Modified CEMIC Scheme for New Service Signals

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Overview

- NVS-01 is now transmitting interoperable service signal in L1 band.
- Study on multiplexing additional new service signals in L1-band with the existing NavIC Synthesized Binary Offset Carrier (SBOC) signal to transmit it through common payload hardware chain is considered.
- The composite signal must have constant envelope to operate the transponder at saturation with maximum efficiency.
- Congestion in L1-band in terms of other GNSS signals is higher than other RNSS bands.
  - It further poses difficulty in coordination of the centre frequency of the new service signal.
- For maintaining interoperability, change in the modulation and frequency of NavIC SBOC signal in L1-band will not be permitted/desirable.
- The data and pilot component of NavIC L1-band signal (SBOC) are multi-level in nature.
  - It posses additional challenge in terms of multiplexing operations.

Hence, a suitable Modified Constant Envelope Multiplexing with Intermodulation Construction (CEMIC) method is devised to incorporate:

- Multi-frequency signals (to exploit frequency diversity) for minimization of inter- and intra-system interference.
- Multi-level signals for supporting backward compatibility (receiver transparency) to the existing SBOC signal in NavIC L1-Band.
Proposed Method: MCEMIC Scheme

- Proposed MCEMIC has highest multiplexing efficiency and currently the state-of-the-art scheme for single frequency BCS signal.
- The same is extended for multi-level & single/multi-frequency signals multiplexing scheme.
- MCEMIC is a waveform Domain Processing for generating constant envelope signal.
- Targeted to provide flexibility in allocating power sharing between signals.
- Using a new centre frequency (constraint to have some discrete values due to existing SBOC signal design) to provide frequency diversity.

Proposed method can be generalized to incorporate additional signals in L1-band.

$ Bhadouria Vijay Singh, Upadhyay Dhaval, Majithiya Parimal, & Bera Subhash Chandra (2022); Modified CEMIC scheme for multiplexing signals over single frequency band. NAVIGATION, 69(3). https://doi.org/10.33012/navi.528
## Case Study: NavIC L1 Band Signals

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Power Sharing (%)</th>
<th>Phasing</th>
<th>Relative frequency Offset (MHz) @</th>
<th>Modulation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBOC- Data</td>
<td>18.3$</td>
<td>90°$</td>
<td>0</td>
<td>MBOC (6,1,1/11)</td>
</tr>
<tr>
<td>SBOC- Pilot</td>
<td>24.7$</td>
<td>0°$</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>New Service Signals</td>
<td>7.9</td>
<td>0°</td>
<td>18.414</td>
<td>BPSK (2)</td>
</tr>
<tr>
<td></td>
<td>7.9</td>
<td>0°</td>
<td>18.414</td>
<td></td>
</tr>
<tr>
<td></td>
<td>23.7</td>
<td>90°</td>
<td>18.414</td>
<td></td>
</tr>
<tr>
<td>IM Components</td>
<td>17.5</td>
<td>0°/90°</td>
<td>18.414</td>
<td>-</td>
</tr>
</tbody>
</table>

$ Relative power sharing and phasing is preserved for the NavIC SBOC signal.

@ Frequency Offset is with respect to the frequency of 1575.42 MHz.

**Note:**
* Signals are to be generated at a sampling rate of 147.312 Msps
MCEMIC Performance

**LUT based Scheme Performance**

**Constellation Points**

- 256 point constellation

**Power Spectral Density**

- SBOC signal
- New Service Signal
Thank You