PNT Requirements for inland shipping

Discussion on GNSS requirements and synergies with Copernicus per applications

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Outline

- Existing Requirements
- New Applications and Developments
- Solutions
- Conclusions
PNT equipment onboard inland vessels

- Main applications are Inland-ECDIS and Inland-AIS.
- Rate of turn indicator is mandatory together with Radar.
- No carriage requirements exists for EPFD onboard inland vessels.
- Mandatory AIS mobile includes a type approved GPS-board.
- No firm requirements exists for a Heading device.
# Requirements for Position Accuracy

<table>
<thead>
<tr>
<th>Application</th>
<th>Position Accuracy [m]</th>
<th>Integrity</th>
</tr>
</thead>
</table>
| Inland ECDIS
  - Navigation | < 5 (Absolut)          | Detection of Errors > 3 σ within 30 Seconds |
|                      | < 5 (1 Sigma)         |                                        |
| Inland AIS
  - Medium-term ahead | 15-100                | Note: In addition, the requirements of the IMO Resolution A.915(22) regarding the integrity, the availability and the continuity for position accuracy on inland waterways shall be fulfilled. |
|  - Short-term ahead   | 10                    |                                        |
|  - Lock/Bridge operation | 1                    |                                        |

1) Inland ECDIS Standard
2) VTT Standard Table 1.2 “overview of accuracy requirements dynamic data”
Developments

- Various European projects about future provision of PNT data (INAV or low cost heading).
- National Research projects (like PiLoNav, LAESSI, SCIPPPER) to develop new driving assistance functionalities.
- CCNR proposed 6 Level of Automation from “No Automation” to “Full Automation”.
- A number of test beds for digitalization and automation are under development.
Driver Assistance Systems (Applications)

- Mooring
- Bridge Passing/Warning
- Conning-Display
- Automatic Track Control & Lock manoeuvre
- Collision Avoidance

much stronger requirements for PNT Data provision
Driver Assistance Systems (General Requirements)

- Precise and integrity checked 3D-Position (PNT-Unit)
- Accurate static data (e.g. for bridges, etc.)
- Accurate dynamic data (e.g. water level, NtS, etc.)
- Standardised Comm. (AIS/VDES) + Protocols (ASM/RTCM)
- Calculation of distances and indication for warning and alarming
Driver Assistance Systems (Performance Requirements)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Bridge collision warning</th>
<th>Automatic guidance</th>
<th>Mooring assistance</th>
<th>Conning display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position accuracy [cm]</td>
<td>20</td>
<td>30</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Height accuracy [cm]</td>
<td>10</td>
<td>not relevant</td>
<td>not relevant</td>
<td>not relevant</td>
</tr>
<tr>
<td>Heading accuracy [°]</td>
<td>0,3</td>
<td>0,17</td>
<td>0,07</td>
<td>0,1</td>
</tr>
<tr>
<td>Integrity risk</td>
<td>10 $10^{-5}$ / 2 min</td>
<td>0,55 $10^{-5}$ / 3 h</td>
<td>18 $10^{-5}$ / 10 min</td>
<td>18 $10^{-5}$ / 1 h</td>
</tr>
<tr>
<td>Time to alarm [s]</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Requirements (based on LAESSI project) are made on the following assumptions:
- Each point on a 185 m convoy shall be known with 30 cm accuracy.
- Integrity risk assumes, that one “non” detected error within three years can be tolerated.
Possible solution (integrated PNT receiver)

Future Navigation- and Communication-Equipment for inland vessels

- RADAR long range
- Sensors short range

Integrated Navigation Receiver (INAV)
Position, Heading, COG, SOG

Inland-ECDIS

Inland-AIS

Onboard Sensors (ROT)

Augmentation
- Code DGNSS
- RTK
- PPP
- other High Accuracy services e.g. from future GNSS and SBAS

Similar to maritime initiative regarding MRR and PNT DP Unit

Lat, Long, Height, HDT, ROT, SOG, COG, Time
Conclusions

- **GNSS is the central sensor** to provide position velocity and time for navigation in maritime and inland waterways.
- New applications for inland shipping will ask for **improved performance requirements for PNT data** provision.
- There is a clear trend to the development of new assistance functions and first steps towards **automated shipping**.
- **Resilient PNT** solutions are the basis for **safe navigation**.
- **High Accuracy positioning** is required for new applications.
Linking space to user needs

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