Galileo and Android 7 devices

Galileo Support

Proprietary information to be protected according to art. 12(6) of the framework contract

30.05.2017
Objectives

- Galileo Pseudoranges generation
  - Pilot tracking
  - *Ambiguous* flag

- Galileo PVT alone

- Galileo usage in PVT
  - Tracking vs PVT usage comparison
Galileo Pseudoranges Generation

Galileo OS Signal

- Galileo OS signal is based on two components:
  - E1B (Data) → primary code (4 ms) is modulated with a navigation message
  - E1C (Pilot) → secondary primary code (100 ms) is transmitted on top of the primary code
  - No navigation bits → tracking can be more robust
Galileo Pseudoranges Generation

Galileo Tracking (Broadcom) – old approach

- 1) Data Component tracked:
  - Acquisition
  - Navigation message decoding

- 2) Pilot Component tracked:
  - Tracing goes to pilot component
  - Flag TOW Decoded NOT enabled
  - Pseudorange ambiguous
    - 100 ms < travel time (~70ms)
    - Ambiguity can be solved

\[ \rho = (t_{rx} - t_{tx})C \]
Galileo Tracking (Broadcom) – Current approach

- Some satellites remain with:
  - TOW Known / TWO Decoded
  - More than 1 hour

- Other satellites go to 2\textsuperscript{nd} Code Lock
  - Pseudoranges ambiguous

Not clear the algorithm to decide the tracking status
Pseudoranges *ambiguous*

- When the flag *ambiguous* is enabled jumps can be expected in the pseudoranges
- In post processing those jumps can be removed
- The proper value of the pseudorange shall be taken when the *TOW decoded* flag is enabled
Galileo PVT

- Galileo Raw Measurements from Samsung S8
- Broadcasted Ephemerids & Clocks from Server (IGS)
- PVT algorithm implemented in Matlab
Galileo PVT – Open Sky

- 5 Galileo Satellites used for the PVT solution
- 2.9 meters accuracy (50%)
- 8.4 meters accuracy (95%)
GPS vs GPS + Galileo PVT - Static

- 5 Galileo Satellites used for the PVT solution
- GPS alone 6.7 meters error
- Galileo increases the accuracy up to 4.5 meters

![Error Comparison Graph]

50% distribution GPS = 6.7 m
50% distribution GPS+GAL = 4.5 m

Error-GPS (95%) = 18.8885 [meters]
Error-GPS+GAL (95%) = 11.8405 [meters]
Raw measurements provide raw information:
- C/No, carrier phase, Received SV time (pr)

No PVT information (just the Clock)

Which satellites have been used in the PVT?

Google Location:
- Satellites used for PVT
- Ephemerids and almanac available

Analysis of Galileo usage in PVT
Galileo usage in PVT

PVT & Tracking: Percentage over the in-view healthy Galileo Satellites

- Same scenario
- Urban Static

**Urban Static Set 1**

- **Galileo Trac & PVT Status**
  - Huawei P10 Broadcom

- **Number of Satellites**

- **In View**: 32.8293%
- **GAL in PVT**: 32.5851%

- **Urban Static Set 1**

- **Galileo Trac & PVT Status**
  - BQ Qualcomm

- **Number of Satellites**

- **In View**: 44.9052%
- **GAL in PVT**: 32.6077%
Galileo usage in PVT

Tracking per Constellation: Channel allocation per constellation

- Same Scenario
- Windowsill

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**Windowsill - Tracked Satellites by Huawei P10 Broadcom**

- GAL Tracking = 11.0122%
- GPS Tracking = 47.0078%
- GLO Tracking = 41.98%

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**Windowsill - Tracked Satellites by BQ Qualcomm**

- GAL Tracking = 25.2338%
- GPS Tracking = 39.2119%
- GLO Tracking = 35.3407%
Galileo usage in PVT

Huawei P10:
• Almost all the measurements are used in the PVT solution.
• Less than 40% of the measurements are tracked

BQ:
• More than 45% of the measurements are tracked in all the scenarios.
• Up to 70% of the measurements are tracked in the windowsill scenario
• The measurements used in PVT reduced

Comparison:
• Huawei uses a bit more of the Galileo measurements for the PVT solution
• BQ tracks almost 2 times more the Galileo satellites compared to Huawei
Huawei P10:
• 15% of the channels track Galileo satellites

BQ:
• 28% of the channels track Galileo satellites

SBAS Satellites have been excluded for the computation of this figure of merit
Almost 60 Smartphone models include Galileo
Leading smartphone manufactures use Galileo

Do you want to know if your smartphone is using Galileo?

http://usegalileo.eu/