European
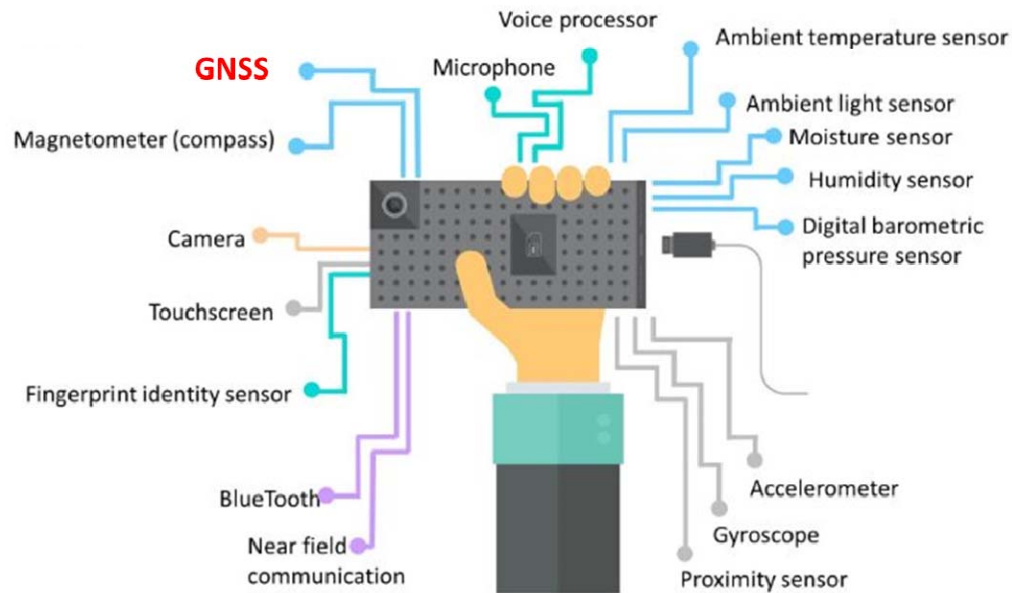**G**lobal Navigation
Satellite Systems
Agency

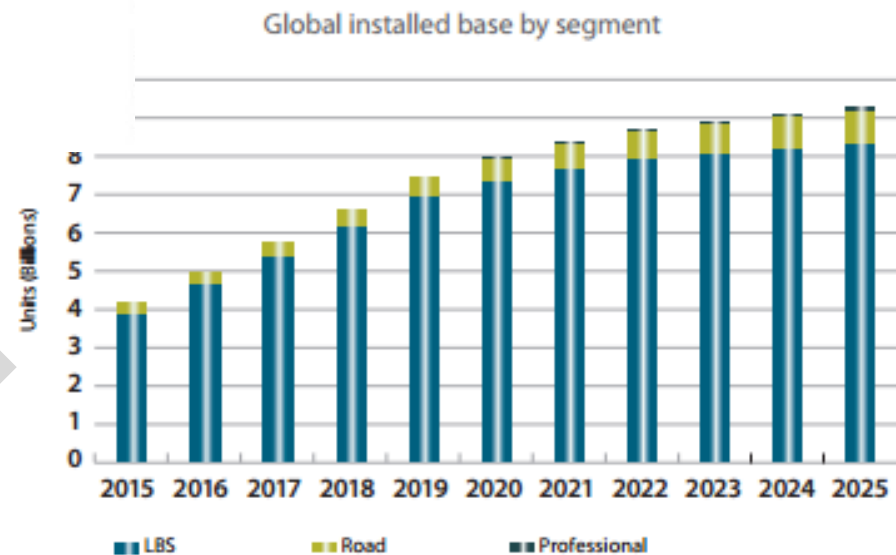# Update on LBS "Location based services" and IoT "Internet of Things"

This presentation can be interpreted only together with the oral comments accompanying it

GNSS is considered a commodity inside smartphones with little room for innovation…

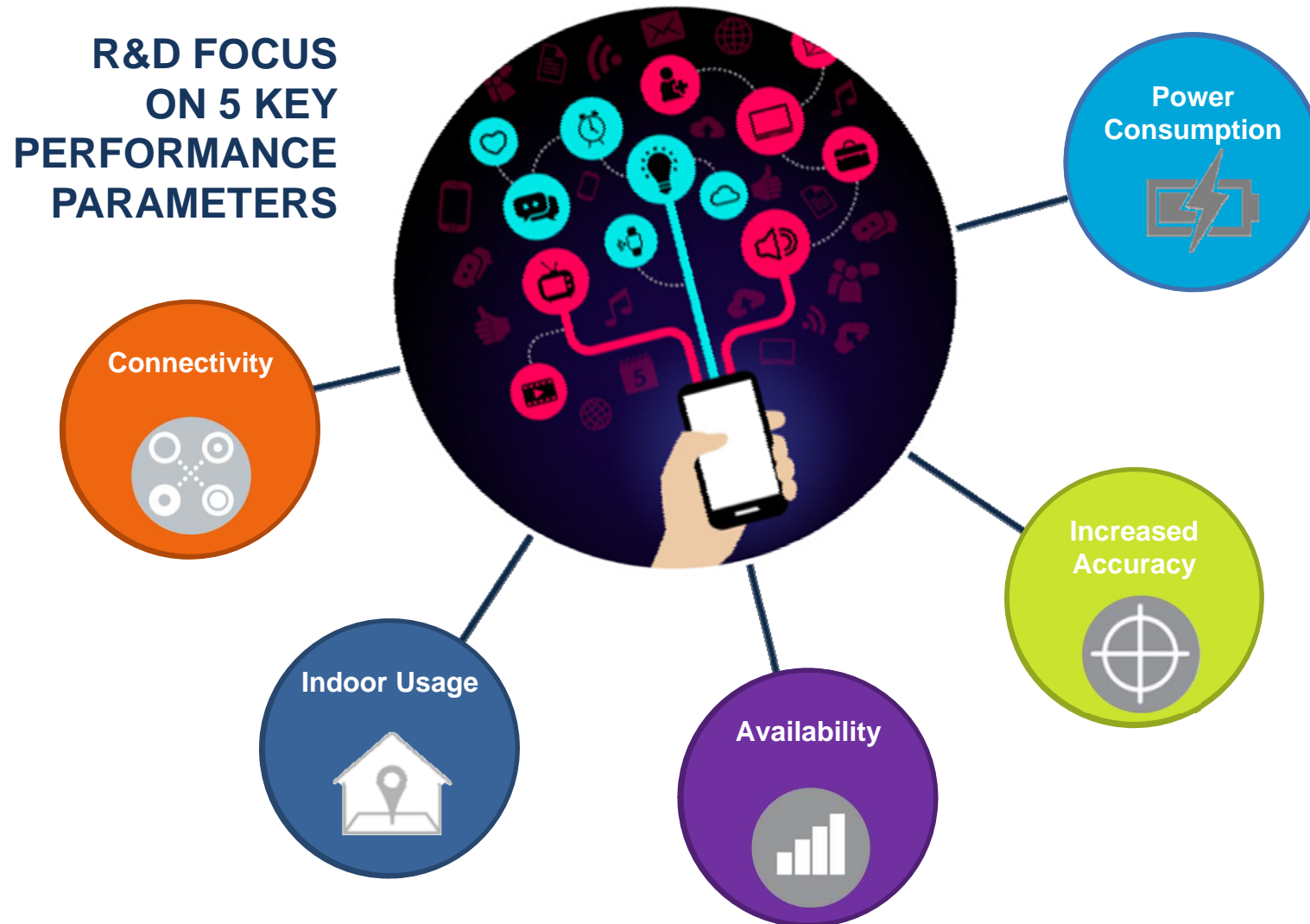

GNSS is today included in all new smartphones

Smartphones account for almost 80% of the global installed base of GNSS devices, being the most popular platform to support mobile "LBS"

Global installed base by segment

...however GNSS plays a role in all technological developments towards LBS of the future

R&D FOCUS ON 5 KEY PERFORMANCE PARAMETERS

Power Consumption

Connectivity

Increased Accuracy

Indoor Usage

Availability

Multi-constellation improves availability in urban environments
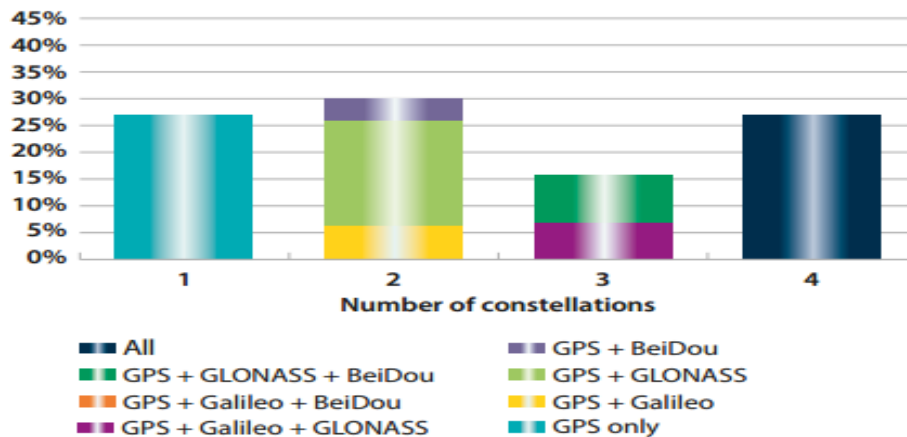
Constellation capability of GNSS receivers[2]

GNSS, RNSS and SBAS constellations
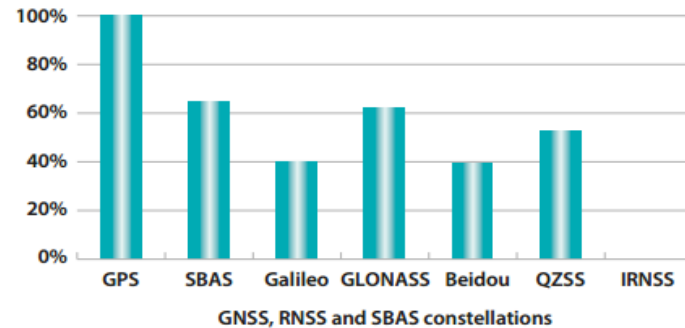
The need to provide enhanced geolocation capabilities in deep urban environment drives the uptake of multi-constellation receivers

Supported constellations by GNSS receivers[4]

Number of constellations

- All
- GPS + GLONASS + BeiDou
- GPS + Galileo + BeiDou
- GPS + Galileo + GLONASS
- GPS + BeiDou
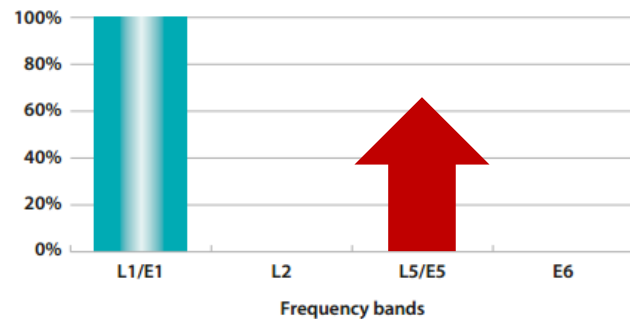- GPS + GLONASS
- GPS + Galileo
- GPS only

Galileo is already adopted by all global leaders in chipset manufacturing:

The demand for further accuracy will support the uptake of dual frequency in mass market

Frequency capability of GNSS receivers[1]

[1] shows percentage of receivers supporting each frequency band"

- Historically, GNSS chipsets for a mass market use are **single frequency** ones

- Recently, the **interest for dual frequency** is increasing:
  - Enabled by semiconductor's industry development
  - Pushed by the use of applications more and more demanding in terms of location

- It will enable a lot of opportunities for app developers to further narrow the gap between professional and mass-market applications
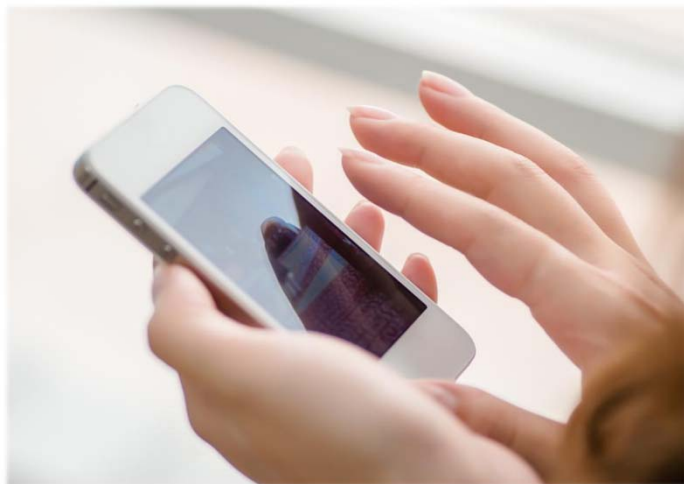
Leading chipset manufactures are already presenting results from their prototypes

GSA&Broadcom workshop
at ION GNSS+,
Portland, Oregon
September 2016

BROADCOM

Innovative software developments promise enhanced accuracy to mass market users

Despite **pseudorange and carrier phase observables** for all signals tracked are available at chipset level, traditional operating systems do not make them available for users

Having access to such additional information would allow sophisticated users to use:

✓ RTK precise positioning
✓ SBAS corrections

d news!

The recently presented Google Android Nougat makes available raw GNSS measurements. It enables new possibilities to application developers

As smartphones connect us everywhere, the need for ubiquitous location increases

By 2020, 80% of population will have access to 3G/4G networks worldwide (GSMA)

GNSS-complementary technologies enable smartphones to deliver an optimised positioning solution

- MEMS
- Signals of Opportunity
- Machine learning techniques
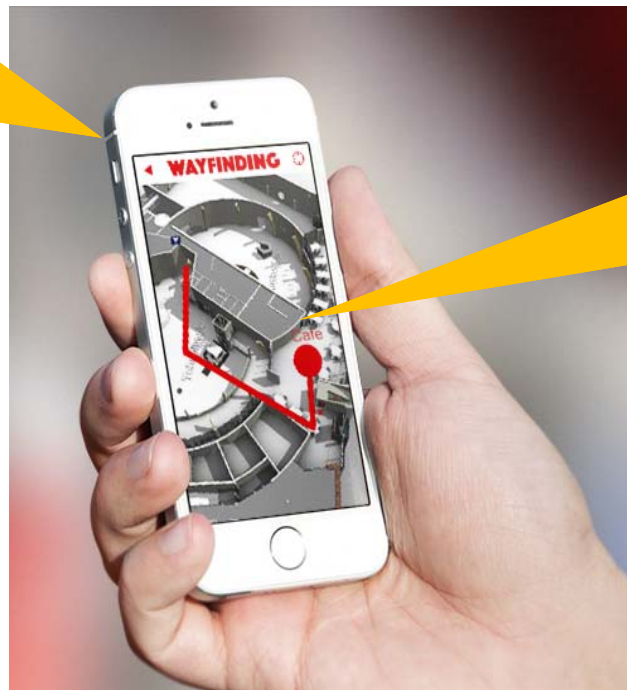
Smartphone chipset manufacturers are incorporating **chip-based indoor location positioning technologies**

A new generation of smartphones will be factory-ready for indoor positioning anywhere…

however GNSS will remain the most important resource to bring location outdoors.

The BQ Aquaris X5 Plus is the first European Galileo ready smartphone

- Launched in **July 2016** it features a Galileo enabled Qualcomm Snapdragon 652 chip

- Today, thanks to the release of the new firmware, the smartphone is capable to track Galileo satellites

Leading smartphone manufacturers have also started to include Galileo on new models
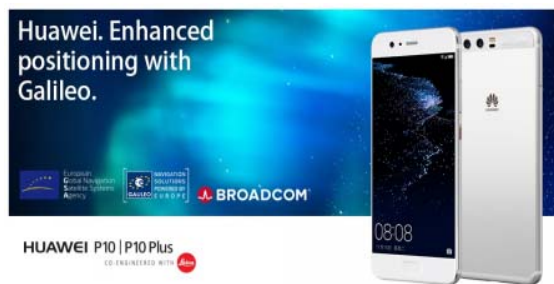
*In **March 2017**, Huawei launched its new, Galileo-enabled P10 Plus smartphone during the Mobile World Congress 2017 in Barcelona*

*In **March 2017**, Samsung unveiled its first Galileo ready smartphones: the Samsung Galaxy S8 and the Samsung Galaxy S8+*

*In **September 2017**, Apple presented its new iPhone models: the iPhone 8, the iPhone 8plus and the iPhone X, all of them Galileo compatible*

LBS is covering a wide range of GNSS applications on consumer devices

Share of LBS revenues attributable to GNSS by app category (2016)

58% | 4% | 9% | 19% | 10%
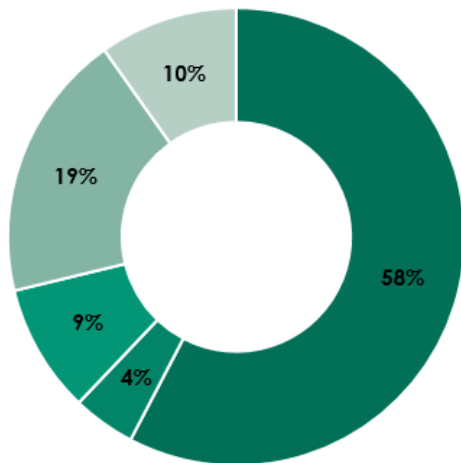
- Navigation
- Social
- Tracking
- Search
- Games and other apps

Navigation: Route planning and turn-by-turn instructions based on GNSS
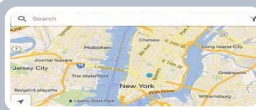
Mapping: Smartphones enable users to become map creators

Geo marketing and advertising: Consumer preferences are combined with positioning data to provide personalized offers to potential customers and create market opportunities for retailers

Safety and emergency: GNSS, in combination with network based methods, provides accurate emergency caller location: e112

Enterprise applications: Mobile workforce management solutions are implemented by companies to improve productivity

Sports: GNSS enables monitoring of users' performance through a variety of fitness applications (e.g. running)

Games and augmented reality: Positioning and virtual information are combined to entertain the user

Social networking: Friend locators provided by dedicated apps or embedded in social networks use GNSS to help keep in touch and share travel information

Positioning and timing information will enable innovative mass market applications

Application Example		Description
Big Data		• **Big data is high-volume, high-velocity and high-variety information assets** that demand cost-effective, innovative forms of information processing for enhanced insight and decision making
Ubiquitous positioninig		• **It is an enabler technology for Outdoor/Indoor Navigation and LBS**. Locating a mobile user ubiquitously with an high accuracy is still a challenging task and requires a mix of different technologies solutions
Assisted GNSS for emergency services		• Combine GNSS with network based methods to **provide accurate emergency caller location.** Today, most of the emergency location services in EU rely on mobile cell or sector ID solutions
Augmented reality		• Augmented reality (AR) is the **integration of digital information with live video or the user's environment in real time**. Basically, AR takes an existing picture and blends new information into it
Crowdsourcing for LBS		• The idea of user-generated content and web-based crowdsourcing is combined to **extend crowdsourcing beyond the digital domain and link it to tasks in the real world**
Internet of Things		• IoT is the network of physical objects that contain embedded technology to **communicate and sense or interact with their internal states or the external environment**

Internet of things is interlinked with new concepts where location is essential

Smart factories

Big data processing

Ubiquitous positioning

Internet of Things

Smart cities

Autonomous vehicles and drones

Tracking of objects and people
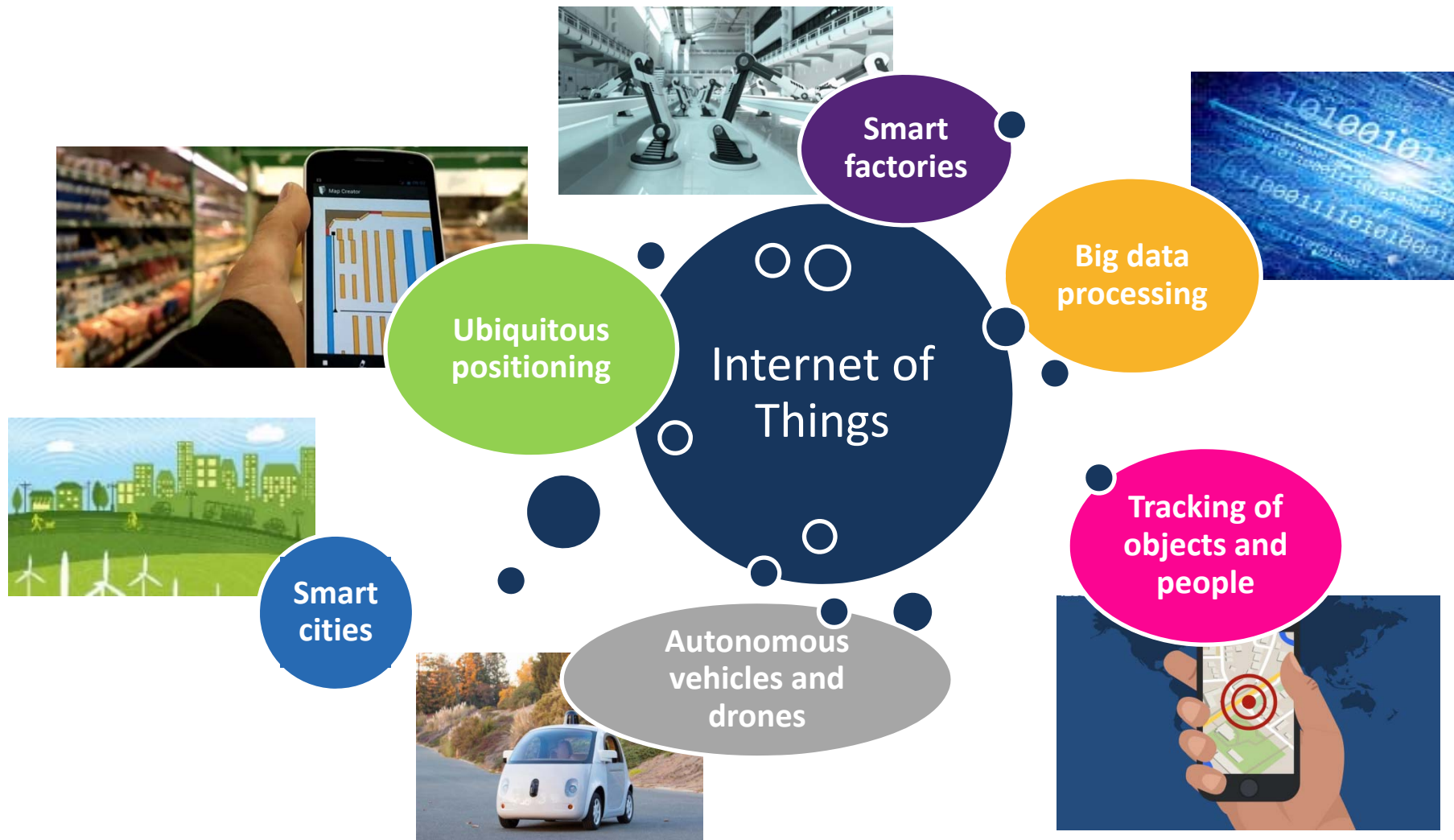
Internet of Things can be categorized into four building blocks where sensing is the enabler

IOT Block Diagram

1 Sensing	**2** Processing	**3** Connectivity	**4** Actuation
Sensors to collect information from external environment	*MCU to enable real-time processing of data or inputs*	*Transfer information to and/or from external devices or systems, via NFC, BTLE, etc.*	*Act on external inputs or data to adjust processess / operations*
GNSS receivers included here *(when required)*			

Software

Security (optional)

Other enabling technologies (e.g. memory, power management)

There is a large number of sensors enabling IoT, among which positioning sensors are key
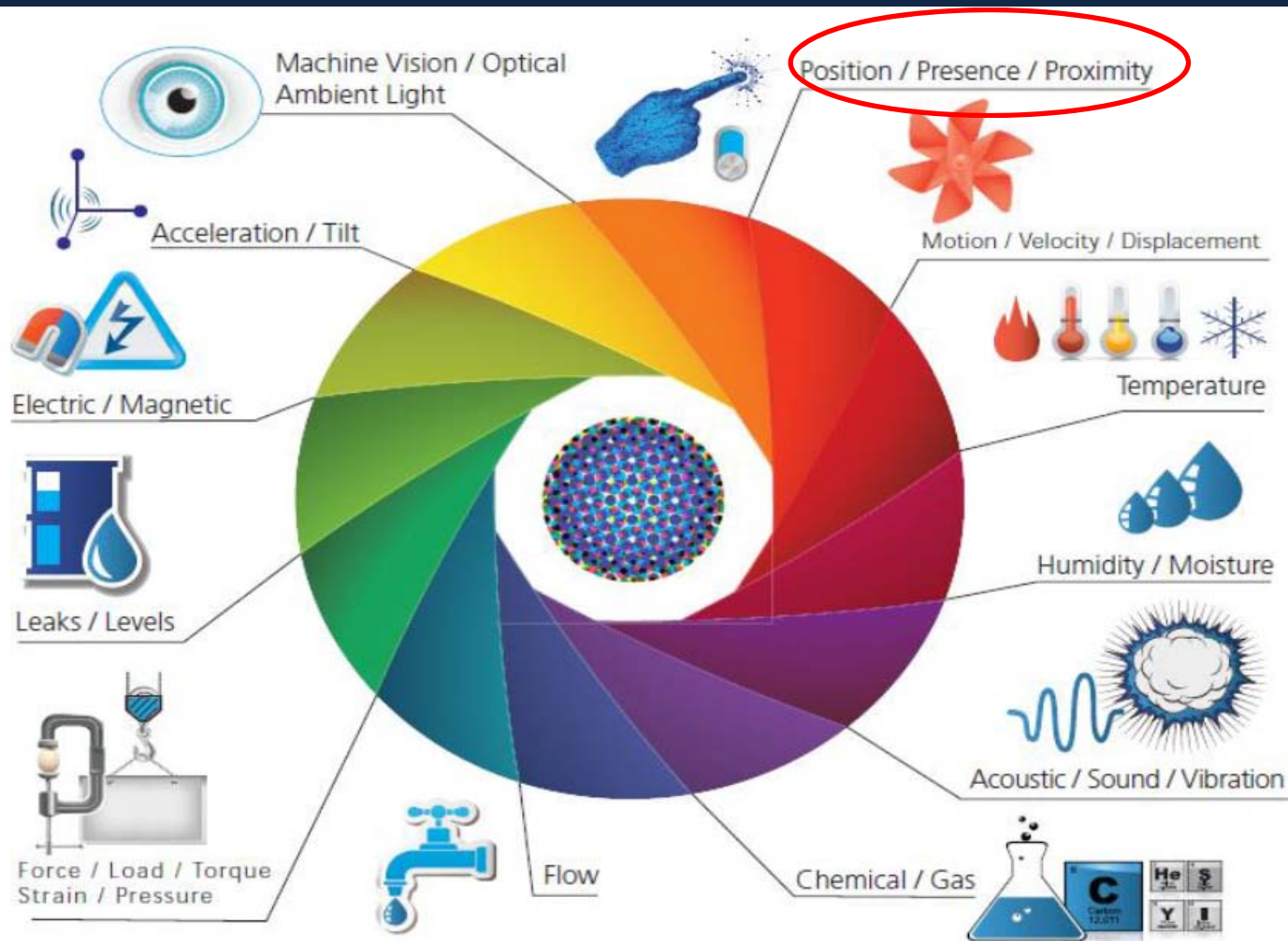
Several technologies can provide positioning capabilities relevant to locate "things"

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 (e.g. a Bluetooth beacon or a Wi-FI router)

In spite of all its possibilities, the GNSS use has some limitations

A **Size**
- GNSS module miniaturization helps **reducing the size of IoT devices**, widening the areas of potential applications where size is a constraint

B **Cost**
- GNSS module cost reduction contributes to **lower total IoT device cost** eventually increasing adoption in current and new area of application (e.g. substitute RFID tags)

C **Power Consumption**
- Reduction of GNSS module power consumption can **help increasing device overall autonomy** with direct benefits in terms of application/service adoption

D **Indoor/ outdoor availability**
- Ubiquitous indoor/outdoor positioning is **one of the critical limits of current IoT location based service/applications**

E **Performances**
- The improvement in positioning performances (e.g. accuracy, TTFF, etc.) would **directly imply an increase in service quality** in many types of apps/services

F **Robustness to attacks**
- System vulnerability **is receiving an increasing attention** from the IoT user community

R&D in progress to overcome these limitations

Market adoption: steps to Galileo use

GALILEO COMPATIBILITY ACHIEVED

Implementation in Hardware
Receiver's hardware is Galileo compatible

Implementation in Firmware
Receiver's firmware is Galileo compatible

Activation
Users start calculating position with Galileo

"Good use" of Galileo
Use of Galileo as a 2nd constellation of choice
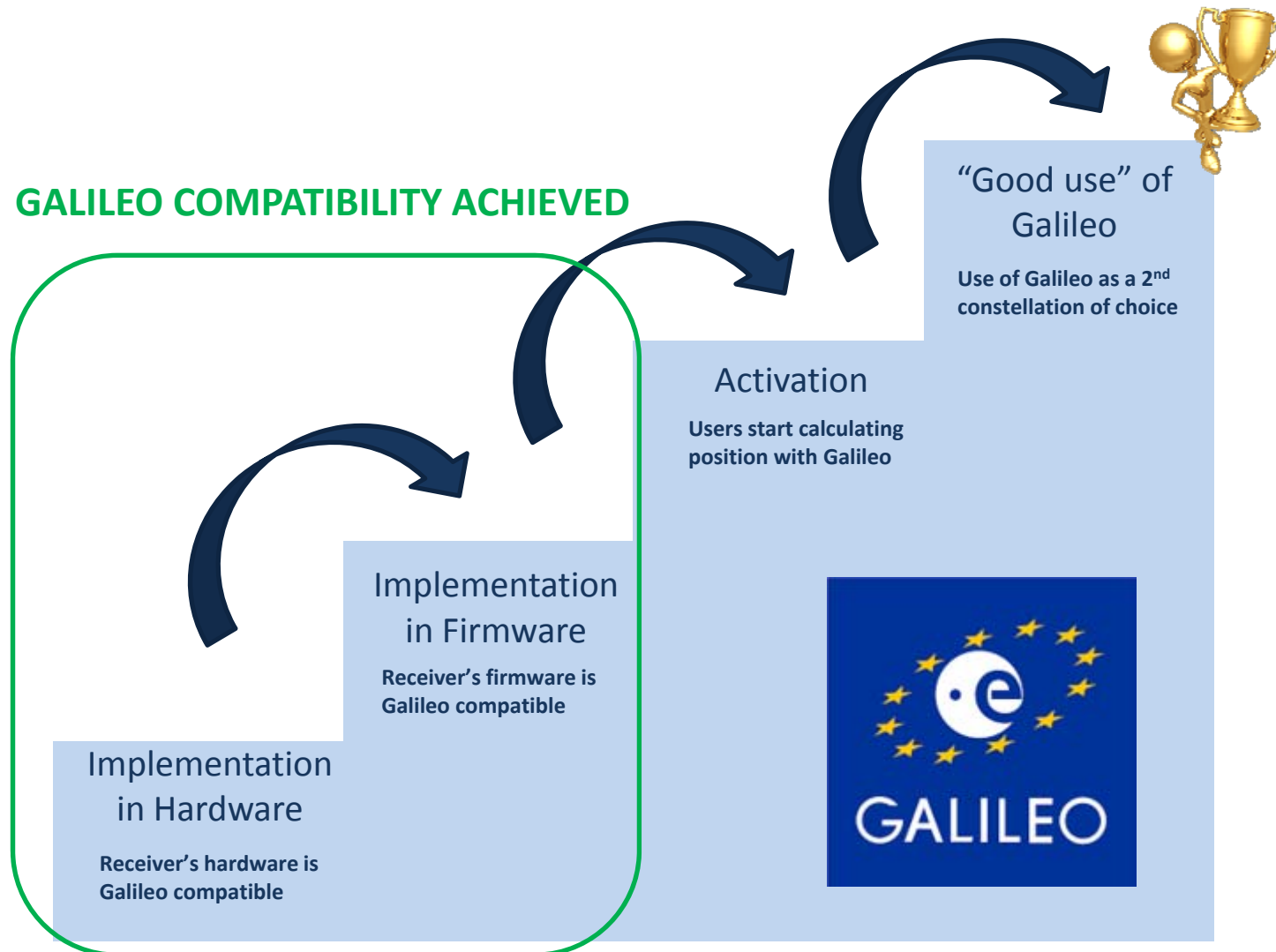
GALILEO

Telecom operators play a role in Galileo adoption as they issue requirements towards OEMs

3

STEP 3: Activation of GALILEO by OEM (SMARTPHONE)

- Consultation conducted with major EU operators and GSMA

- Galileo already included (or going to be soon) among device requirements by some leading operators

- Further actions planned towards full engagement

Requirements towards OEMs

GNSS works much faster at connected devices using the assistance data – already available for Galileo!

STEP 4: "GOOD USE" of GALILEO with ASSISTANCE DATA

3GPP ➡ 3G, 4G/LTE…
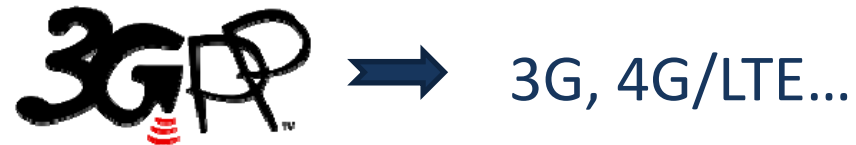
Galileo already included in **Assisted GNSS standard**, starting from next release…

…which means there is no action needed at the level of location server providers such as Google!

The ultimate step is to stimulate the application development to valorise Galileo differentiators

Dancing with apps: Galileo Hackathon codes for the community
—
Published: 07 November 2016

Didactic Disco - "a fun map drawing game, but one that had potential for serious use too."

EU STRENGHT LIES IN APPLICATIONS DEVELOPMENT

4 — STEP 4: "GOOD USE" of GALILEO with innovative applications
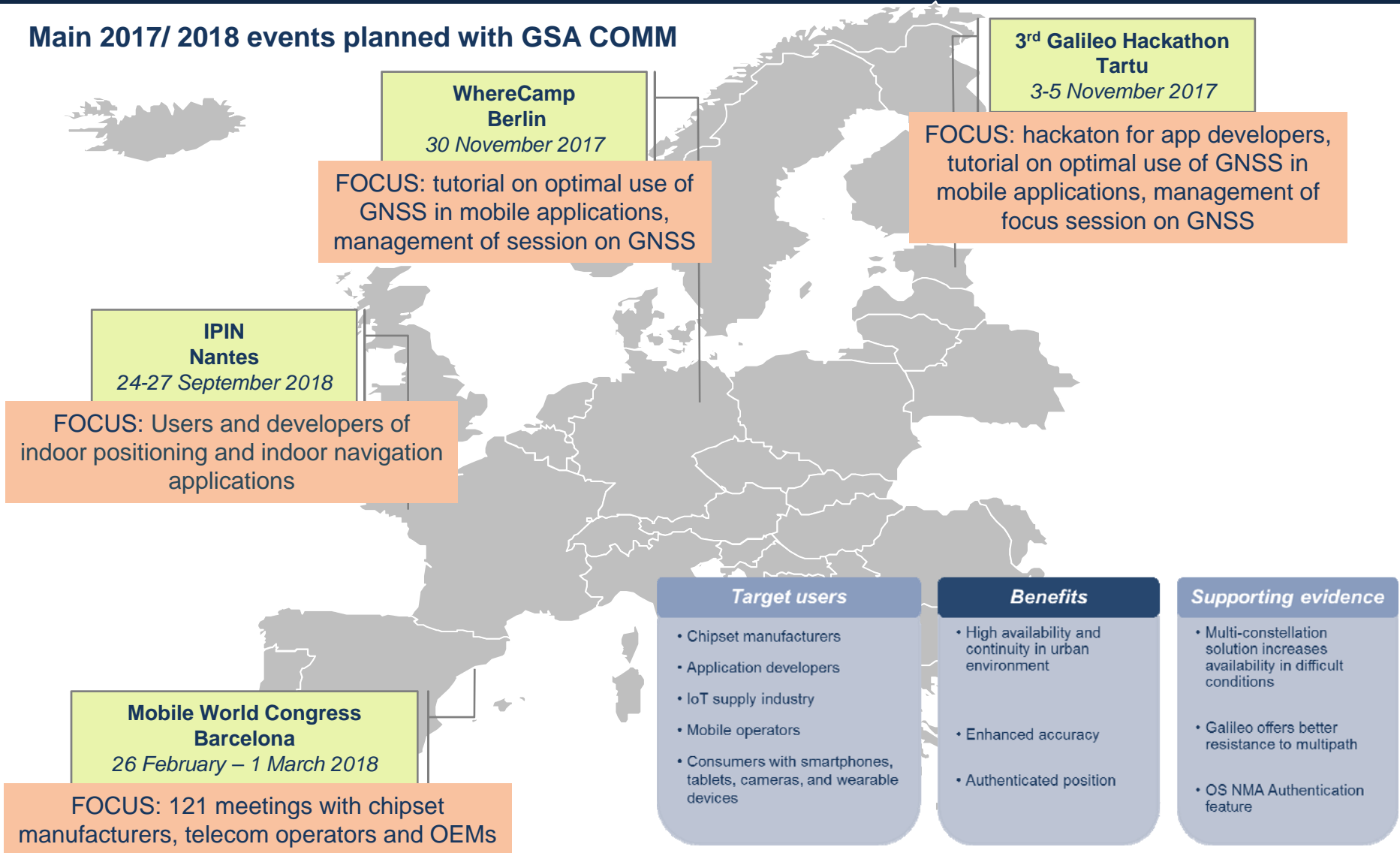
Dedicated events organized alongside Initial Services:

- Organization of an Hackaton at Wherecamp Berlin 2016

- Awards and demonstrations for developers (e.g. Geo IoT World Awards 2016)

- European Satellite Navigation Competition (9th edition)

Working with stakeholders: focus on OEM activation and app development

How to get there

Main 2017/ 2018 events planned with GSA COMM

3rd Galileo Hackathon Tartu
3-5 November 2017

FOCUS: hackaton for app developers, tutorial on optimal use of GNSS in mobile applications, management of focus session on GNSS

WhereCamp Berlin
30 November 2017

FOCUS: tutorial on optimal use of GNSS in mobile applications, management of session on GNSS

IPIN Nantes
24-27 September 2018

FOCUS: Users and developers of indoor positioning and indoor navigation applications

Mobile World Congress Barcelona
26 February – 1 March 2018

FOCUS: 121 meetings with chipset manufacturers, telecom operators and OEMs

Target users
- Chipset manufacturers
- Application developers
- IoT supply industry
- Mobile operators
- Consumers with smartphones, tablets, cameras, and wearable devices

Benefits
- High availability and continuity in urban environment
- Enhanced accuracy
- Authenticated position

Supporting evidence
- Multi-constellation solution increases availability in difficult conditions
- Galileo offers better resistance to multipath
- OS NMA Authentication feature

European
Global Navigation
Satellite Systems
Agency

THANK YOU