Relative positioning with Galileo

E5 AltBOC code measurements

The CLGE Students' Contest 2016

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Context

Google opens up GNSS **code measurements** access

Possibility of precise positioning with ANDROID raw code pseudoranges ?

Challenge

Codes

- Expected precision on a position :

Metres

Challenge

Mass market applications

- Required precision on a position :

Decimetres

Hypothesis

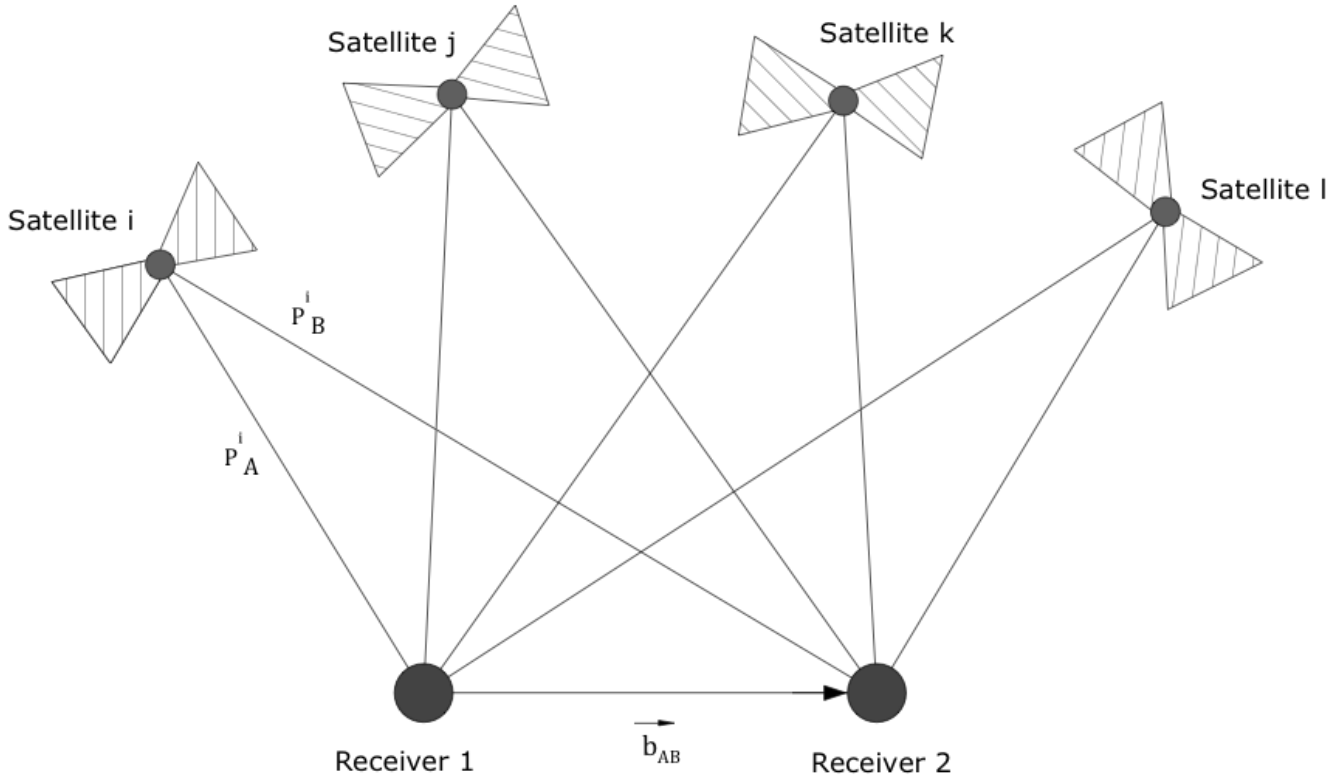
Galileo E5 signal

AltBOC Modulation

- High tracking accuracy
- Strong multipath resistance

Improvement of the code pseudoranges' precision

Method



Double difference :

Difference between two **SIMULTANEOUS** receivers' observations of the two same satellites

Relative Positioning

Configurations

ZERO BASELINE

SHORT BASELINE

MEDIUM BASELINE

Configurations

ZERO BASELINE

Theoretical case

Baseline length: 0 metre

SHORT BASELINE

Not used in practice

Estimation of receiver's observation noise

MEDIUM BASELINE

Receiver's observation noise

Configurations

ZERO BASELINE

SHORT BASELINE

MEDIUM BASELINE

Analytical case

Baseline length: 5 metres

Observable precision

Estimation of the **precision of the OBSERVATIONS**

Multipath
+
Noise

Configurations

ZERO BASELINE

SHORT BASELINE

MEDIUM BASELINE

Practical case

Baselines length:

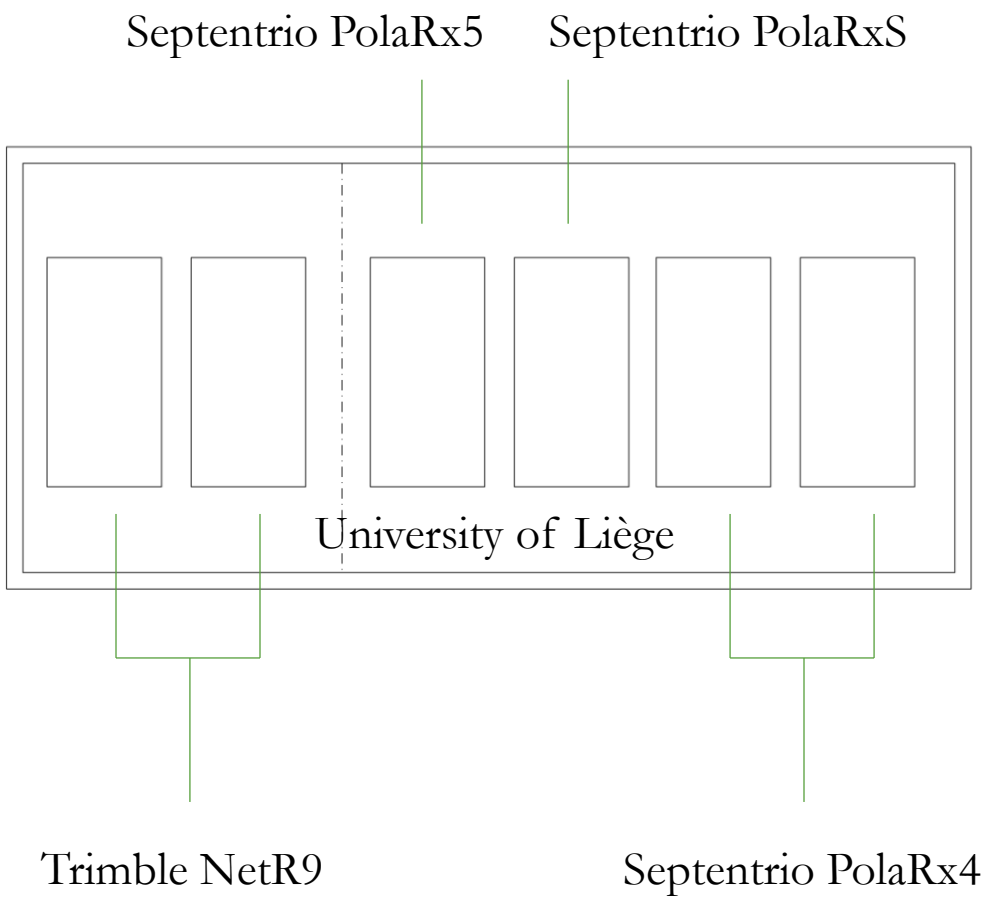
23 kilometres (Liège – Waremme)
87 kilometres (Liège – Brussels)

Position precision

Precision of the estimated **POSITIONS**

Atmospheric errors
+
Multipath
+
Noise

Equipment



Waremme

Septentrio PolaRx4

Brussels

Septentrio PolaRx4TR

Observable precision (metres)

	GPS			Galileo			E5 AltBOC
	L1	**L2**	**L5**	**E1**	**E5a**	**E5b**	
Trimble	0.38	0.30	0.30	0.24	0.22	0.24	0.14
Septentrio	0.20	0.12	0.14	0.17	0.14	0.14	0.06

Short baselines in Liège

Days Of Year 145 – 154 (2016)

Results

Observable precision

CONCLUSIONS

Different precisions for different receiver's types

Galileo E5 AltBOC outperforms other GPS and Galileo signals

Galileo signals are more precise than GPS signals

Galileo E1 & GPS L1 show the worst precision

GPS L2/ GPS L5, Galileo E5a/Galileo E5b show similar quality

Precision of the estimated position (metres)

Galileo E5 AltBOC

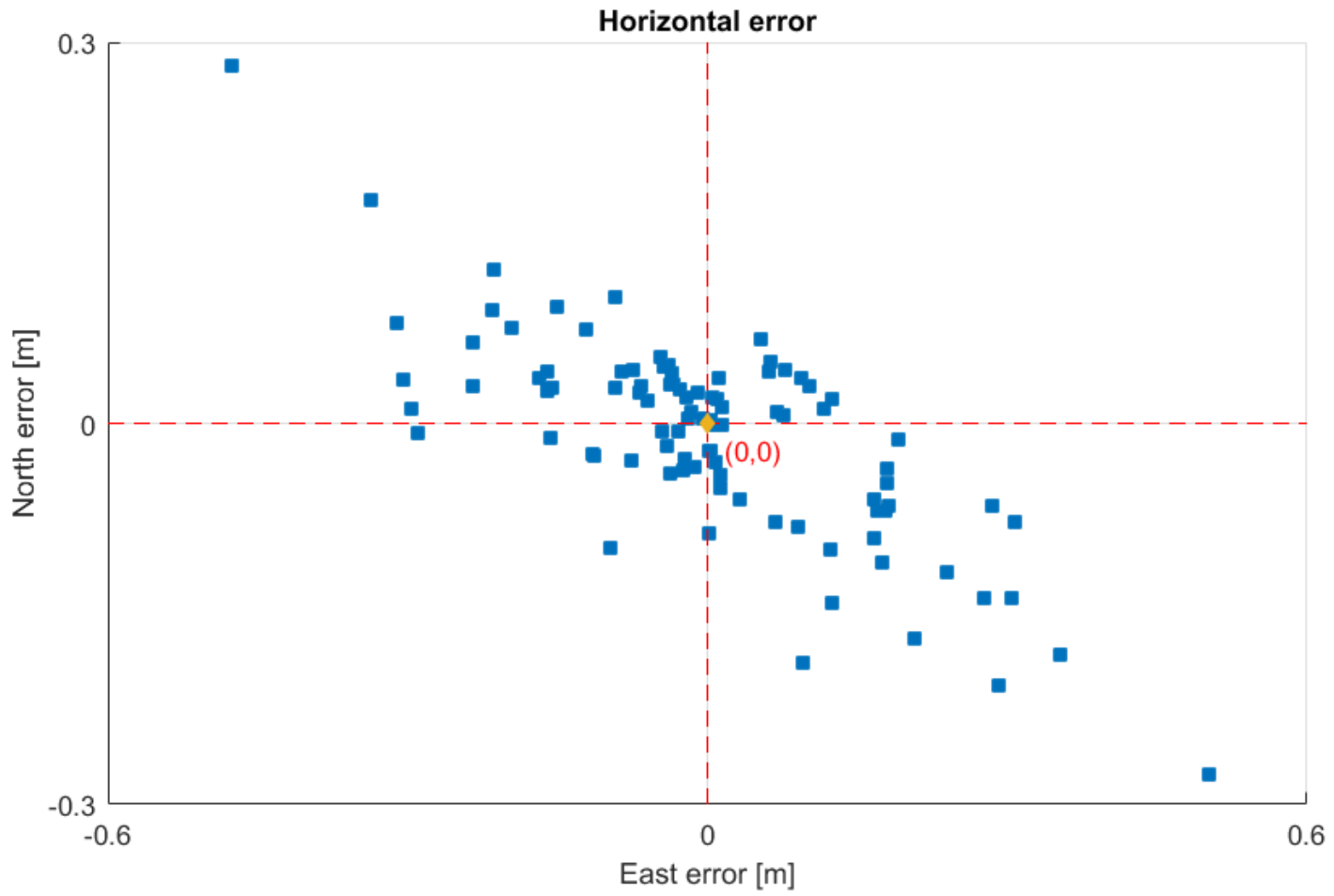
Liège

5 metres baseline

RMS 3D

0.53 metres

DOY 17 of 2016



Precision of the estimated position (metres)

Galileo E5 AltBOC

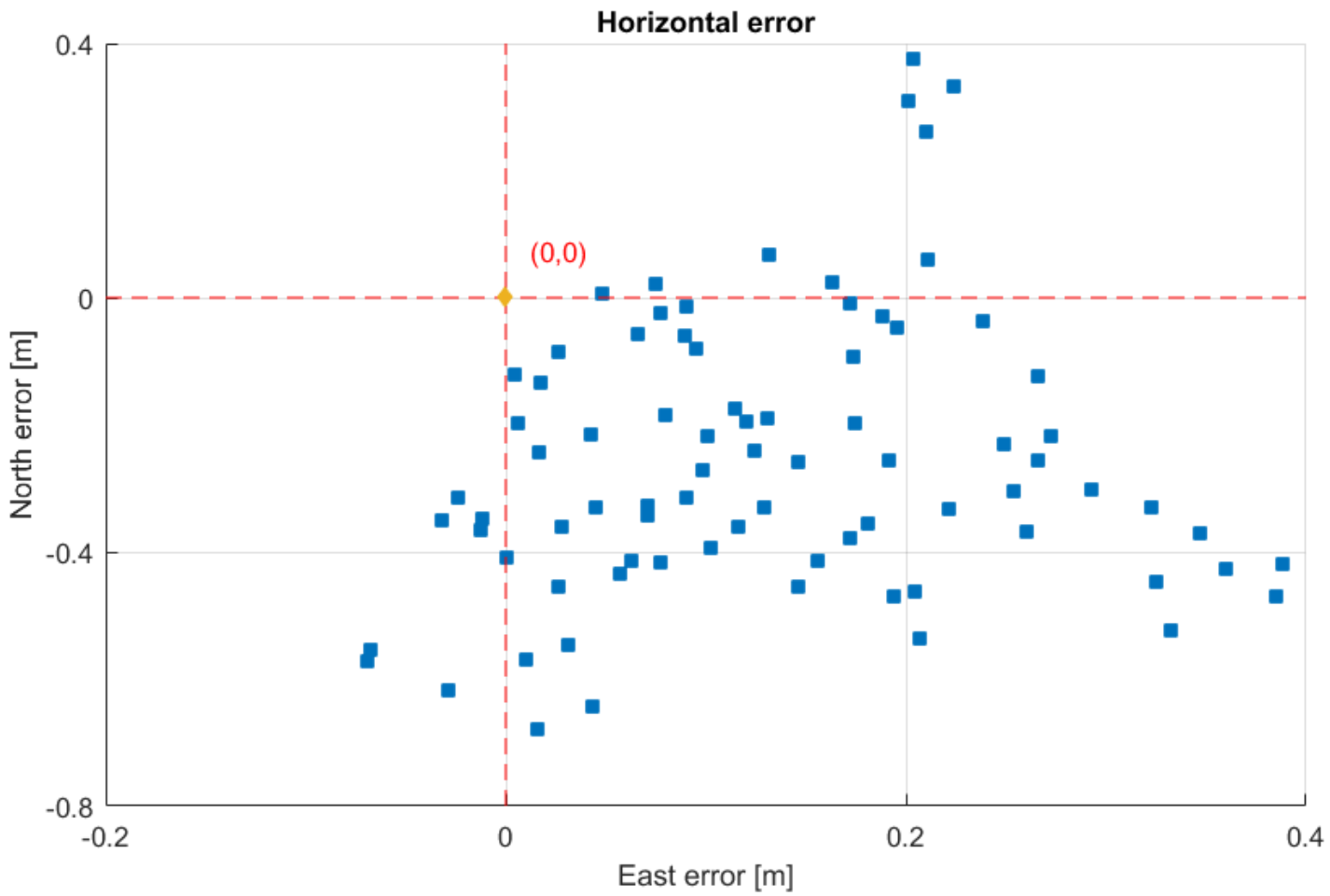
Waremme

23 kilometres baseline

RMS 3D

0.61 metres

DOY 91 of 2015



Precision of the estimated position (metres)

Galileo E5 AltBOC

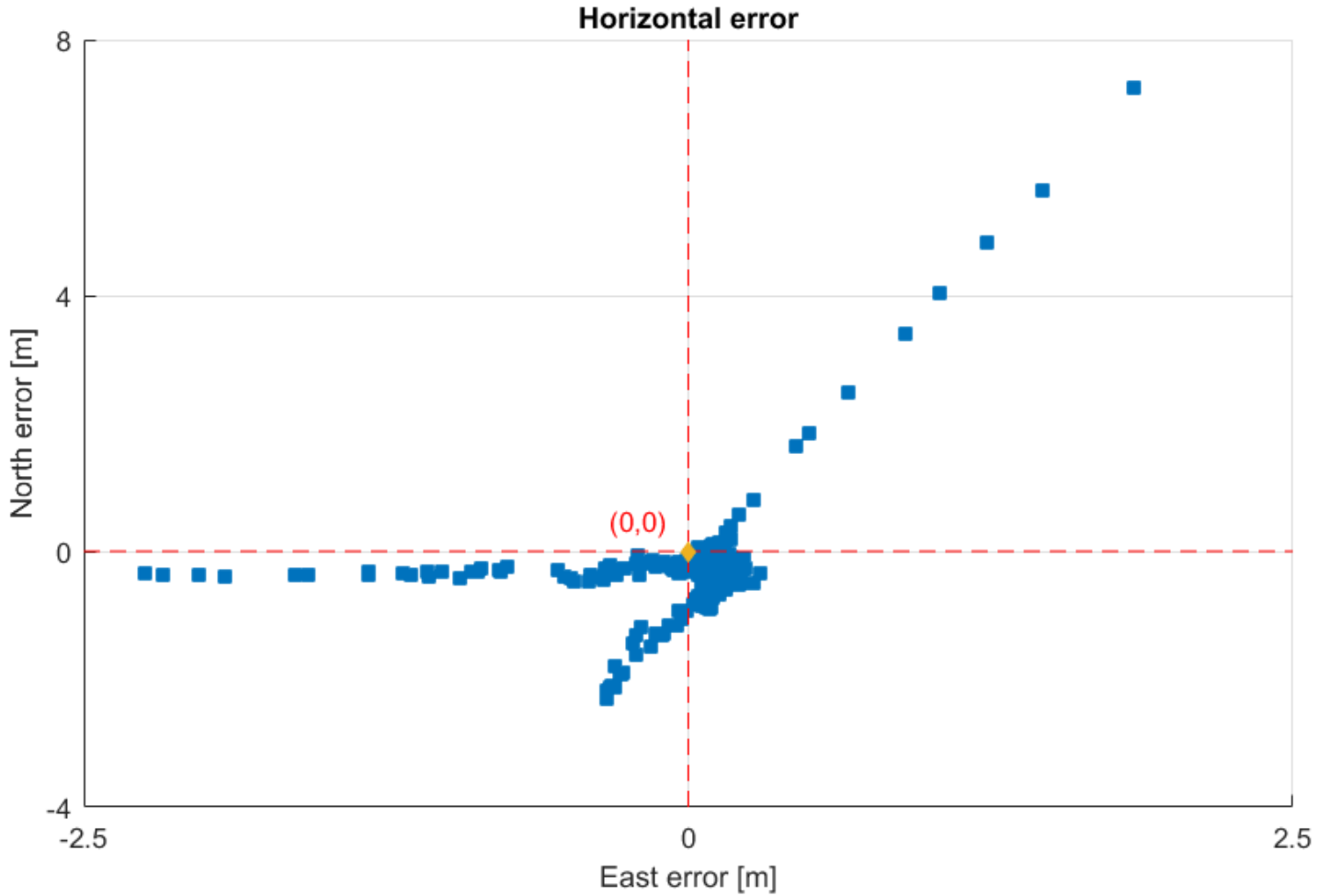
Brussels

87 kilometres baseline

RMS 3D

1,73 metres

DOY 91 of 2015



Conclusions

OBSERVATION precisions

Galileo shows a precision highly superior to GPS signals

Analysis on both Trimble and Septentrio receivers

Among all signals, Galileo E5 AltBOC is outstanding

Analysis on both Trimble and Septentrio receivers

POSITION precisions

Conclusions

OBSERVATION precisions

POSITION precisions

Limited number of available Galileo satellites degrades the solution

When compared to reduced-GPS constellations, Galileo results are very promising

Days with good satellite visibility allow reaching few decimetres precision

For baselines from 5 metres to 23 kilometres