



18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



# Next Generation **P**ositioning **I**nfrasturcture The GNSS Network in the 21<sup>st</sup> Century

Joel VAN CRANENBROECK & Partners  
Beyond East & West GeoSensing Community

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy

**INFRASTRUCTURE "The installations that form the basis for any operation or system".**

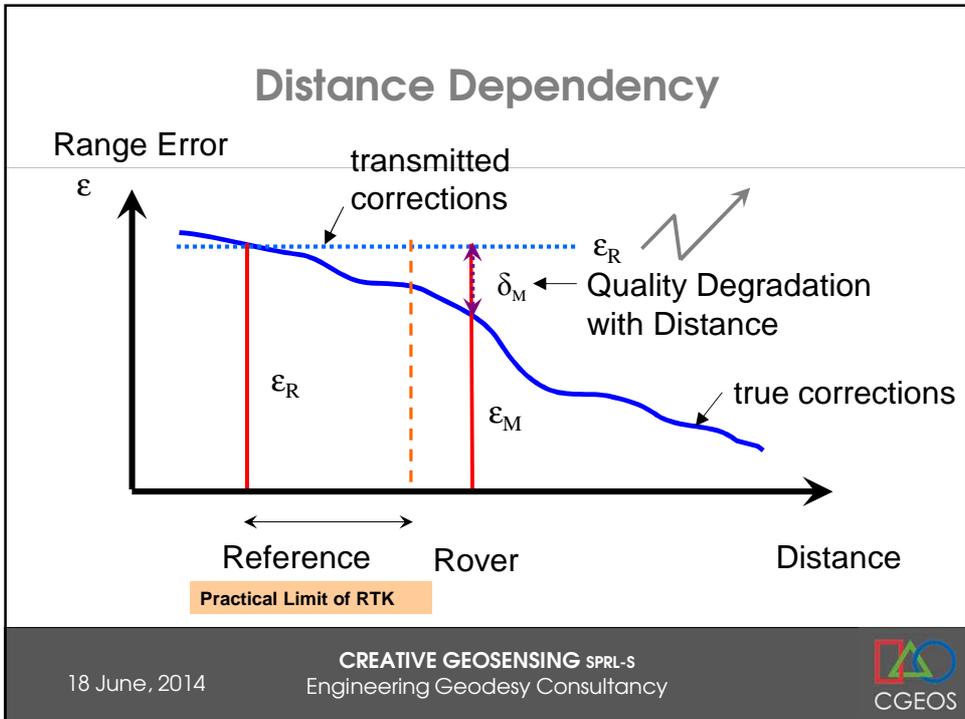
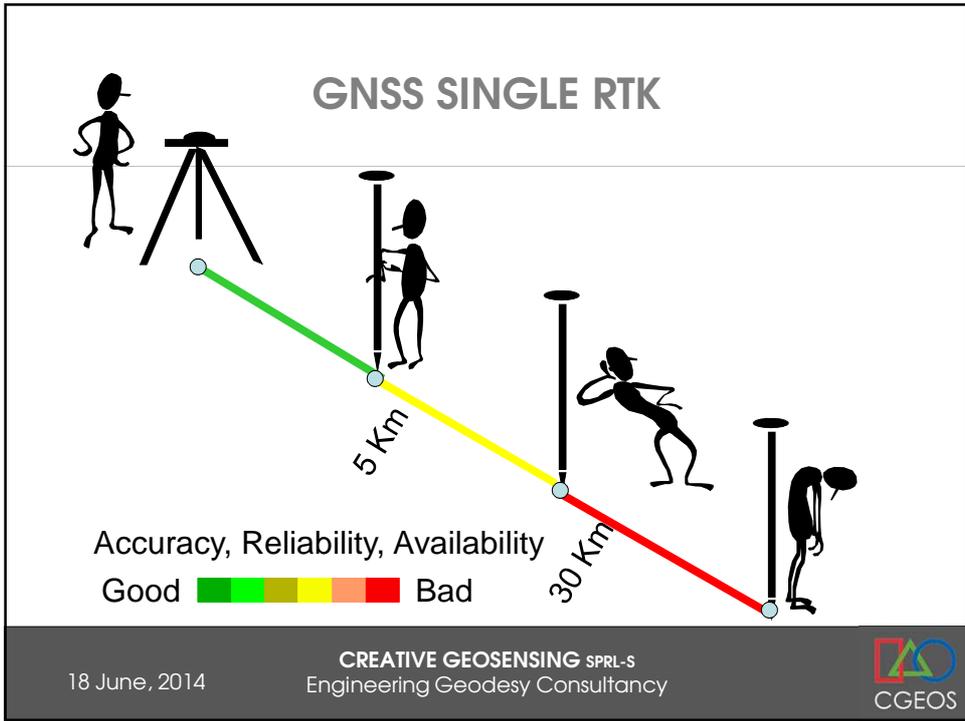


**GNSS RTK is High Precision Survey**

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



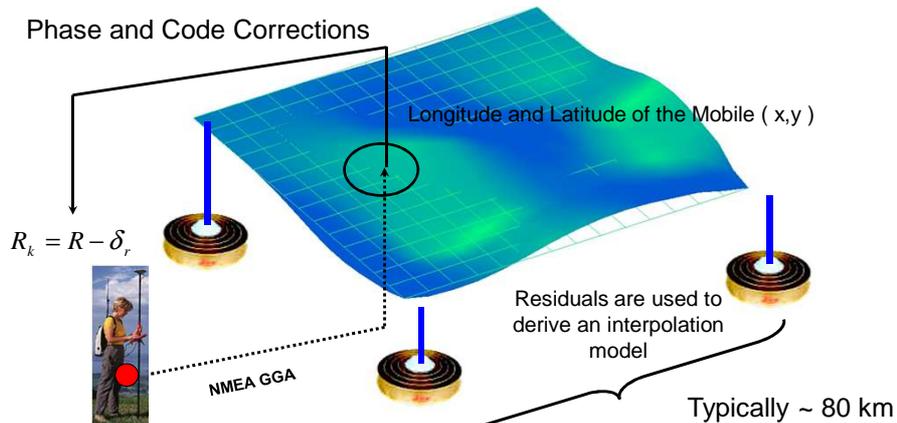


## Derived Observation Corrections

$$\delta_{r0} = \alpha(N_0(\varphi - \varphi_R) + E_0(\lambda - \lambda_R)\cos(\varphi_R))$$

$$\delta_{r1} = \beta \cdot H(N_1(\varphi - \varphi_R) + E_1(\lambda - \lambda_R)\cos(\varphi_R))$$

Phase and Code Corrections

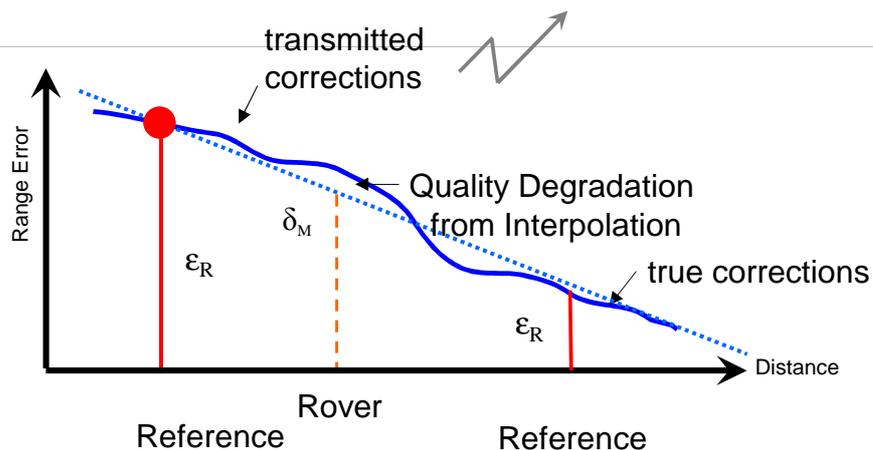


18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## Network Corrections



18 June, 2014

With a GNSS Network RTK (interpolation & extrapolation) no more distance dependency. The choice of the Master Station can be any Reference station selected within the cell.



## GNSS Network RTK

Accuracy, Reliability, Availability  
Good  Bad

18 June, 2014      CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy      CGEOS

## GNSS NETWORK BENEFITS

18 June, 2014      CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy      CGEOS



 **CGEOS**  
Engineering Geodesy Consultancy

*GNSS NETWORK RTK*



18 June, 2014

**CREATIVE GEOSENSING** SPRL-S  
Engineering Geodesy Consultancy





18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



## Positioning Infrastructure



Building Construction



Utilities Sector



GPS Monitoring



Precise Vehicle Tracking



Emergency Services



Port Operations



Land Surveying



Machine Control



Agriculture



18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



## From 2001 ...

- GNSS Network RTK developed for supporting High Accuracy Surveying GNSS RTK
- **Only one GNSS Rover RTK needed !**
- Good Communication ( GSM, GPRS, 4G, ... ) is mandatory ! ( Network & Rover )
- **Manufacturers are competing with models VRS™, PRS, iMAX, MAC, FKP, ...**
- **Same corrections ... different results ! Homogenous precision ?**

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## Today ...

- Multi-constellations, Multiple frequencies ...  
GPS, GLONASS, **BDS ... nothing from GALILEO ! Manufacturers compete on channel' s number ...**

XXXXXXXXX processes GPS (including L2C and I5), GLONASS and Galileo (including AltBOC) data in the standard RINEX format that is supported by all leading reference station software.

"With the addition of Galileo and BeiDou MEO support, we offer researchers, scientists and academics the opportunity to evaluate and experiment with results from these evolving satellite constellations,"

XXXXXXXXX provides simultaneous high-quality GPS, GLONASS and Galileo tracking together with a digital UHF radio and GSM/GPRS or CDMA modem for robust RTK upon demand.

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



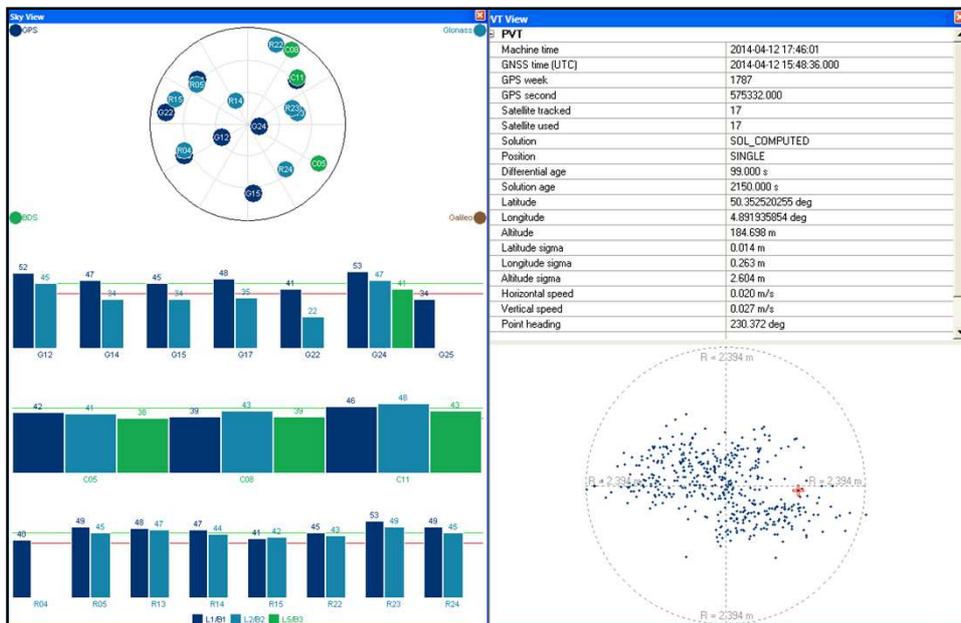


# First trial in Belgium



05 June, 2014

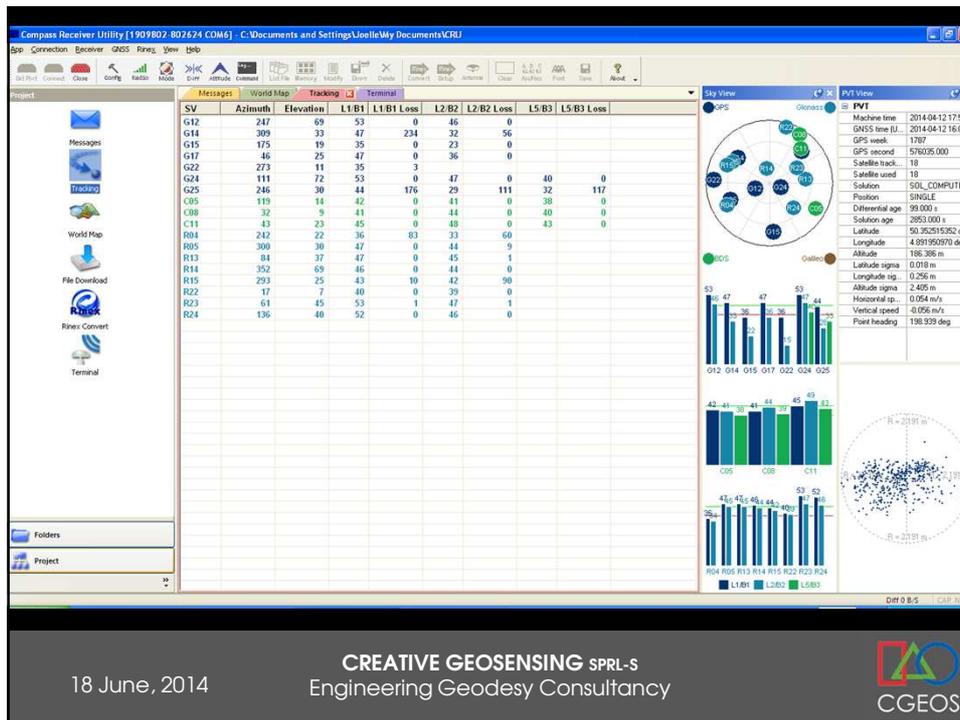
CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



05 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## Today ...

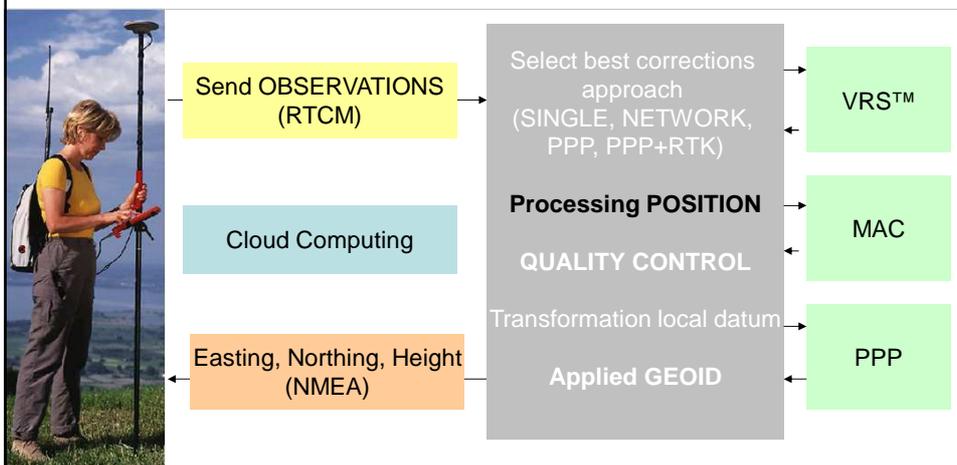
- Manufacturers and Academics are promoting **PPP ( Precise Point Positioning )** but **SLOW** on initialisation ...
- PPP + RTK is the best combination, FAST but similar to GNSS Network ... **Still need a GNSS NETWORK.**
- Manufacturers provide RTK solutions with different performances and results. Firmware upgrade produces other results ...

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## CLOUD RTK® Coordinates as a Service

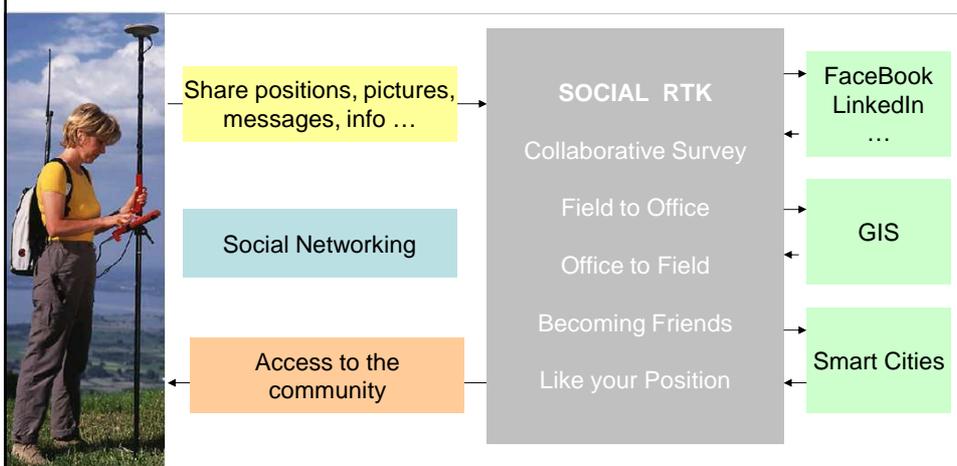


18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## SOCIAL RTK®



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## GNSS ... the Truth !

- GPS, GLONASS, BDS are positioning tools for DEFENSE APPLICATIONS never designed for Surveyors !
- In the cities (urban canyons), under ground, indoor ... GNSS is not working !
- The GNSS signals can be easily jammed !



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## GNSS is vulnerable !

- In the US the company “Light Square” setup communication network along the highway on the same frequency than GPS !
- With the idea to track everything (cars, trucks, people, ...) now people are considering GPS Jammer to get their privacy.
- Jamming GNSS signals is EASY and UNDETECTABLE ...

05 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



# GPS JAMMERS



User selectable GPS bands



Internal Cooling Fan With Wind Slots

**All GPS bands  
Jammer!**

Including GPS L1,L2,L3,L4,L5  
**All In One GPS Jammer!**

[more](#)



05 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



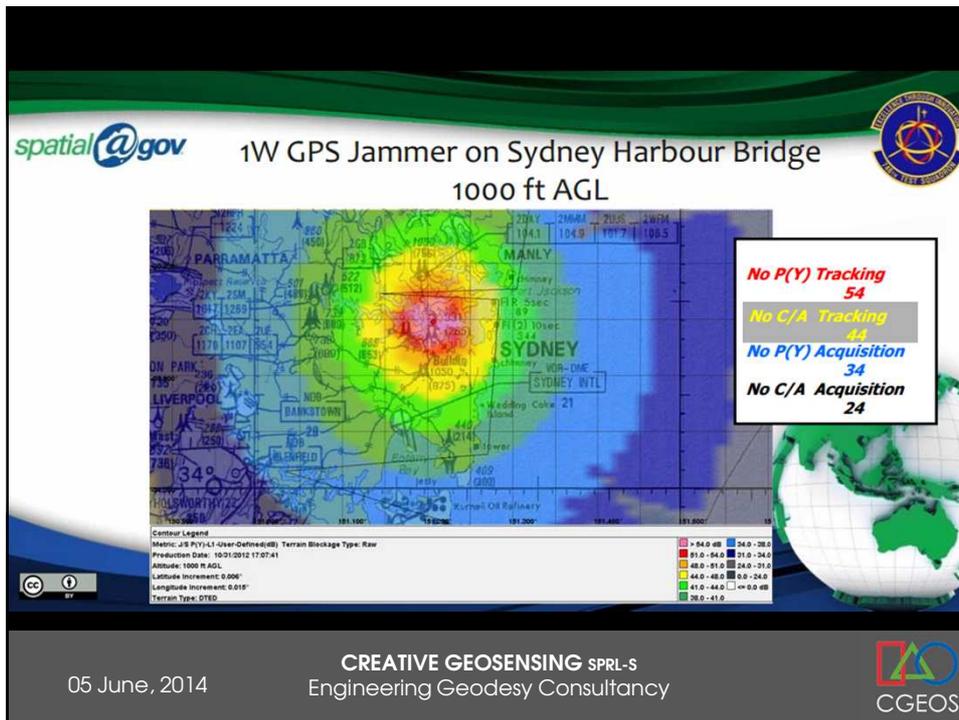
# GPS Jammers and Battlefield



05 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





## What would be the world without GNSS ?

- Positions will be wrong or impossible to obtain ...
- Financial transactions (ATM) are using GPS TIME ...
- Lot of automation systems are fully based on GPS and never imagine GPS signals can be jammed ... (UAV, Mapping, Surveying, ...)
- Are we prepare for that situation ?



## Analysis of GNSS Interference Impact on Society and Evaluation of Spectrum Protection Strategies: Research Paper Introduction (RPI)

POSTED BY DO ALEXIS SANOU - 20 SEP 2013 - AEROSPACE & LAND TRANSPORTATION, RPI

05 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy

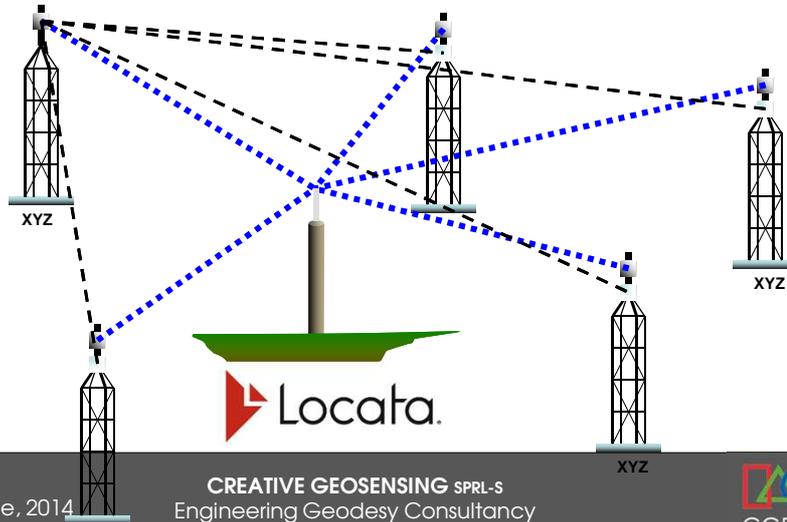


18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



# LocataLite Network. Time-synchronized transceivers.



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



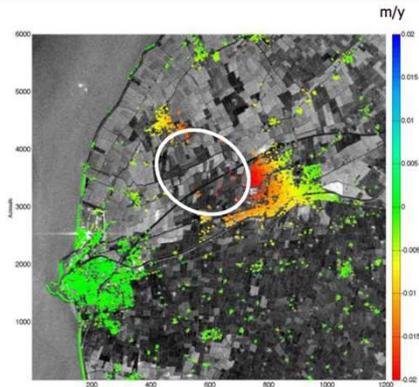
## LOCATA Positioning



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





Ground deformation per year (2003-2009) due to gas extraction and salt mining at Harlingen, The Netherlands, using PSI on Envisat ASAR data.

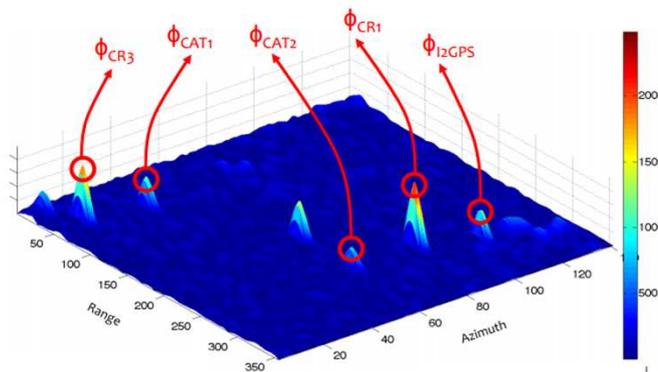
Persistent Scattered SAR Interferometry present a geodetic network of opportunity but the “points” are not marked.

Outside urbanised area’s PS is not possible without Corner Reflector.

Researches are conducted (DELFT) to validate if Compact Active Transponders can be a valuable alternative to Passive Corner Reflectors.

18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



Compact Active Transponders for SAR Interferometry  
P.S.Mahapatra@tudelft.nl

18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



METEO sensors

New GNSS ANTENNA

COMMUNICATION

New GNSS RECEIVER

PILLAR, CABINET, POWER

LOCATA

LEVELLING

CATS ( InSAR Active CC )

18 June, 2014

**CREATIVE GEOSENSING** SPRL-S  
Engineering Geodesy Consultancy



CLOUD RTK®

GPS + GLONASS + BDS

GNSS + LOCATA

SOCIAL NETWORK

18 June, 2014

**CREATIVE GEOSENSING** SPRL-S  
Engineering Geodesy Consultancy



## Positioning Infrastructure New Generation

- GNSS Network RTK has proven to be effective to support GNSS RTK surveying (no need local base station) and GNSS monitoring operations. **Can a GNSS Network locates a jamming source ?**  
**Can disable a GNSS constellation that is failing ( 2<sup>nd</sup> of April 2014 ) ?**
- **Must move from “corrections” as service to “coordinates” as service ( Cloud computing RTK ).**
- Today GNSS receivers are not tuned to provide highest grade of measurements ( ME same than others ). Next Generation is coming ... New GNSS Antenna (VRAY) to counter jamming.
- **Compact active transponders (CATs) for SAR Interferometry will benefit greatly of being host.**
- LOCATA ground to ground location systems proves they will join
- **Is there any other sensors to be considered as part of such positioning infrastructure ?**

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## Not only for Surveyors ... new users !



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



**HOW TO INTERACT WITH A DIGITAL MODEL EVEN A SMART ONE ?**



18 June, 2014

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy



Hydrology & Salmonid Habitat

Priority Land Cover

Beneficial Land Use

Infrastructure - Unsuitable Land Use - Zoning

Results

Suitability  
Most Suitable  
Least Suitable

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy

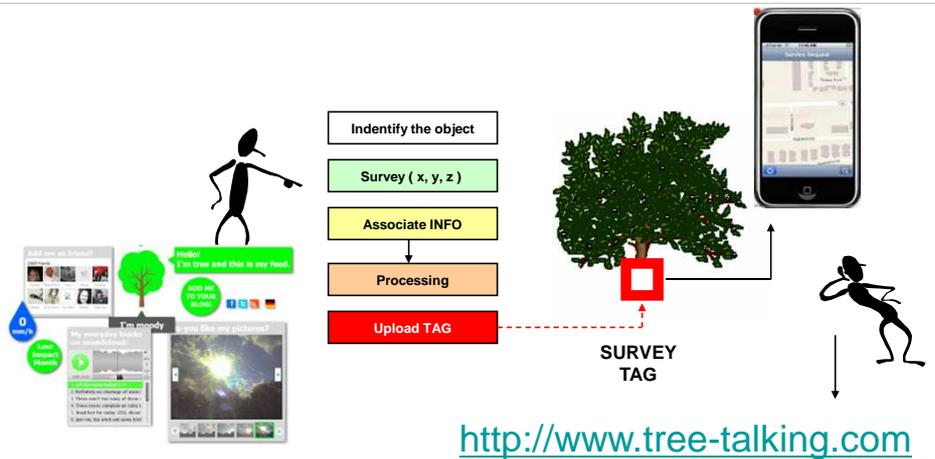
CGEOS

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy

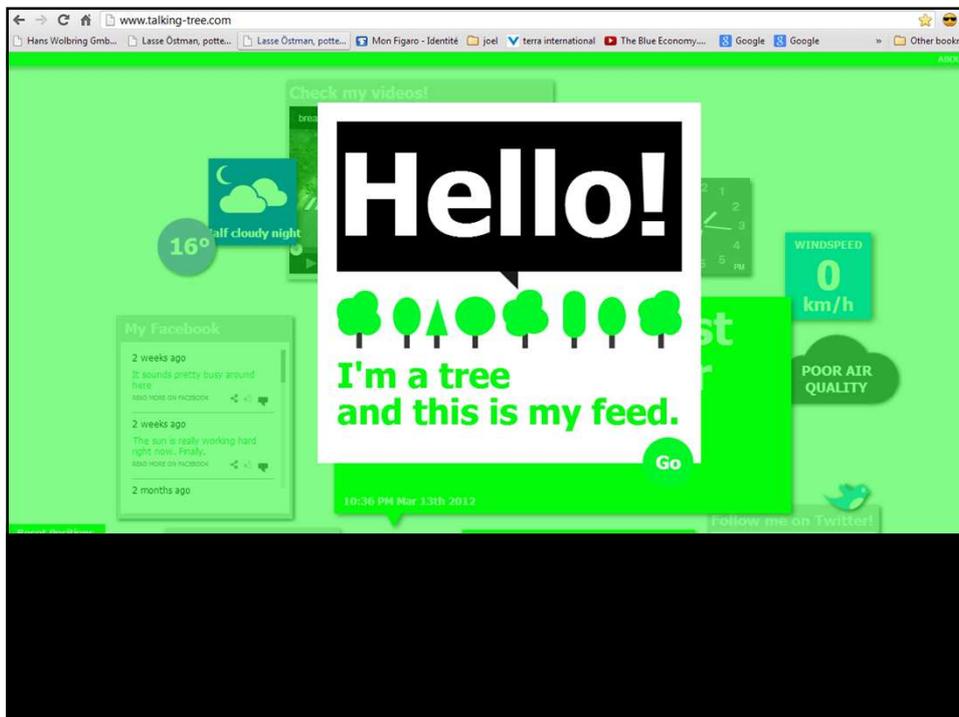
CGEOS

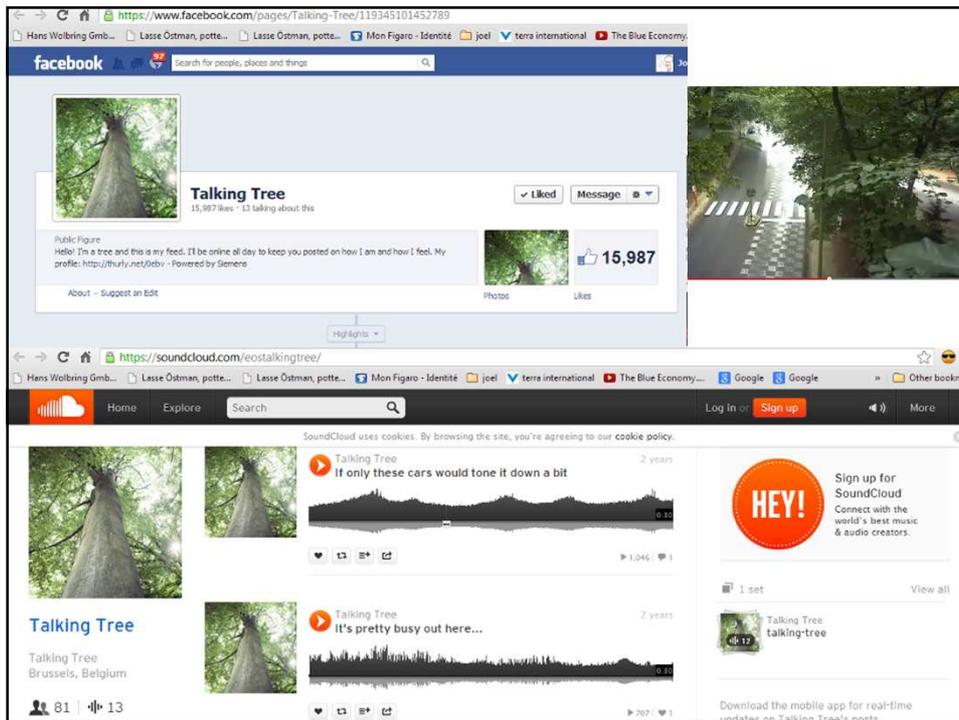
# To hyperlink the geo-spatial object



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





## It's all about Geo-tags !

**QUICK CODE**






**RFID**




18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





European Commission

## JOINT RESEARCH CENTRE

### SESAMONET - Secure and safe mobility network

European Commission > JRC > IPSC > Sesamonet



The idea consists in using **RFID** (Radio Frequency Identification) passive transponders (i.e. microchips) to create a path guiding a visually impaired person through a location. The walking stick has an embedded antenna (with a bluetooth transmitter) which detects/reads the RFID transponders.

Each transponder sends a signal via the antenna to a Smart Phone equipped with a database with information on the location.

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





## JOINT RESEARCH CENTRE

SESAMONET - Secure and safe mobility network

European Commission > JRC > IPSC > Sesamonet



Passive transponders buried in the pavement and a dedicated electronic walking cane help to guide visually impaired people by acoustic signals inside an airport terminal.

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



 **CGEOS**  
Engineering Geodesy Consultancy

*AUGMENTED GEOSENSING*



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



Most of the GNSS Network RTK projects have been developed by the economical justification that an active geodetic network would reduce the cost of maintaining a traditional geodetic network where **the maintenance of the benchmarks and the control survey were a significant part of the owner's budget.**



18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy



## Conclusion

- Next Generation Positioning Infrastructure will rock with **millions of active geodetic marks and new signals, new receivers ...**
- **GPS, GLONASS, BDS and ... LOCATA is the 4<sup>th</sup> constellation !**
- GNSS receivers & Antenna must be re-engineered ... totally !
- **Positioning Infrastructure as a Service ( Cloud RTK© )**
- GNSS is vulnerable and we have to address that !
- What we do need is PI 2.0 !

18 June, 2014

CREATIVE GEOSENSING SPRL-S  
Engineering Geodesy Consultancy





**Thank you so much !**

Creativity and passion will refresh  
Engineering Geodesy and  
Surveying in the 21<sup>st</sup> Century by  
GEOSENSING the World

**CREATIVE GEOSENSING SPRL-S**  
Engineering Geodesy Consultancy

A hand holding a globe, with various logos overlaid on the right side. The logos include CGEOS, iS 数联空间 ispatial.com.cn, COMNAV, and Locata.

**Beyond East & West GeoSensing Community**

JOEL VAN CRANENBROECK – [Info@creative-geosensing.com](mailto:Info@creative-geosensing.com)