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# FEASIBILITY STUDY ON A DECENTRALISED SYSTEM ARCHITECTURE FOR ANIMAL TRANSPORT TRACING SYSTEMS (DEAR-TRACE)

Final Report

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## SUMMARY

The objective of the study was to demonstrate whether the data recorded by the tracing systems of long journey animal transport vehicles for the official controls under Regulation 1/2005 and managed by different private service providers for trucks fitted with their systems could be made remotely available to competent authorities in this decentralized system architecture.

The concept was tested for around 2 months with 2 tracing systems from different service providers, with volunteering transport companies using these systems and with the participation of competent authorities in 3 Member States with a substantial share in the international animal transport.

On one side there was a system which allowed tracking of single consignments with a great level of flexibility, in order to implement functionalities in the field of logistics, and on the other side there was a more simplified system, designed exclusively for the purpose of monitoring animal welfare during transport.

In the absence of an automatic system to detect the presence of the animals on the vehicle the identification of an animal journey relies on the driver declarations of start and end. However the system gives to the competent authorities the possibility of verifying the compliance of the declarations using automatically recorded data on the position of the vehicle, presence/absence of movement and on door openings.

Data transmissions, data management and visualization was built around the idea of monitoring animal journeys defined as the entire transport operation between the loading of the first animal on the vehicle and the unloading of the last animal. The tests revealed a number of weaknesses which should be addressed to get most use out of the tracing systems in animal transports. For most of the improvements only minor changes to the applications would be required.

The definition of journey and batch / consignment is not always used in a consistent manner resulting in some inconsistencies in the tracing.

Overall the experiment proved that with limited software development resources the integration of commercial tracing systems in animal transports would be feasible and offer several advantages to the competent authorities both in respect of animal welfare and traceability of animal movement.

# 1. INTRODUCTION

The Joint Research Centre of the European Commission (JRC) has a long record of research activities in the traceability in the food chain, including the tracing and tracking of livestock and livestock transports. The reliable and fast traceability of livestock and animal products is in many public and animal health aspects of importance, but in particular in assessing and managing risks of spreading diseases as major crises, such as BSE and Foot & Mouth Disease have shown.

With respect to the implementation of relevant parts of the EU legislation, JRC has drawn up for DG SANCO Technical Specifications meant to become the minimum requirements for a harmonised EU wide tracing system in long journey animal transports. The Technical Specifications were discussed with the relevant stakeholders in several circumstances, including dedicated JRC workshops in 2006 and 2009. Despite several amendments and modifications made on request of Member States the attempts of DG SANCO failed until now to achieve agreement on common minimum requirements regarding the basic elements and functionalities of such a tracing system and to transform them into binding EU legislation.

Transport associations and some Member States were not inclined to support a centralised system architecture, with all vehicles transmitting data directly to a central European remote receiver from where the competent authorities would have access to the data. As main concerns data security and privacy issues were mentioned.

Being a requirement for new vehicles already since 2007 and for other long journey vehicles since 2009, vehicles are equipped since than with very different tracing systems. It is argued that the differences in the technical solutions regarding e.g. the on-board architecture, system architecture and functionalities render the tracing system not useful in the official controls as the data could not be easily made available.

Some of the existing tracing systems are managed by service providers which on behalf of transport companies install and maintain the on-board equipment, receive and manage data transmitted by the on board equipment.

In the existing context instead of aiming at establishing a centralized receiver it might still be feasible to foresee the transmission of data from these service providers to a central repository where competent authorities would be in any case able to access information relevant for official controls.

This decentralized architecture corresponds to a business model which would allow solving many concerns on data privacy, ensuring flexibility for future technological developments and integrating a system established for official controls with other functionalities useful for the transport companies.

A group of interested national authorities, transporters, service providers and the JRC carried out a study on the feasibility of connecting the different on-board systems for tracing animal transports under a decentralized system architecture – DEAR-TRACE.

# 2. OBJECTIVE AND SCOPE OF THE STUDY

The objective of the study was to demonstrate whether the data recorded by the tracing systems of long journey animal transport vehicles for the official controls under Regulation 1/2005 and managed by different private service providers for trucks fitted with their systems could be made remotely available to competent authorities through a central receiver (decentralized system architecture).

The concept was tested for around 2 months with 2 tracing systems from different service providers, with volunteering transport companies using these systems and with the participation of competent authorities in 3 Member States with a substantial share in the international animal transport.

# 3. METHODS AND PROCEDURES

## 3.1 Structure of the system architecture to be studied

In principle the decentralized system architecture had three levels as shown in the graphic below (figure 1):

- vehicles with different hardware solutions, transmitting data to a private service provider. As most systems are mainly used as management tool for the transport companies, the systems monitor and transmit much more data than required for a navigation system according to Regulation 1/2005;
- private service providers which receive and manage data from their clients' vehicles. The service providers should send defined data to a central receiver;
- central receiver receiving data from the private service providers and acting as a platform to which competent authorities and transporters could connect to see defined data of the transport vehicles.

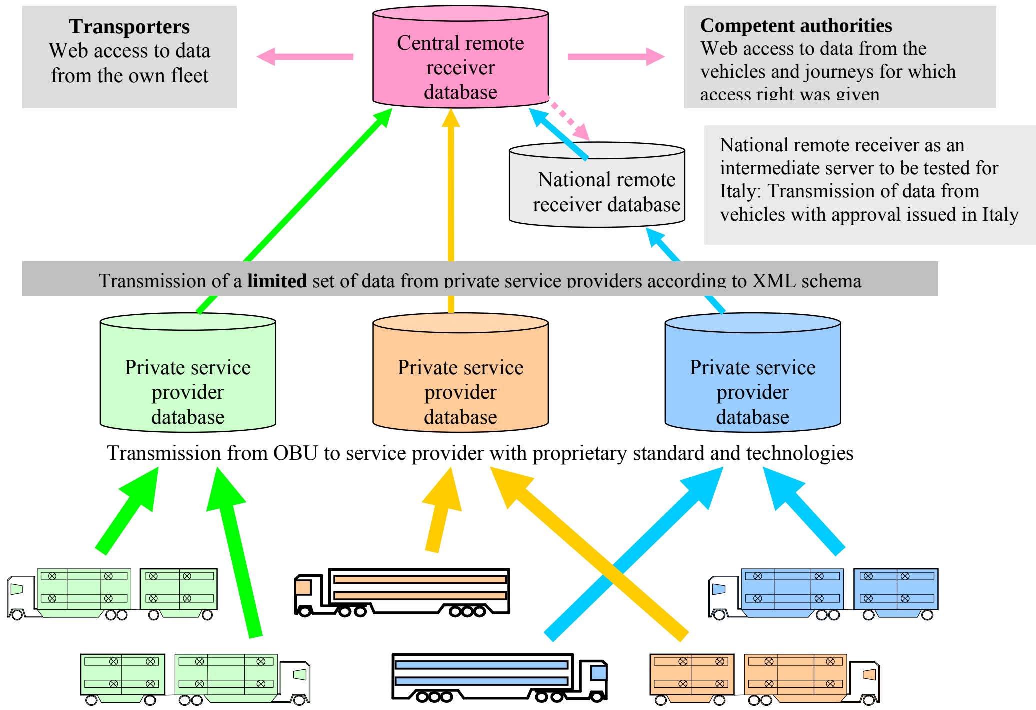


**Figure 1** Principle layout of the study for decentralised system architecture for the tracing systems in animal journeys

The participating transport companies have contracts with private service providers which manage the data from the vehicles' tracing systems. The service providers use their own hardware and software and transmit data from the vehicles to their remote server with their proprietary standards and technologies. Profiting from the existing structures, for the study only a central remote receiver had to be set up to which the private service providers send a defined set of data according a common standard.

As shown in the graphic above, access was given to the participants to see data via a web application at the central remote receivers' database according to defined access rights. For Italy there was in addition an intermediate national remote receiver set up for receiving data from the private service providers of all transport vehicles for which approval was issued in Italy.

## 3.2 Participants

**Transporters / vehicles**: two Italian transport companies with two semi-trailers and one truck & trailer and one Dutch transport company with three trucks & trailers participated in the study. Also three German transport companies agreed to participate but the service provider of their system withdrew (see below).

**Private service providers**: two service provider, one from Italy and one from the Netherlands participated with their tracing systems. Originally also an Austrian service provider agreed to take part in the study. Unfortunately after the kick off meeting he withdrew his participation. As a replacement, another service provider accepted his participation but due to the limited period of the study only a short test transmission could be achieved. In Annex I the two systems participating throughout the study are briefly described.

**Competent authorities**: Regional and local competent authorities from the Food and Consumer Safety Authority of the Netherlands, from the Ministry for Health in Italy and from the State Ministry for Food, Agriculture, Consumer Protection and Rural Planning of Lower Saxony in Germany had access to the data from animal journeys.

**Italian national remote receiver**: the Istituto Zooprofilattico Sperimentale (IZS) dell' Abruzzo e del Molise in Teramo acted as the national remote receiver in Italy.

**Central remote receiver**: The central remote receiver was set up and managed at the JRC site in Ispra / Italy. It included a web service and a database to receive and record the data from the participating vehicles in the agreed schema and a web application to access the received data.

## 3.3 Data made available to the central remote receiver

The participating tracing systems are built on different technical basis and monitor and record not exactly the same sets of parameters in the same format. A standard was defined to allow transmission by the participating systems of a minimum and comparable set of data to the central remote receiver.

**Basic data for each participating vehicle**

The following basic data were provided in advance for each participating transporter / vehicle:

- identifier of the vehicle for which data is transmitted (encoded);
- for each participating vehicle a table with position in the vehicle of temperature and door sensors ;
- identifier of the transport company owning the vehicle (encoded);
- identifier of the service provider;
- country in which the vehicle was approved and what category of vehicle (semi-trailer, truck& trailer).

**Regular data from each participating vehicle**

The following data were transmitted from the private service providers for each participating vehicle:

- time and position at regular intervals;
- temperature at the temperature sensors at regular intervals;
- opening/closing of loading door on basis of change of status and at regular intervals;
- movement or stationary status of the vehicle on basis of change of status and at regular intervals (shown as speed $\neq 0$ or speed $= 0$);
- journey identifier from the start to the end of an animal journey;
- loading and unloading events with species or category and number of animals of animals loaded/unloaded.

The data had to be recorded and transmitted from the vehicle to the private service provider in intervals of maximum 15 minutes and transmitted from the private service provider to the central remote receiver with a delay of maximum 15 minutes.

All data regularly transmitted to the central remote receiver were identified by the encoded identifier of the vehicle and time and position at acquisition. The common data schema for the transmission from private service providers to the central remote receiver is shown in Annex II.

## 3.4 Data accessible at the central remote receiver

The web application showing the data from the database was aimed exclusively at presenting information relevant for official controls such as:

- origin and destination and geographical trace of the transport operation (the animal journeys including a buffer of two to four hours before and after the end of a journey);
- duration of the journey and stationary times during a journey;
- temperatures maintained during the transport.

The participating bodies had access to the agreed subset of data received by the central remote receiver:

- each service provider to the data he forwarded to the central remote receiver;
- each transporter to the data recorded from his participating vehicle(s);
- the competent authorities to journey data of vehicles approved in their country and of journeys of all participating vehicles when starting, transiting or ending in their country.

The information in the web application was available for ongoing journeys and historically for journeys which took place during the entire duration of the experiment. The application included a short tutorial how the data were presented and in which ways the data could be accessed, e.g. journeys listed by vehicle, individual journey by vehicle, journeys of vehicles by date. Annex III lists the main submenus through which the data were accessible.

# 4. RESULTS

The results are based on the two systems which participated throughout the data collection phase of the study with 6 vehicles (4 truck & trailers and 2 semi-trailers).

## 4.1 Data transmission

The data transmission between service providers, central remote receiver and national receiver through web services did not pose any problems of implementation. Limited resources were needed for software programming in order to integrate the different systems adopted by the two service providers and the Italian national remote receiver using the common standard described in Annex II.

The average delays between acquisition of data at the on board unit and availability at the central remote receiver were 13 minutes for transmissions through the service provider and 20 minutes for transmissions through the national remote receiver.

Layout and design of the participating transport vehicles were not provided by all transporters, leaving some authorities without the possibility to see the type of vehicle and allocating temperatures and open doors to the senor position. An example of the layout and sensor locations is shown in Annex III.

Although foreseen, no information was received for the participating vehicles about their number of decks and their maximum loading surface.

## 4.2 Data recording

The average frequency of recording was every 3 minutes for one service provider and every 12 minutes for the other one.

The standards for the recording frequency (at least every 15 minutes) and transmission delay (maximum 15 minutes) proved to be an acceptable compromise to ensure an almost real-time tracing application.

At the central remote receiver the geo coding of data was an important element for establishing access rights by the competent authorities and forwarding part of the data to the national remote receiver. The geo coding was performed against a grid with cells of 10 km instead against exact country boundaries due to technical limitations in the database server used for the experiment. Given this approximation in some cases there were wrong attributions of the country of origin, transit and destination. This limitation could be easily overcome in a large scale application by using more advanced location functionalities at the remote receiver.

Few problems emerged in relation to data recorded by most of the sensors in the vehicles. In one vehicle, one sensor indicated a constantly open door and in another vehicle, one a temperature sensor recorded constantly temperatures out of range.

The recording, transmission and management of temperatures data, overall, proved to be reliable and not posing particular problems.

Most of the data collection took place during November and December 2010 and January 2011 with very low temperatures in central Europe. This is mirrored by the temperatures recorded during the journeys which frequently were below the regulatory limit of 0°C (see figure 2).

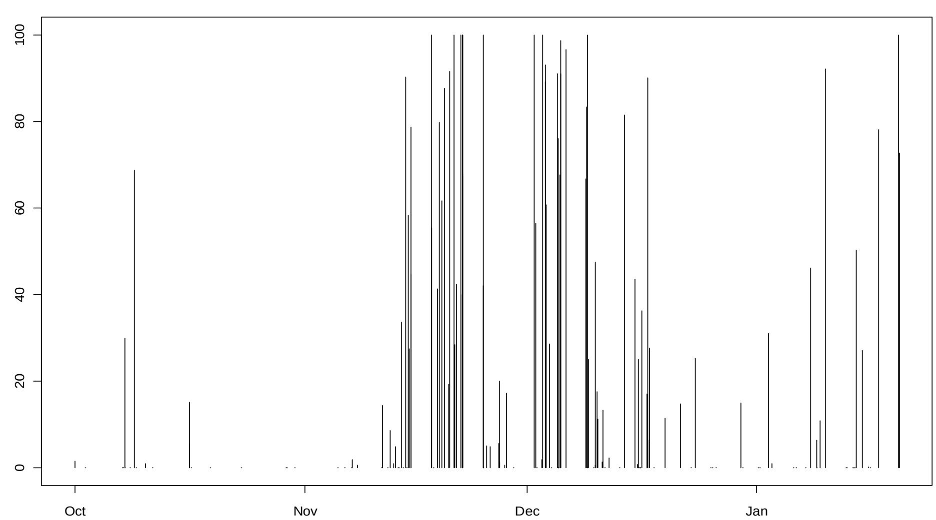


**Figure 2:** Percentage of transmissions with temperature below the limit of <0°C for each of the 187 journeys by date of the journeys (x-axis = months, y-axis = percentage of journey time below 0ºC)

The system of one service provider allowed, in the case of truck and trailer, configuration for independent recording of data for the trailer not only in relation to door sensors and temperature but also in relation to position and timestamp. The data about the trailer was sent in separate messages and the linking with information from the truck proved to be problematic due to the absence of exact alignment between timestamps for records from the truck and from the trailer.

Table 1 and figure 3 show the number of journeys by vehicle and the average duration of the journeys by country of origin and destination.

| **vehicle (encoded)** | **number of journeys** |
|---|---:|
| 54 | 44 |
| 56 | 40 |
| 57 | 17 |
| V001 | 39 |
| V002 | 19 |
| V003 | 28 |
| **Total** | **187** |

**Table 1** Number of journeys by vehicle\

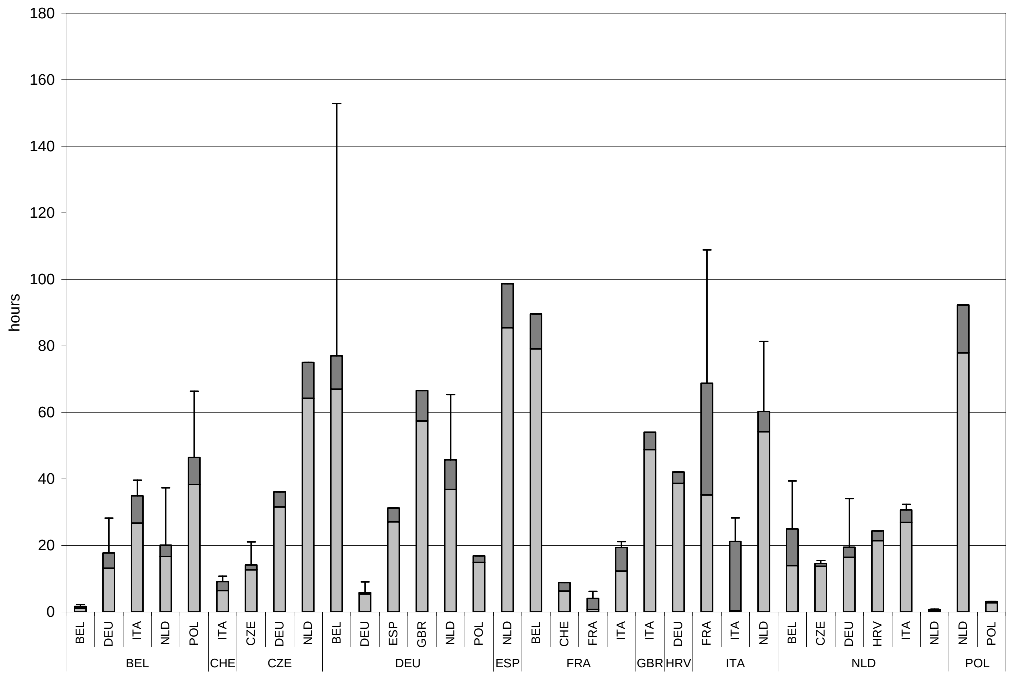


**Figure 3** Average duration with error bars of the journeys by country of origin and destination. Dark grey indicates the average of the total time the vehicle was not moving during each journey (x-axis = combination of origin and destinations, y-axis = hours)

In many cases, the calculation of the duration of the journey using information from the declarations from the driver lead to mistakes and inconsistencies in respect of the information from the corresponding timelines and maps and are shown in figure 3 as error bars.

## 4.3 Journeys and batches of animals

The two participating tracing systems differ in the entities they allow to trace. One is covering the start and end of an animal journey, irrespectively how many batches/consignments are loaded or unloaded during the journey. The other is able to record the individual batches of a journey.

**Tracing system recording animal journeys**

The figures 4 and 5 and table 2 give an example of often recorded journeys from France to Italy with a truck & trailer. The total duration of this journey based on driver declarations was 26 hours. One loading and one unloading event were declared for this journey.

The map (figure 4) shows the route with one loading and one unloading event and 6 indications of an open door.

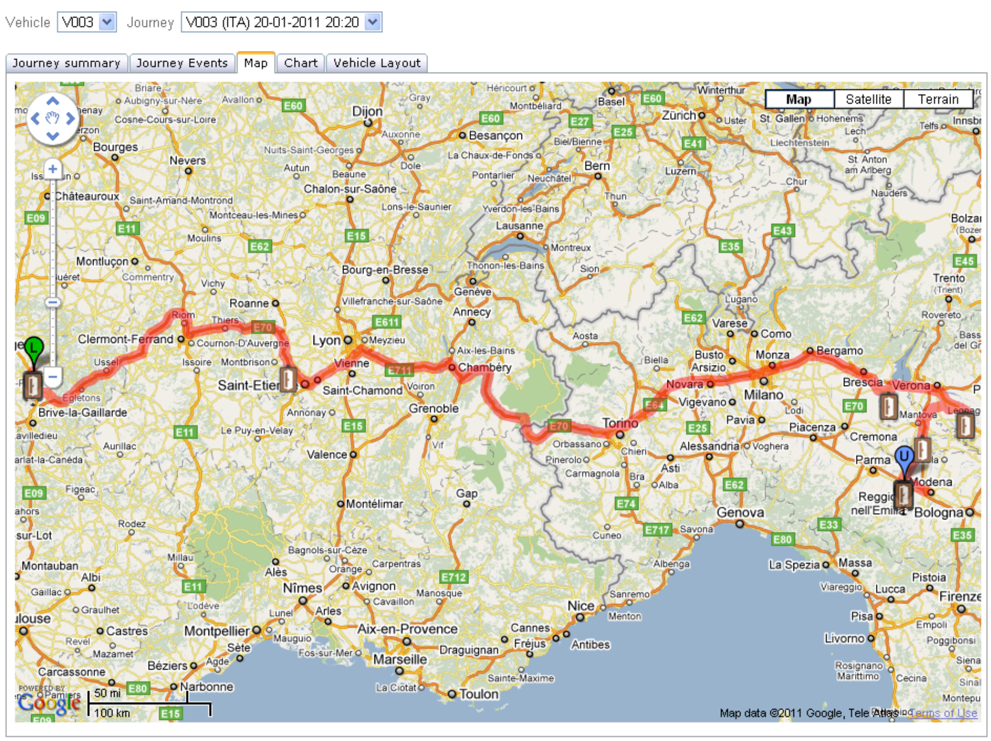


**Figure 4** Trace of a typical journey from France to Italy (L = loading declared by driver, U = unloading declared by driver, rectangles = open loading door automatically recorded)

The chart in figure 5 displays the recorded temperatures from the 3 temperature sensors, the loading and unloading declaration, the vehicle movements and the door status of the loading door of the truck and of the trailer.

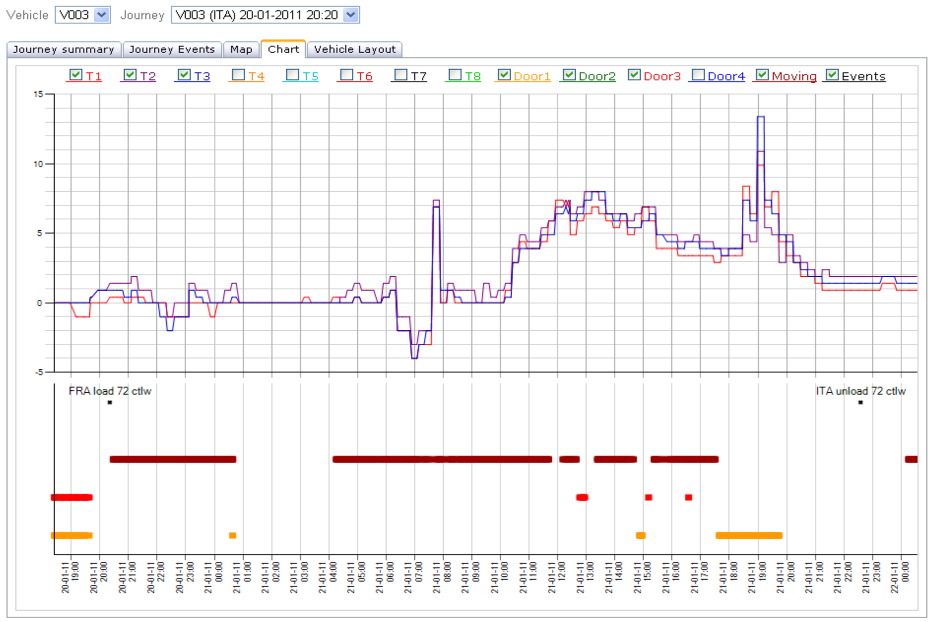

**Figure 5** Time and temperature lines of the journey shown geographically in figure 4. The upper part shows the temperatures from 3 sensors (y-axis = temperature in ºC). The lower part of the figure shows the declarations of the driver, the movement = brown line, the opening of the 2 loading doors, yellow = door from truck, red = door from trailer. The time line includes a buffer of two hours before and after the declarations of start and end of the journey.

| Date and time | Journey identifier | Journey event |
|---|---|---|
| 20/01/2011 19:10 | | |
| 20/01/2011 19:12 | | |
| 20/01/2011 19:13 | | |
| 20/01/2011 19:20 | 32 | load |
| 20/01/2011 19:27 | 32 | |
| … | …. | …. |
| 21/01/2011 21:30 | 32 | |
| 21/01/2011 21:35 | 32 | unload |
| 21/01/2011 21:44 | | |
| 21/01/2011 21:45 | | |
| 21/01/2011 21:50 | | |

**Table 2** Extract of the detailed records for the journey in figure 4. The journey identifier is repeated at every record as long as animal are present on the vehicle while loading and unloading events are transmitted as they occur.

By comparing the declaration of events by the driver and the time line of the vehicle movements and door openings the following can be concluded:

- the start of the journey and the loading event were declared two hours after the opening of the doors;
- at some stops of the vehicle the doors were opened and animal were most likely unloaded at three intermediate locations in addition to the final destination without a possibility for the driver to indicate the unloading of a batch during the journey;
- the end of the journey was declared almost 3 hours after the closing of the doors which would mean that the journey was at least 2 hours shorter than declared.

### Tracing system recording animal journey and batches/consignments

Figures 6 and 7 and table 3 show an example of a journey from Netherlands to Italy with a truck & trailer and recordings of 4 separate consignments.

The map (figure 6) shows the route with two loading and two unloading events.

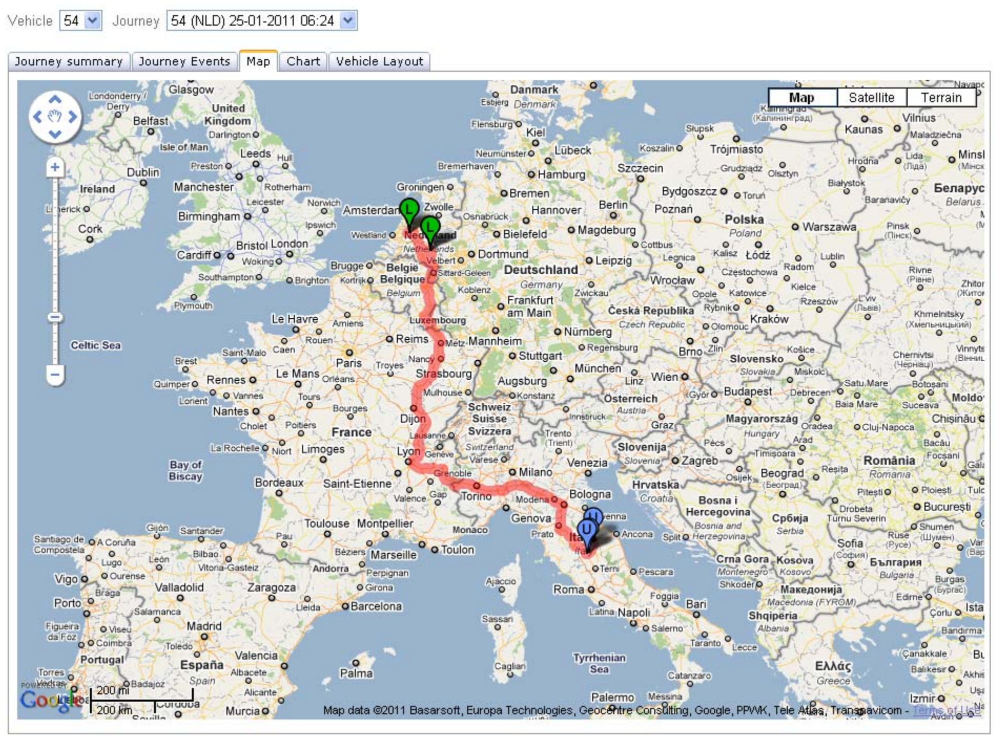


**Figure 6** Trace of a typical journey from Netherlands to Italy (L = loading declared by driver, U = unloading declared by driver).

The chart in figure 7 displays the recorded temperatures from 3 temperature sensors, the declared loading and unloading events and the vehicle movements. The status of the door sensor was not transmitted.

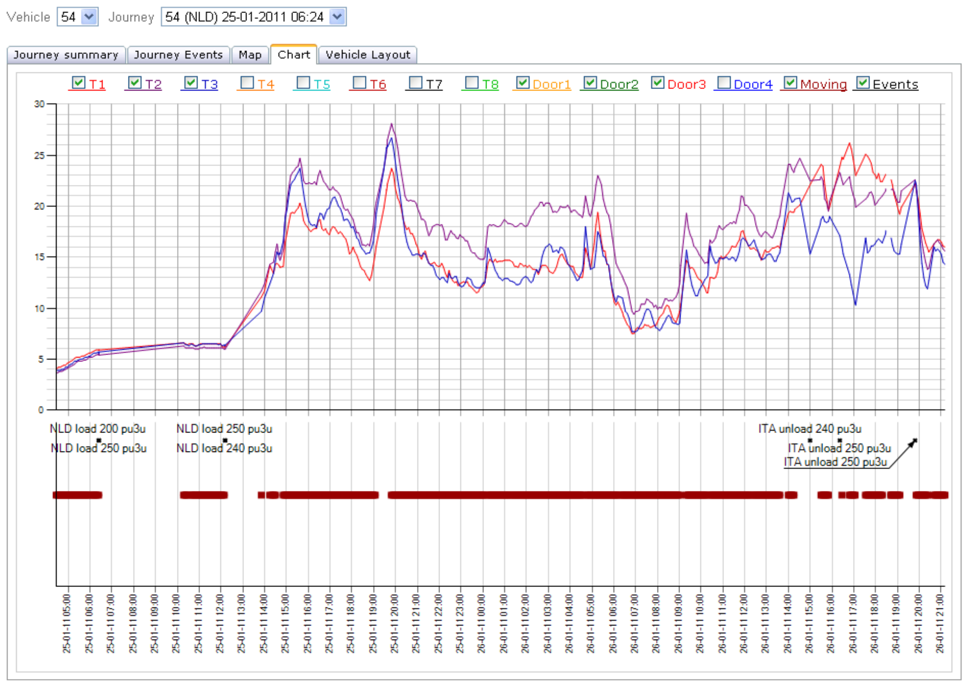


**Figure 7** Time and temperature line of the journey in figure 6. The upper part shows the temperatures from 3 sensors (y-axis = temperature in ºC). The lower part of the figure shows the 4 loading and 3 off the 4 unloading declarations of the driver and the movement = brown line. The opening of the 2 loading doors was not transmitted. The time line includes a buffer of two hours before and after the declarations of start and end of the journeys.

| Date time | Journey identifier | Journey event | Type of animals | Number of animals | Country |
|---|---|---|---|---|---|
| 25/01/2011 05:23 | 15270 | load | Pigs | 200 | NLD |
| 25/01/2011 05:24 | 15271 | load | Pigs | 250 | NLD |
| … | … | … | … | … | … |
| 25/01/2011 11:10 | 15272 | load | Pigs | 250 | NLD |
| 25/01/2011 11:11 | 15273 | load | Pigs | 240 | NLD |
| … | … | … | … | … | … |
| 26/01/2011 13:59 | 15273 | unload | Pigs | 240 | ITA |
| 26/01/2011 15:21 | 15271 | unload | Pigs | 250 | ITA |
| 26/01/2011 18:48 | 15272 | unload | Pigs | 250 | ITA |
| 26/01/2011 22:28 | 15272 | unload | Pigs | 200 | ITA |

**Table 3** Details of the recorded data for the journey in figure 6. Although the 4 batches comprised one journey, for each batch a new journey identifier was entered by the driver, giving the impression there were 4 overlapping journeys at each consignment. No unloading was reported for the first consignment but twice for the third.

The fact that each consignment was identified with a separate journey number did not allow retrieving the information as part of a single journey (from when the first animal of the first batch was loaded on the vehicle until the last animal was unloaded). In the case of the load “15270” there was no unload indicated while in the case of load “15272” there were two unload events indicated, one with 250 animals and one (erroneous) with 200. In such cases the duration of the journey could not be calculated correctly.

## 4.4 Regional and local competent authorities

All competent authorities with access rights were able to connect to the central remote receiver.

Most of the participating competent authorities considered the type of information provided through the central web application very useful and helpful for the control and surveillance of animal welfare in transports. For them the system with all the test limitations offers already more information on a animal journey than the journey logs do. In addition the access to the data was perceived much easier than the classical way through requests to transporters, other authorities or only on the spot. Some authorities mentioned also that the online access was less time consuming and faster than the usual requests to transporters and saving also transporters' time.

Although it was not the aim of the project to display the data in a sophisticated manner, the feedback from the users was positive regarding the sorting and layout of data. The short tutorial they considered sufficient to use the system. The following points for improvements were highlighted by most of the participating competent authorities:

- With a possibility to open directly from one of the submenus "list of journeys by vehicle" or "list of journeys by date" a selected journey could render the application more user-friendly.
- The application did not allow tracing in a selected journey the stops of the vehicle as indicated in the journey chart also directly on the journey route as displayed in the map submenu.
- While the test application geo-coded the received data only against national borders to give access when the vehicle entered into a national territory, for a routine use it would only be useful if also a regional geo-coding is applied, e.g. to highlight regional authorities only vehicles relevant for their region.
- To show the trace of a vehicle already 2 hours before and after the journey as declared by the driver found great acceptance. Misleading declarations from the driver, such as declaring the consecutive starts of journeys while these are batches of a single journey make it sometimes very difficult for the authorities to analyse a journey, especially when the previous loading or following unloading was within the 2 hours buffer.
- Additional filter function would help to select journeys also regarding further criteria, such as species/category of animals, country or origin or country of destination. A filter for the species and category of animals would also require a standardised entering by the drivers.
- Also if a system does not allow for tracking single batches of a journey, the total number of animals loaded should be recorded in addition to the recording of the number of animals loaded at the start of the journey and unloaded at the end of a journey.

Although not a requirement for navigation systems for animal transports in the relevant legislation, the participating Italian competent authorities would favour for enabling better controls some additional information out of section 1 of the journey log in the tracing system, such as telephone number of the person in charge, veterinary certificate numbers, total weight of and space provided for the consignment. They consider the training and collaboration of the drivers essential for a correct use of the systems and to avoid inconsistencies observed during some journeys (e.g. journey without indicating the animal species or wrong animal category, or without indicating the start or the end of a journey).

## 4.5 National and private service providers

The Italian national remote receiver analysed data received from the participating vehicles with information in TRACES and in the national animal database.

- The information provided in TRACES gave the presumed destination while the ongoing journey was visible from the tracing system, sometimes before the vehicle crossed the border to Italy. Combining the TRACES information with the tracing system during the exercise it was possible to understand which batches formed part of a given (ongoing) journey and which should be the presumed unloading points.
- In an application the path of a journey and location of holdings were geographically displayed together. The data from the vehicle together with the geographical coordinates of holdings stored in the national animal database allowed correctly identifying a holding of destination even when an unloading declaration of the batch or journey was not transmitted.
- In addition, the movement notifications received by the national database some days after the transport (individual animals in the case of cattle, batches of pigs) were compared with the data from the tracing system for consistencies.
- The notifications from the holding of arrival for individual cattle coming from outside Italy are recorded in the national cattle database as a generic movement from another Member State (e.g. France). When merging this information with data from the tracing system, the authorities got an understanding which animals were together on the same vehicle and from which location in the Member State of dispatch they came.

From the private service providers' view the study demonstrated that an interface between private service providers and a central remote receiver is feasible with the existing tracing systems / applications installed in the vehicles. Most of the points mentioned above on how the information for the competent authorities could be further improved would require only minor changes in the system applications.

One private service provider proposed to identify a journey by automatically uploading the digital route plan with its identification from TRACES onto the on-board system. The driver would enter only consignment identifiers if appropriate. Entering consignment identification at loading and ticking them off at unloading would follow more the divers' routine at loading and unloading than the more abstract journey identification. This approach however would require a consistent and strict use of journey and consignment definition by the different parties.

One private service provider sees advantages of a national central receiver if it is receiving the data from the central remote receiver but not when placed in between private service provider and central receiver. It would give the possibility if deemed necessary to verify on national level journeys other than long journeys.

# 5. DISCUSSIONS

The technical specifications for the transmission of data to the central remote receiver were aimed at establishing a common standard for different systems of on-board units to make animal journeys remotely accessible to the competent authorities concerned. On one side there was a system which allowed tracking of single consignments with a great level of flexibility, in order to implement functionalities in the field of logistics, and on the other side there was a more simplified system, designed exclusively for the purpose of monitoring animal welfare during transport.

The system of transmissions, data management and visualization was built around the idea of monitoring animal journeys defined as the entire transport operation between the loading of the first animal on the vehicle and the unloading of the last animal. The tests revealed a number of weaknesses which should be addressed to get most use out of the tracing systems in animal transports; some of them would require only minor modifications in the applications.

In the absence of an automatic system to detect the presence of the animals on the vehicle the identification of an animal journey relies on the driver declarations of start and end. However the system gives to the competent authorities the possibility of verifying the compliance of the declarations using automatically recorded data on the position of the vehicle, presence/absence of movement and on door openings.

In one system, given the fact that the OBU did not give the possibility to indicate intermediate consignments, the reconstruction of the intermediate unloading events had to be interpreted looking at automatically recorded data about movement of the vehicle and openings of the doors. On the other side, the attribution of loading and unloading events to a unique journey identifier at the level of the OBU, allowed identifying correctly the animal journey and all the related data from start to end.

In the other system the fact that the identification of the journey and linking of loading and unloading events was left to driver determined several problems in selecting and displaying correctly the journeys and the related information. The calculation of the journey durations was undermined by the lack of consistency in the declaration of loading and unloading events.

While a system of recordings based on declaration of single consignments would offer several benefits for the purpose of traceability it is recommended that:

- journeys should be clearly identified at the level of the OBU limiting at the minimum the entry of information by the drivers;
- a clear distinction should be made between journey and consignments;
- the link between journeys and consignments should be controlled at the level of OBU software to avoid lack of consistency of the declarations.

The competent authorities were assigned the right to see only information related to an associated journey plus a buffer of 2 hours before the start of a journey and after its end in order to overview arrival and loading at holding of departure and unloading and departure from holding of arrival.

The use of automatically recorded information and the inclusion of buffer information proved to be an essential element in verifying compliance of driver declarations. Therefore it is recommended that:

- information to the central remote receiver should be sent continuously and that part of the information before and after a declared animal journey should be made available to the competent authorities.

Although the recording of independent information by a secondary on-board unit on the trailer could offer some advantages, to solve the problem of interpreting the data at the remote receiver it is recommended that:

- the transmission of data for a coupled trailer should be incorporated in a single message with unique position and date-time attributes.

In order to identify periods of rest for the animals instead of relying to declarations from the driver it was decided to use automatically recoded information from the position and movement of the vehicle. This proved to be an acceptable compromise also considering the difficulty in clearly defining and distinguishing an animal rest from other types of rests.

The correct identification of a journey was a key element not only for the calculation of the duration of the journey but also for establishing access rights for the visualization of the data and ensuring data protection and confidentiality. The fact that in the boundary zones between the Netherlands, Belgium, France and Germany often access was given to the competent authorities in the neighbouring country could easily be overcome by better location functionalities in the application at the remote receiver.

The transmission through a national service provider did not provide any advantage against the more straight forward transmission to the central remote receiver. Especially in the case when a private service provider has his clients in different Member States he would have to set up a sophisticated system to forward selected data according to the nationality of the authorisation of the vehicle to the concerned national service providers which in turn would send the data to the central receiver. Such a system of transmission through national service providers system would require additional human and financial resources at Member State level, bearing the risk that in case of failure the information from a national fleet as a whole would not be accessible.

To the contrary, making the relevant data available at the central remote receiver to a national service point could be of added value for analysing data from the tracing systems on a national level with information in TRACES and the national animal database. Such alignments and comparisons of data would have advantages in several aspects:

- it would allow for a batch tracing even with transport tracing systems not catering for batch traceability;
- although the animal tracing systems have to rely on the drivers' declarations of start and end of journeys, it would allow verifying holdings of origin, transfer and destination;
- it would serve animal health aspects about animals/batches transported together and holdings of contact.

The functionalities developed in the web application demonstrated a first concrete example of how the information collected by a central remote receiver could help improving control activities by the competent authorities. Several suggestions for improvements were put forward by the competent authorities testing the web application. All the suggestions, such as additional filters, stops shown on the map, could be easily implemented in a large scale and operational application with limited software development efforts. In addition the integration between information on animal transport and information from national livestock databases on holdings locations showed additional possibilities which would enhance even more the usefulness of the navigation system in relation to animal movement tracing and verification of movement declarations at the national livestock database.

Overall the experiment proved that with limited software development resources the integration of commercial tracing systems in animal transports would be feasible and offer several advantages to the competent authorities both in respect of animal welfare and traceability of animal movement.

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# Annex I Participating Tracing Systems

## Tracing system 1:

| | | System 1 |
|---|---|---|
| **data** | | |
| Data block | date & time | yes |
| | position long./lat. | if no GPS - last fixed position with internal clock |
| | OBU ID | yes |
| journey information | journey ID/TRACES | max 6 Nr. (optional with CUI) |
| | start | manual |
| | break begin | manual |
| | break end | manual |
| | end | manual |
| | species/category | yes |
| | number animals | yes, (only with optional CUI per batch) |
| | number dead | yes |
| | number injured | yes |
| temperature | sensor ID | yes |
| | thresholds | fixed |
| | values | each sensor |
| loading door | sensor ID | yes |
| | values | status |
| **hard & firmware** | | connection to ventilation (optional) |
| | OBU | 1 OBU |
| | CUI | yes (optional in cabin) |
| | Display | yeas |
| | Printer | yes |
| | max. number of temp. sensors | 8 |
| | connection of components | wired on vehicle, wireless to cabin |
| | recording frequency | 5 min. |
| | transmission frequency | 1 hour (costs) |
| | transmission costs | ~ 50 € /month in EU 27 |
| | local memory | yes |
| | Alarm | outside cabin (inside optional with CUI) |
| | backup power | no |

## Tracing System 2:

| | | System 2 |
|---|---|---|
| **data** | | |
| Data block | date & time | yes |
| | position long./lat. | if no GPS - last fixed position with internal clock |
| | OBU ID | yes |
| journey information | journey ID/TRACES | automatic uploaded per batch with ref. numbers |
| | start | manual, arrival at loading |
| | break begin | all breaks recorded with manual selection of activity |
| | break end | |
| | end | manual, arrival at unloading |
| | species/category | yes, definition open |
| | number animals | yes, per batch |
| | number dead | yes |
| | number injured | yes |
| temperature | sensor ID | yes |
| | thresholds | flexible |
| | values | each sensor |
| loading door | sensor ID | yes |
| | values | status |
| **hard & firmware** | | two way communication and upload |
| | OBU | 1-2 OBUs |
| | CUI | yes, only for truck OBU |
| | Display | yes |
| | Printer | optional |
| | max. number of temp. sensors | 8 / OBU |
| | connection of components | Wired / wireless |
| | recording frequency | 5 min. (flexible) + when an event occurs |
| | transmission frequency | Immediately after event and with recording interval |
| | transmission costs | ~ 10 € /months in EU |
| | local memory | yes |
| | Alarm | driver and server |
| | backup power | operational for 15-30 minutes,<br>back-up battery for data coverage and internal clock,<br>data are stored on external memory (no power necessary) |

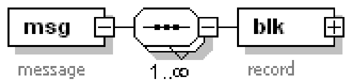
This tracing system puts emphasis on extended management features able to record a much wider range of data than the data requested for the study.

# ANNEX II DATA TRANSMISSION SCHEME

**Documentation of the schema for the transmission of data from Service Providers**

## element **msg**

diagram

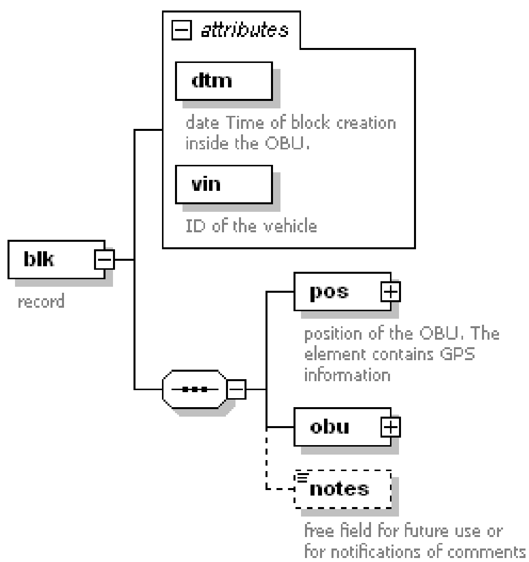



annotation

Each transmission can contain one or more data blocks (hereafter records).
The transmission to the web service requires username and password in plain text in the SOAP headers (see WSDL file).
After each transmission the web service will return one of the following responses enclosed in an element response:
**no connection:** if the database is offline
**invalid login**: if the credentials in the SOAP headers are wrong or missing;
**not well formed message**: if the message is not respecting xml standards;
**invalid message**: if the message is not respecting the schema;
**ok**: if a valid message is received.

## element **msg/blk**

diagram




annotation

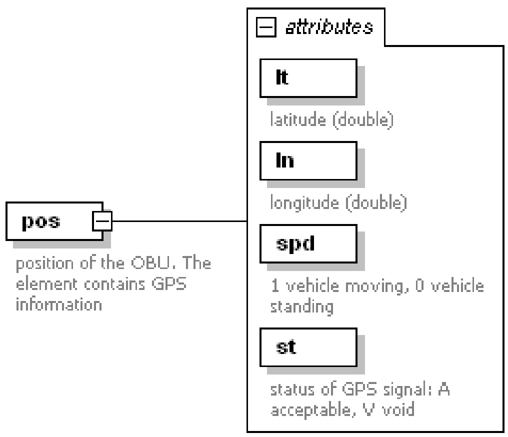
The records are identified by the combination of time stamp (**dtm**) and vehicle identifier (**vin**).
A record should be sent for each vehicle every 15’ minutes or as soon as possible if the record is notifying an event (see below).
The maximum delay between acquisition and transmission should be of 15’.
The time stamp refers to the date and time of the registration of the data at the on board unit.
**dtm** should be formatted according to xs:dateTime type (2000-01-16T12:00:00Z). The time should be expressed in Coordinated Universal Time (UTC).
The **vin** should be an anonimised string identifying uniquely the truck in the context of the experiment. In case of truck and trailer the identifier of the connected trailer should be included in the attribute **sobu** (see below).
A table with the list of identifiers for the trucks and trailers participating to the experiment should be provided with indication of the country where the vehicle was approved for animal transport, the maximum surface available on all

decks for animals and a descriptor for each sensors position (see example below).
Autonomous and independent transmission of position and events for the trailer is not foreseen; data recorded from temperatures and door sensors in the connected trailer should be included in the same data block of the truck (see below **sens**).

| attribute | Type | Use | Enumerations |
|---|---|---|---|
| vin | String | Required | |
| dtm | dateTime | Required | |

## element **msg/blk/pos**

diagram



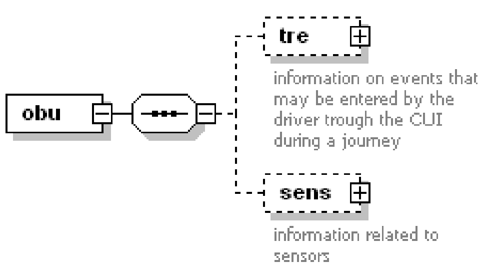

annotation

Latitude (**lt**) and longitude (**ln**) should be expressed in decimal degrees with negative value for latitudes south of equator and for longitudes west of the prime meridian.
If a valid GPS signal is not available (e.g. vehicle crossing tunnel or on a ferry) the coordinates of the last valid position should be transmitted until a valid signal is again available. The value of the attribute **st** should be set in this case to V (void) to indicate that the GPS signal is invalid; for all the remaining cases of coordinates with valid GPS signal the attribute **st** should be set to A.
**spd** should indicate if the vehicle is moving (1) or not moving (0). The attribute is required for each record.

| attribute | type | Use | Enumerations |
|---|---|---|---|
| lt | Double | Required | |
| ln | Double | Required | |
| spd | String | Required | 1, 0 |
| st | String | Required | A, V |

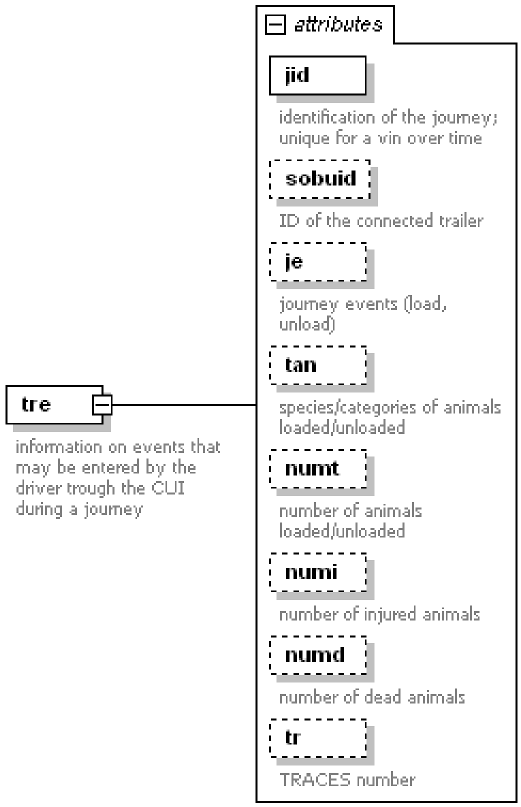
## element **msg/blk/obu**

diagram



## element **msg/blk/obu/tre**

diagram




annotation

Journey identification (**Required**)
The attributes: **jid**, and **sobu** are based on status notification rather than events.
**jid** identifies uniquely for a given vehicle an animal journey (from the first animal loaded on the vehicle to last animal unloaded). **jid** is required for each record during an animal journey.
The correct identification of the journey is essential to verify the duration of the animal transport against regulatory requirements and to establish access right for the data by the Competent Authorities.
**sobu** is required for each record during an animal journey whenever a trailer is connected to the truck; it contains a string uniquely identifying a trailer in the context of the experiment.

**je** is used to notify with an event based notification, loading (ld) and unloading (uld) events as soon as they happen.
Each event should be sent in a separate data block.
The first record of animal journey should contain, in addition to jid, the event load, the total number of animal loaded (**numt**), the type of animals according to predefined categories (**tan**) and if available the traces number (**tr**).
The category of animals can be notified on the basis of animal welfare requirements or, if not available, at a more generic level (see table below).
The last record should contain the event unload and, if any, the number of animals injured (**numi**) or dead (**numd**).

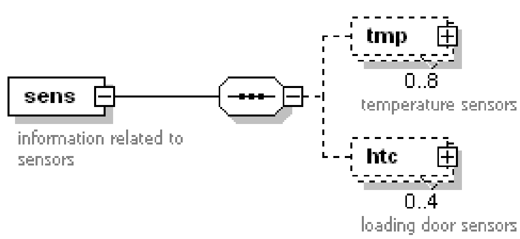
Consignments identification (**Would like**)
Within an animal journey several events of loading unloading may take place. A group of animals transported from one origin to one destination represents a separate consignment. Each load unload event should be accompanied by the number and type of animals loaded/unloaded (**numt**) and if available the traces number or other identifiers of the consignment (**tr**).

| attribute | Type | Use | Enumerations |
|---|---|---|---|
| jid | String | Required | |
| sobu | String | | |
| je | String | | load, unload |
| tr | String | | |
| tan | String | | pu3u, pu3w, pm3e, pm3n, ctlu, ctlw, slfu, slfw, slsu, slsw, dequ, deqr, equidae, pigs, sheep, goats, bovine, other |
| numt | Integer | | |
| numi | Integer | | |
| numd | Integer | | |

| **Categories of animals on the basis of animal welfare requirements** | |
|---|---|
| pu3u | pigs up to 30kg live weight unweaned |
| pu3w | pigs up to 30kg live weight weaned |
| pm3e | pigs more than 30kg live weight compartment(s) not equipped with misting devices |
| pm3n | pigs more than 30kg live weight compartment(s) equipped with misting devices |
| ctlu | cattle unweaned |
| ctlw | weaned |
| slfu | cattle unweaned |
| slfw | sheep with long fleece weaned |
| slsu | sheep with short fleece/goats unweaned |
| slsw | sheep with short fleece/goats weaned |
| dequ | domestic equidae unbroken |
| deqr | domestic equidae other than registered |
| **Generic categories** | |
| equidae | |
| pigs | |
| sheep | |
| goats | |
| bovine | |
| other | |

## element **msg/blk/obu/sens**

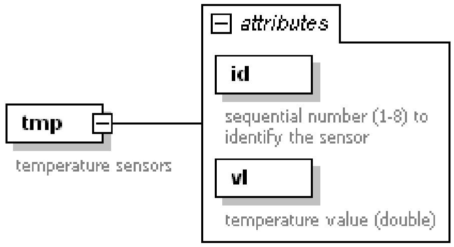
diagram




annotation **sens** contains the information about sensors. Data from the sensors should be provided for each record independently from animal journeys or related events taking place.

## element **msg/blk/obu/sens/tmp**

diagram



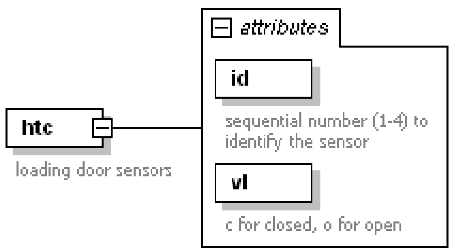

annotation

**tmp** is used to transmit temperatures values recorded by the sensors.
A number from 1 to 8 in the attribute **id** should be used to identify each sensor. A separate table of correspondence between the number and a description of the sensor (e.g.: external, low, center, truck, trailer, min, max) should be provided for each vehicle participating to the experiment.

| attribute | type | Use | Enumerations |
|---|---|---|---|
| id | String | Required | 1,2,3,4,5,6,7,8 |
| vl | Double | Required | |

## element **msg/blk/obu/sens/htc**

diagram




annotation

**htc** is used to transmit the status of the door sensors (c for closed, o for open).
A number from 1 to 4 in the attribute **id** should be used to identify each door. A separate table of correspondence between the number and a description of the door (e.g.: lateral, back, truck, trailer) should be provided for each vehicle participating to the experiment.

| attribute | type | use | Enumerations |
|---|---|---|---|
| id | String | Required | 1,2,3,4 |
| vl | String | Required | C, O |

## element **msg/blk/notes**

diagram


annotation

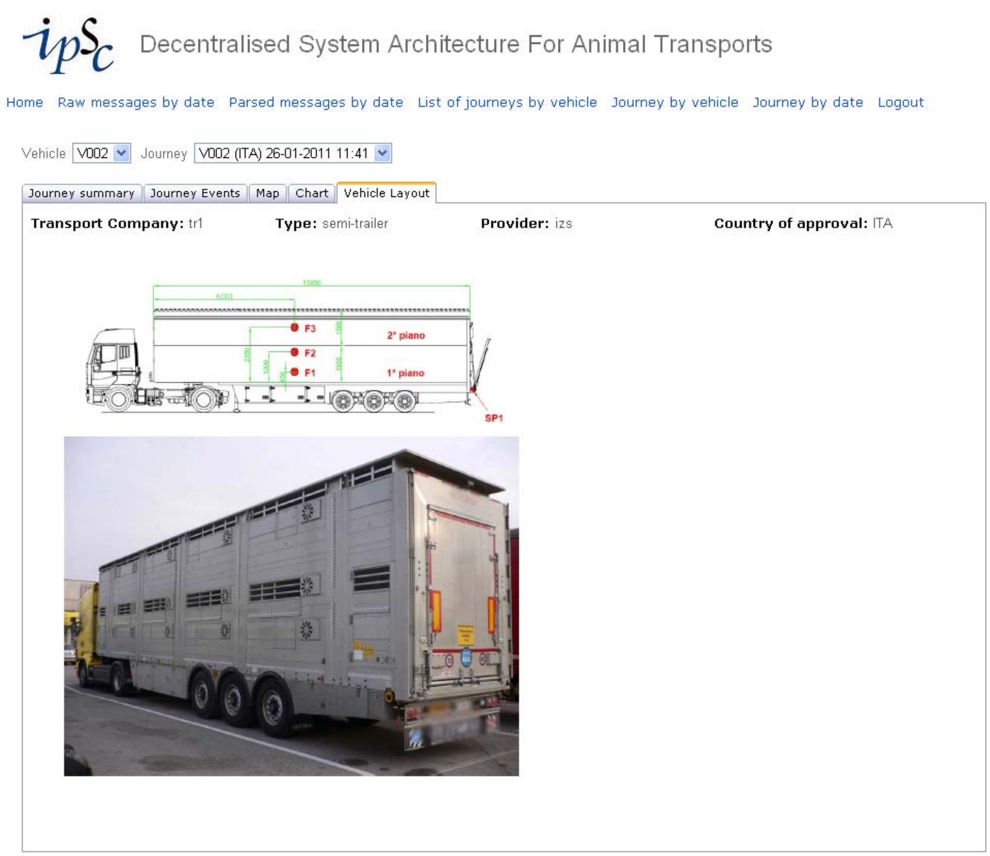
**notes** is an optional element of string type reserved for future needs or for transmission of comments regarding the data in the record (e.g.: filtering, deletion, additions, editing made at the service provider in respect of the original data from the on-board unit).

# ANNEX III WEB APPLICATION AT THE CENTRAL REMOTE RECEIVER

Data were sorted and accessible as through the submenus

- raw messages by date (only to see at central remote receiver)
- parsed messages by date (only to see at central remote receiver)
- list of journeys by vehicle
- journey by vehicle with details in the submenus
  - journey summary
  - journey events
  - map
  - chart
  - vehicle layout (example shown below)
- journey by date with the same submenus as above

Example of the layout and sensor allocations at the submenu "vehicle layout" of a chosen vehicle



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**Abstract**
The study was to demonstrate whether the data recorded by the tracing systems of long journey animal transport vehicles for the official controls under Regulation 1/2005 and managed by different private service providers for trucks fitted with their systems could be made remotely available to competent authorities in this decentralized system architecture.
With limited software development resources the integration of commercial tracing systems in animal transports was feasible and offered several advantages to the competent authorities both in respect of animal welfare and traceability of animal movement.

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