto-georeferenced RTK Base Station:
Ensure compatibility of our PPP services with actual RTK rovers:

- Automatic georeferencing of the RTK Base station by PPP-IAR or PPP-RTK in the local geodetic system
- Sending RTK corrections by UHF radio and/or GPRS



Up to 4 cm, everywhere in the world, every time, in real time or post-processing,

To serve applicative integrators with available and open GNSS augmentation,

To endows the others sensors of a global localization system with the power of our solutions,

To use GNSS in mass market applications

SNCF

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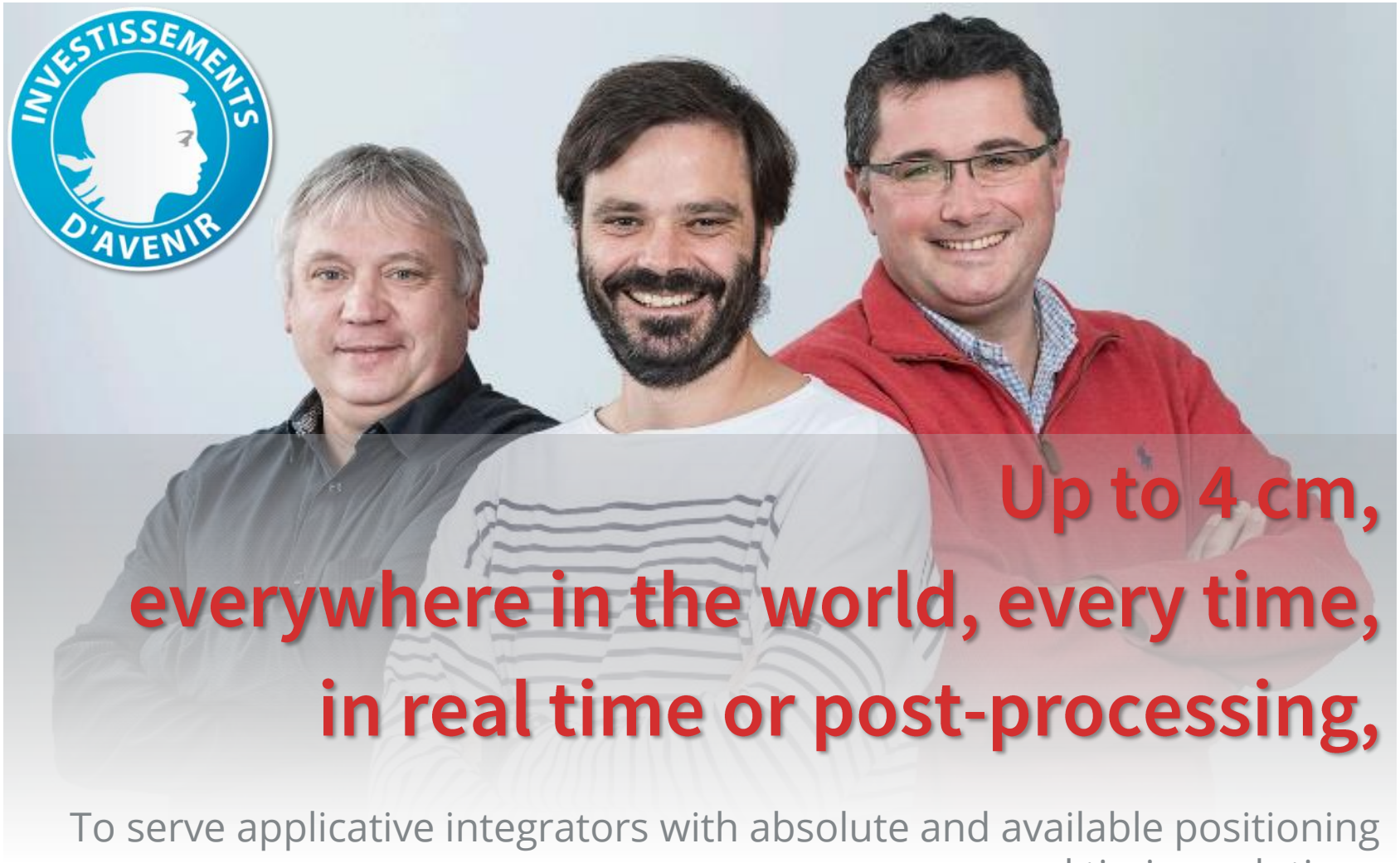

Up to 4 cm, everywhere in the world, every time, in real time or post-processing,

To serve applicative integrators with absolute and available positioning and timing solutions

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