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Practical Results on the Contribution of Beidou GNSS Signals in Belgium

FIG Working Week SOFIA 2015

Joel VAN CRANENBROECK Director **CGEOS**, Belgium
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Objectives

- Practical evaluation of the **contribution of COMPASS/Beidou** GNSS Constellation to the daily work of surveyors in Belgium, Europa
- While we can hardly track more than 5-6 Beidou satellites (full coverage in 2020) the addition of them to GPS and GLONASS should be analyzed
- **ComNav Technology** is the first Chinese company to design and develop their own GNSS measuring engine and therefore can access Beidou B3 frequency.

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5 March, 2014

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Making GNSS Receivers a Creative Technology

Located in Shanghai, China, ComNav Technology Ltd. develops and manufactures multi-constellation, multi-frequency GNSS measurement engine boards and receivers for ultimate high-precision positioning applications. It is the first Chinese company to have developed, designed and produced combined GNSS (GPS and GLONASS) plus BeiDou OEM boards. With its fast-paced business growth, ComNav is making waves in the global high-precision GNSS industry.

China has a long legacy in astronomy, space exploration and the invention, design and manufacture of precise observation instrumentation, and ComNav Technology Ltd. is continuing this tradition. ComNav is located in Shanghai, the commercial and economic centre of China. The company develops and manufactures multi-constellation, multi-frequency GNSS measurement engine boards and receivers for ultimate high-precision positioning applications. ComNav addresses specific demands in four key business areas: intelligent transportation applications; the entire geospatial industry including surveying, geodesy and civil engineering applications; deformation monitoring including the surveillance of man-made infrastructures and natural hazards; and precision farming.

Dr Yongquan Wang.

Every month *GIM International* invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.

R&D-DRIVEN

ComNav was founded in March 2012 by Dr Yongquan Wang, who is an undisputed expert within the Chinese high-precision GNSS industry: in 1996, Dr Wang developed the first Chinese GNSS receiver, and in 2008 he developed the first Chinese high-precision GPS OEM board. As an R&D-driven company ComNav invests 10% of its annual revenue in R&D, and over half of all ComNav employees have extensive experience in high-precision GNSS or engineering. The company currently employs 120 people, and that figure is increasing all the time.

ComNav has enjoyed rapid growth thanks in particular to two important factors. One was the BeiDou navigation satellite system which started deployment in 2012, and the other is the large demand from intelligent transportation systems. Within one year of being founded, ComNav had sold more than 10,000 units of its high-precision GNSS OEM board in the Chinese domestic market. On the day that milestone was passed, ComNav allocated USD15 million to building the largest R&D and manufacturing GNSS plant in China to enable production to keep pace with demand. In 2013, ComNav sold more than 20,000 units of its GNSS OEM board in China, accounting for 25% of the Chinese market. ComNav has already gained a reputation for supplying products with high quality and performance at a fair price. "We just want everyone to be able to invest in and enjoy a highly accurate GNSS receiver which is easy to use and does the job smoothly and efficiently

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ComNav GNSS T300

- **256 channels** – GPS, GLONASS, BEIDOU multi-frequencies (BDS B1, B2 and **B3** E-RTK), QUAN™ technology
- GSM, GPRS, WIFI, NTRIP, RTCM 2.x, 3.x
- UHF radio (0,5 up to 2 Watts) onboard
- Lightest and smallest **0.950 Kg (with batteries)**
- Autonomous over 8 hours with hot swap battery mechanism
- Bluetooth™, cables, external battery, external radio, …
- CGSurvey software, FieldGenius, SurvCE, …
- **RTK, E-RTK, DGPS, Network RTK, Static, Kinematic, Post-Processing, …**
- **Can be configured as Rover or Base Station**
- Very accurate measurements and much more !

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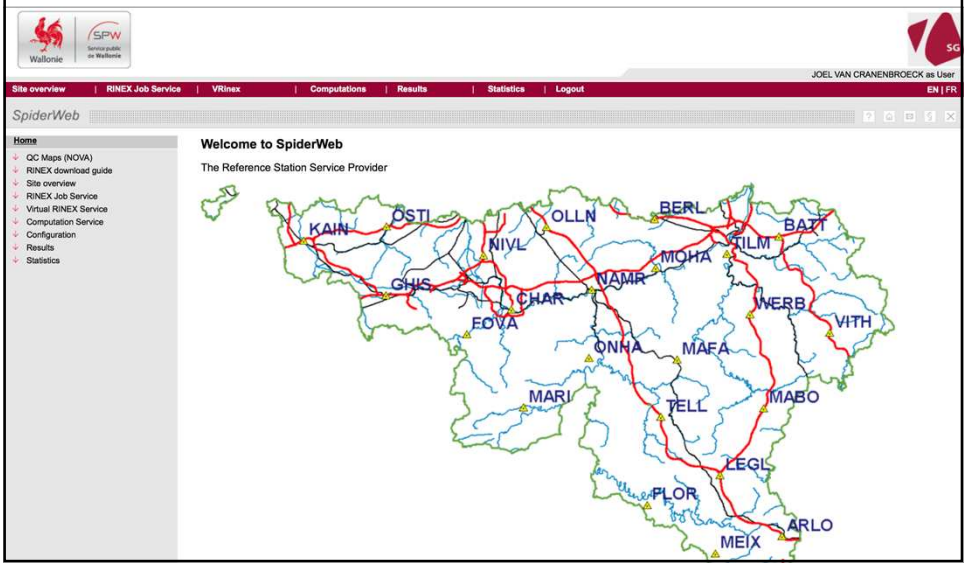
WALCORS GNSS RTK Network



Comparison vs other Brands

COMPARISON WITH NATIONAL GEODETIC BENCHMARK VALUES

NGIb	COMNAV T300			TOPCON GR-5			TRIMBLE R10			LEICA VIVA		
	ΔE	*ΔN*	*Δh*	*ΔE*	*ΔN*	*Δh*	*ΔE*	*ΔN*	*Δh*	*ΔE*	*ΔN*	*Δh*
47G02C2	0,018	0,024	-0,030	-0,014	-0,013	0,007	0,037	0,022	-0,043	0,009	0,013	-0,051
47G06C1	-0,012	0,033	0,022	0,009	-0,011	-0,046	0,002	0,023	-0,008	-0,008	0,018	0,007
47G12C1	0,006	-0,002	-0,011	0,006	0,004	0,000	-0,004	0,017	0,001	-0,005	0,004	-0,014
47G11C1	0,003	-0,001	0,003	0,006	0,000	-0,012	0,001	0,003	0,012	-0,001	0,001	-0,027
MEAN	**0,004**	**0,013**	**-0,004**	**0,002**	**-0,005**	**-0,013**	**0,009**	**0,016**	**-0,009**	**-0,001**	**0,009**	**-0,021**
STDEV	*0,013*	*0,017*	*0,022*				*0,019*	*0,009*	*0,024*	0,007	0,008	0,024
Quadratic	**0,014**			**0,014**			**0,021**			**0,023**		

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QIAO 橋 GNSS CORS STATION
ComNav, CGEOS Build First BeiDou CORS Station in Europe
April 9, 2015 - By GPS World staff
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Positioning
Positioning > GNSS
ComNav and CGEOS Build First BeiDou CORS Station in Europe 10/04/2015
Recently, the first European BeiDou CORS station – QIAO CORS Station – was built in Wallonia, Belgium, by the ComNav local partner CGEOS. 'Qiao' means 'bridge' in Chinese and Joël Van Cranenbroeck, managing director of CGEOS, is working to build a bridge between the Chinese and European GNSS industries by introducing ComNav's high-precision Chinese GNSS technologies to European users.
mNav T300 for surveying.
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ComNav M300 Pro
M300 Pro
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ComNav M300 Pro

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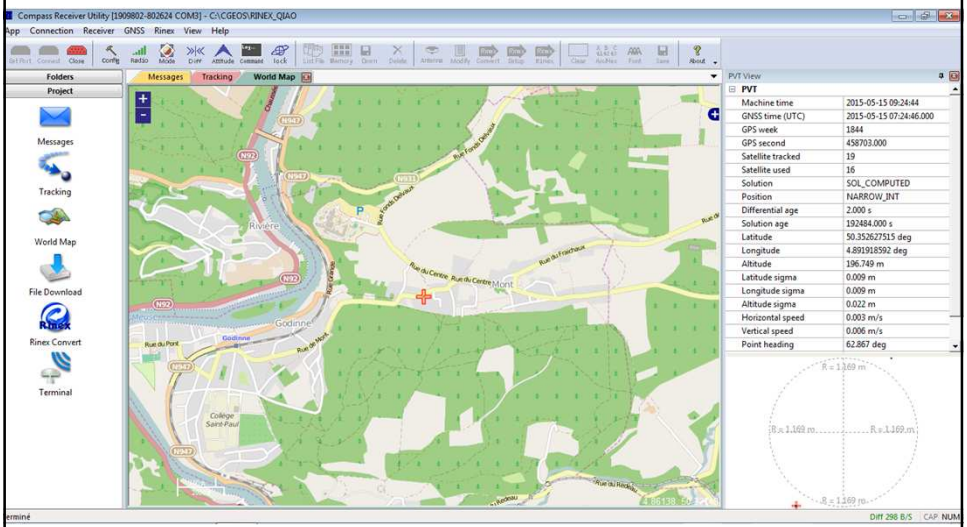

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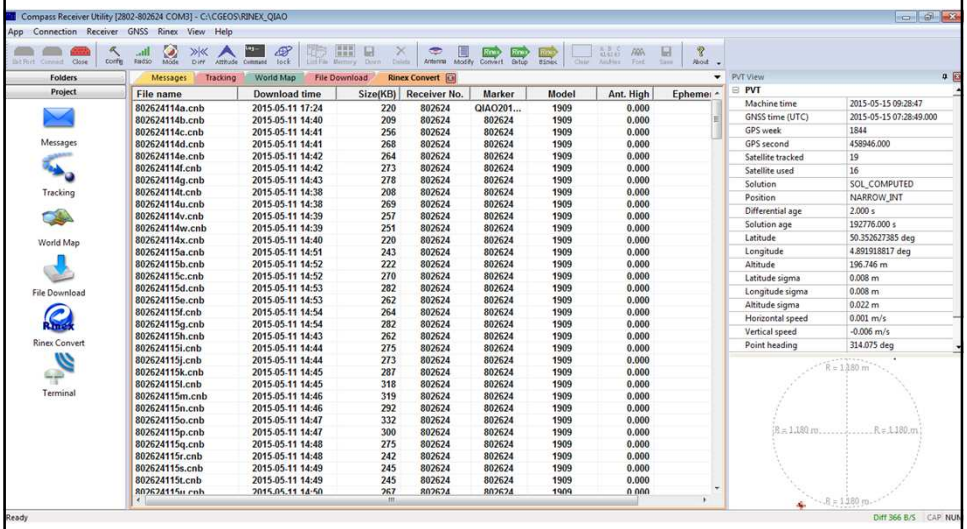
RINEX V3.x Files



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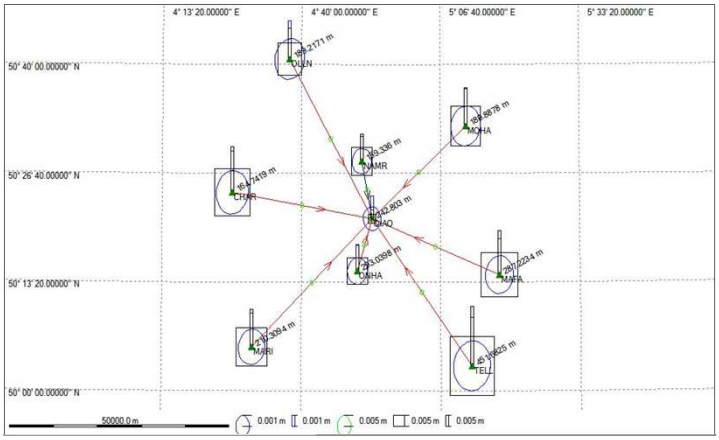

	LATITUDE	LONGITUDE	ALTITUDE	σ Latitude	σ Longitude	σ Altitude
WGS-84	50° 21' 09.45861" N	4° 53' 30.90660" E	242,803	0,001	0,001	0,002
WGS-84	4063040,181	347748,125	4888095,822	0,002	0,001	0,002
WGS-84	50° 352627392	4° 891918500	242,803	0,001	0,001	0,002
LAMBERT 2008	687237,683	615878,438	196,611	0,001	0,001	0,002

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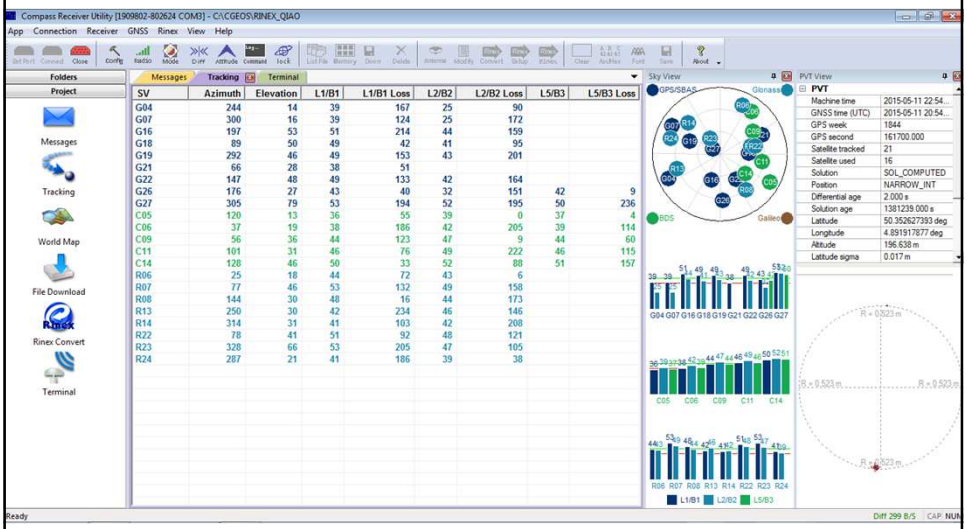
GNSS Constellations Visible in Belgium



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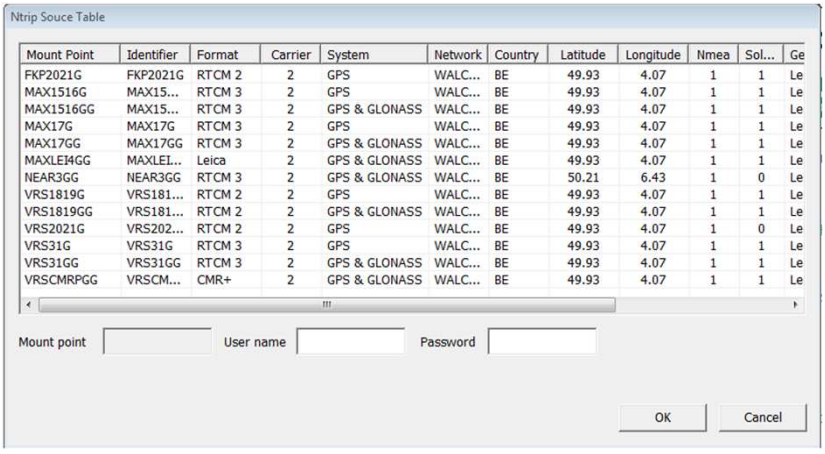
WALCORS – GNSS Network RTK



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Permanent Network RTK Integrity Monitoring Rover Station for GPS and GLONASS

PVT View

PVT	
Machine time	2015-05-15 09:22:33
GNSS time (UTC)	2015-05-15 07:22:35.000
GPS week	1844
GPS second	458572.000
Satellite tracked	19
Satellite used	16
Solution	SOL_COMPUTED
Position	NARROW_INT
Differential age	2.000 s
Solution age	192327.000 s
Latitude	50.352627557 deg
Longitude	4.891918543 deg
Altitude	196.737 m
Latitude sigma	0.008 m
Longitude sigma	0.008 m
Altitude sigma	0.020 m
Horizontal speed	0.003 m/s
Vertical speed	-0.008 m/s
Point heading	68.796 deg

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Base Station Position by using GNSS Network RTK (NTRIP) Virtual Reference Station Solution

Point ID	Northing (Local)	Easting (Local)	Elevation (Local)	Δ Easting	Δ Northing	Δ Elevation
BASE1	611818,858	672943,911	314,970	-0,002	-0,004	0,013
BASE2	611818,856	672943,913	314,954	-0,004	-0,002	-0,003
BASE3	611818,858	672943,910	314,958	-0,002	-0,005	0,001
BASE4	611818,860	672943,912	314,957	0,000	-0,003	0,000
BASE5	611818,857	672943,911	314,954	-0,003	-0,004	-0,003
BASE6	611818,860	672943,910	314,953	0,000	-0,005	-0,005
BASE7	611818,858	672943,914	314,953	-0,002	-0,001	-0,005
BASE8	611818,860	672943,916	314,949	0,000	0,001	-0,008
BASE9	611818,859	672943,916	314,947	-0,001	0,001	-0,010
BASE10	611818,861	672943,913	314,944	0,001	-0,002	-0,013
BASE11	611818,860	672943,913	314,960	0,000	-0,002	0,002
BASE12	611818,861	672943,917	314,964	0,001	0,002	0,007
BASE13	611818,858	672943,916	314,967	-0,002	0,001	0,010
BASE14	611818,857	672943,920	314,964	-0,003	0,005	0,007
BASE15	611818,864	672943,920	314,967	0,004	0,005	0,010
BASE16	611818,861	672943,919	314,955	0,001	0,004	-0,002
BASE17	611818,865	672943,917	314,960	0,005	0,002	0,002
BASE18	611818,862	672943,917	314,959	0,002	0,002	0,002
MEAN	611818,860	672943,915	314,958	0,000	0,000	0,000
MEDIAN	611818,860	672943,915	314,958	0,000	0,000	0,000
MIN	611818,856	672943,910	314,944	-0,004	-0,005	-0,013
MAX	611818,865	672943,920	314,970	0,005	0,005	0,013
STDEV	0,002	0,003	0,007	0,002	0,003	0,007

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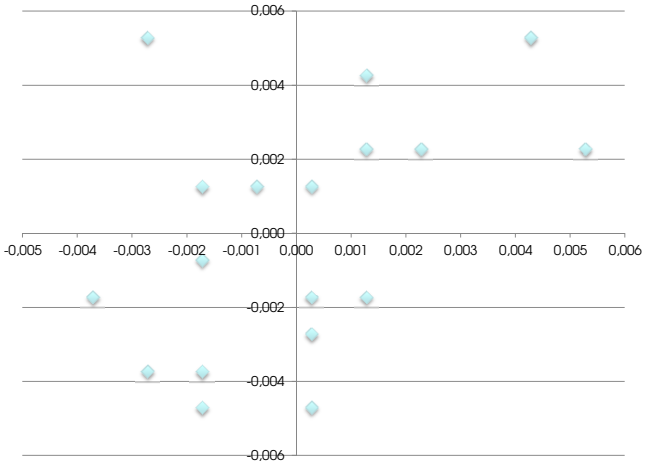
Base Station Position by using GNSS Network RTK (NTRIP) Virtual Reference Station Solution



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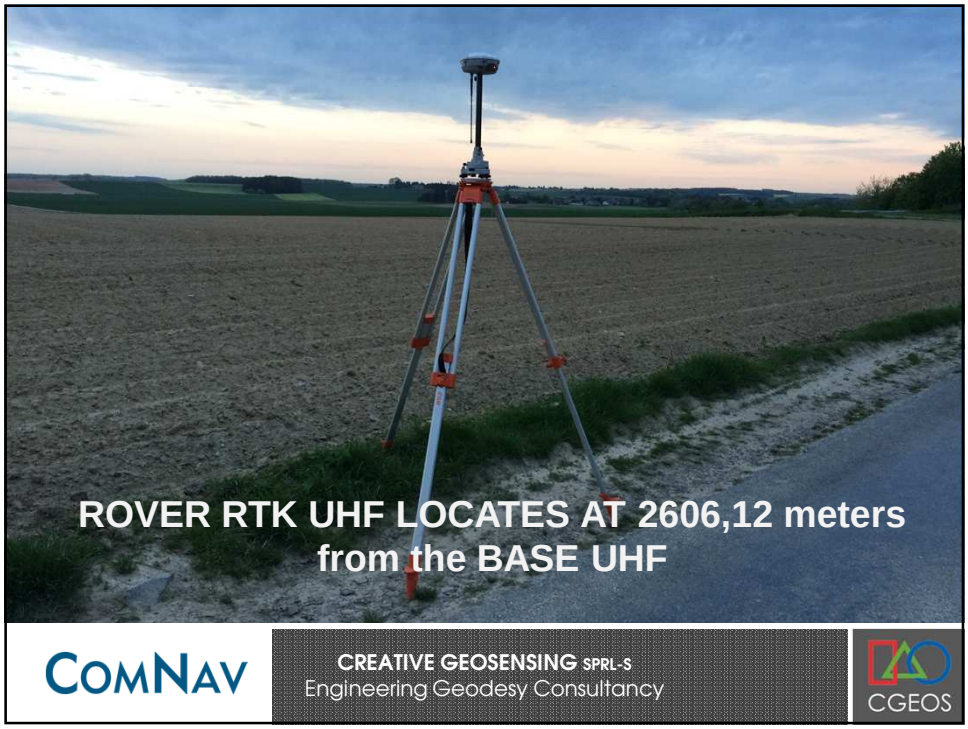
ROVER RTK UHF LOCATES AT 2606,12 meters
from the BASE UHF
1-GFD-276


ROVER RTK UHF LOCATES AT 2606,12 meters
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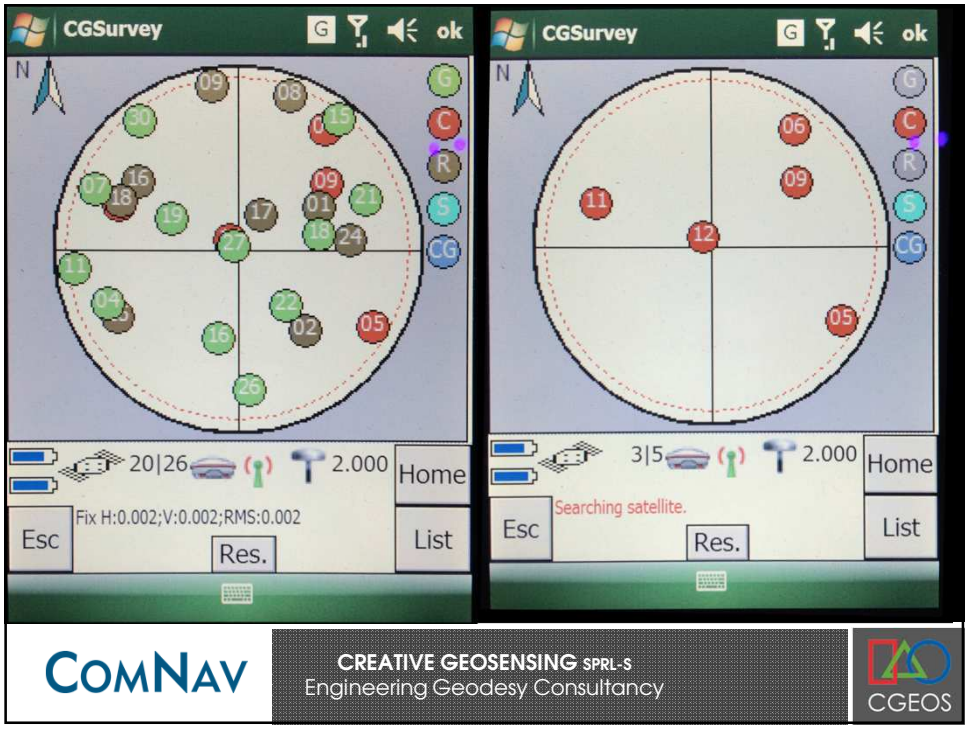

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Protocol de test

	GPS	GLONASS	BEIDOU
Network RTK	X		
idem		X	
idem	X	X	
Radio RTK	X		
idem		X	
idem			X
idem	X	X	
idem	X		X
idem		X	X
idem	X	X	X

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Reference Values

RADIO GNSS	STDEV	0,004	0,004	0,005	0,007
	MIN	613965,308	672434,348	308,823	
	MAX	613965,321	672434,360	308,841	
	DIFF	0,013	0,012	0,018	0,025
	MEAN	613965,314	672434,353	308,833	

RADIO GNSS	STDEV	0,004	0,004	0,009	0,011
	MIN	613965,316	672434,345	308,823	
	MAX	613965,329	672434,358	308,852	
	DIFF	0,013	0,013	0,029	0,034
	MEAN	613965,321	672434,350	308,838	

Δ	**-0,006**	**0,003**	**-0,005**
MEAN	**613965,318**	**672434,352**	**308,836**

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GPS vs GLONASS (RTK)

RADIO GPS	STDEV	0,003	0,003	0,006	0,008
	MIN	613965,318	672434,348	308,821	
	MAX	613965,328	672434,363	308,847	
	DIFF	0,010	0,015	0,026	0,032
	MEAN	613965,322	672434,355	308,835	

Δ	**0,005**	**0,003**	**-0,001**

RADIO GLO	STDEV	0,007	0,003	0,006	0,010
	MIN	613965,302	672434,340	308,821	
	MAX	613965,324	672434,352	308,842	
	DIFF	0,022	0,012	0,021	0,033
	MEAN	613965,313	672434,345	308,832	

Δ	**-0,005**	**-0,007**	**-0,004**

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GPS+BDS vs GLONASS+BDS

RADIO GPS+BDS	STDEV	0,005	0,005	0,014	0,016
	MIN	613965,305	672434,353	308,793	
	MAX	613965,326	672434,373	308,863	
	DIFF	0,021	0,020	0,070	0,076
	MEAN	613965,312	672434,359	308,833	
	Δ	**-0,005**	**0,007**	**-0,003**	

RADIO GLO+BDS	STDEV	0,003	0,008	0,007	0,011
	MIN	613965,302	672434,328	308,806	
	MAX	613965,314	672434,362	308,838	
	DIFF	0,012	0,034	0,032	0,048
	MEAN	613965,309	672434,349	308,826	
	Δ	**-0,009**	**-0,003**	**-0,010**	

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GPS+GLONASS vs GPS (VRS31)

VRS31GG	STDEV	0,007	0,004	0,005	0,009
	MIN	613965,302	672434,349	310,653	
	MAX	613965,331	672434,363	310,670	
	DIFF	0,029	0,014	0,017	0,036
	MEAN	613965,316	672434,355	308,850	
	Δ	**-0,001**	**0,003**	**0,014**	

VRS31G	STDEV	0,007	0,004	0,012	0,014
	MIN	613965,303	672434,350	310,625	
	MAX	613965,327	672434,365	310,663	
	DIFF	0,024	0,015	0,038	0,047
	MEAN	613965,313	672434,356	308,838	
	Δ	**-0,005**	**0,004**	**0,002**	

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GLONASS (VRS31GLO)

- **There is simply no solution !**
- We cannot receive Network RTK corrections from Leica SpiderNET that can be used on a rover configured only to receive GLONASS signals to fix in RTK mode.
- As many other manufacturers, Leica Geosystems seems using GLONASS (and we can imagine BDS as well) in a second role, keeping GPS as the major contributor.

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Conclusions 1/3

- There is a high value to consider a GNSS Rover RTK able to select a specific GNSS constellation. (GPS or GLONASS or BDS and any combination)
- If a constellation failed (GLONASS 1st April 2014) only that kind of GNSS Rover RTK will be able to carry a proper autonomous integrity monitoring and select the right one.

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Conclusions 2/3

- Actually with 5-6 satellites in view from Belgium, there is already an advantage when we want **to operate in an adverse GNSS environment.**
- We look forward to have a full global coverage with BEIDOU (2020) as we don't see GALILEO contributing today like BEIDOU
- We hope having shared our experience would benefit you in your daily practice

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MANY THANKS FOR YOUR CONSIDERATION

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