

European  
Global Navigation  
Satellite Systems  
Agency



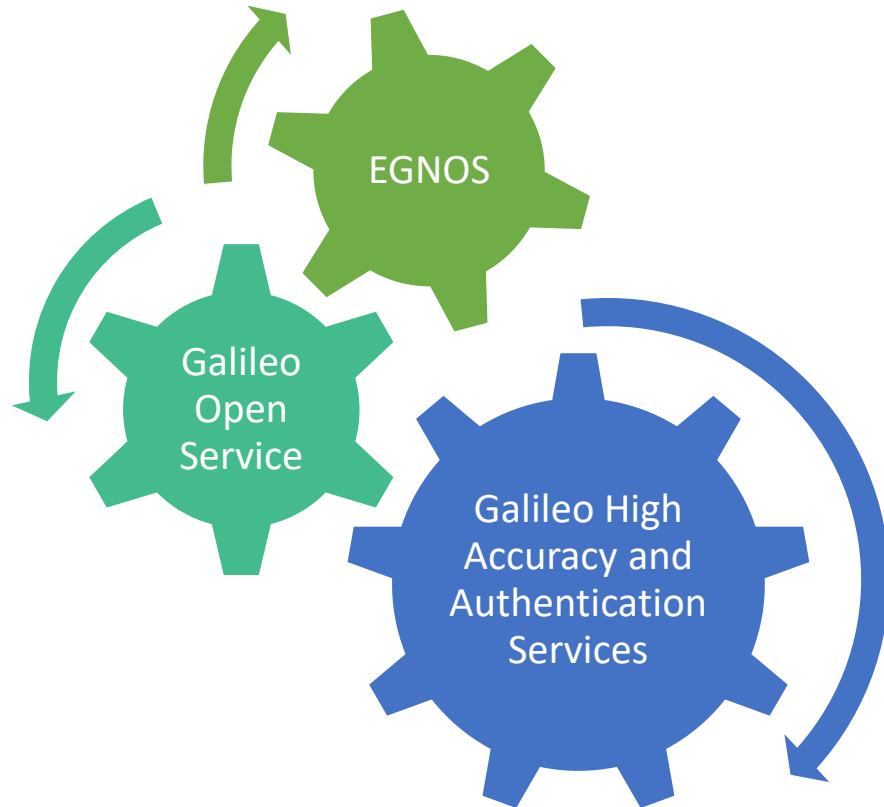
# EGNOS and Galileo for Precision Farming

United Nations/Romania International Conference on Space Solutions  
for Sustainable Agriculture and Precision Farming

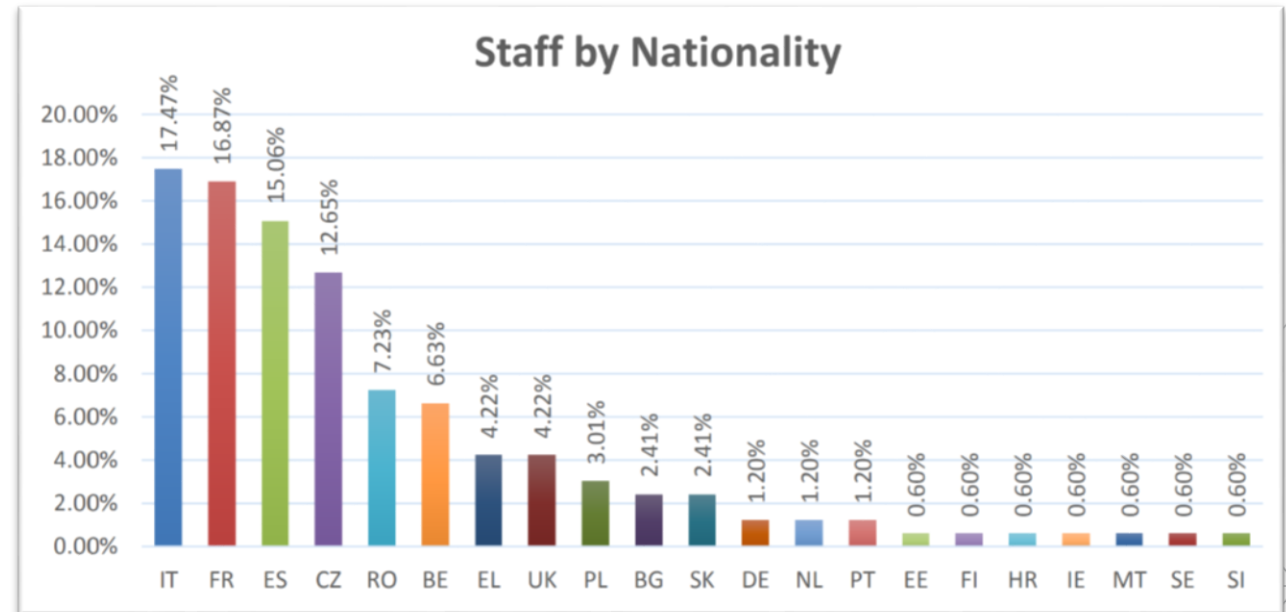
**Joaquín REYES GONZÁLEZ**

**May 6<sup>th</sup> 2019, Cluj (Romania)**

# Relevant European services are available for agriculture



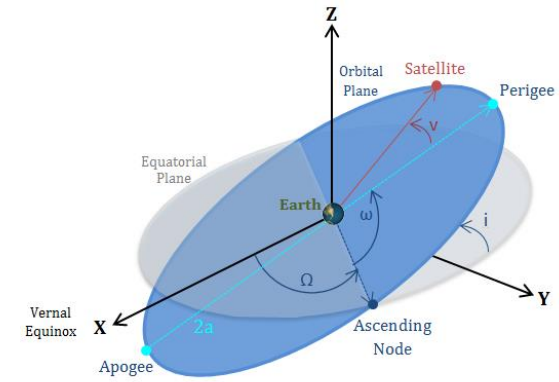
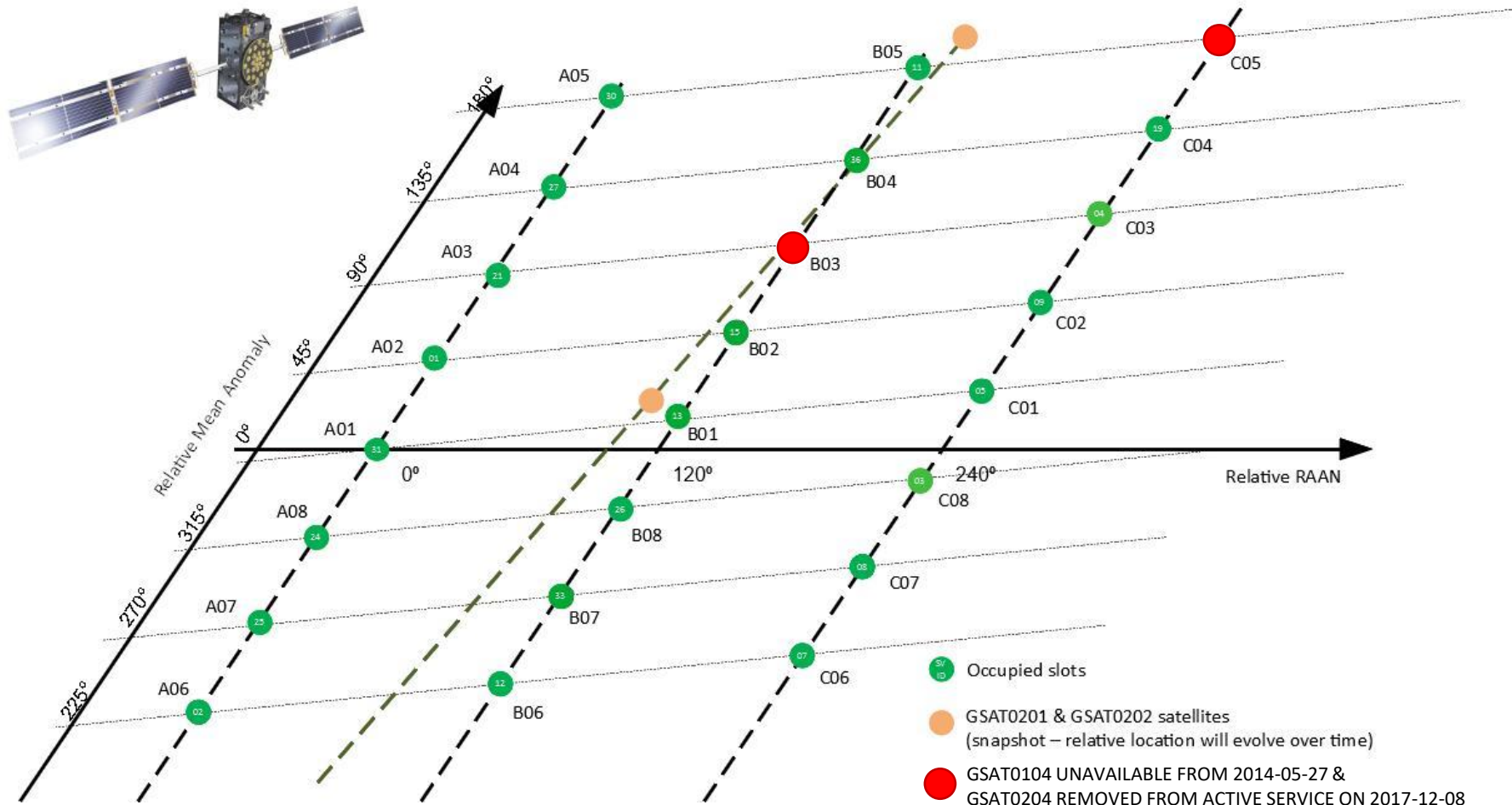
# GSA is headquarter in Prague with Galileo subsidiaries across Europe



Source: SPD 2018

Find more information at [www.gsa.europa.eu](http://www.gsa.europa.eu)

# GSA reports the Galileo Constellation status at the GNSS Service Centre



Find more available information at [www.gsc-europa.eu](http://www.gsc-europa.eu)

# EGNOS already available serving EU citizens and industry



- Accuracy  $\sim 1\text{m}$ , free



Open Service (OS)

- Accuracy  $\sim 1\text{m}$ , **compliant to aviation standards** by providing correction data and **integrity**

Safety of Life Service (SoL)



- Accuracy  $< 1\text{m}$ , **corrections provided via internet**

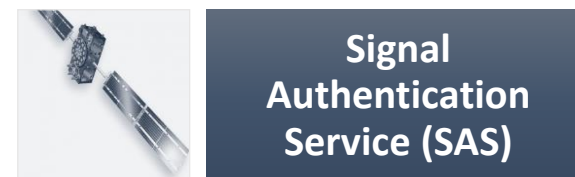
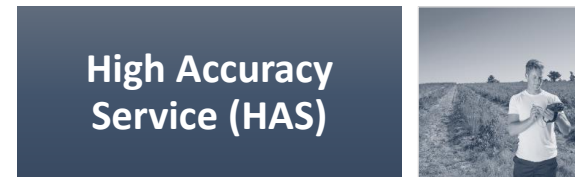
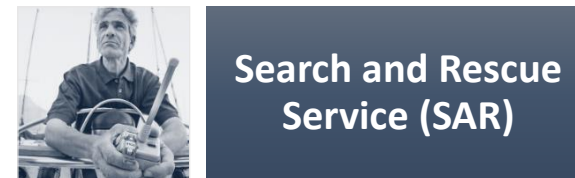
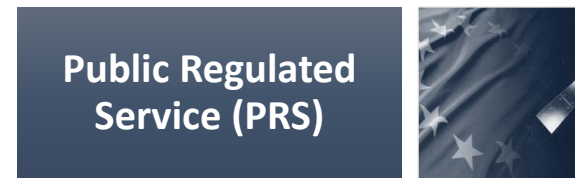
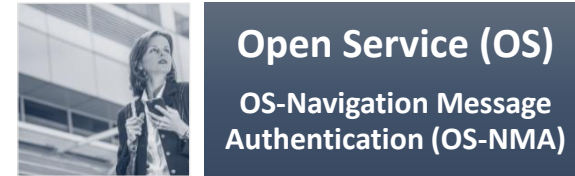
EGNOS Data Access Service (EDAS)



# Galileo is the European GNSS offering a wide range of services



- Freely accessible service for positioning, timing and navigation message authentication
- Encrypted service designed for greater robustness and higher availability
- Assists locating people in distress and confirms that help is on the way
- Freely accessible high accuracy positioning service
- Authentication service based on the E6 signal code encryption and OS-NMA, allowing for increased robustness of professional applications



# EGNOS and Galileo provides advantages to both farmers and society



**Affordable entry-level solution** for precision agriculture

**“Free” Sub-meter accuracy** for basic-value crop cultivation (e.g. cereals)



**New value-added services**

**Improvement of existing ones**

**Innovative applications**



More satellites, Galileo signal design and multi frequency capability contribute to **better operations in harsh environment**

The only constellation offering **“Free” high accuracy service** directly from satellites **without dependency of Internet** or additional communication channels, and **Authentication** services

**EGNOS and Galileo provides advantages to both farmers (higher profits margins) and society (increased food supply and more environmentally friendly agriculture)**

**Around 80% of all ‘GNSS tractors’ in the EU are EGNOS enabled**

**Around 55 % of all new ‘GNSS tractors’ in the EU are Galileo enabled**



# Machine guidance receiver testing campaign to confirm Galileo added value for precision farming activities



- **Open call for interest** in a testing campaign of agriculture receivers
- **All top manufacturers expressed their interest**
- The testing campaign using **live signals in different environment** will be conducted at specialised testing facilities in 2019
- The final goal is to **properly estimate specific key Parameters** such as Pass-to-Pass accuracy or Positioning error, but also to **assess the added value of Galileo** through the different configurations and different environment.





# Today's way of life is transforming agriculture needs



World **population** is growing



Climate change



Impact of **urbanisation** on rural labour



Eating habits and consumption **patterns** are changing



**Shrinking of arable land**



**Price and availability of energy**



People are “**connected**” and globally networked



**Precision and Digital Farming help to cope with the food, agriculture and climate challenges**

# Bigger machines are no solution for today's challenges



Image courtesy CLAAS



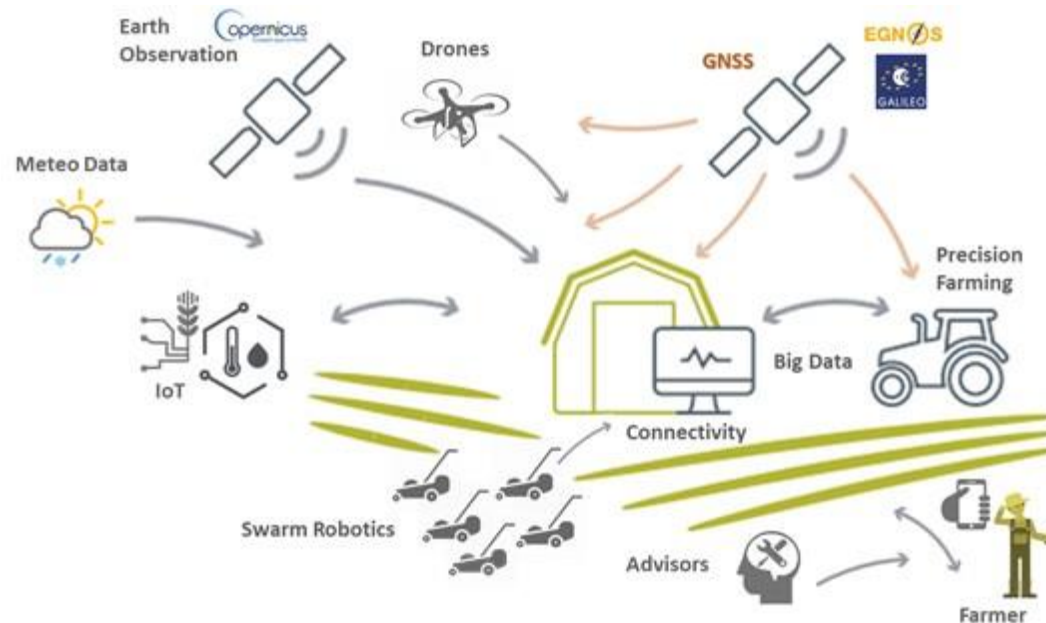
Image courtesy MM Channel



# GNSS is the core component in the digital farming ecosystem (Agriculture 4.0)



1.0: Year 1900 Mechanisation	2.0: Year 1950 Green Revolution	3.0: Year 1990 Precision Agriculture	4.0: Year 2010 Digital Farming
Introduction of tractors Increasing efficiency Manual labour required Low production, family needs	New agronomical practices Use of fertilizer and pesticides Improvement of quality seed Increasing the yield	Guidance Sensing and Control Telematics Data Management	Cheap and improved sensors and actuators Cloud based ICT systems High bandwidth cellular com Big Data Analytics



**GNSS has become one out of many elements in the complete production system, although an eminently important one**

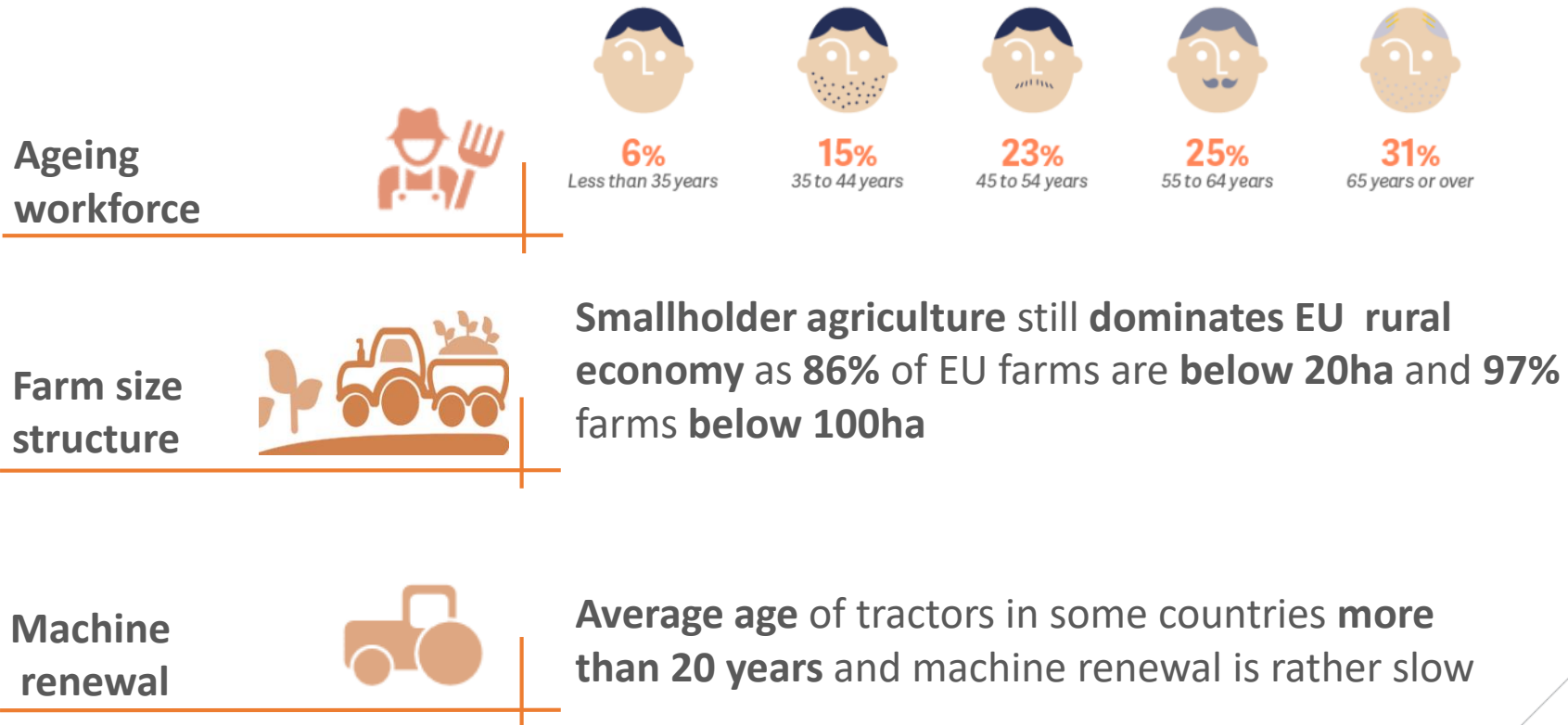
# Today's precision farming offers more possibilities with increased efficiency and sustainability



Image courtesy CLAAS



# However, the uptake of Precision Farming is still very low in Europe and varies from country to country



As a result, still, less than 25% of EU farmers have access to Precision Agriculture technologies according to CEMA

# However, the uptake of Precision Farming is still very low in Europe and varies from country to country



Image courtesy Aerovision



**Precision agriculture without GNSS**

# Key market and technology trends in agriculture



Increased connectivity (**IoT**), advanced sensing capabilities (e.g. via **satellites** and **drones**) and **big data**

**GNSS** has become an integral part of smart, connected and integrated farm management solutions and a **key driver** for precision farming across the whole crop cycle

**Precision Farming market** is growing at a **CAGR of 14%**, driven by increased adoption of **GNSS-enabled telematics solutions**

**5G**: a key to unlock the benefits of **digital farming**

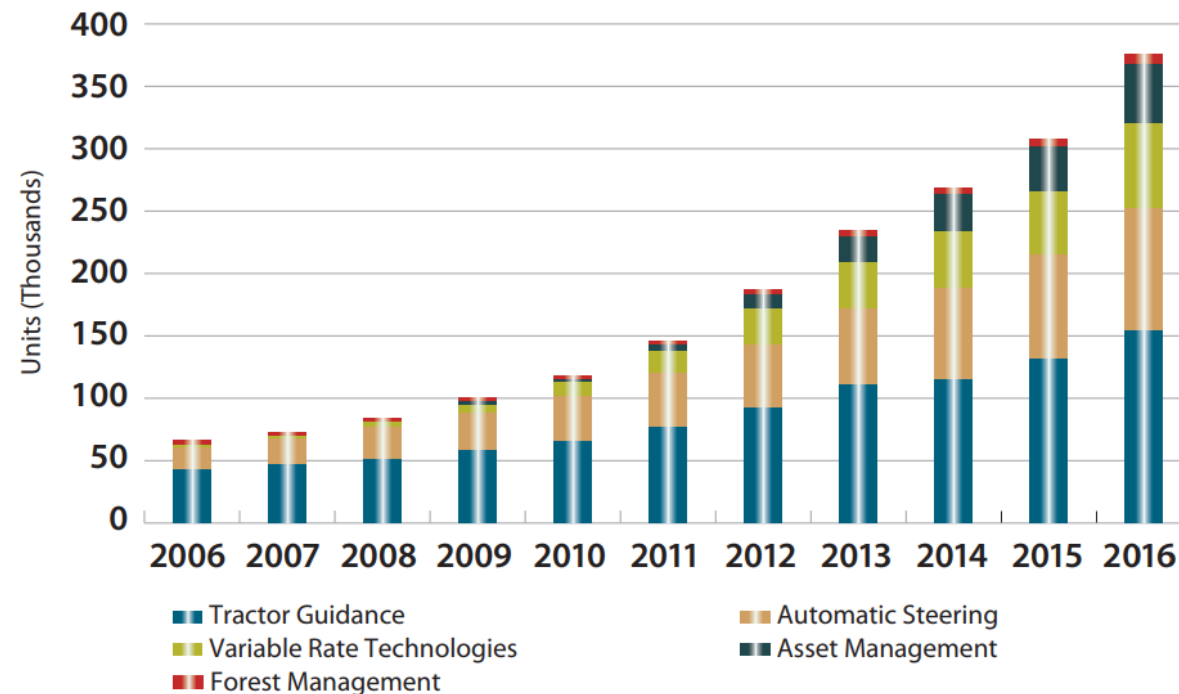
**Vertical Farming and inter-cropping**



# Precision agriculture solutions registered growth across applications



Shipments of GNSS devices by application



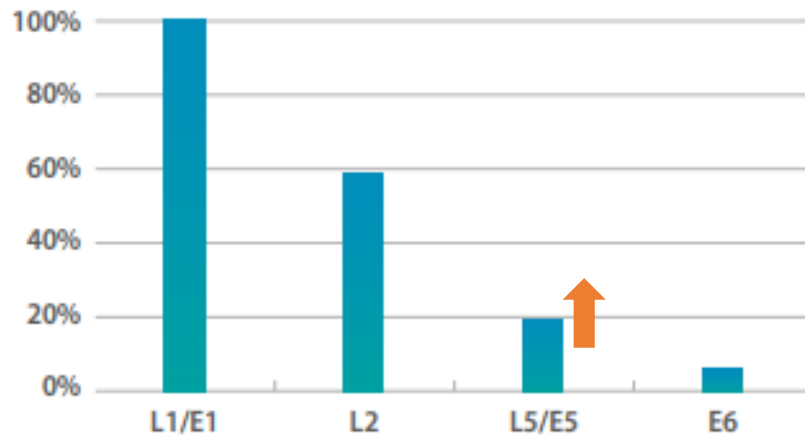
**Tractor Guidance and Automatic Steering continued to constitute the most spread application**



# Stringent requirements in precision agriculture are behind the wide adoption of Galileo key differentiators

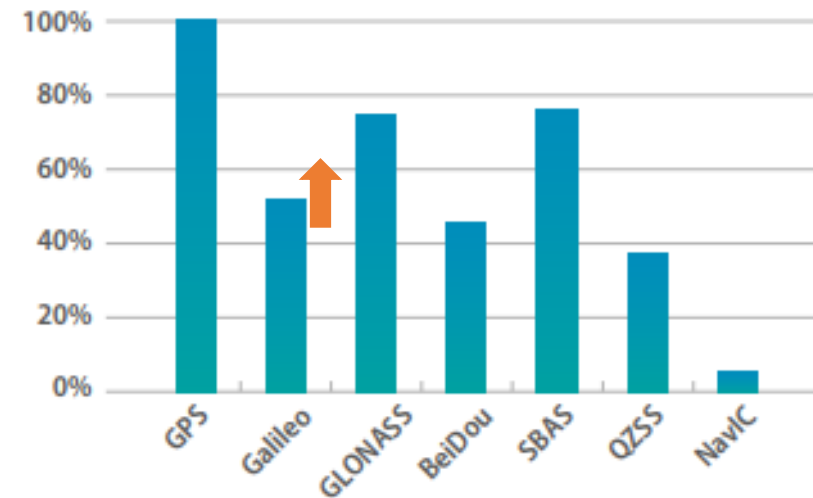


Frequency capability of GNSS receivers<sup>1</sup>



<sup>1</sup> shows the percentage of receivers supporting each frequency band

Constellation capability of GNSS receivers<sup>2</sup>



<sup>2</sup> shows the percentage of receivers capable of tracking each constellation

**Augmentation services**

Majority of RTK providers upgraded or have started to upgrade to Galileo capabilities and the main PPP or PPP-RTK providers support Galileo corrections

# A Growing potential for high-precision solutions delivered through mass market devices



Android 7+ access to raw GNSS measurements

Dual frequency mass market receivers

Democratisation of mapping and affordable augmentation services

Over 125 smartphones models Galileo enabled



GSA GNSS Raw Measurement Task Force

World's first two dual-frequency GNSS smartphones hit the market



Mobile apps are becoming increasingly important in precision agriculture



Smartphones will be the most popular platform for farmers in getting a real-time data of the farming management system



# Dual frequency brings better positioning performance



- Red: BCM4774 (L1)
- Green: BCM4775 (L1+L5) – dual frequency

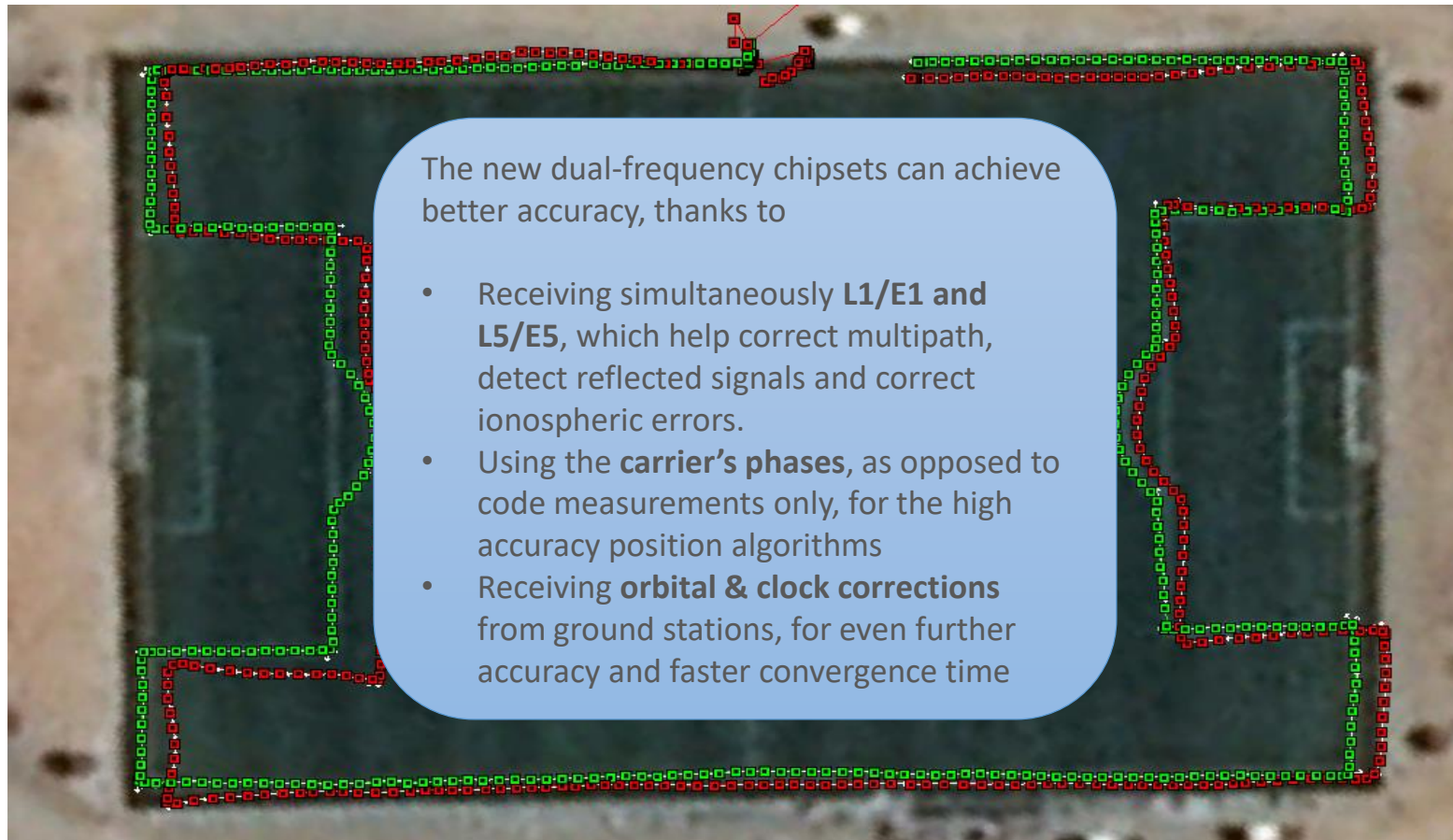
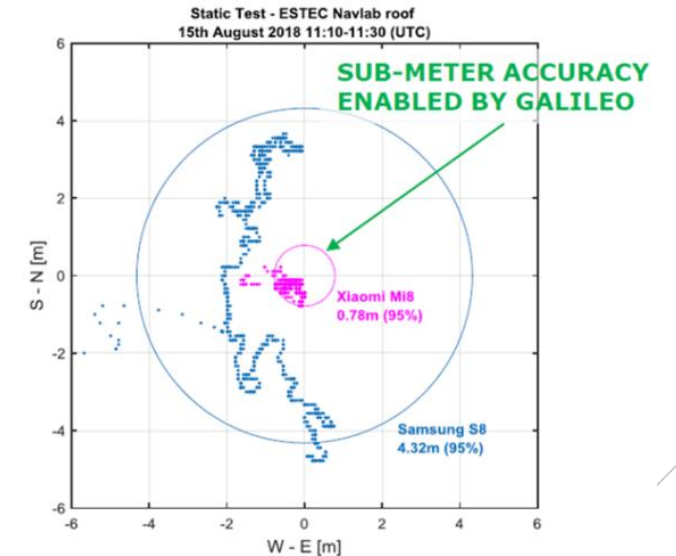
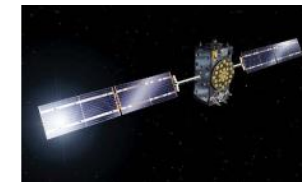


Image Courtesy of Broadcom



Source: ESA



**22 operational Galileo sat (E1/E5)**



**12 operational GPS Block IIF sat (L1/L5)**

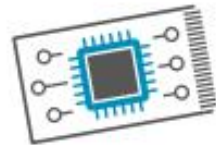
# Spoofing, the emerging threats across all market segments



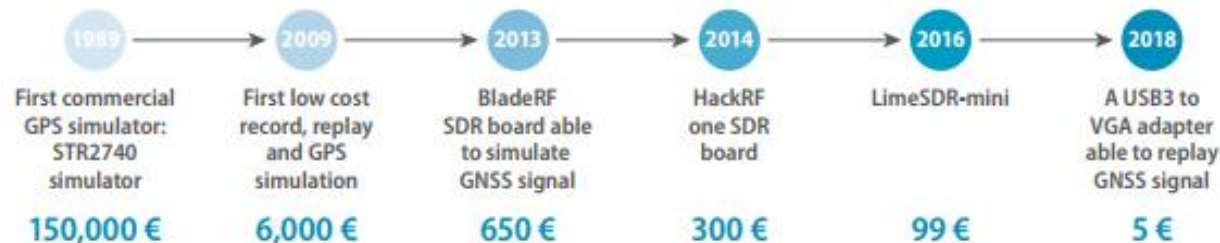
The importance of protecting against vulnerabilities was strongly highlighted during the User Consultation Platform (UCP) as a common theme of user demands across all market segments



GNSS SPOOFING CAPABLE DEVICES EVOLUTION COST



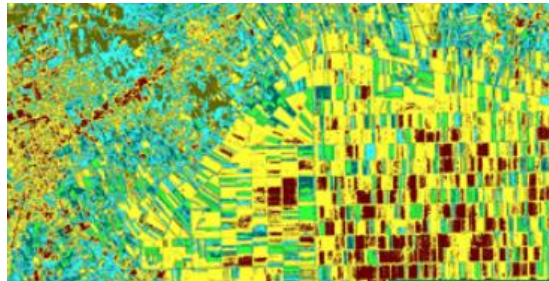
OS-NMA is the ability of the system to **confirm to the users** that they are **utilising navigation data**, which comes from **Galileo satellites** (and not from any other sources).



# E-GNSS works in synergy with Copernicus at the centre of new CAP



Monitoring approach using Sentinel data



E-GNSS based tools and applications



Smartphone based Geo-tagged Photos



Galileo brings **unique features** to achieve both **higher accuracy** (dual-frequency, upcoming high-accuracy services) and **robustness** (message authentication)

# GSA is funding an Android APP (based in EGNSS) for geo-tagged photos



## Objective

- Open Source **Android application** using GNSS raw measurements that can be integrated and customise for end-user solutions.
- To generate input for the Integrated Administrative Control System (IACS) of the Common Agricultural Policy (CAP).

## Benefits

- All the EU paying agencies will benefit from smoother flow of information into their systems.
- To enable farmers around EU to digitalize many procedures reducing errors and duplication and improving efficiency.

## Timeframe

- The outcome shall be available by Q4 2019, in line with the Galileo Open Service Navigation Message Authentication Signal in Space (OS-NMA SiS testing phase).



# Find today a Galileo-enabled device to use all the advantages



Over 125 smartphone models are **Galileo** enabled

Galileo dual-frequency smartphones and upcoming high-accuracy services will allow **sub-meter accuracy and more robust positioning** which will **accelerate innovative solutions** in CAP and Digital Farming



# Copernicus address 6 main thematic areas, corresponding to daily needs of European citizens



*Copernicus Atmosphere Monitoring Service (CAMS)*



*Copernicus Climate Change Service (C3S)*



*Copernicus Marine Environment Monitoring Service (CMEMS)*



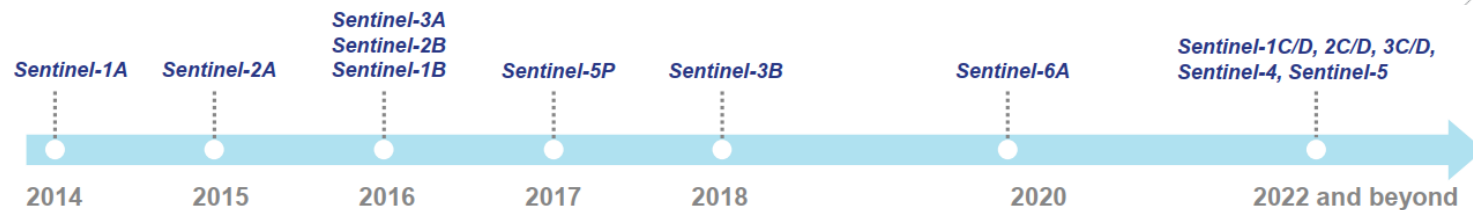
*Copernicus Emergency Management Service (CEMS)*



*Copernicus Land Monitoring Service (CLMS)*



*Copernicus Security Service*





# The joint use of E-GNSS and Copernicus unleashes an array of synergies



## Synergies

### Value-Added app



Urban planning

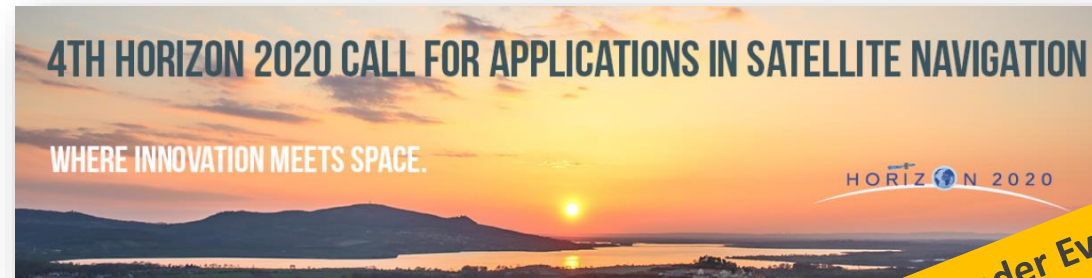
Precision farming

Natural resources management

Smart mobility



# GSA has been leveraging two main R&D programmes as tools to stimulate the offer and increase E-GNSS adoption



**Under Evaluation**



Aims to foster adoption of EGNSS via content and application development and supports the integration of services provided by these programmes into devices and their commercialisation



Fundamental Elements projects focus on fostering the development of innovative Galileo and EGNOS enabled receivers, antennas and chipsets technologies

# Farming by Satellite contest is fostering innovation and business ideas



**How can we use Satellite Technologies to Improve Agriculture and Reduce Environmental Impact?**

A summer project competition for students and young people across Europe

**FARMING BY SATELLITE prize**

Logos at the top: ESA, European Environment Agency, CLAAS, Copernicus, GALILEO, EGNOS.



Teagasc, the Irish Agriculture and Food Development Authority, took the first prize in 2018 year's competition with **FODDERApp**, a mobile app for grass and grazing management



<http://www.farmingbysatellite.eu/>

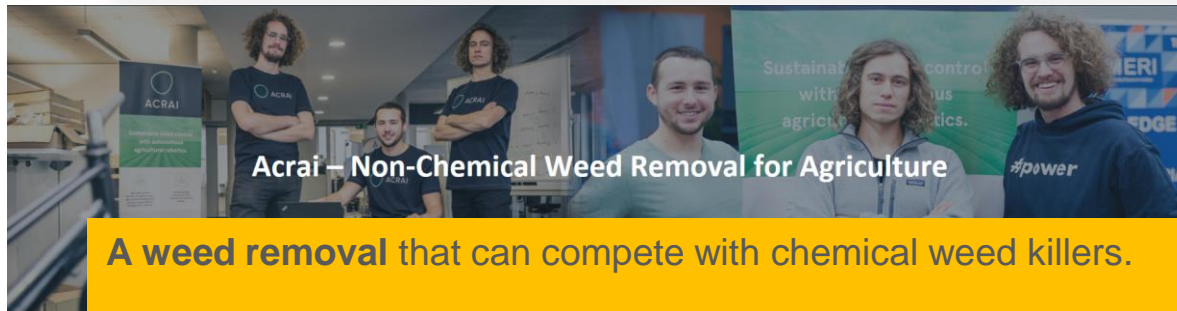
# Galileo Masters competition annually awards the innovative ideas using satellite navigation in everyday life



Protecting Wild Animals During Harvesting with Galileo-Enabled UAVs

**Saving lives of hundreds of thousand wild animals** that are being killed every year by mechanized crop harvesting.

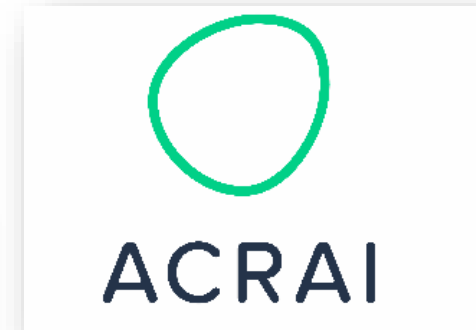
**A simple combination of Galileo enabled drones, infra-red cameras and near real time access to Land Parcel Information System.**



Acrai – Non-Chemical Weed Removal for Agriculture

**A weed removal that can compete with chemical weed killers.**

**The solution relies heavily on the use of GNSS to navigate and relocate robots on the field.**



# Interested to know more? Feel free to download GSA GNSS reports



## GNSS market trends & applications



<https://www.gsa.europa.eu/market/market-report>

## GNSS receiver trends & technology



[https://www.gsa.europa.eu/system/files/reports/gnss\\_user\\_tech\\_report\\_2018.pdf](https://www.gsa.europa.eu/system/files/reports/gnss_user_tech_report_2018.pdf)

# Linking space to user needs



How to get in touch:



[www.GSA.europa.eu](http://www.GSA.europa.eu)



[EGNOS-portal.eu](http://EGNOS-portal.eu)



**GALILEO**

[GSC-europa.eu](http://GSC-europa.eu)

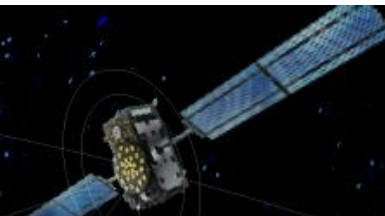


[UseGalileo.eu](http://UseGalileo.eu)



The European GNSS Agency is hiring!

**Apply today** and help shape the future of satellite navigation!



# EC, JRC and GSA are taking concrete steps for a geo-tagged photo application



GSA is boosting the innovation around the high-precision and Open Service, Navigation Message Authentication in the mass market

EC in cooperation with GSA/JRC to build an Open Source Application which will help to achieve better positioning accuracy and increased robustness for geo-tagging photo application for post-2020 CAP

## GNSS Raw Measurements Task Force



Since June 2017

## GSA supports R&D



Next steps:  
2019  
2020 – 2021

Solution implementation  
Application available for MS

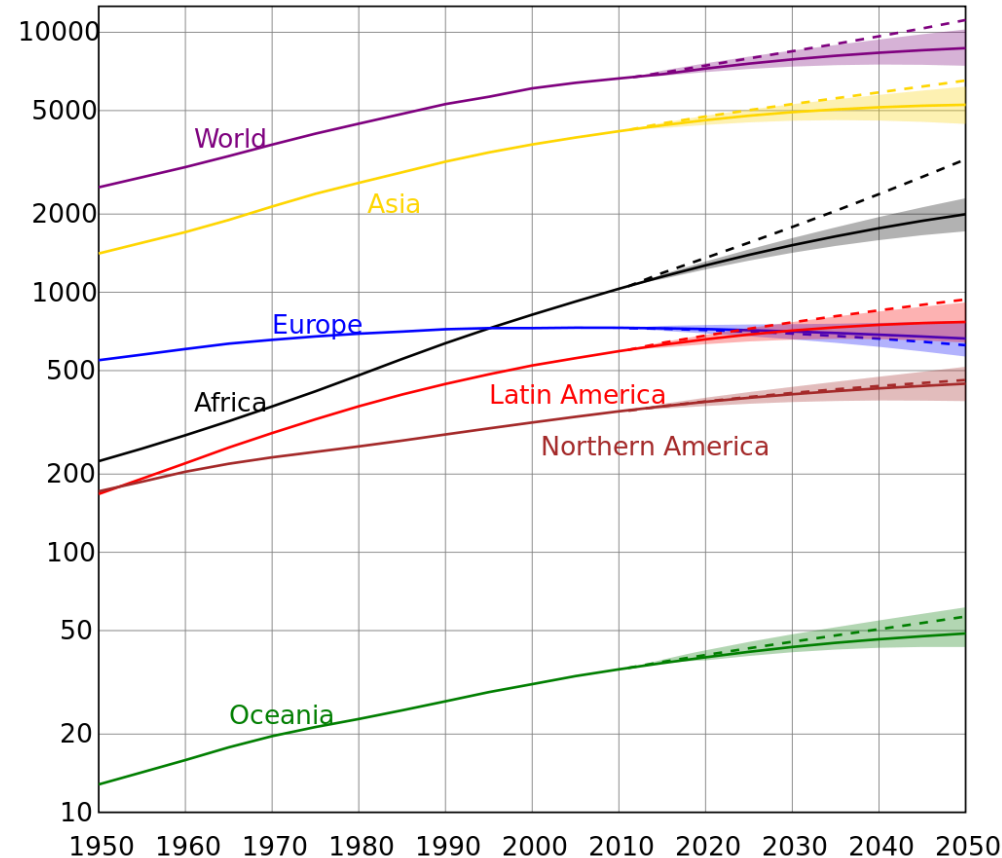


The need for synchronisation with other R&D initiatives, stakeholders (MoA, Paying agencies), JRC, DG Agri, etc.

# Agriculture is a strategic sector for the European society and economy



The increased global food demand and limited natural resources, require increasing the profitability and production in agriculture and form the main drivers of usage of **precision farming techniques**.

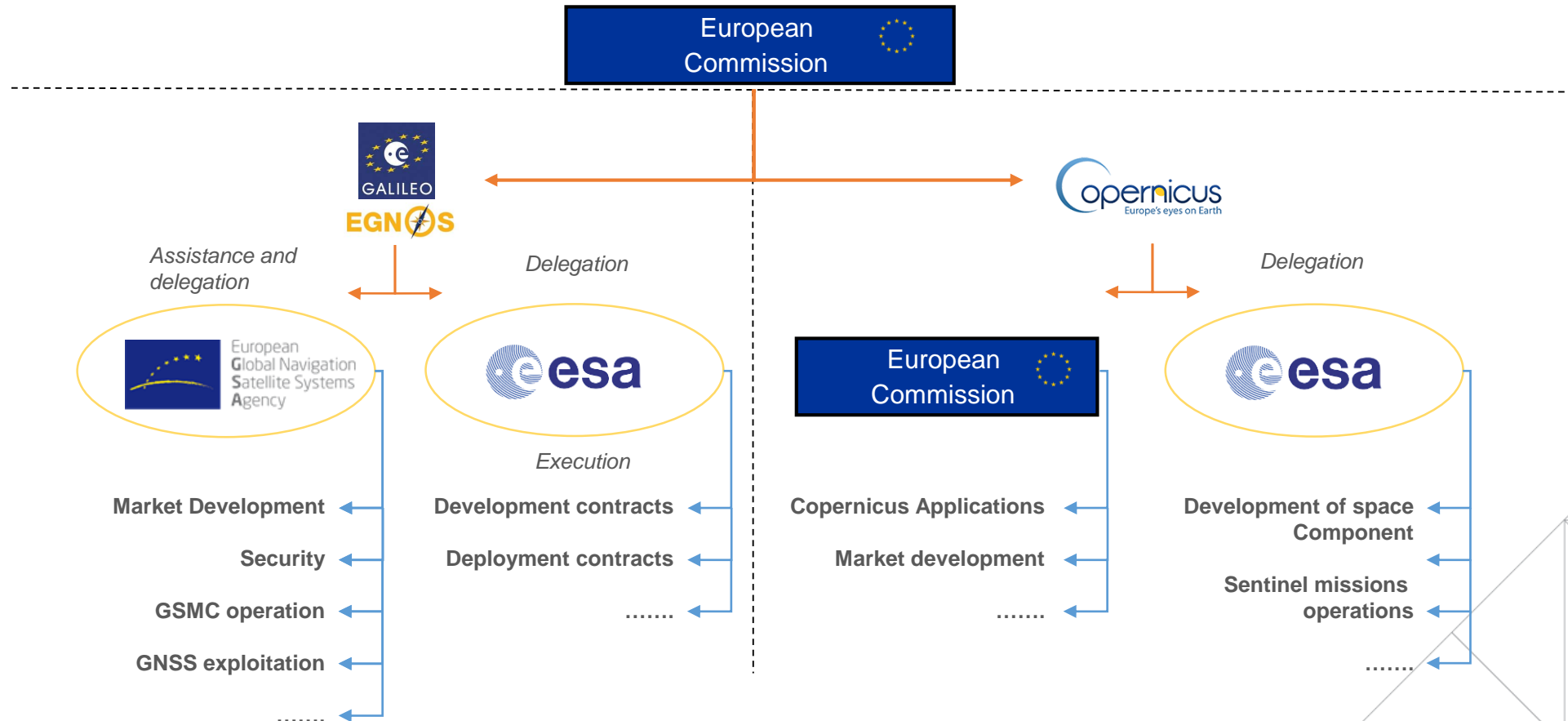


Estimation of population evolution, versus years, in different continents between 1950 and 2050, according to the United Nations. The vertical axis is logarithmic and is in millions of people.

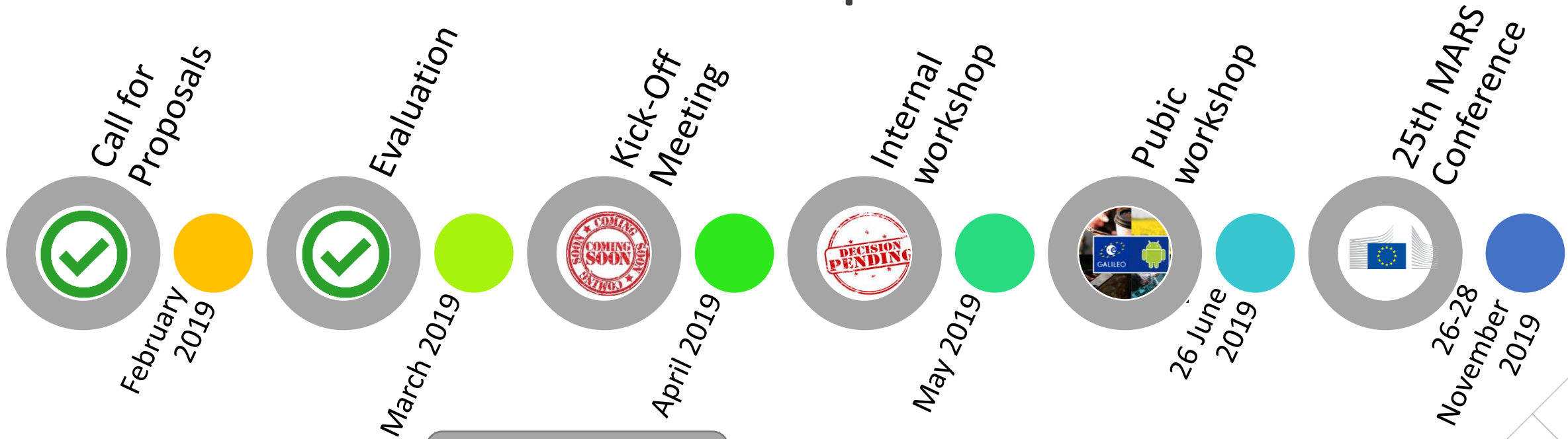
**GNSS is the backbone and enabler of precision farming**



# The role of GSA in the EC space programmes



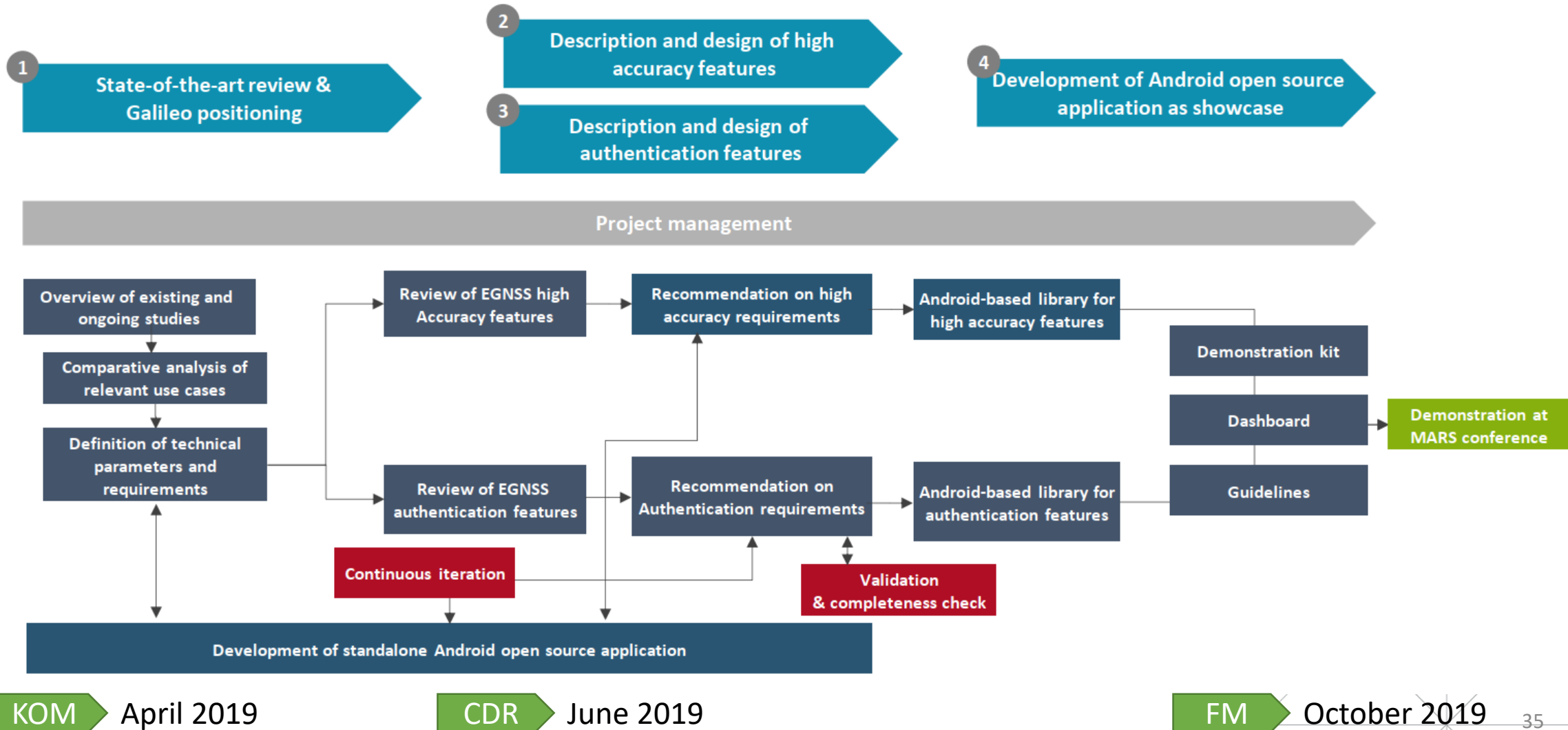
# The timeline is already defined and you are welcome to follow-up!



[joaquin.reyes@gsa.europa.eu](mailto:joaquin.reyes@gsa.europa.eu)



# Timeline is already defined



# Example 1: GNSS-Copernicus synergies support optimal application of fertilisers



## Agriculture: VRT (Variable Rate Applications)



- Differentiated maps of the crops: health of crops, vegetation index (NDVI)



EGNOS



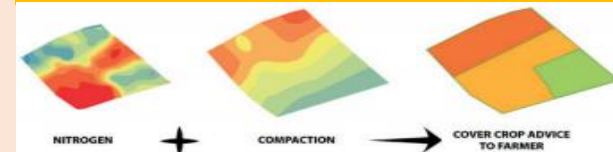
- Location-tagging of soil/plant samples
- Highly accurate positioning of machinery

### Synergetic output

- Create a simple guide for farmers on how to best apply fertilisers and pesticides where and when they are most necessary

### Benefit

- Lower environmental footprint



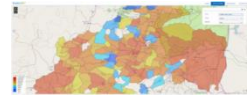
# Example 2: EGNSS-Copernicus synergies provide enhanced soil monitoring capabilities



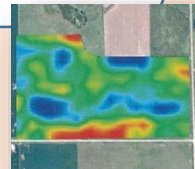
## Agriculture: Soil monitoring (humidity, sampling, etc.)



- Agricultural field's soil conditions (humidity, composition)
- Evaporation data



- In-situ measurements of soil parameters (e.g., moisture by GNSS reflectometry)
- Geo tagging local measurements for validation and calibration



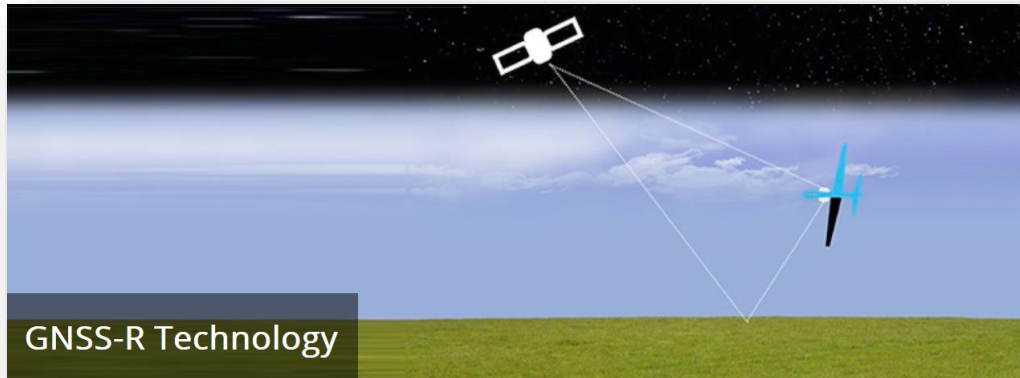
### Synergetic output

- Metre and sub-metre level maps of soil parameters
- Targeted irrigations and treatments

### Benefit

- Optimised water consumption

# H2020 Mistrale project delivers soil moisture content information



Using dedicated RPAS to measuring soil moisture using the GNSS Reflectometry

Providing **soil moisture content information** to farmers and water managers. Besides soil moisture maps, Mistrale can also produce maps of **water logging, flooding extent and other soil moisture related information products.**



# H2020 Greenpatrol robot for Integrated Pest Management in Greenhouses



Innovative and efficient **robotic solution** for **Integrated Pest Management** in Greenhouses.

The robot will use the most sophisticated **signals** of satellites especially the **Multiple-frequencies** E1, E5 and E6 by **Galileo**, the network of European satellites for accurate global positioning.

