

# HORIZON EUROPE EGNSS UPSTREAM R&D

Prof. Thomas Pany, Uni. Armed Forces, Germany

HORIZON EUROPE CONSULTATION WORKSHOP • Prague, 13<sup>th</sup> Sept. 2019

# Service first ...



# White spots on the Galileo map ...

Galileo developed according to ESA standards ...

- To which extent can those standards be applied to a navigation service?
  - Procurement and operation under market conditions and political constraints!
- Galileo appears to the public as satellites, services and applications
  - But what about ground segment and operations?
- R&D on procurement, operations and ground segment
  - Conceptual, programmatic and regulations
  - To understand relevant process, make them robust against market conditions, foster interest of young people

# The GNSS challenge



## New nav. Technologies:

- Camera/LiDAR (Aug. Real)
- HD Radar (self driving)
- *Unprecedented Acc. & Avail*

Who is the backup?

C-band for small user antenna arrays  
Mega-constellation

GNSS/Galileo



Signal optimization

# Galileo navigation message improvements

- Classical one-way satellite navigation highly consolidated; nevertheless Galileo found great ways of improvements:
  - I/NAV improvement on E1 (reduced TTFF)
    - *On-demand research based on established comm. knowledge*
  - OSNMA (authentication) on E1
    - *Demand created by research*
  - High Accuracy Service on E6
    - *On-demand adaption an established concept (PPP)*
  - E5b? E1D,E,F,...?
  - ...

**Willingness to focus and to wait (as within GPS)...**

**Flexibility in payload, ground segment and operations**

# The antenna array challenge ...

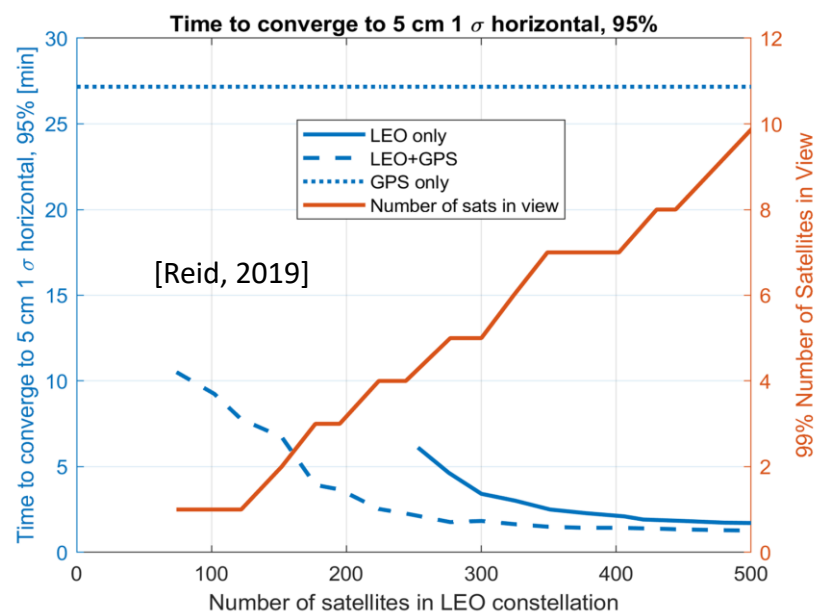
Today virtually only single antenna receivers are used ...

- But:
  - GSM/UMTS (single) => LTE (2x2,4x4) => LTE-A (8x8) => 5G (massive)
  - Receiver technology follows Moore's law
    - Now ready to support many elements
  - Obvious and well known benefits
    - Anti-jam, anti-spoofing, higher ranging accuracy, higher signal robustness (cycle slips, ...)
- But size matters ...
  - Antenna size ...  $1/f$
- Integration with 5G
  - Limited number of visible 5G transmitters
  - Massive 5G ground multipath, antenna array?

**Coordinated R&D to support higher GNSS  
frequency bands (C-Band and beyond)**

# GNSS mega-constellations

- Current MEO concept highly consolidated
  - 130+ satellites in orbit
- Mega-constellation (1000+ satellites)
  - Benefit in geometry, signal availability, PPP-convergence time:



- Feasibility?
  - No on-board atomic clocks!
  - Sync via MEO constellation? Inter satellite links?
  - Synergy with comm?

**THANK YOU**

thomas.pany@unibw.de

<http://ec.europa.eu/galileo>