Seamless traffic data dissemination across urban and inter-urban networks

SEAMLESS

21/11/2012

PEB Meeting, Delft
The Story

Cooperative Systems

"Innovative"

The Challenge

"Traditional"

Traffic Management

SEAMLESS – an ERA-NET ROAD project
The Story

• Wake up call for traditional Traffic Management: Cooperative Systems are coming!
  – new technologies
  – new infrastructure
  – new players
  – maybe even new mindset

• Two strong and proud communities – who takes care of connecting the two worlds?
Traditional Service Chain

- **Delivery Channels**
  - Cable from stationary detector
  - Cellular Networks: 2G, 3G, 4G
  - WIFI/WLAN: IEEE 802.11p
  - Ethernet

- **Event, Traffic situation**
  - Proprietary (from det)
  - CAM (vehicle)
  - GATS (no longer in use)

- **Message Standards**
  - proprietary
  - DATEX II

- **Detection Content Collection**

- **Content preprocessing**

- **Info-Service provision**
  - Analogue Radio: VHF/FM RDS
  - Digital Radio: DAB, DAB+, etc.
  - Cellular Networks: 2G, 3G, 4G
  - WIFI/WLAN: IEEE 802.11p
  - Cable to VMS
  - Ethernet to Web Side

- **Info-Service presentation**

End User

What is spared here - for the sake of simplicity - are the Location referencing standards, which is big issue, too.
Possible influence of Cooperative Systems

Need of public data for private services or vice versa
Possible influence of Cooperative Systems

Input from a variety of different (distributed) sources
Possible influence of Cooperative Systems

Services for a variety of different service providers and end-user channels
The Story

Possible influence of Cooperative Systems

Use of different channels for the same data origin and receiver
• A lot of Test Fields for Cooperative Systems
• And yes if you scratch the surface there are efforts to connect legacy (somewhere in the Annex …)

- Often bespoke/proprietary solutions which do not survive the end of the project
- Few (no?) use of standards
- There is a gap!
“Prepare traffic data dissemination that works seamlessly across urban and inter-urban networks”

Main topics
- Data dissemination to in-vehicle systems
- Link to cooperative systems
- Linking Legacy
The Challenge

Road authorities must make best use of existing road capacity and keep track of
- Rising traffic demand
- Environmental challenges
- Economical feasibility

Road authorities have recognised the growing importance but also the huge potential of intelligent infrastructure

Challenges in distributing road authority data to travellers:
- Not all data available (with public funding?!) reaches travellers (e.g. due to administrative problems)
- Road authorities are seeking to reduce their dependency on bespoke roadside infrastructure for traffic management
• Lots of money was invested

But results are poor

• New technology-channels are to come up

But even new channels have no content, if back end data exchange does not work

Lack of seamless services
• Deliverable Nr 1 “Analysis of existing research on road data dissemination to in-vehicle devices”

• Analysis of existing research
  – Summarized 42 projects in total with respect to Cooperative Systems
  – Description of standards
  – Stakeholder and their objectives
  – Description of Use Cases

<table>
<thead>
<tr>
<th>Actor – Role Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Management Centre</td>
</tr>
<tr>
<td>Public</td>
</tr>
<tr>
<td>Private</td>
</tr>
</tbody>
</table>

SEAMLESS – an ERA-NET ROAD project
CVIS

<table>
<thead>
<tr>
<th>Project Organisation</th>
<th>Coordinator</th>
<th>ERTICO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner involved</td>
<td>OEM, suppliers, research, academia</td>
<td></td>
</tr>
<tr>
<td>Contact Seamless</td>
<td>Dr.-Ing. Thomas Benz, Dr.-Ing. Michael Ortgiese</td>
<td></td>
</tr>
<tr>
<td>Start date</td>
<td>01.04.2008</td>
<td></td>
</tr>
<tr>
<td>End date</td>
<td>30.06.2010</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application Use Cases</th>
<th>Description</th>
<th>Relevance for SEAMLESS</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cooperative network management, Cooperative Area Routing, Flexible Lane Management, Flexible Lane Allocation, Cooperative Driver Awareness, Travellers Assistance, monitoring and guidance of dangerous goods, parking zone management, an access control to sensitive infrastructures. Cooperative Traffic Monitoring</td>
<td>Architecture for C2X services based on a hybrid communication architecture.</td>
<td>☐ Safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>x UC Traffic Light x UC Journey Time</td>
<td>x Urban</td>
</tr>
<tr>
<td>Business Structure</td>
<td>Stakeholder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x Road Operator</td>
<td>x Automotive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Service Provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2C payment</td>
<td>x Free of Charge</td>
<td>□ Paid service</td>
<td></td>
</tr>
<tr>
<td>B2B / B2A payment</td>
<td>x Free of Charge</td>
<td>□ Paid service</td>
<td></td>
</tr>
<tr>
<td>Contracts</td>
<td>--</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expected Benefits of the cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
</tr>
<tr>
<td>Automotive</td>
</tr>
<tr>
<td>Service Provider</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Semantic</td>
</tr>
<tr>
<td>Communication Protocol</td>
</tr>
<tr>
<td>Channel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entities</td>
</tr>
<tr>
<td>x Center - Center</td>
</tr>
<tr>
<td>□ Center - Car</td>
</tr>
<tr>
<td>x Center - Infrastructure</td>
</tr>
<tr>
<td>x Car - Infrastructure</td>
</tr>
<tr>
<td>x Car – Car</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decentralised architecture in a research phase; Results were influencing the ETSI station architecture.</td>
</tr>
</tbody>
</table>
• Huge number of standardisation and business development activities
• Work of TISA as well as of ETSI/CEN will influence the future market
• Innovation-oriented activities are mainly based on
  – COMeSAFTEY
    (consolidation the outcomes of the research projects)
  – CVIS/SafeSpot/Coopers
    (basic technology oriented results)
  – SimTD and Drive C2X
    (most relevant field operation tests (FOT))
• Introduction of new services must be based on sound migration strategy
WP2: Business Case Considerations

- Value and cost of urban data
- Value and cost of seamless services
- Data characteristics necessary for effective services
- Current Business Models and Factors Driving the Evolution of New Business Models

Questions which were driving this workpackage
- Why should road authorities who generate urban data from legacy traffic management systems seek to make it widely available?
- How can this data be most effectively disseminated to in-vehicle devices?
- Why is maximising usage and up-take of such in-vehicle devices by end users important?
- What is the value of the benefits that can ultimately be realised?
Advantages of new data-exchange cooperations

Road Operators:
- Direct communicate with the driver
- Better acceptance of the measures

Car Manufactures:
- Improvement of vehicle safety systems
- Driver information and efficient engine control

Service Providers:
- Commercial distribution of data and information

Appropriate organizational arrangements needed for cooperation – for example Mobility Data Market Place

Focus on long period operation without losing quality

Business structures must be in line with all technical and organizational aspects

Cost savings, quality improvement of information

Exchange of data
Free Delivery
Payment Model
WP3: Architecture

- Adapting existing architectures
- Options on existing architectures are rated with respect to seamless services
- Considering and publishing
  - the architectural assumptions that can be made
  - the architectural recommendations that the SEAMLESS project will make
Now building up a **generic architecture** ...
<table>
<thead>
<tr>
<th>Service Providers</th>
<th>Road Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Layer</td>
<td>Central Layer</td>
</tr>
<tr>
<td>Mobile Layer</td>
<td>Central Layer</td>
</tr>
</tbody>
</table>
Service Providers

- Central ITS-station
- Roadside ITS-station
- Vehicle ITS-station
- Personal ITS-station

Road Operators

- Central ITS-station
- Roadside ITS-station
Service Providers

- Central ITS-station
- Vehicle Service Backend
- Roadside backend

Road Operators

- Central ITS-station
- Traffic Management
- Roadside backend
- Vehicle Service Backend

Legacy Systems

- Roadside ITS-station
  - Vehicle Services
  - Infrastructure Services

- Vehicle ITS-station
  - Personal ITS-station

- Central ITS-station
  - Traffic Management

- Roadside ITS-station
  - Infrastructure Services
  - Vehicle Services
  - Signals & Displays
  - Sensors

- Central ITS-station
  - Traffic Management

- Roadside ITS-station
  - Infrastructure Services
  - Vehicle Services
  - Signals & Displays
  - Sensors

- Central ITS-station
  - Traffic Management

Digital Broadcast (unidirectional)

Peer to peer connection based on mobile networks

ITS G5
• Service Providers
  – want to deliver their information through a dedicated channel
  – want to set their services apart from other service providers
  – do not feel unhappy when controlling both ends of the channel
    (e.g. bespoke solution on customer side)

• Road Operators
  – are interested in complete and coincident information on customer side and
  – consistent data deliveries
  – like to use more than one channel to get a wider information spread and to compensate channel constraints
Use Case

Example Traffic Light Phase Assistant
• Different architectures possible
  (direct communication via Field Layer, Central routing, ...)

• Different communication channels
  (digital or local broadcast, peer to peer, ...)

• Different Data Models
  (type and amount of data to transfer differs a lot)

• Different channel characteristics
  (Latency, Bandwidth)

• Different applications
  (Real time prognosis, routing, eco-driving, ...)

All of these Points influence each other!
Service Providers

Road Operators

Legacy Systems

Central ITS-station
- Vehicle Service Backend
- Roadside backend

Central ITS-station
- Traffic Management
- Roadside backend
- Vehicle Service Backend

Roadside ITS-station
- Vehicle Services
- Infrastructure Services
- Sensors

Roadside ITS-station
- Infrastructure Services
- Vehicle Services
- Signals & Displays
- Sensors

Mobile Layer

Example communication via Field Layer
Service Providers

Road Operators

Legacy Systems

Central ITS-station
- Vehicle Service Backend
- Roadside backend

Roadside ITS-station
- Vehicle Services
- Infrastructure Services
- Sensors

Vehicle ITS-station
- Personal ITS-station

Central ITS-station
- Traffic Management
- Roadside backend
- Vehicle Service Backend

Example communication via Service Provider
Roadside ITS station is raising questions
- Where is it placed physically?
- Multifunctional approach
  (like \(\text{sim}^{TD}\), with framework and applications)
  \(\text{sim}^{TD}\), CVIS paradigm: adding elements at runtime

or "Plug-in" for Traffic light controller
  (intended by manufactures of traffic light controllers
  \(\rightarrow\) more complex data handling inside the controller necessary)

And even more
- Own radio module for every application?
- Will OCIT-O need to transport FCD data? (in fact, this is planned)
- New controlling methods/software necessary?! 
  (also think of budget approaches regarding Public Transport)
Example Traffic Light Phase Assistant (cont.)

Communication part of an ITS Roadside Station (left side)
Example Traffic Light Phase Assistant (cont.)

Signal Phase Data

class SignalState

PayloadPublication

GenericPublication::GenericPublication

+ genericPublicationName: String

«class»

SignalPhaseAndTimingData

«attribute»

+ intersectionRef: VersionedReference

«class»

IntersectionStatus

«attribute»

+ conflict: Boolean
  + exceptional: Boolean
  + flashYellowAll: Boolean
  + flashYelMin: Boolean
  + manual: Boolean
  + off: Boolean
  + partOff: Boolean
  + preempt: Boolean
  + problem: Boolean
  + proceedYel: Boolean
  + stopTime: Boolean
  + transit: Boolean

«class»

MovementState

«attribute»

+ lane: LaneEnum [1..127]
  + lineRef: String
  + vehicleCount: Integer [0..1]

«class»

ColorState

«attribute»

+ flashing: Boolean
  + green: Boolean
  + red: Boolean
  + yellow: Boolean

«class»

Change

«attribute»

+ confidence: PercentageValue
  + passState: Boolean
  + predCnt: Integer

«class»

TrafficCategory

«attribute»

+ privateTraffic: Boolean
  + publicTransportRail: Boolean
  + publicTransportRoad: Boolean

«class»

Lanes::TurnDirection

«attribute»

+ left: Boolean
  + right: Boolean
  + sharpLeft: Boolean
  + sharpRight: Boolean
  + slightLeft: Boolean
  + slightRight: Boolean
  + straight: Boolean
  + uTurn: Boolean

«datatype»

Specific::Seconds

+ trafficCategory
  + nextChanges 1..*

+ likelyTimeToChange
  + maxTimeToChange
  + minTimeToChange

SEAMLESS – an ERA-NET ROAD project
Another Possibility:
Coding by vector of probabilities for “Green”: 
# DATEX II – TPEG mapping

## Header Information

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PayloadPublication</td>
<td>publicationTime</td>
<td>Date/time at which the payload publication was created.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>urgency</td>
<td>Indicates the urgency with which a message recipient or Client should distribute the enclosed information.</td>
<td>0..1</td>
<td>UrgencyEnum</td>
</tr>
</tbody>
</table>

## Message Management

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMCTemplate</td>
<td>messageExpiryTime</td>
<td>Mandatory timestamp. If the current time is past the messageExpiryTime, the message has to be considered &quot;invalid&quot;. The transmission system has to ensure that the message, or a newer version thereof, is sent before the message expires. Expire times are channel specific and might differ from transmission channel to transmission channel.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>cancelFlag</td>
<td>This flag has to be set (cancelFlag = 1), if a message, identified by its messageID, is no longer valid and has to be deleted in the client device. The message body of messages with the cancelFlag set shall be empty.</td>
<td>1</td>
<td>Boolean</td>
</tr>
</tbody>
</table>

## DATEX 2 Payload - SituationPublication

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PayloadPublication</td>
<td>publicationTime</td>
<td>Date/time at which the payload publication was created.</td>
<td>1</td>
<td>DateTime</td>
</tr>
</tbody>
</table>

## TPEG TEC Message

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMCTemplate</td>
<td>messageExpiryTime</td>
<td>Mandatory timestamp. If the current time is past the messageExpiryTime, the message has to be considered &quot;invalid&quot;. The transmission system has to ensure that the message, or a newer version thereof, is sent before the message expires. Expire times are channel specific and might differ from transmission channel to transmission channel.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>cancelFlag</td>
<td>This flag has to be set (cancelFlag = 1), if a message, identified by its messageID, is no longer valid and has to be deleted in the client device. The message body of messages with the cancelFlag set shall be empty.</td>
<td>1</td>
<td>Boolean</td>
</tr>
</tbody>
</table>

## Class Name | Attribute Name | Definition                                                                 | Multiplicity | Data Type |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PayloadPublication</td>
<td>publicationTime</td>
<td>Date/time at which the payload publication was created.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>urgency</td>
<td>Indicates the urgency with which a message recipient or Client should distribute the enclosed information.</td>
<td>0..1</td>
<td>UrgencyEnum</td>
</tr>
</tbody>
</table>

## Message Management

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMCTemplate</td>
<td>messageExpiryTime</td>
<td>Mandatory timestamp. If the current time is past the messageExpiryTime, the message has to be considered &quot;invalid&quot;. The transmission system has to ensure that the message, or a newer version thereof, is sent before the message expires. Expire times are channel specific and might differ from transmission channel to transmission channel.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>cancelFlag</td>
<td>This flag has to be set (cancelFlag = 1), if a message, identified by its messageID, is no longer valid and has to be deleted in the client device. The message body of messages with the cancelFlag set shall be empty.</td>
<td>1</td>
<td>Boolean</td>
</tr>
</tbody>
</table>

## DATEX 2 Payload - SituationPublication

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PayloadPublication</td>
<td>publicationTime</td>
<td>Date/time at which the payload publication was created.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>urgency</td>
<td>Indicates the urgency with which a message recipient or Client should distribute the enclosed information.</td>
<td>0..1</td>
<td>UrgencyEnum</td>
</tr>
</tbody>
</table>

## TPEG TEC Message

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMCTemplate</td>
<td>messageExpiryTime</td>
<td>Mandatory timestamp. If the current time is past the messageExpiryTime, the message has to be considered &quot;invalid&quot;. The transmission system has to ensure that the message, or a newer version thereof, is sent before the message expires. Expire times are channel specific and might differ from transmission channel to transmission channel.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>cancelFlag</td>
<td>This flag has to be set (cancelFlag = 1), if a message, identified by its messageID, is no longer valid and has to be deleted in the client device. The message body of messages with the cancelFlag set shall be empty.</td>
<td>1</td>
<td>Boolean</td>
</tr>
</tbody>
</table>

## Class Name | Attribute Name | Definition                                                                 | Multiplicity | Data Type |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PayloadPublication</td>
<td>publicationTime</td>
<td>Date/time at which the payload publication was created.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>urgency</td>
<td>Indicates the urgency with which a message recipient or Client should distribute the enclosed information.</td>
<td>0..1</td>
<td>UrgencyEnum</td>
</tr>
</tbody>
</table>

## Message Management

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Attribute Name</th>
<th>Definition</th>
<th>Multiplicity</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMCTemplate</td>
<td>messageExpiryTime</td>
<td>Mandatory timestamp. If the current time is past the messageExpiryTime, the message has to be considered &quot;invalid&quot;. The transmission system has to ensure that the message, or a newer version thereof, is sent before the message expires. Expire times are channel specific and might differ from transmission channel to transmission channel.</td>
<td>1</td>
<td>DateTime</td>
</tr>
<tr>
<td>MMCTemplate</td>
<td>cancelFlag</td>
<td>This flag has to be set (cancelFlag = 1), if a message, identified by its messageID, is no longer valid and has to be deleted in the client device. The message body of messages with the cancelFlag set shall be empty.</td>
<td>1</td>
<td>Boolean</td>
</tr>
</tbody>
</table>
• DATEX II message of profile for Traffic Management Plan and Navigation Service was translated to TPEG
Example Mapping to UTMC

Service Providers

Road Operators

Key:
ICS: ITS Central Station  IVS: ITS Vehicle Station  IMS: ITS Mobile Station  IRS: ITS Roadside Station

Node B
Traffic management centre

Node C
Outstation

Node D
Controlled unit

Vehicle
In Summary

• Data today is still not always accessible in a satisfying way
• Danger of reducing interest in new technologies

Project SEAMLESS is encouraging ...
• further trans-national deployments
• future developments to adopt interoperable approaches

and giving recommendations for Road Operators on how to deal best with the new technologies:
• Where do standards not fit?
• Are there right and wrong Deployment-szenarios?

Furthermore:
• EU-wide know-how and orientations are incorporated into SEAMLESS by the Deployment Guidelines (in form of knowledge from more than 140 road operators)
• A prospective successor of European Commission mandate M/453 could be a place for SEAMLESS thoughts
Thank you for your attention

Jörg Freudenstein
joerg.freudenstein@albrechtConsult.com
Tel: +49 241 500 720

On behalf of the SEAMLESS partners:
Mott MacDonald, UK
PTV, Germany
TrafficMaster, UK
AlbrechtConsult, Germany
Collection of Links

- www.albrechtConsult.com
- www.ptv.de
- www.mottmac.com
- www.trafficmaster.co.uk
- www.ffg.at
- www.oca-ev.org
- www.datex2.eu
- www.ocit.org
- www.ots2.org
- www.utmc.uk.com
- www.simtd.de
- www.cvisproject.org