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MBOC Multi-constellation Interoperable Signal: Consequences on the Noise Floor

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Introduction

- Scope of this presentation is to contribute to the discussion about the raise of the noise floor resulting from the pollution of the L1/E1 band

- Simulations of a Multi-Constellation Interoperable system based on an MBOC signal transmitted at 1575.42 MHz have been run

- Results on DOP and Interference caused by the presence of Multi-Constellation signals are presented as a function of the number of available satellites

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Simulation Settings

- A full simulation approach has been followed
    - ✓ Full orbit propagator
    - ✓ Dynamic link budgets performed at different places and times for the different satellites in visibility
- 3°x 3° grid for the user locations has been used
- Each constellation propagated over 10 days
- Post-correlator aggregate interference power spectral density to which the MBOC receiver is subjected computed following ITU-R M. 1831

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Simulation Scenarios - 1

- The performance of the Multi-Constellation Interoperable GNSS System are assessed with respect to the number of available satellites (systems)

    - For the moment GPS and Galileo are the only systems that have adopted MBOC for their baseline in E1/L1

    - Compass has announced the intention to transmit an MBOC Open Service Signal at 1575.42 MHz

    - A fourth and a fifth constellation are here taken into account

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Simulation Scenarios - 2

- Starting from a Galileo-Only constellation, four further steps are performed:
  - ✓ Galileo
  - ✓ Galileo + GPS
  - ✓ Galileo + GPS + Compass
  - ✓ Galileo + GPS + Compass + MBOC4
  - ✓ Galileo + GPS + Compass + MBOC4 + MBOC5
- Reasonable realistic assumptions for constellation characteristics and link budgets have been also considered

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Dilution of Precision

Horizontal and Vertical DOP
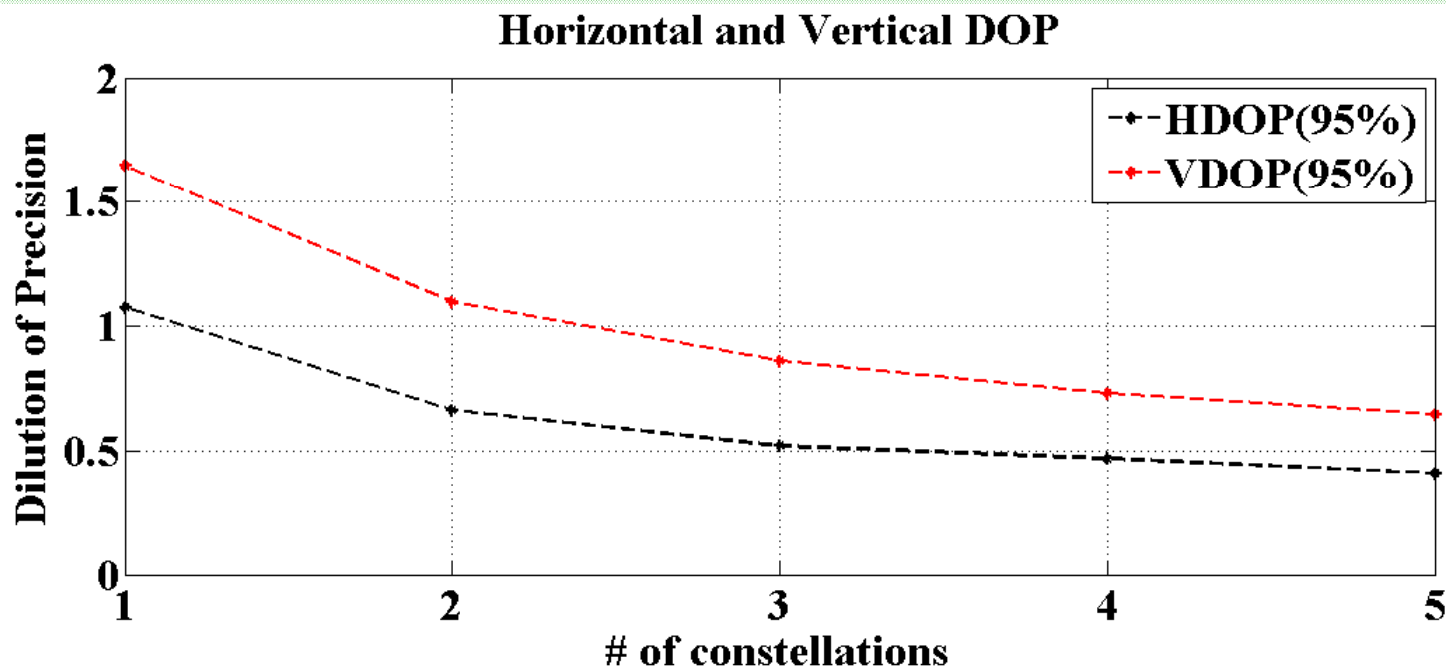
- **95th percentile of Horizontal and Vertical DOPs**

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Comments on DOPs Results

- Very big improvement from first to second systems (as very well known)

  - ✓ DOP improves of almost 33%

- The contribution of each further constellation to the DOP improvement is decreasing with increasing the number of constellations:

  - Third constellation: 22%

  - Fourth constellation: 15%

  - Fifth constellation: 11 %

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Aggregate Interference
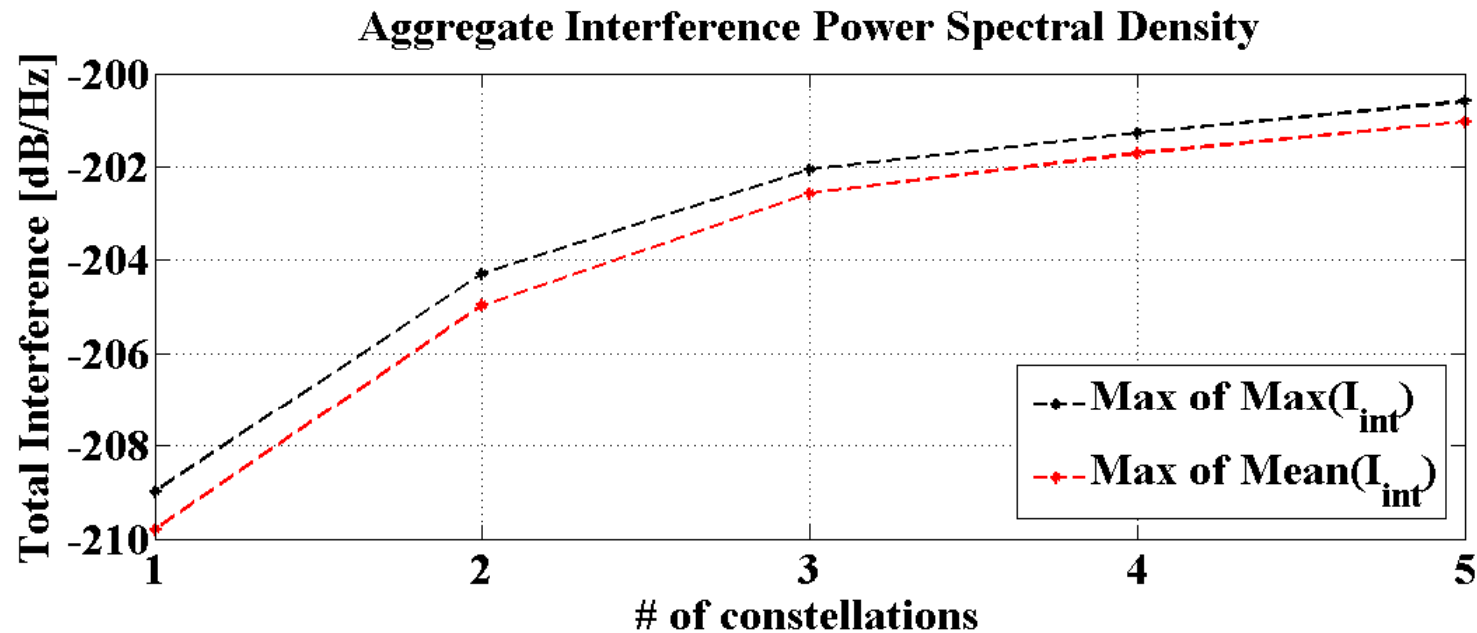
- $I_{int\_total} = I_{interop} + I_{inter}$
  - ✓ $I_{interop}$ is the contribution from the Interoperable MBOC signal transmitted by all the constellations
  - ✓ I_{inter} Is the inter-system interference (in this case interference from GPS C/A and P(Y))

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Conclusions - 1

- **The little improvement in terms of DOP for more than three systems (very limited) is annulated by the increase of interference level and code noise**

- **The level of the interference for more than three systems (reaching the noise floor) could cause harmful problems for the acquisition of many satellites**

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Conclusions - 2

- **Apportionment of the noise floor is an important criterion that should be discussed in order to limit the problem**

- **Compatibility is a fundamental prerequisite to achieve interoperability**

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Way Forward

- **This presentation is just an intermediate step of an ongoing activity on the topic of Multi-Constellation Interoperable GNSS system and receiver performance**

- **A more complete set of results based on several different simulation scenarios will be presented at a later stage**

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