Agenda

• Trends in maps and location referencing

• Challenges

• Examples of solutions in Traffic and HAD
We’ve Always Had a Bold Vision for Our Maps…
…to produce state of the art computable index of the world around us

Static flat maps
25 years ago map creation started out by digitizing physical map sources

Computable Roads
NAVTEQ started to collect precise road geometries with rich sets of attributes to make them computable

Computable Reality
We are creating fully interconnected and attributed 3D models, combining aerial and street level technologies
Maps getting ever more detailed and precise.
Unlocking new possibilities
Location Referencing requirements increase

<table>
<thead>
<tr>
<th>TMC (FM based)</th>
<th>DLR (Connected focused)</th>
<th>3D (Broadband required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique Map IDs</td>
<td>Matching using Geo coordinates. Map version and supplier independent</td>
<td>3D will require a yet to be completed referencing system and development of standard</td>
</tr>
<tr>
<td>Highly matured, widely adopted and cost effective</td>
<td>Specifications based on a series of Latitudes/Longitude (geocoded/map matched by client device)</td>
<td></td>
</tr>
<tr>
<td>100% correct location reference</td>
<td>Various industry standard DLR methods available</td>
<td></td>
</tr>
</tbody>
</table>
Key challenges in maps / location referencing

- 100% coverage of the map
- Precise location referencing without quality loss

- Cost efficient solution (Data-cost vs. customer benefit)
- Compression technologies or pre-defined locations (e.g. TMC)

- The usage of industry standard and different maps
- Quickly developing and new requirements towards usage location referencing (e.g. in context of ADAS, highly automated driving)
Offering a complete portfolio is key for success

<table>
<thead>
<tr>
<th></th>
<th>Reliable Map Matching</th>
<th>Full Map Coverage</th>
<th>Version/Provider Independent</th>
<th>Industry Standard</th>
<th>Lean Cost Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TMC</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A single 2 byte ID</td>
</tr>
<tr>
<td><strong>OpenLR</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40-60 bytes ~10X cellular network cost compared to other options</td>
</tr>
<tr>
<td><strong>HERE LinkID</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Main limitation: HERE map and version specific.</td>
<td></td>
<td>A single 4 byte ID</td>
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<tr>
<td><strong>HERE SHP</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40-60 bytes ~10X cellular network cost compared to other options</td>
</tr>
<tr>
<td><strong>ULR</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
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</table>
LR application example in Traffic: Combining LR standards to achieve 100% road coverage

100% coverage on controlled access roads, 24x7 (FC1-FC2 roads/major highways)

Full TMC table coverage globally

In markets where TMC coded roads are not sufficient, DLR helps fill the gaps
HERE – HD Map
HD Maps - location reference precision evolving and getting more accurate

- HD Map will provide **sub lane level accuracy** – from meters to centimeters in terms traditional mapping – but also provide fresh tile updates only for the relevant driving corridor.

- HD Map allows for **sub lane level positioning** due to lateral and longitudinal positioning components (i.e. Guard rails, walls, bridges, tunnels etc.)

- **Reduced data bandwidth** through incremental map updates

- **Important for V2X** as positioning accuracy of both sender and receiver of messages are relevant for the quality of the data fusion.
Example: Lateral Highway Positioning

Lateral Highway positioning

- HD Map Lane Model
- Physical linear structures along the road
  - Road Surface boundary (end of asphalt/concrete)
  - Guardrails
  - Walls
Example: Longitudinal Highway positioning

Longitudinal highway positioning

- HD Map Lane Model (lane start/end/merge locations)
- Physical overhead structures
  - Gantries
  - Bridges
  - Tunnel ceiling
- Sign locations where needed
Summary

• Maps become a computable, dynamic digital representation of the world

• Current requirements in LR such as efficiency, precision, coverage best met by a combining methods to best customer value

• New requirements like 3D mapping and highly automated driving will require LR to evolve
Geneva Motor Show

Thank you for your attention