

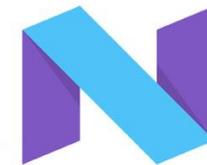
Training and Outreach with Galileo App Competition for Smartphones

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European Space Agency

***UN ICG-13
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Background

- ★ With the release of Android 7 (Nougat) in 2016, Google made **GNSS raw measurements** available to smartphone users
- ★ Access to a range of **advanced GNSS processing techniques** that had previously been restricted to more professional GNSS receivers
- ★ Raw measurements produced by the phone's GNSS chip allow users to calculate **pseudoranges** (the distance between the user's receiver and the satellite) and **position, velocity and time** (PVT) using Android devices
- ★ Allow the development of applications to compute position fixes based on **specific satellites** as configured by the application developer
- ★ ESA launched **Galileo App Competition** in 2017 and 2018 to develop such applications on Android smartphones



Android 7.0 Nougat



Objectives



- ★ Design a smartphone app to:
 - ★ allow user to select the constellations used for navigation
(**mandatory:** Galileo-only, GPS-only, Galileo + GPS; **optional:** GLONASS and BeiDou)
 - ★ allow the user to compute **single** and **dual frequency positioning solutions** and assess the performance using various constellation combinations
 - ★ provide direct and **real-time visualisation** on an open source world-wide map of the computed positions
 - ★ allow user to log their positions and the raw measurements used for computation
 - ★ demonstrate the quality of the position in the most modern and visual way

- ★ Competition open to:
 - ★ Young graduate/national trainees within ESA as pilot project for the 2017 Edition
 - ★ Extended to all students in universities and trainees at R&D organisations located in Europe for the 2018 Edition

- ★ Team Composition:
 - ★ 3 - 5 people
 - ★ Diversity within the team considered an asset
 - ★ Cooperation across different sites/countries are encouraged



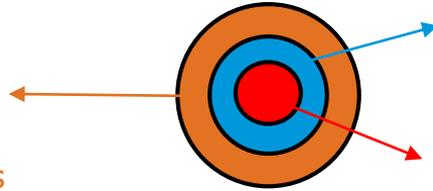
1st Galileo App Competition



- Launch of ESA internal competition: *17 October 2017*
- Objectives of the competition

Form teams
(3 to 5 persons)

ESA YGTs, Trainees,
Internal Research Fellows

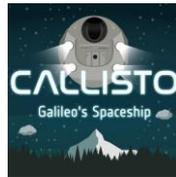


Design an Android application that processes GNSS raw measurements

Galileo only, GPS only and Galileo+GPS PVT functionalities



- Prize: ESA/JRC International Summerschool on GNSS 2018 in Austria
- Three teams in the final:



Chocolat team



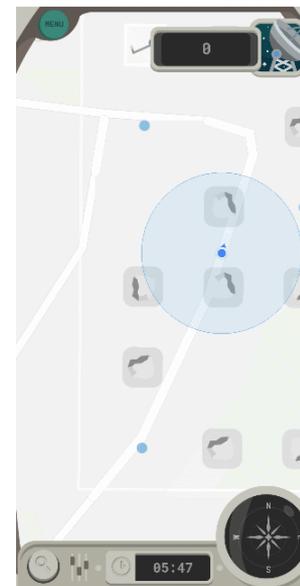
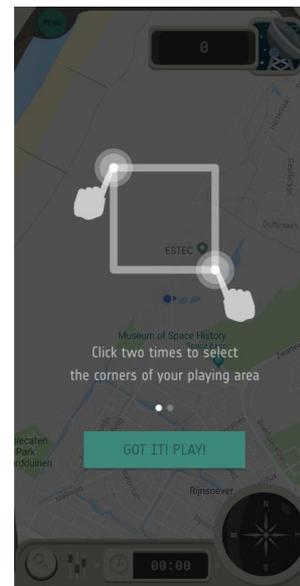
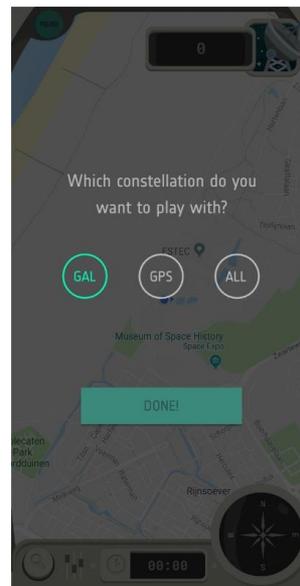
Team 5G

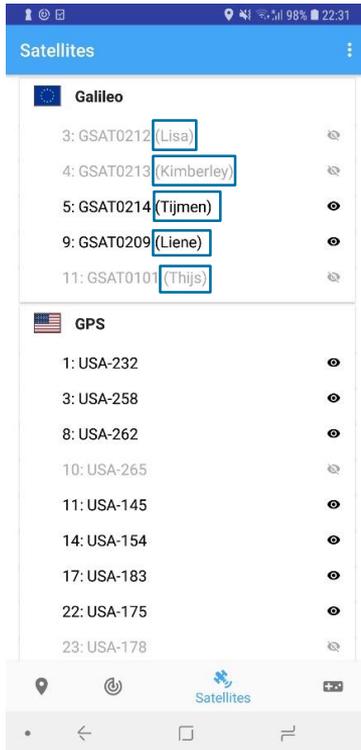


The Galfins



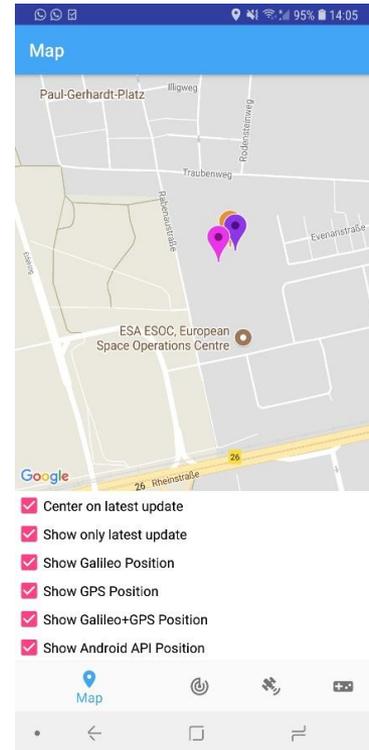
Callisto by Chocolateam





Display of the Galileo satellites names

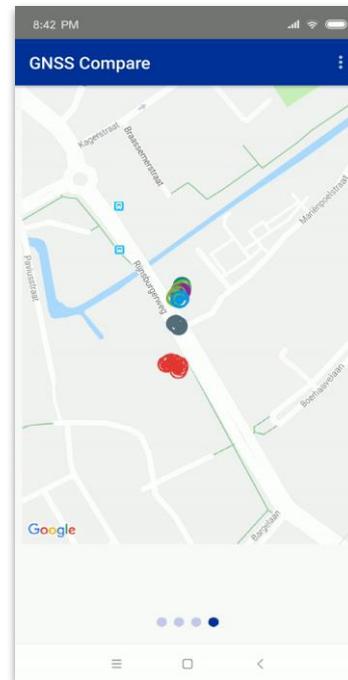
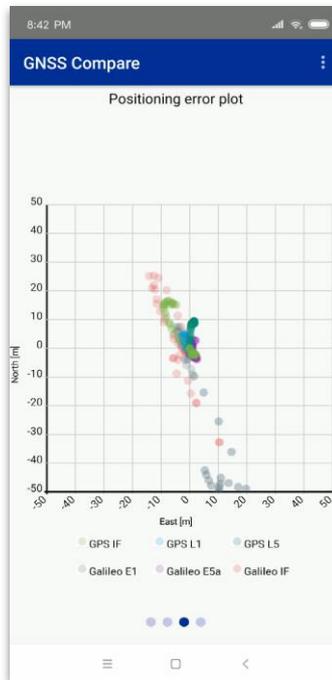
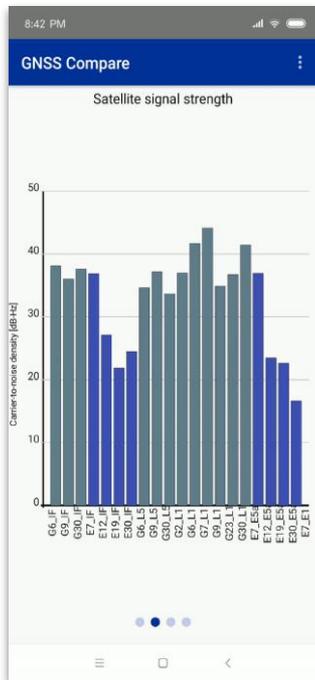
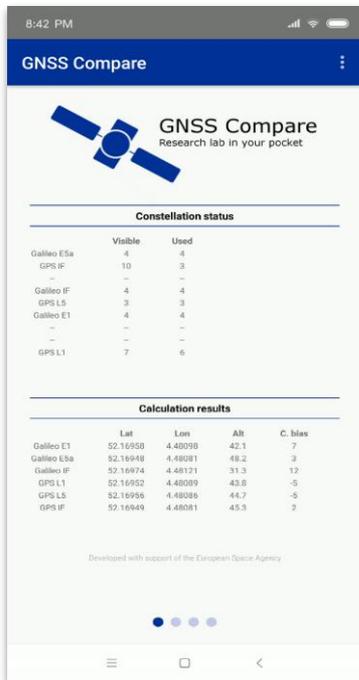
Display of the GPS satellites names



Navigation algorithms coded from scratch



GNSS Compare by The Galfins



Winner of Galileo App Competition!



GalileoPVT by ESA Technical Advisory Team



GalileoPVT

svID	Type	C/N0	Az	Elev	UPD	Meas	Sync	Msg	(ms)	Age
23	Glo	40	312° 42'	U-	161	T/T	0	-	-	Live
3	GPS	39	96° 44'	U-	162	T/T	25	-	-	Live
26	Gal	38	315° 27'	U-	155	2/T	0	81.8	-	Live
7	Glo	36	340° 75'	U-	161	T/T	0	-	-	Live
2	-GPS	36	315° 15'	U-	162	T/T	26	-	-	Live
6	GPS	36	287° 57'	U-	162	T/T	26	-	-	Live
22	GPS	34	102° 23'	U-	162	T/2	26	-	-	Live
19	GPS	33	251° 28'	U-	162	T/T	26	-	-	Live
6	Gal	32	249° 70'	U-	156	2/T	0	72.0	-	Live
21	Bei	32	0° 1'	U-	47	T/T	0	-	-	Live
3	Gal	31	70° 53'	U-	152	2/1	0	81.0	-	Live
9	Glo	31	125° 13'	U-	131	T/1	0	-	-	Live
22	Glo	31	223° 45'	U-	162	T/T	0	-	-	Live

7 Galileo and 11 GPS live signals. Show Galileo only INFO

Sky plot: Line signal, Available, NOK. Includes a circular plot and a bar chart.

Android location known. RESTART GNSS. Ephemerides up to date.

MAP 7 Galileo 4 usable 5 Fix Log

GalileoPVT

Galileo GPS Galileo+GPS

25.7713 N 25.7712 N 25.7712 N
 -80.1927 E -80.1925 E -80.1925 E

7 sats used 5 sats used 12 sats used

DOWNTOWN MIAMI

SW 2nd St, SW 3rd St, SW 4th St, SW 5th St, SW 6th St, SW 7th St, SW 8th St, Water Ave, S Miami Ave, Brickell City Centre, Miami Tower, SE 2nd St, SE 3rd St, U.S. Hwy, Brickell Fwy, SE 5th St, SE 6th St, SE 7th St, SE 8th St, SW 8th St, 90, 41, Two Channels Meridian

SATS 7 Galileo 7 usable 5 Fix Log

RECEIVING GALILEO AR

MAP 5 signals 0 used 5 Fix Log

GalileoPVT

GalileoPVT

svID: 27
 AZIM: 154°
 ELEV: 44°
 TYPE: FOC
 BAND: G4B/SSTL
 LAUNCH: 12 DEC 2017
 LINK: AIRCANE S
 ORBIT: A01
 C/N0: 44 dBHz
 FREQ: 1575.42 MHz
 SYNC: 704 10000
 BESI: 004 10000
 PSYB: 6170
 TOW S: 518122478
 WAOFS: 678445192
 WANS: 24611 us

MAP 6 Galileo 5 usable 5 Fix Log

GalileoPVT

svID	Type	C/N0	Az	Elev	UPD	Meas	Sync	Msg	(ms)	Age
3	FOC	23M	46° 26'	U-	102	0/1	0	-	-	Live
8	FOC	22M	108° 51'	U-	44	0/1	0	-	-	Live
7	FOC	22M	171° 26'	U-	137	0/1	0	-	-	Live
1	FOC	0	270° 20'	-	66	0/1	0	-	-	0:11
21	FOC	0	??	??	57	0/1	0	-	-	0:12

3 Galileo and 6 GPS live signals. Show Galileo only INFO

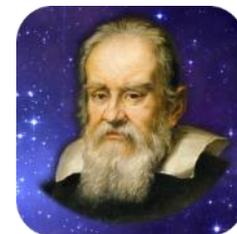
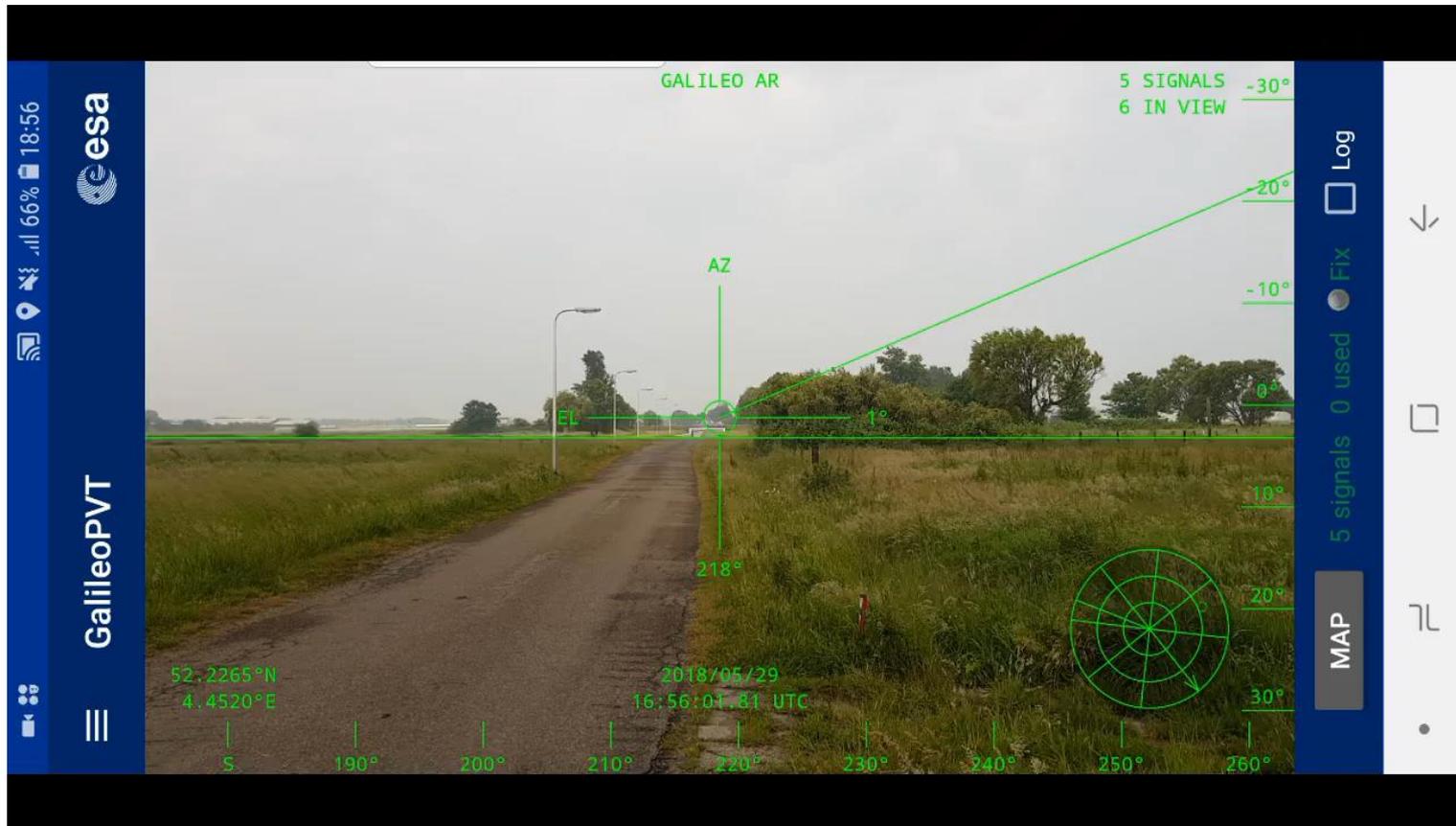
Sky plot: Line signal, Available, NOK. Includes a circular plot and a bar chart.

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MAP 3 Galileo 0 usable 5 Fix Log



GalileoPVT - Augmented Reality View



GalileoPVT



- ★ App development competition is a good tool for **dissemination and capacity building**
- ★ 1st edition **internal to ESA** was a success with 3 apps already on Google Play
 - ★ Boosted motivation for young professionals and trainees within ESA
 - ★ Offered valuable learning experience on GNSS and Android development with exposure to full product development lifecycle



- ★ 2nd edition **extended to European region** open to all students in universities and trainees at R&D organisations
 - ★ Final award ceremony on 18 April 2019 at ESA site in Netherlands with live web streaming and on-line voting
- ★ Future extension to other regions **worldwide** with other Service Providers could be considered

Tune in for the final award ceremony and cast your vote on 18 April 2019



<http://www.esa.int/GalileoAppCompetition>

