European Global Navigation Satellite Systems Agency

GALILEO EGNOS
NAVIGATION SOLUTIONS POWERED BY EUROPE

Galileo: The European GNSS enhances location performance for IoT

IoT Week 2019

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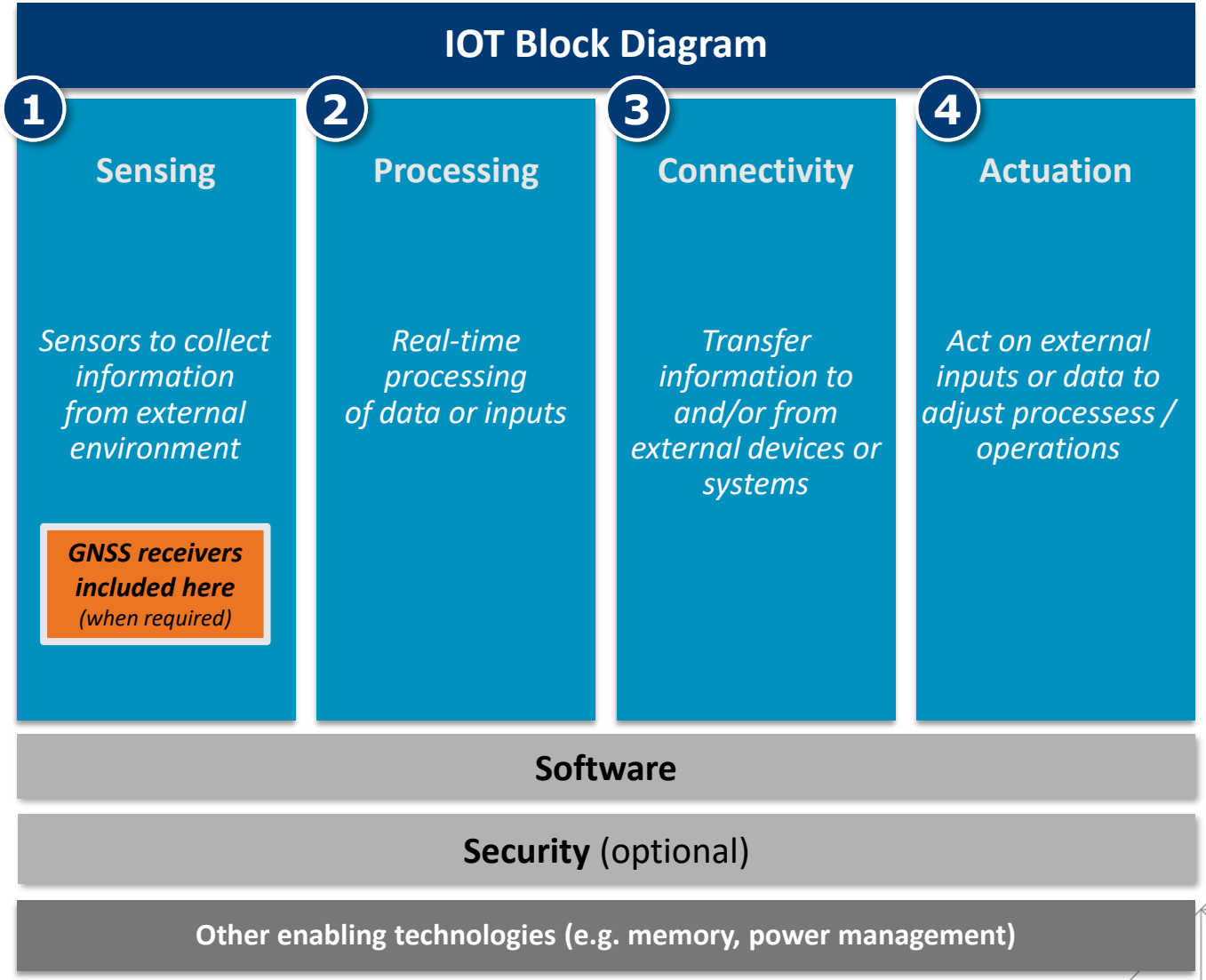
Several technologies can provide positioning capabilities relevant to locate “things”

Main absolute positioning technologies and accuracy

	Indoor	Outdoor	Accuracy
Network based	Cell-ID		200-5000m
	Cell Tower Triangulation		50-1000m
Handset based		GNSS	1 - 50m
Hybrid		A-GNSS	
Infrastructure based	Wi-Fi		3-10m /20-50m
	Bluetooth		3-10m
	UWB		20 cm-10 m
	RFID		<3m

- **Network based**: (Cell-ID, E-OTD, TDOA etc.) using the telecommunication networks
- **Handset based**: (GNSS) the handset itself is the primary means of positioning the user. The A-GNSS corresponds to a hybrid technology based on the GNSS but using the cellular network
- **Infrastructure based**: (Bluetooth, UWB, Wi-Fi or RFID) the position is computed by evaluating of the distance between the device and transmitters (for example a Bluetooth beacon or a Wi-FI router)

Internet of Things is developing alongside 4 building blocks where sensing is the enabler



Source: Bain analysis, 2016

Current GNSS is not enough… emerging applications are more and more demanding in terms of performance

Augmented reality

Self-driving cars

Drones

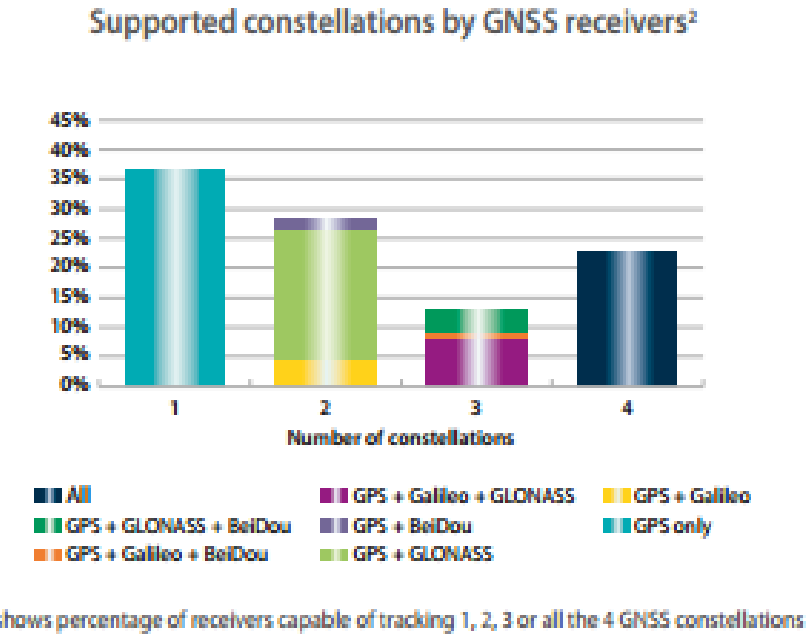
Smart cities

Automation on the farm

Antifraud applications

Improving GNSS-based location (1/2)

Multi-constellation for more availability of the signals



² shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 GNSS constellations

Multi – constellation is already widely used in many applications but is **not yet a standard in IoT**

Usual combination of GPS and Glonass is now expanded with Galileo and Beidou

R&D progress enabled multiple constellations to work together **without much impact on the power** consumption

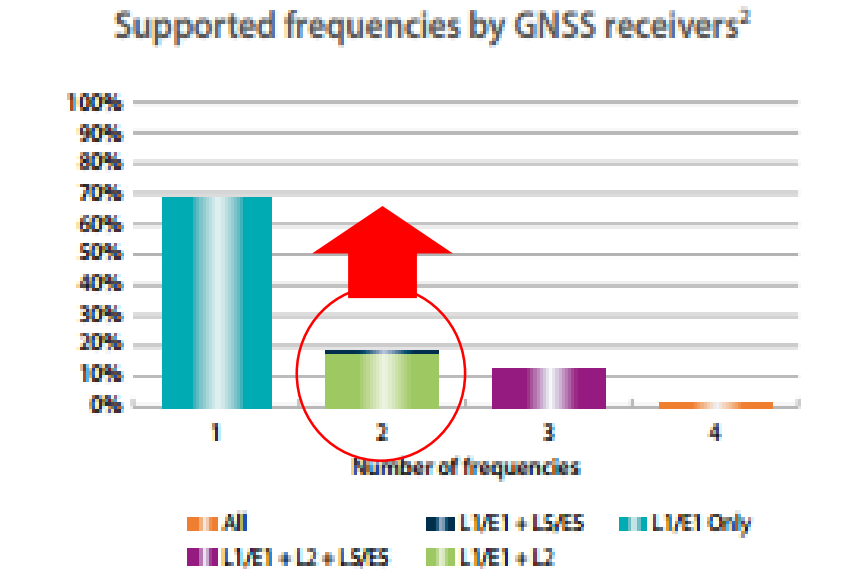
Improving GNSS-based location (2/2)

First dual frequency chipsets now available for the mass market

Available today:

Announced prototypes:

Multi-frequency for better accuracy of the position



[2] shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 frequencies

E5/L5: The second frequency of choice

- Wide band signal providing increased **accuracy**
- Exceptional resistance to **multipath**
- In combination with E1 providing **iono-free** solution
- All constellations support this frequency, the number of available signals will grow rapidly
- E1/E5 combination is recognized in **all segments,** professional, automotive and also mass market

Future GNSS/RNSS common frequencies, showing the potential of E5a/L5 and of E1/L1 combination

	L5 / L5OC / E5a / B2a	L2 / L2C / L2OC	E6 / LEX	L1 / L1OC / E1 / B1
GPS	30	30		30
GLONASS	24	24		24
Galileo	30		30	30
BeiDou	35		35	35
QZSS	3	3	3	3
IRNSS	7			
	129	← ARNS* Bands →		122

Frequency band used by the system, with N = number of satellites

Frequency band not used by the system

** ARNS = Aeronautical Radio Navigation Service: Frequency bands allocated worldwide to GNSS on a primary basis, granting a better protection against interference*

Galileo can contribute with innovative features to IoT

- Authentication
  - **Data level**: Navigation Message Authentication

    Integrated in the E1-B band for OS. Aimed at consumer users and offered for free. Already prototyped and under testing

  - **Range level**: Signal Authentication

    Based on the E6-C Spreading Code Encryption to protect against more sophisticated attacks

Galileo OS Navigation Message Authentication

"Navigation Message Authentication" is the ability of the system to guarantee to the users that they are utilising legitimate navigation data that has not been modified and comes from the Galileo satellites and not from any other source (spoofing).

- Clear **differentiator w.r.t. other GNSS** available to the civil community
- Fully **backward compatible**
- Disseminated on the first Galileo frequency (**E1B**)
- Contributes to **mitigate GNSS vulnerabilities**
- No need to store secret keys in the Rx, just public key
- Follows crypto standards and recommendations to be secure over the next decades

Galileo OS-NMA can add value to multiple markets

Fundamental Elements

The use of OSNMA is expected to **reduce the associated spoofing risk** in many applications categories:

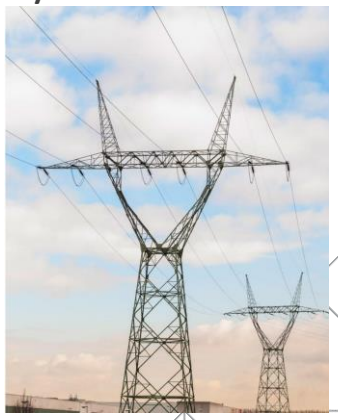
Road
(AD, PAYD, RUC)

Logistics
(proof of delivery)

Mobile payments

Internet of Things

Timing & Synchronisation



Commercial Marine

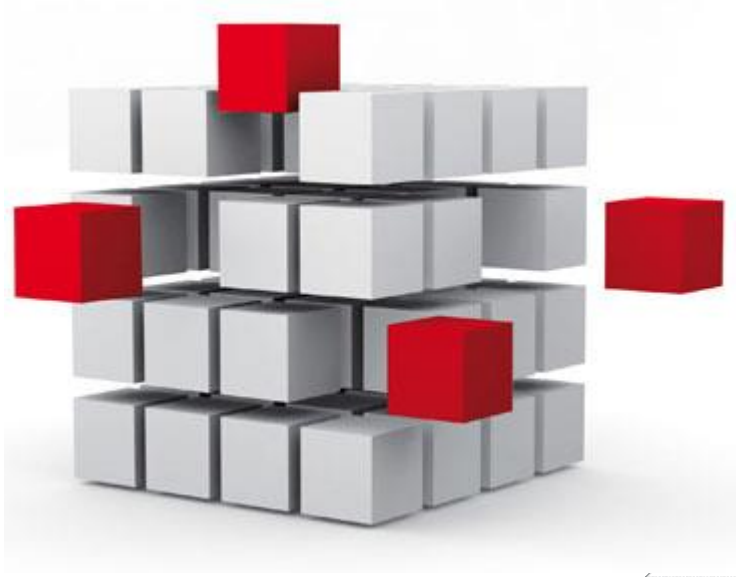
Augmented Reality

UAV

Not exhaustive list…..

Galileo High Accuracy Service on E6 to be offered for FREE

- User positioning accuracy with **decimeter level error** (*≈20cm*)
- **No need of additional** ground communication **channel** (*448 bps allocated on Galileo E6B*)
- **No need of proximity to base stations** to access corrections (*as opposite to RTK*)
- **Triple frequency** to further **increase accuracy** and **reduce** PPP **convergence time***
- Improved line-of-sight and **better coverage** at high latitudes

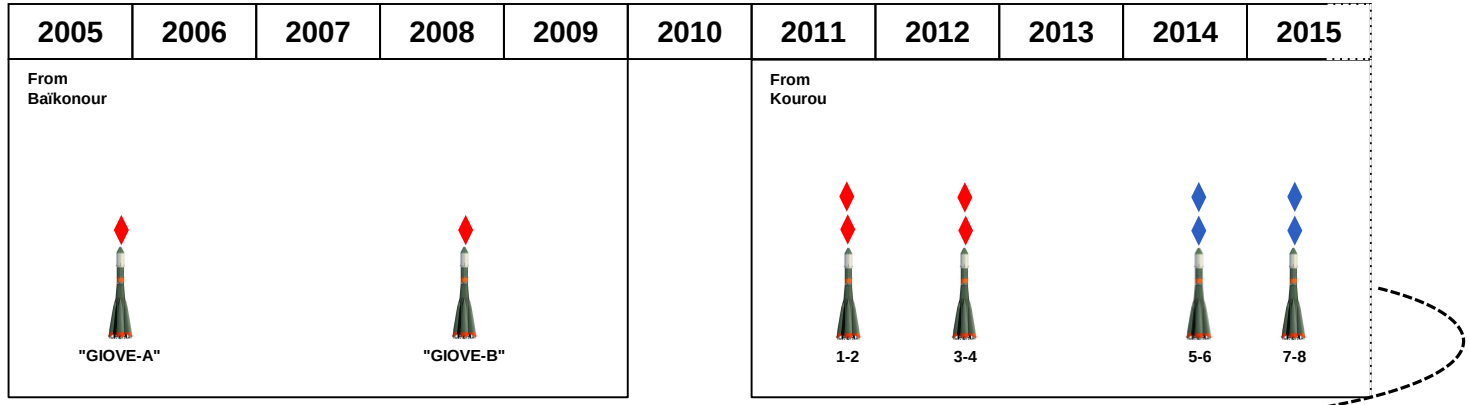


* It will require compatible receivers E1/E5/E6

Can we use Galileo right now?

Short answer: **Yes!**

- Galileo operational since 2016
- 26 satellites already lunched
- 22 satellites are usable
- 12 more satellites procured



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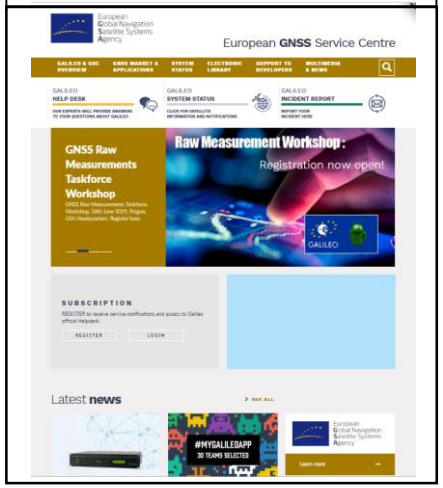
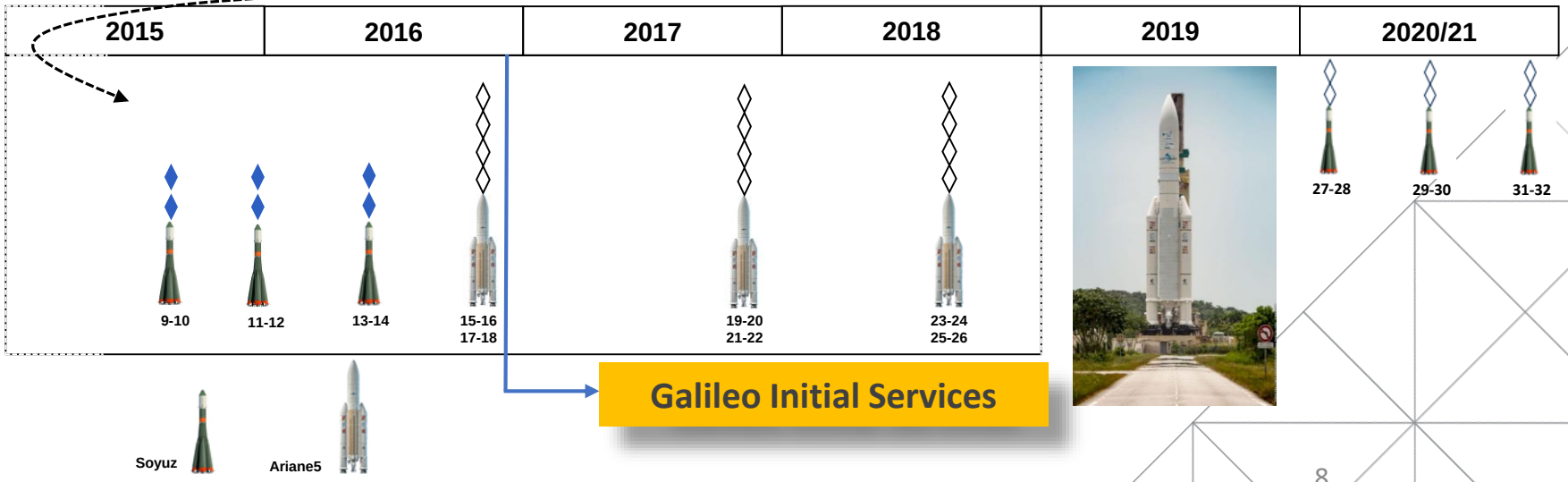




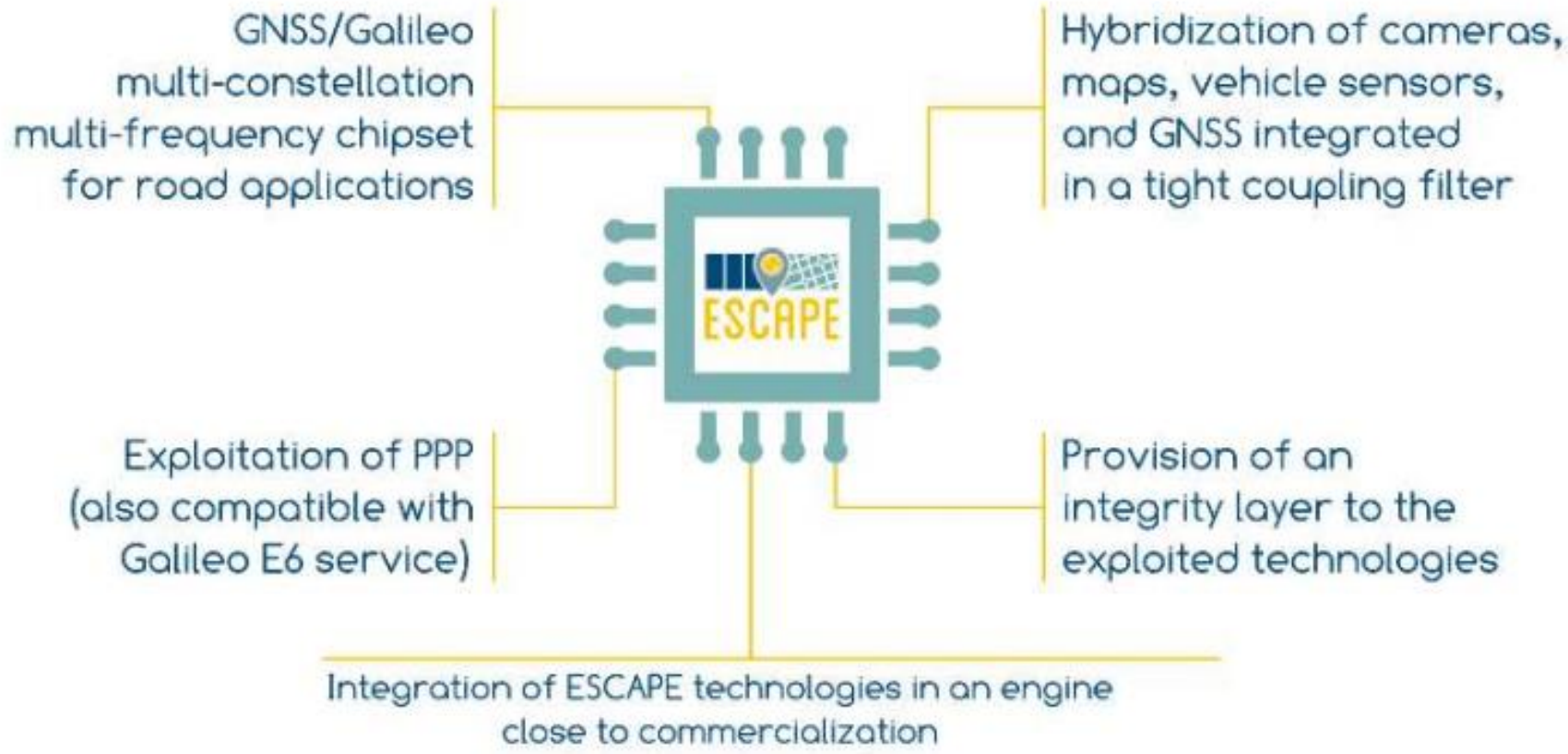
First dual frequency phone was launched in 2018

Providing enhanced performance, the Mi 8 offers users better positioning in urban environments

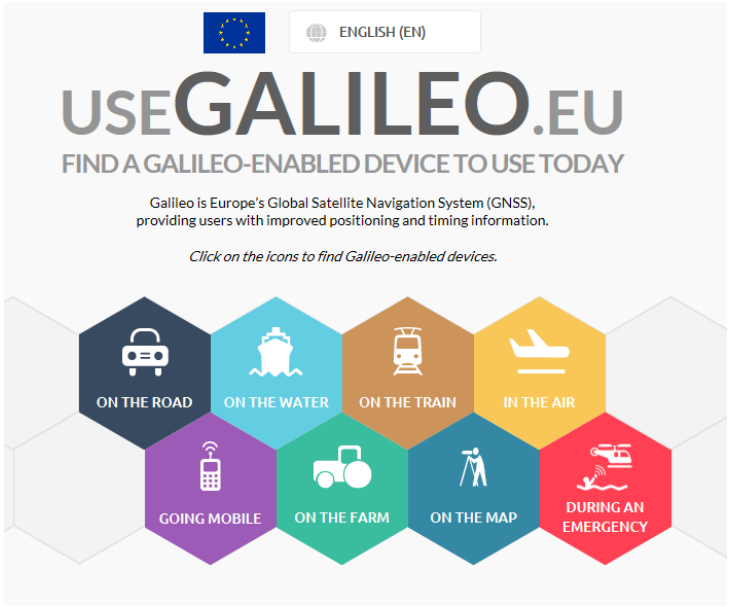
Xiaomi Mi8
Powered by Broadcom 4775
Dual frequency E1/L1 and E5/L5

Example of implementation of a dual frequency positioning module for autonomous driving

GSA funded project ESCAPE that develops a highly automated positioning engine



Galileo-enabled devices are already available



TIMING

spectracom Synchronizing Critical Operations

Leica Geosystems

SMARTPHONES/MASS MARKET

intel QUALCOMM BROADCOM MEDIATEK

AUTOMOTIVE

CSR QUALCOMM

STMicroelectronics

UAVs

ublox

HIGH PRECISION

THALES FURUNO

NovAtel JAVAD Trimble

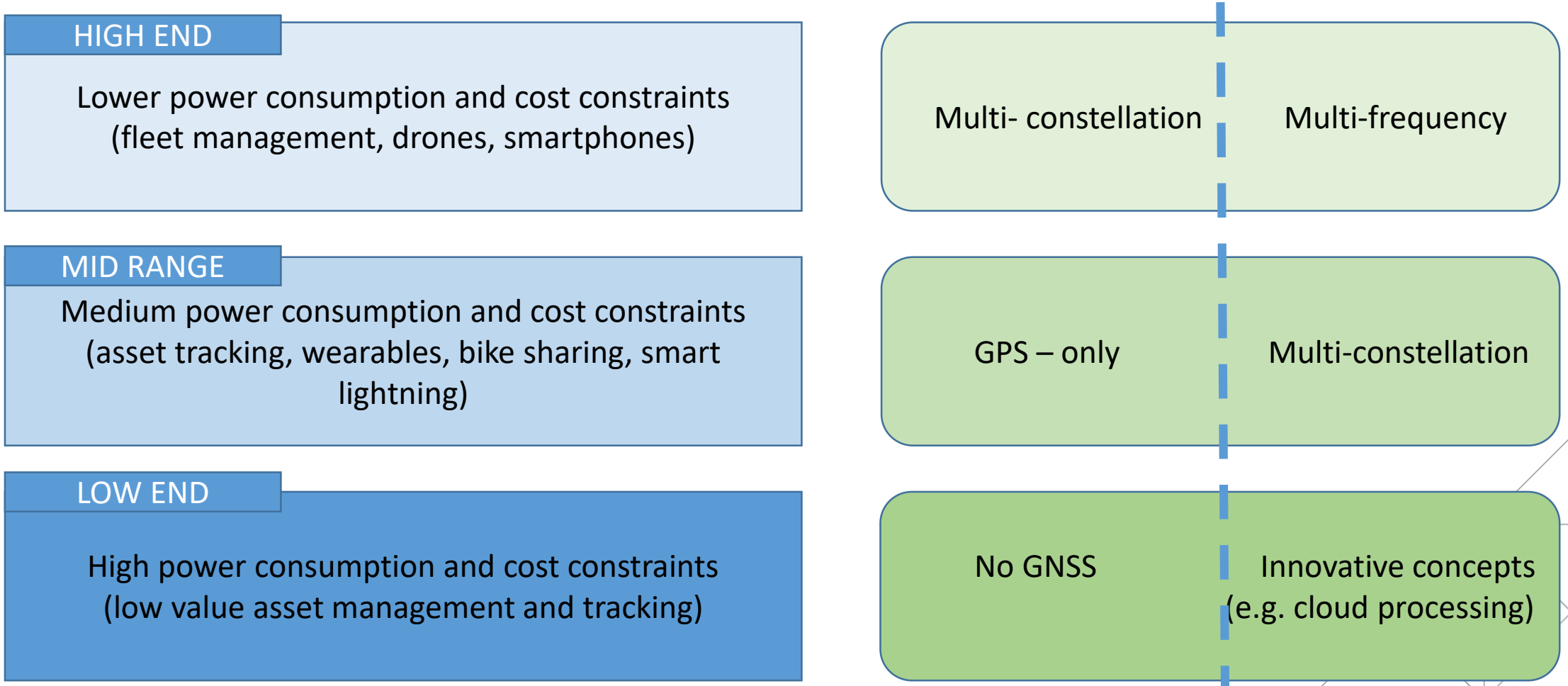
TOPCON septentrio

bq

HUAWEI

SAMSUNG

A perspective of IoT from the GNSS point of view



Summary of Galileo differentiators for IoT applications

Need for NMA authentication emerged from users to enhance Galileo value proposition wrt:

- Enabling **commercially sensitive applications**
- Enhancing **big data** collection

Main applications: Fraud management, billing, payment by location…

Galileo High Accuracy Service

Free provision service based on PPP transmission in E6B and via internet link
Future differentiator of Galileo for **semi-professional applications**

Galileo NMA Authentication

Development of new value-added services

Enhancement of offered ones

Multipath Resistant

Galileo better mitigates **multipath effects** through dual frequency E1/E5 **Main applications: navigation, tracking, augmented reality…**

Linking space to user needs

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