



EGNOS, it's there. Use it.

Enhancing Smartphones' Location with EDAS (EGNOS Data Access Service) Internet Corrections



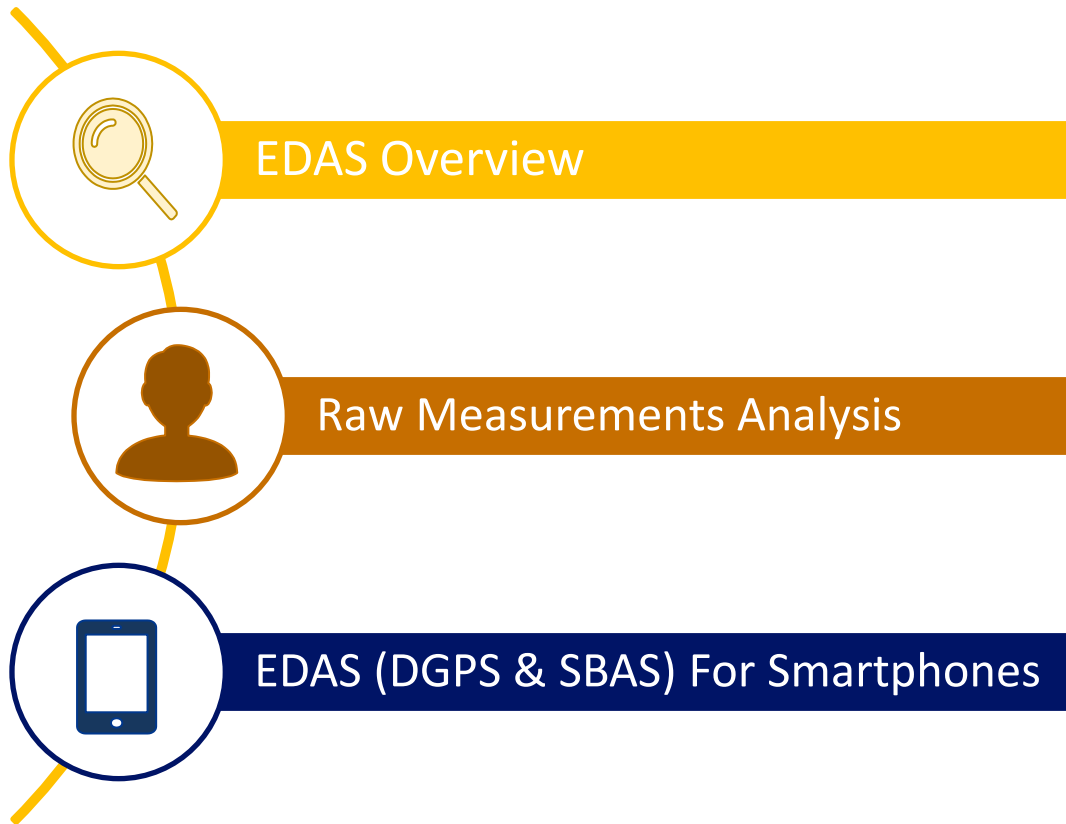
European
Global Navigation
Satellite Systems
Agency



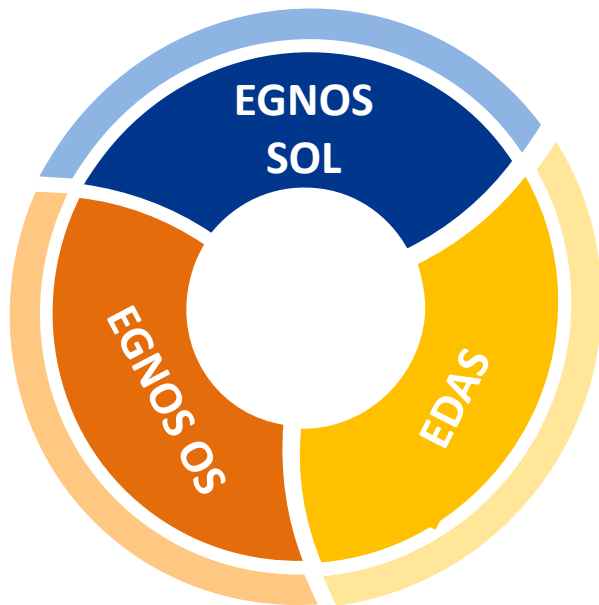
Precise navigation,
powered by Europe



TABLE OF CONTENTS

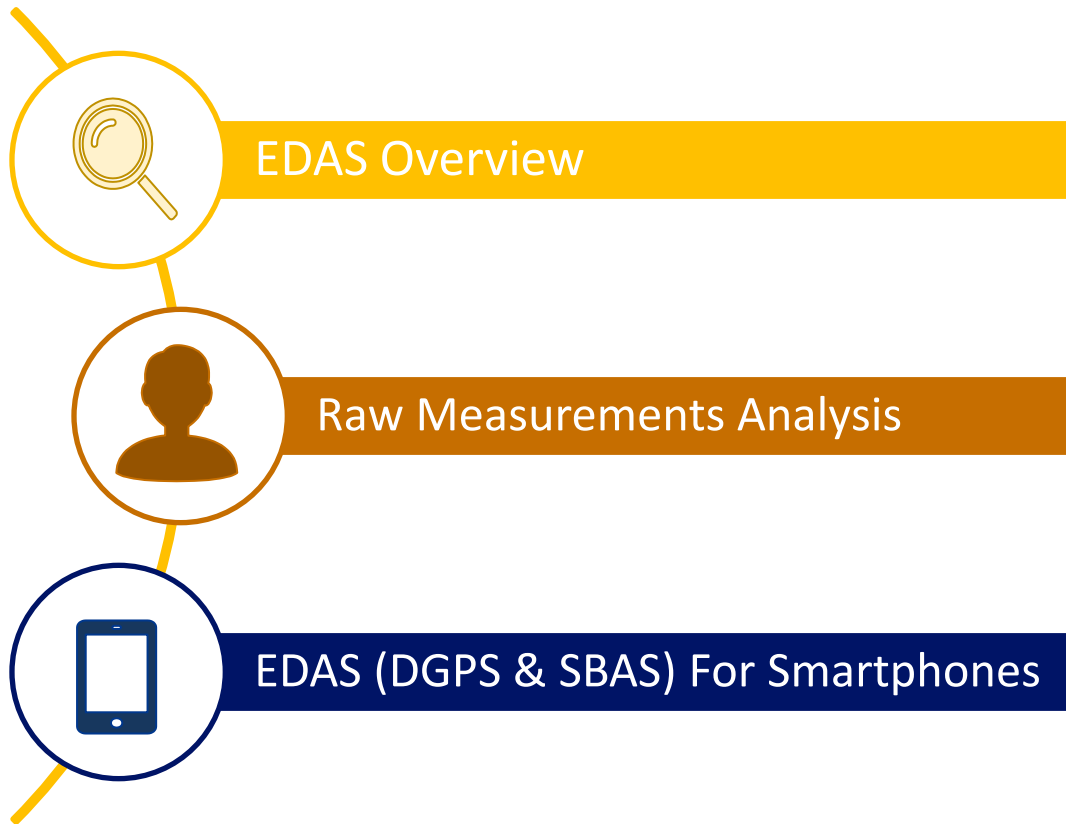


EDAS Overview



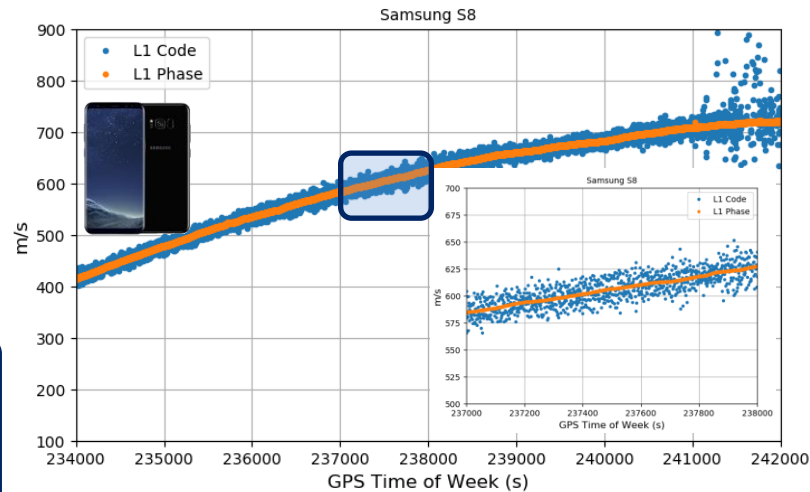
	EDAS Service	Type of Data				Service Description	
		OBS & NAV	EGNOS MSG	RTK MSG	DGNSS COR	FORMAT	PROTOCOL
Real Time	Service Level 0						
	Data Filtering SL0	×	×			ASN.1	EDAS
	Service Level 2						
	Data Filtering SL2	×	×			RTCM3.1	EDAS
	SISNET		×			RTCA	SISNeT
	Ntrip	×		×	×	RTCM 2.x, 3.1	Ntrip (v1, v2)
Archive	FTP	×	×			RINEX, EMS, IONEX...	FTP

TABLE OF CONTENTS

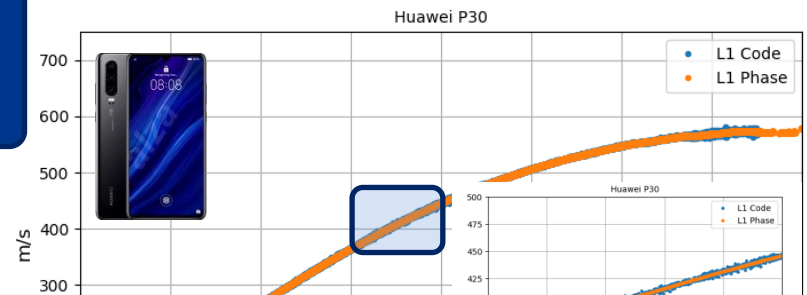
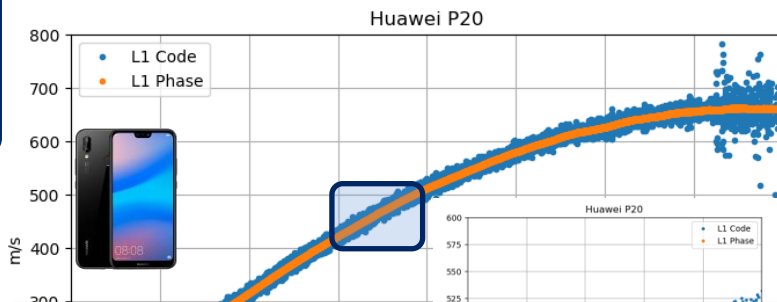
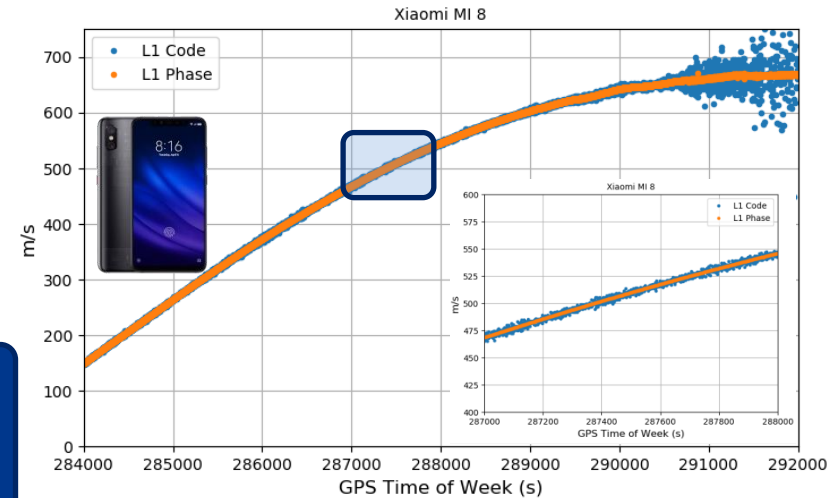


L1 Code Analysis (I)

BCM4774



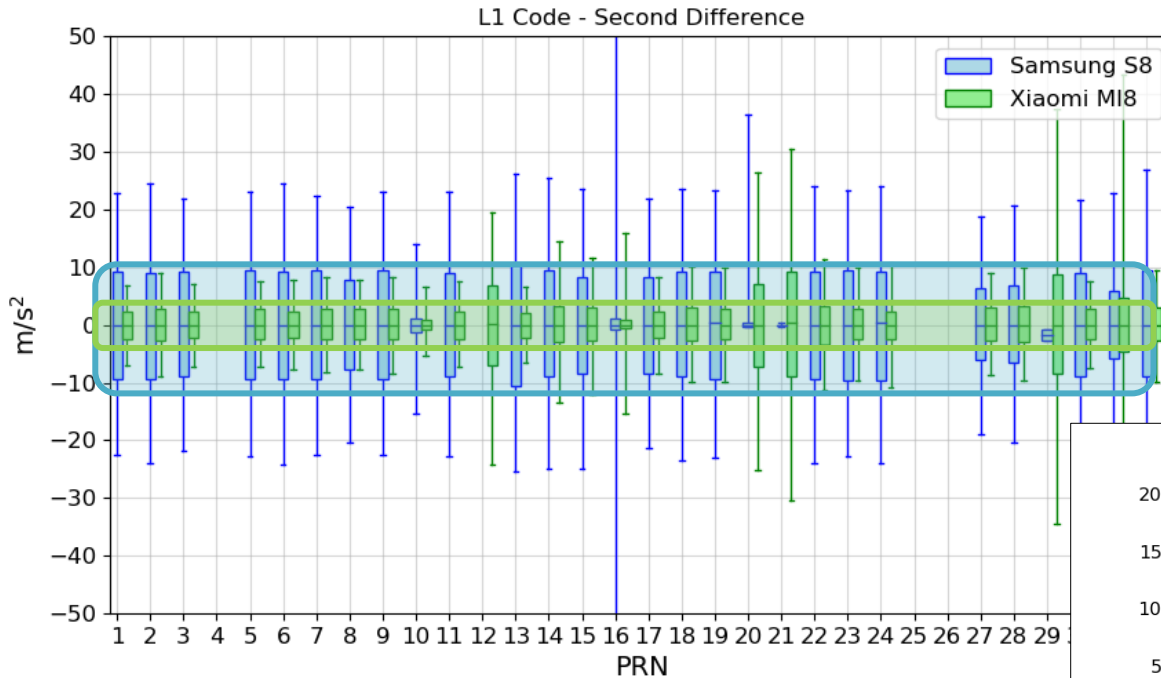
BCM4775



L1 code measurements are much noisier than L1 phase's → the noisy (but unambiguous) code pseudorange shall be smoothed with the precise (but ambiguous) carrier phase measurements

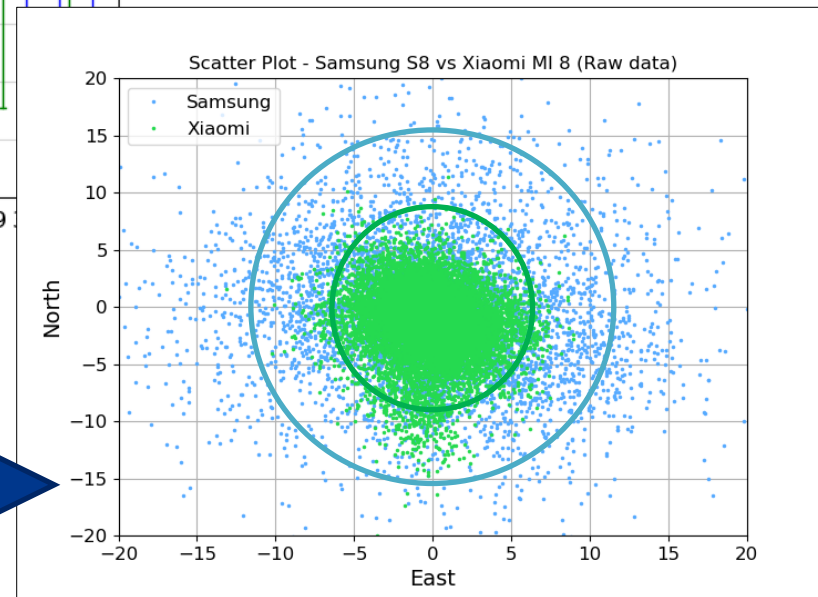
Samsung S8 and Huawei P20s Measurements are less precise than Xiaomi MI8 and Huawei P30's

L1 Code Analysis (II)



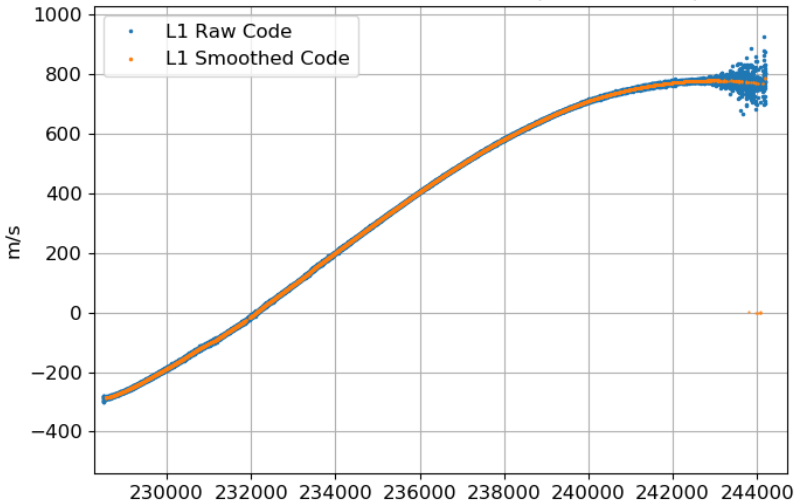
Samsung S8 measurements are twice noisier than Xiaomi MI 8's

The noise in the pseudorange domain is reflected in the position domain



Smoothing Code Measurements

Xiaomi MI8 - Raw Vs Smoothed Code (First Difference)



$$\hat{\rho}_s(t) = \alpha \cdot \rho_s(t) + (1 - \alpha) \cdot [\hat{\rho}_s(t-1) + \phi_s(t) - \phi_s(t-1)]$$

$\rho_s(t)$ and $\phi_s(t)$ are the code and phase of satellite s at epoch t

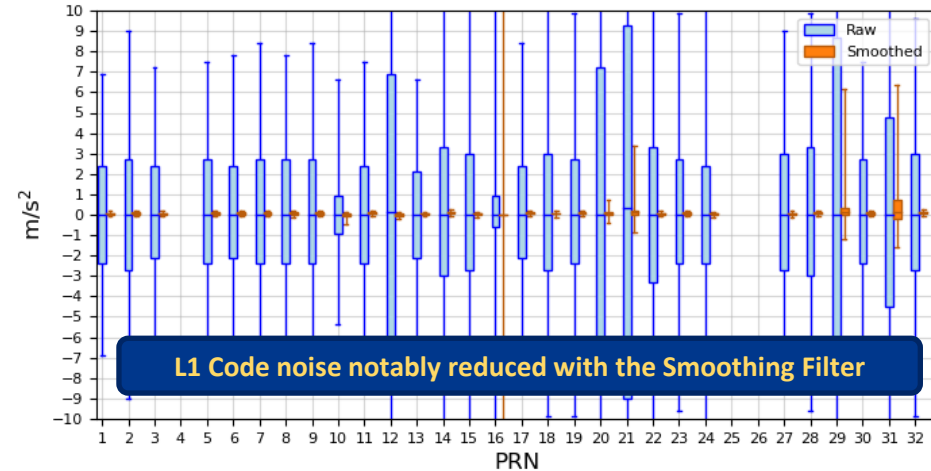
$\hat{\rho}_s(t)$ is the smoothed code of satellite s at epoch t

α is the weighting factor

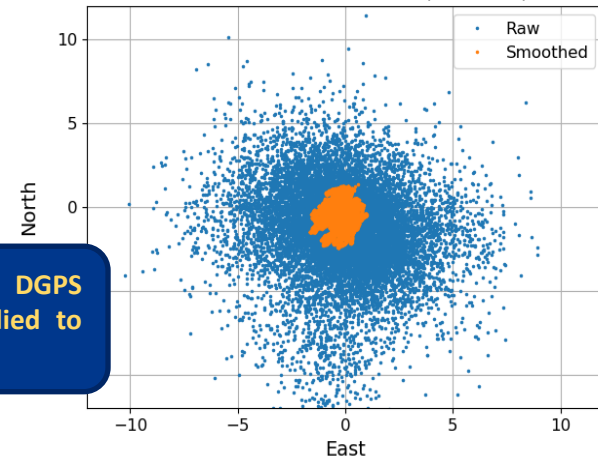
$[\hat{\rho}_s(t-1) + \phi_s(t) - \phi_s(t-1)]$ is the projected range at epoch t

With this level of noise, the EGNOS and EDAS DGPS corrections provided to the L1 code could be applied to reduce the navigation error in the position domain

L1 Code - Second Difference



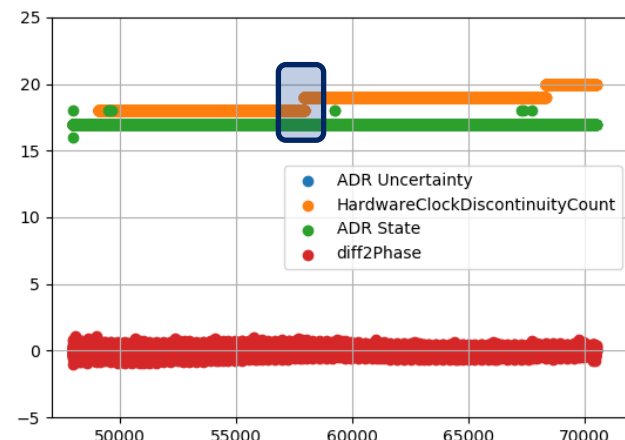
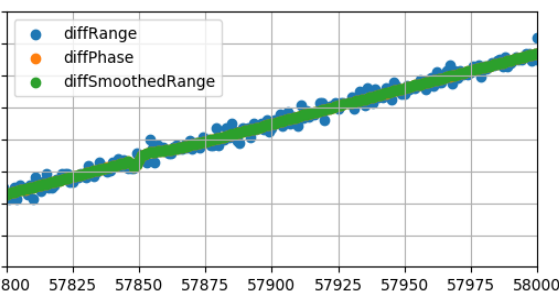
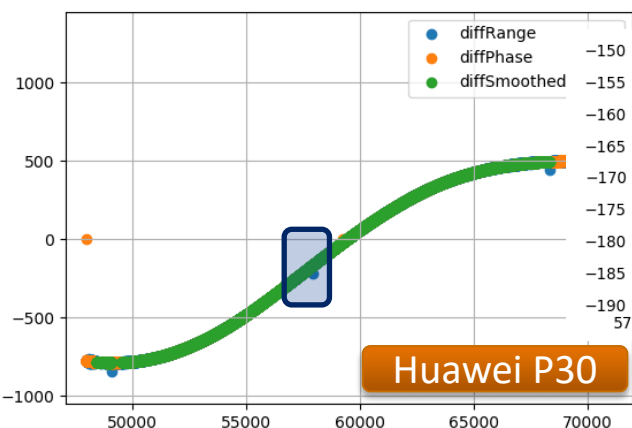
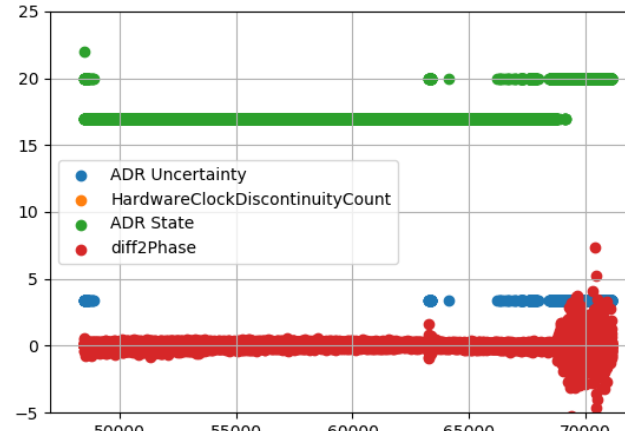
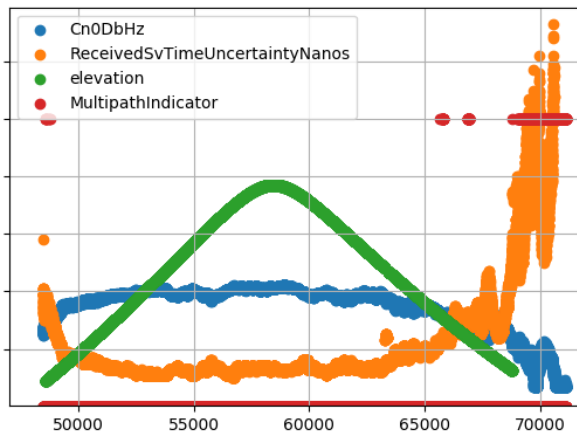
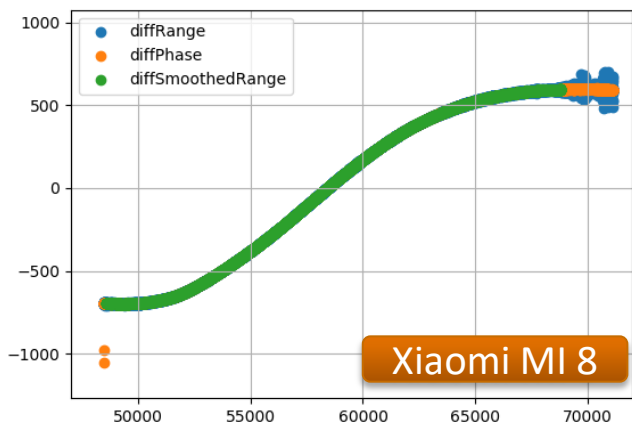
Scatter Plot - Raw vs Smoothed (Xiaomi MI8)



Android API Quality Indicators (I)

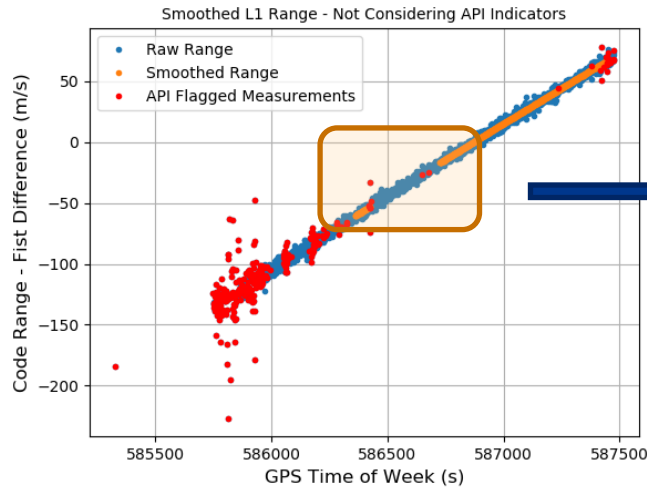
Code Indicators

Phase Indicators

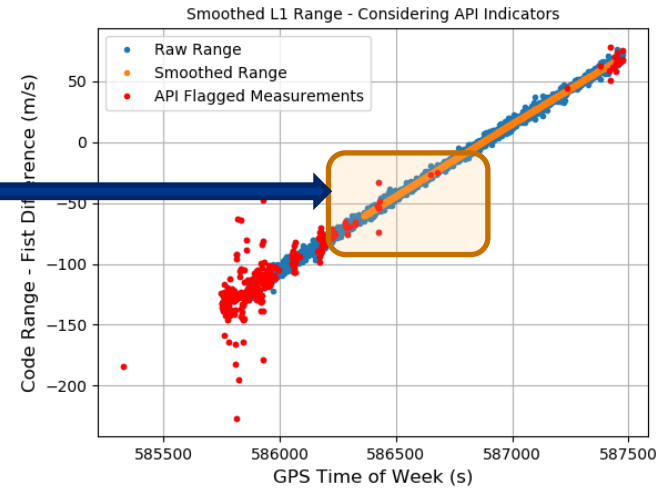


Android API Quality Indicators (II)

The Android API indicators could be used, a **customised smoothing filter** could be implemented to increase the **availability** of the smoothed solution



Code underweighted when there is a code flagged epoch



A **trade off** must be done between the smoothed solutions **availability** and the data quality / **accuracy**

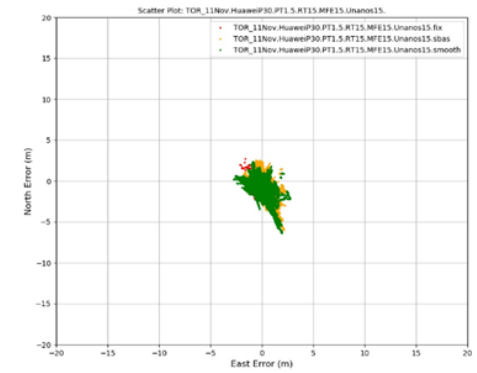
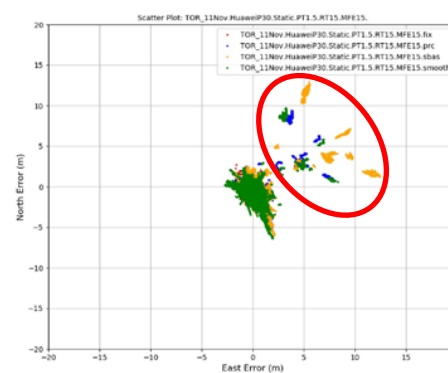
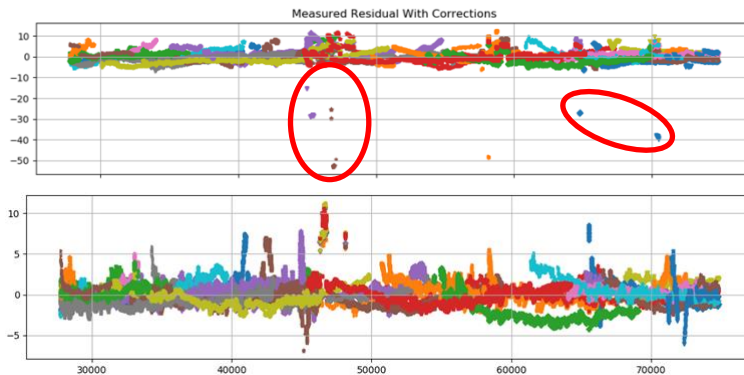
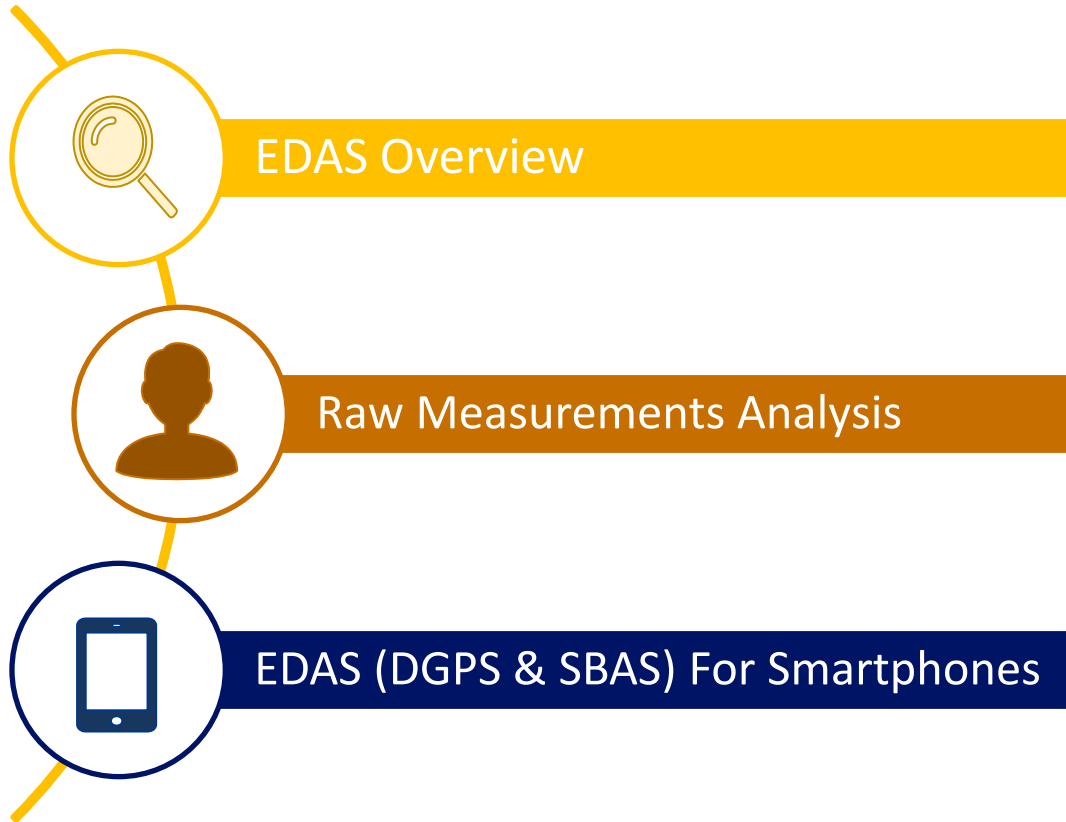
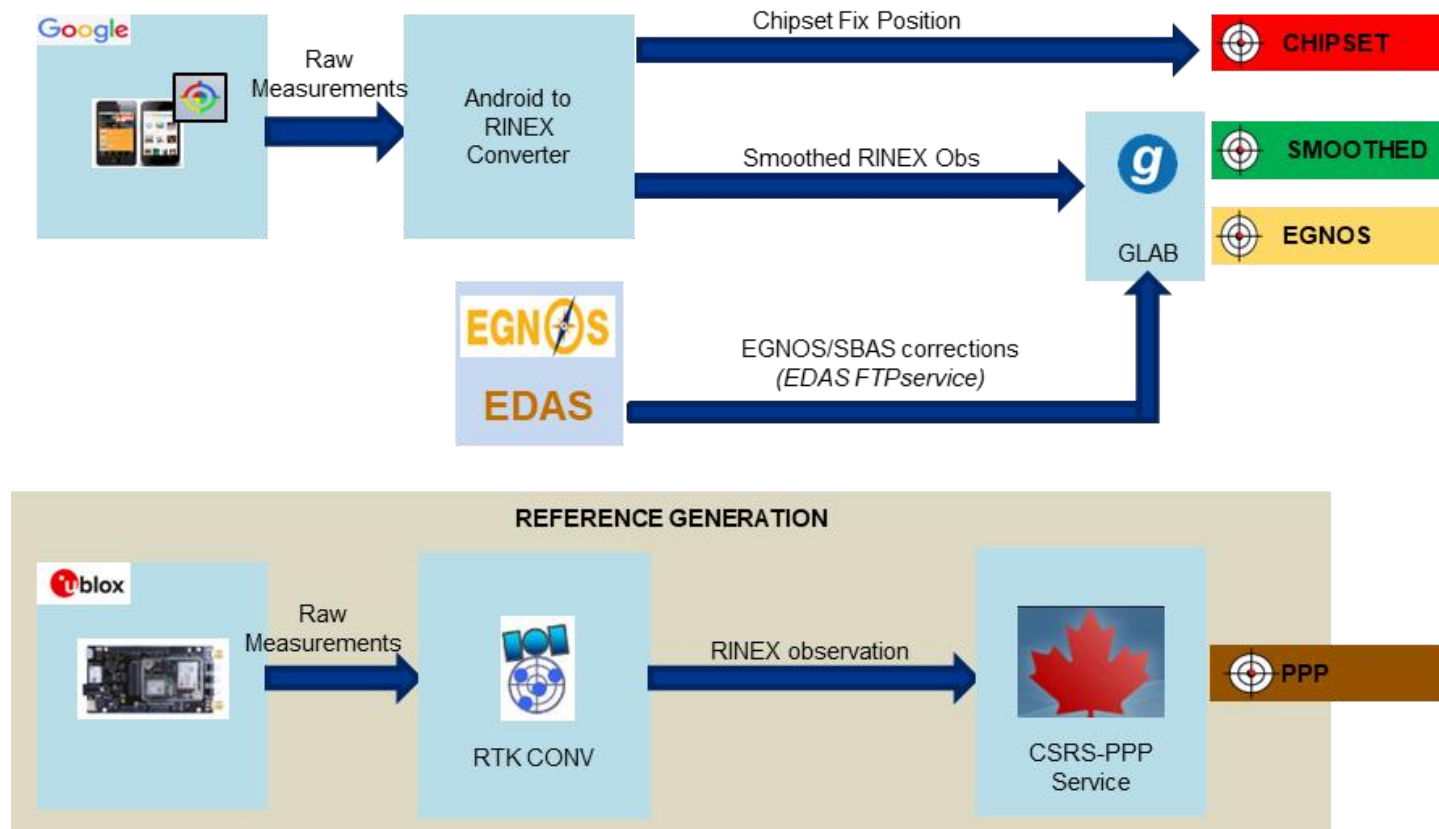


TABLE OF CONTENTS



DATA CAMPAIGN SETUP



STATIC OPEN SKY SCENARIO (I)

Location: Madrid

Test Duration: 10 days (~300K epochs)

Environment: Open Sky

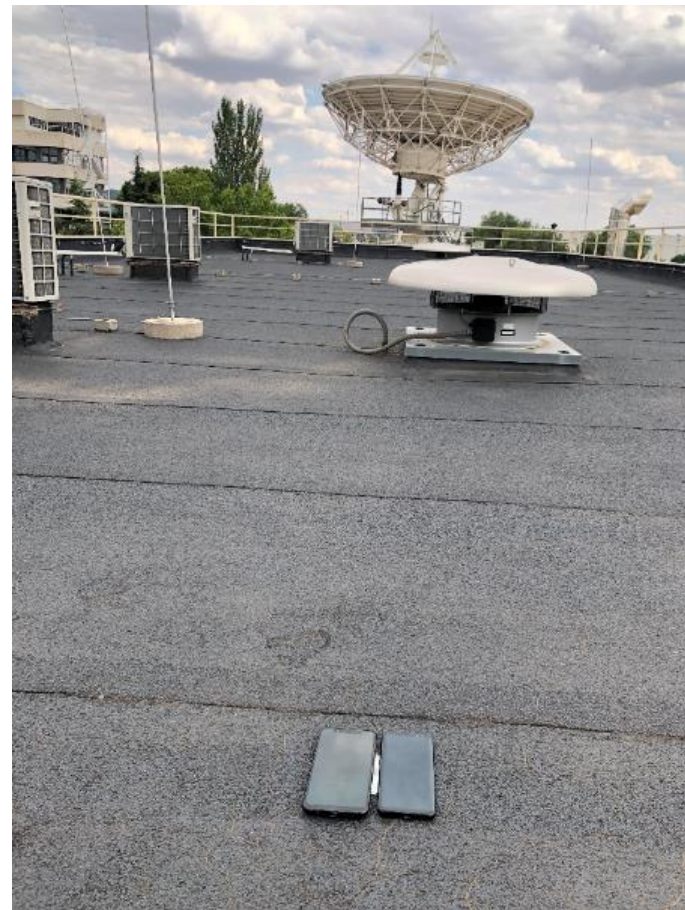
Dynamics: Static

Smartphones: Xiaomi MI8 and Huawei P30

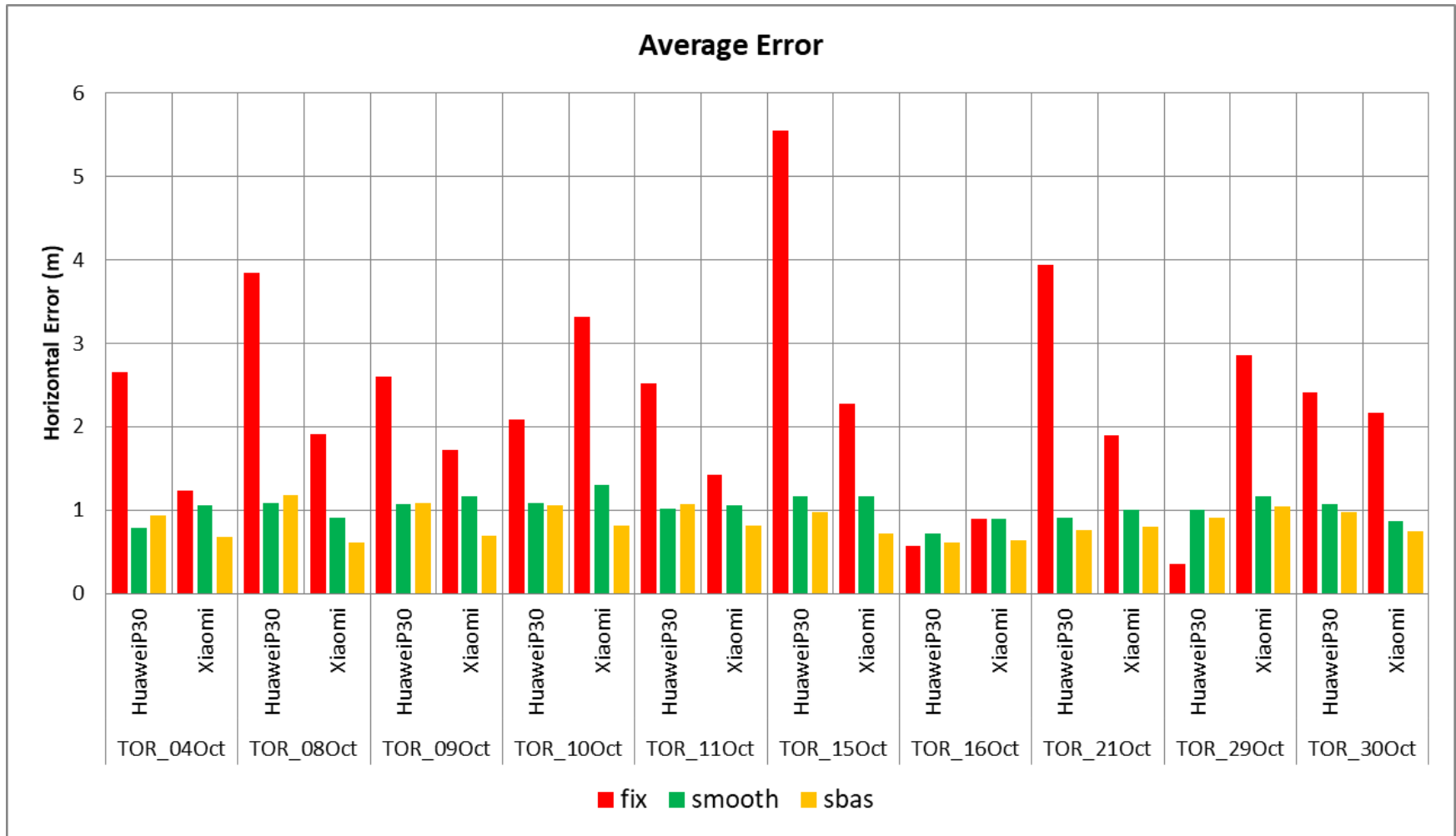
Solutions Assessed:

- **Fix:** Position reported by the chip
- **Smoothed:** GPS L1 + Smoothing Filter
- **SBAS:** GPS L1 + Smoothing Filter + EGNOS Corrections

Reference Position: ublox's C099-F9P (PPP by CSRS-PPP Service)

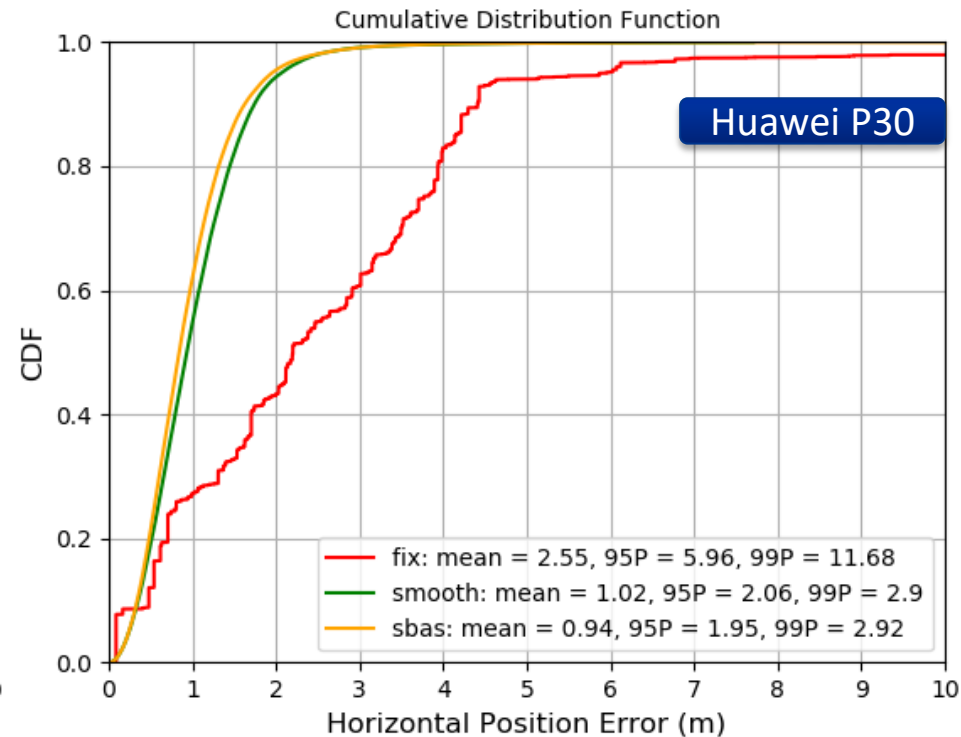
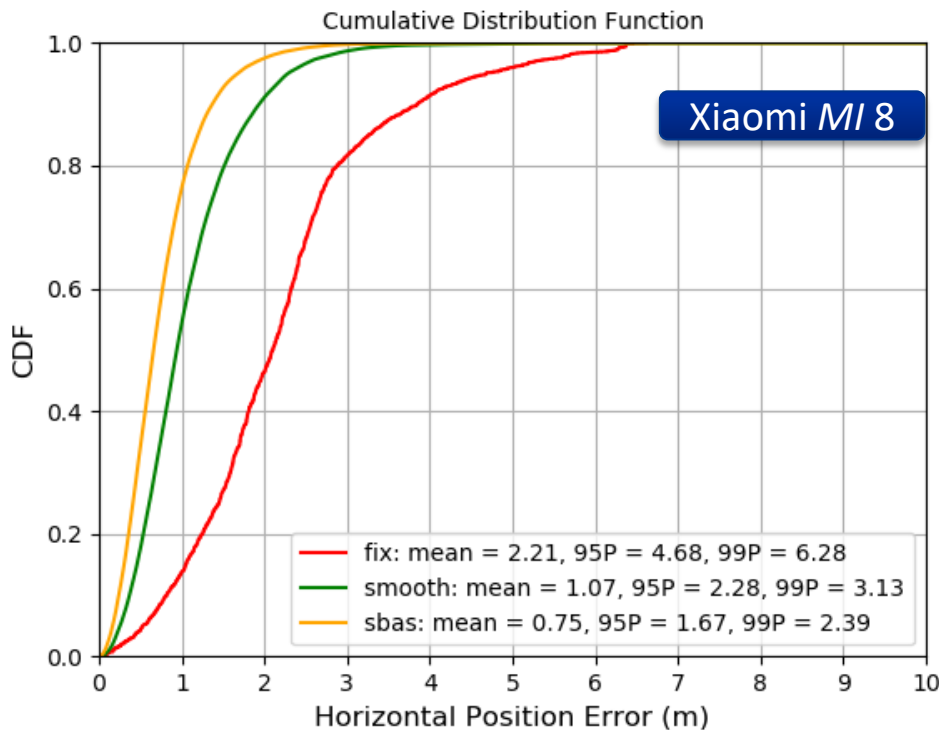


STATIC OPEN SKY SCENARIO (II)



STATIC OPEN SKY SCENARIO (III)

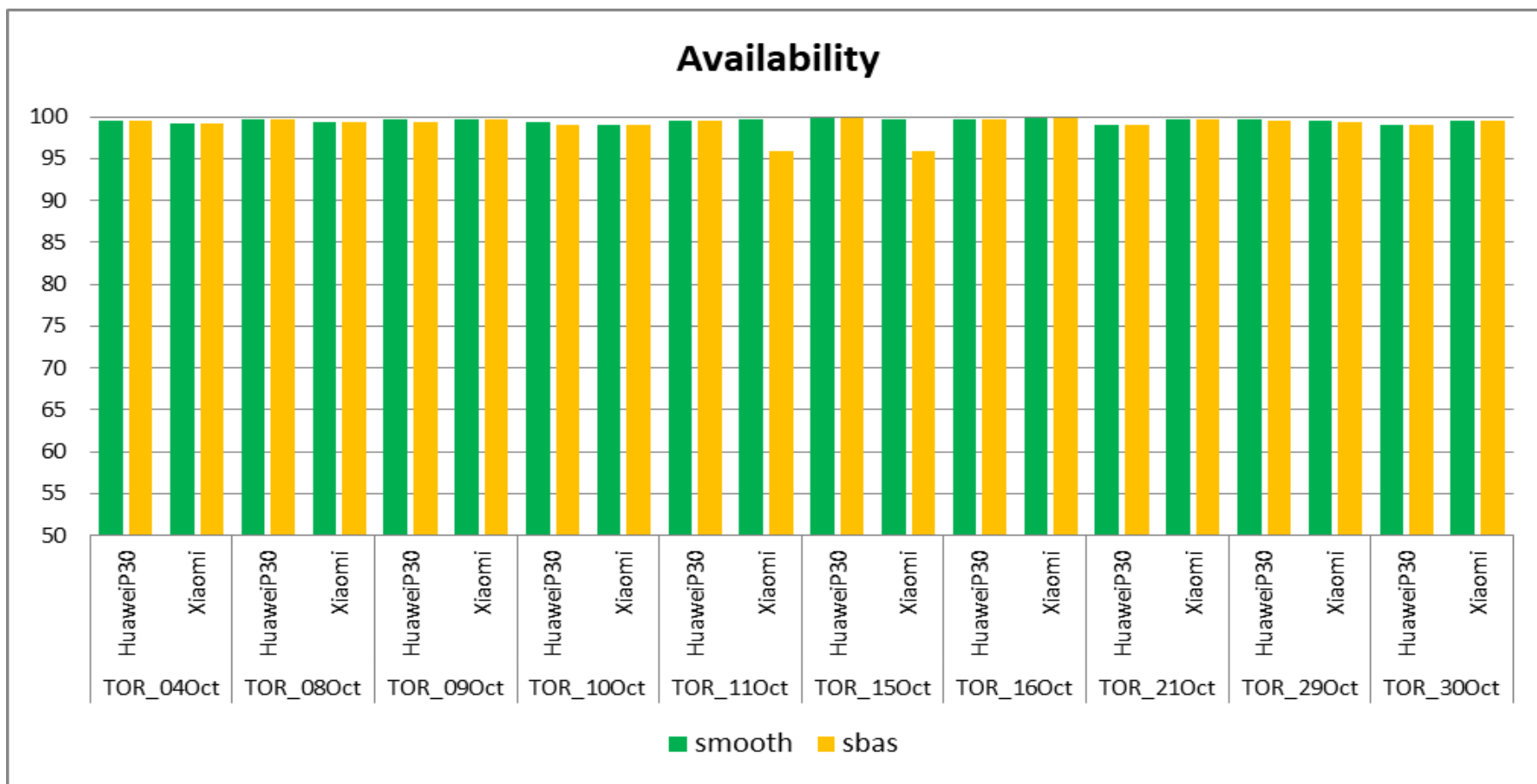
10 days of data \approx 300K epochs



The **SBAS/DGPS corrections**, together with a smoothing of the reconstructed raw measurements, **outperform** the smartphone computed position **by a 60 -65%**

STATIC OPEN SKY SCENARIO (IV)

10 days of data \approx 300K epochs



STATIC RURAL SCENARIO (I)

Location: Madrid

Test Duration: 3 days (80K epochs)

Environment: Rural

Dynamics: Static

Smartphones: Xiaomi MI8 and Huawei P30

Solutions Assessed:

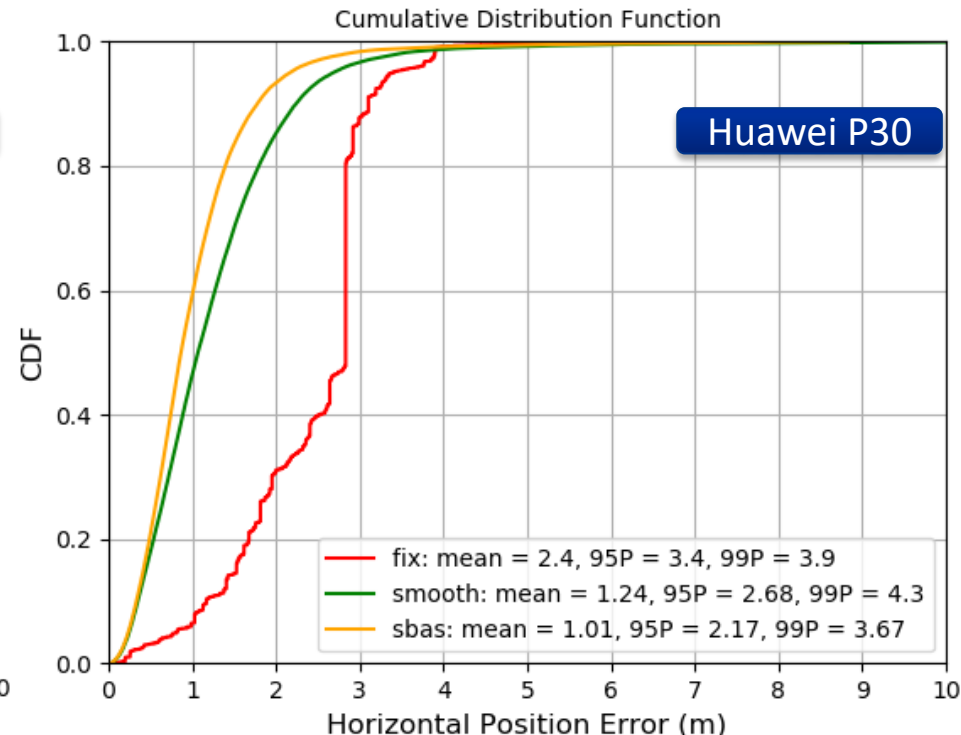
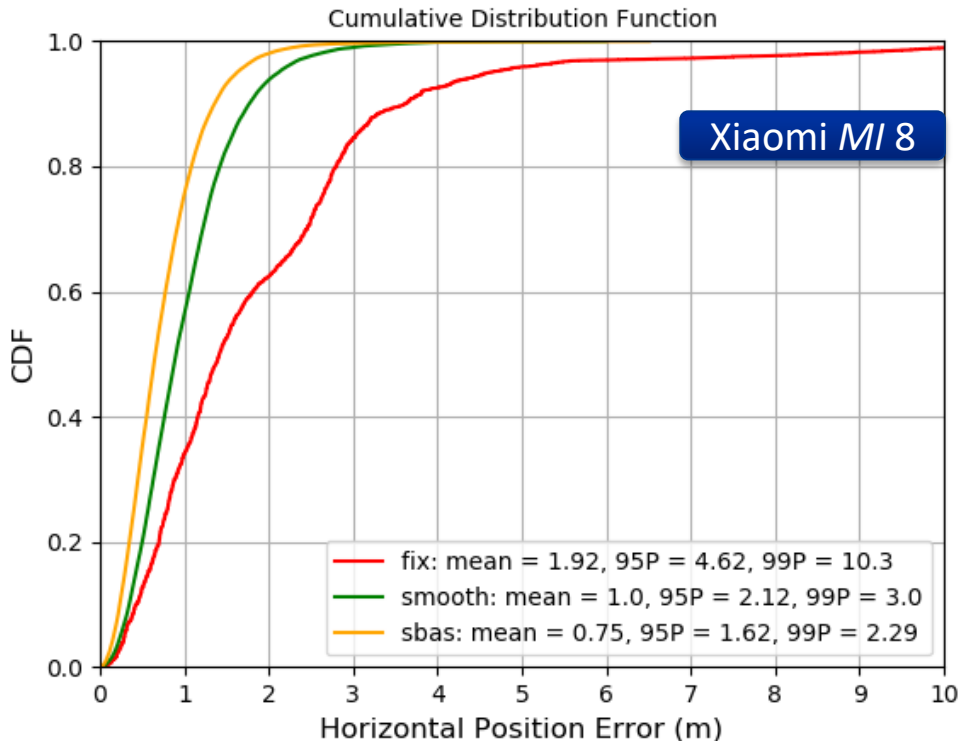
- **Fix:** Position reported by the chip
- **Smoothed:** GPS L1 + Smoothing Filter
- **SBAS:** GPS L1 + Smoothing Filter + EGNOS Corrections

Reference Position: ublox's C099-F9P (PPP by CSRS-PPP Service)



STATIC RURAL SCENARIO (II)

3 days of data \approx 80K epochs



The **SBAS/DGPS corrections**, together with a smoothing of the reconstructed raw measurements, **outperform** the smartphone computed position **by a 60%**

CONCLUSIONS AND NEXT STEPS

Code measurements are very noisy, while phase measurements are quite stable

Smoothing filter and Data processing techniques (considering the Android API indicators) required to obtain a good and stable navigation solution

Huge difference of quality in the measurements from the : **Xiaomi Mi8** and **Huawei P30** vs **Samsung S8** and **Huawei P20**

For the analysed scenarios, a proper smoothing filter together with the application of **EGNOS/DGPS corrections** over smartphone data **improves** the position accuracy **by a ~60%** (reference from embedded DFMC chipset)

EGNOS/DGPS corrections can support **average horizontal accuracies below 1m** with **availability in excess of 99.5%** (both for clear sky and rural scenarios).



EGNOS, it's there. Use it.

Thank you!



www.essp-sas.eu

Jorge.moran@essp-sas.eu



<http://egnos-user-support.essp-sas.eu>

egnos-helpdesk@essp-sas.eu

+34 911 236 555 (H24/7)



Corporate Video