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

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INTRODUCTION

APPROACH DESCRIPTION AND ASSUMPTIONS

SIMULATION RESULTS

CONCLUSIONS AND WAY FORWARD
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
- $3^\circ \times 3^\circ$ 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
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
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.
Dilution of Precision

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

![Graph showing Horizontal and Vertical DOP](image-url)
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%
**SIMULATION RESULTS**

**Aggregate Interference**

\[ I_{\text{int\_total}} = I_{\text{interop}} + I_{\text{inter}} \]

- **Max of Max** \( I_{\text{int}} \)
- **Max of Mean** \( I_{\text{int}} \)

- \( I_{\text{interop}} \) is the contribution from the Interoperable MBOC signal transmitted by all the constellations.

- \( I_{\text{inter}} \) is the inter-system interference (in this case interference from GPS C/A and P(Y)).
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.
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.
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