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Space-based Signals of Opportunity - an Opportunity to Resiliency

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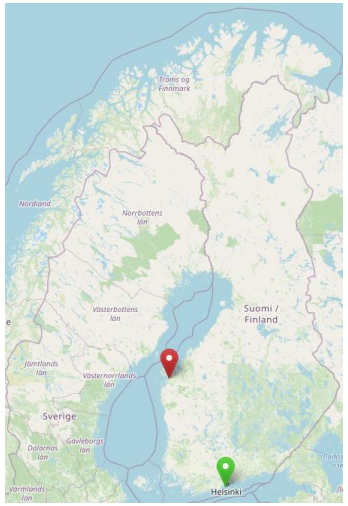
Background



openstreetmap.org

- University of Vaasa
- INCUBATE
  - The INCUBATE project aims at promoting the exploitation of LEO small satellites for precise position, navigation, and timing (PNT) information in challenging conditions and how these can be obtained in indoor environments.
  - Financed by Technology Industries of Finland Centennial Foundation and Jane and Aatos Erkko Foundation

Teknologiateollisuuden 100-vuotissäätiö

J&AE JANE JA AATOS ERKON SÄÄTIÖ

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What is opportunistic positioning

Terrestrial signals

- many sources
- TV - broadcast from low number of points to large areas
- Mobile networks - small cells - high number of transmitters

Space-based signals

- From terrestrial signal to space-based
- Global coverage
- No local tuning/surveying needed
- Huge constellations available or in the making

Photo by T.H. Chia on Unsplash

Opportunistic positioning - Why

- GNSS weaknesses
- Megaconstellations
- Availability in GNSS challenged and denied environments
- No need to build more infrastructure
- Resiliency
  - stronger signal
  - communication use, interference detection
  - space vehicle dynamics
  - high number of space vehicles

Photo by Jayden Staines on Unsplash

Opportunistic positioning - Why - SDGs

- 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- 11: Make cities and human settlements inclusive, safe, resilient and sustainable
- 12: Ensure sustainable consumption and production patterns
- 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

sdgs.un.org

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SoOp positioning

- Ways to do
  - Terrestrial with pre-surveying
  - Blind signal use
  - Reverse engineering
- Low earth orbit satellites
  - Communication satellites
    - Iridium, Starlink, OneWeb, Orbcomm
  - Earth observation satellites
  - LEO – rapid dynamics
- Doppler-based
- Pseudorange-based

SoOp positioning – business case

- Signal is free
- Space-based - available almost anywhere
- Co-operation with constellation owners/operators
- Building a product – threat of signal change and availability
  - risk mitigation by using multiple constellations
  - contractual agreement with operators
- Complexity with multiple constellations, signals and frequencies
- costs/development costs vs. use case (military/industry/consumer)

Resiliency

- Isolated constellation
- Huge number of satellites – one failure does not affect much
- Higher signal power
  - Frequencies chosen with data transmission and availability in mind
- Jamming - more constellations
  - Power and frequencies needed for jamming
- Spoofing - use of data transmission link
  - SoOp can be used passively but does not need to be

Challenges

- Some of the benefits are related to LEO
- Co-operation with satellite constellation operators
  - Guaranteed signal structure and availability
  - Reverse engineering of the signal
  - Overlapping signal availability in data transmission
- Satellite communication will be the driver
  - Supply chain uncertainty
- To which markets is SoOp suitable

References

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- Psiaki, 2021, Navigation using carrier Doppler shift from a LEO constellation: TRANSIT on steroids
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Thank you

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