DRIVE C2X
Tools for data analysis for cooperative system FOTs

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DRIVE-C2X Tools for data analysis for cooperative system FOTs

- Project Status
- Data Flow Process
- 2 Approaches to data analysis
  - Technical Evaluation
  - Impact Evaluation
- Examples of Technical Evaluation
Safety & Traffic Efficiency Functions

- In-Vehicle Signage
- Green Light Optimal Speed Advice
- Road works warning
- Approaching emergency vehicle
- Weather warning
- Emergency electronic brake lights
- Slow vehicle warning
- Car breakdown warning
- Traffic jam ahead warning
- Post crash warning
- Obstacle warning
- Motorcycle warning
Data Flow

ITS stations
- Reference system data logging

TS data storage
- Data validation
- Video annotation and management

TS-specific sources
- Local traffic and weather sources

Central data storage
- Data import
- Data enrichment and indicator calculation
- Questionnaires and study descriptions
- Final storage

Analysts
- Partial copy of central DB
2 approaches to data analysis

**Technical Evaluation**
- Evaluate the performance of time synchronisation, communication, positioning, HMI, applications
- Validate/invalidate test run, data consistency, system behaviour

*Analysis Data:*
- All logged parameters and components
- Full test run
- Calculate performance indicators

*Output:* Database with all valid data

**Impact Evaluation**
- Evaluate the effects of the cooperative functions on traffic efficiency, safety and environment, driver behaviour and system interaction
- Assume test data is valid and consistent

*Analysis Data:*
- Subset of logged parameters
- Cut-out events
- Calculate indicators for events

*Output:* summary tables with indicators
Data Analysis for Impact Evaluation

Test site log files (zipped raw data) -> Decode using abstraction XML file -> Verify content with tools

Two software tools for quick validation of log files (html reports and error logs): LogPro and LogMover

Database import and rearrangements to assist analysts

Data enrichment: map-match coordinates, calculate communication distances etc.

Calculate requested indicators and derived variables

Summary tables and indicators

Link events with weather, traffic data, video timestamps

Search and list common locations

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Data Analysis for Technical Evaluation

1. Log definition compliancy check
   - Non Compliant
     - Stop

2. Sanity check for facilities
   - Check failed
     - Stop

3. Sanity check for applications and HMI
   - Check failed
     - Stop

4. Resampling and smoothing

5. Event detection

6. Indicator calculation

Event database

Indicators
Step 1 – Log definition compliance checks

Typical errors:
- Old SW bundles installed on application platform
- Deprecated log definitions are used by a component
- Value out of range
- Invalid enumeration
- Incorrect scaling

If undetected:
- Decoding fails
- Incorrect decoding of values
Step 2 – Sanity checks of Facilities

Typical issues to detect automatically:

- Time gaps in logging (e.g. CPU load)
- Time synchronisation offset between stations or within
- Required parameters from the CAN bus
- Position confidence (from GPS)
- Offset in positions (from POTI and CAM)
- Offset in speeds (from POTI and CAN)
- Offset in acceleration (from CAM and CAN)
Step 3 – Sanity checks of Applications

Typical issues to detect:

• Distance between DENM and application activations
• Distance between TOPO/SPAT and GLOSA activations
• Applications triggering with same priority to HMI
LogMover – Technical Evaluation

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Event database

Indicators

Logfiles

Log database
Events – GLOSA Green Light Optimal Speed Advice

**Time/distance scale**

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>t1</td>
<td>t2</td>
<td>t3</td>
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**Crossing**

**Notification by the GLOSA function to the driver**

- **Subcase A**
  - overall
  - sub-divided by different speed advices

- **Subcase B**
  - sub-events for Speed advice (>30 km/h) versus remaining time (V<30 km/h)
  - Further sub-divided by different speed advices

**Event definition**

- EVENT
Green Light Optimal Speed Advice

VehicleSpeed (km/h)
DistanceToStopline (10 m)
RemainingPhaseline (s)
SpeedAdvice (km/h)

driving direction
Stop line

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In-Vehicle Signage (IVS - Speed limits)

Subevents relative to SpeedLimit $S$
based on warning levels:

1. $V < S - 10$ km/h
2. $S - 10 < V < S$
3. $S < V < S + 10$ km/h
4. $S + 10 < V$

KPI per stage:
- Relative duration / distance
- Number of occurrences
- Speed variation
- Average speed (in 1, 4)
Conclusions
Data Analysis tools in DRIVE-C2X

- 2 approaches to data analysis: Technical and Impact evaluation
- Detailed analysis is necessary of technical issues and data quality
- Automate data processing for immediate feedback on success of a test, and details on inconsistencies in (interactions between) components
- Data analysis tools are independent of specific log format
  - Standard databases & tools
  - Configurable for different Test Sites and projects
LogMover data analysis process

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4. Resampling and smoothing
5. Event detection
   - Event database
6. Indicator calculation
   - Indicators

Logfiles

Log database

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project start date: 01.01.2011 | end date: 31.12.2013
In-Vehicle Signage (IVS - Speed limits)

**Speed vs time:** HMIS warnings, Vehicle speed