Animal Welfare Monitoring and Livestock Traceability During Transport

Adriano Di Pasquale (*), Enzo Isocrono (*), Luigi Possenti (*), Cesare Di Francesco (*), Walter Di Donato (*), Gianluca Fiore (*), Johann Hofherr (*), Fabrizio Natale (*), Fausto Bonavitacola (*)

(*) Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “Giuseppe Caporale”, Teramo, Italy, http://www.izs.it

Abstract

The paper presents an experimental project aimed to establish an effective navigation system in accordance with Regulation (EC) 1/2005 concerning animal welfare during transports. The prototype realized during the project consists of both hardware and software components. An On Board Unit is installed at truck level. It collects and transmits real-time information of the animal transport to a remote receiver database. A WEB-GIS application is used to analyze and monitor the received information. The hardware and software architecture of the project is presented, focusing on the features of the WEB-GIS application.

Introduction

In the last years the scientific community has developed a new approach concerning animal welfare, based on the principle that animals are recognized as “sentient beings” (and therefore they deserve the best possible treatment), but they are also the first ring of the food chain (and therefore the animal welfare has to be ensured due to its impact on the consumers). This new approach has resulted in moving from a position which was mainly aimed to establish solid requirements in order to prevent unnecessary pains to the animals (in the farm, abattoir as well as in the means of transport) to an integrated animal welfare/food safety approach. In addition, traceability of animals in the intra-Community trade is an essential element to prevent the spread of diseases and to ensure consumer confidence.

In that context, a number of technical collaborations in the field of the animal welfare and livestock traceability in long journeys have been launched between the EU Commission (Joint Research Centre, thereafter JRC) and the Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “G. Caporale” (thereafter IZSAM). In particular, one of the projects is aimed to establish an effective navigation system in accordance with Regulation (EC) 1/2005 on the protection of animals during transport, in order to ensure that animal welfare and livestock traceability requirements are fulfilled during the journey. By recording and transmitting a number of predefined information in real time, the system can ensure compliance with legal requirements concerning animal welfare and livestock traceability, a substantial decrease of the administrative burden stakeholders and competent authorities and will contribute to the prevention of fraud. The system enables the competent authorities to perform more targeted and efficient controls on such transports and to ensure the uniform implementation of the above Regulation within the Community. In fact, the Navigation System establishes the possibility for a totally different approach to the veterinary control organization and implementation. For instance, due to the lack of modern tool the only chance for the EU member states competent authorities is to monitor the implementation of Regulation 1/2005 by inspecting circulating trucks in collaboration with police authorities. The aim of the monitoring is to verify the compliance/incompliance by inspecting the conditions of animal transport and the relevant documents. However, those controls are not targeted to specific cases of non compliance. Instead, the Navigation System allows the authorities to implement much more targeted controls, investing the present resources in a number of compliant cases which have been detected by the system itself at the headquarter of the Authorities before the inspection will take place.

The available technology enables the integration of the temperature monitoring with positioning and recording into the navigation system, avoiding duplication of devices and information and allowing shared use and simplification of systems. A communication system shall be able to send the stored data from the transport vehicle at regular intervals and/or when certain events occur to a remote receiver. One of the possible option in a future scenario is to transmit the relevant information to a central, remote receiver from where the data could be displayed according to strict access rights (e.g. transport companies may see their own data, competent authorities the data for their area). In terms of livestock traceability, there is also a need to link the information collected by the satellite navigation system with data made available in TRACES [TRACES], the Community Information System which establishes the communication between EU member states on animal trade. The single batch of transported animals, identified with the TRACES number and accompanied by a dedicated veterinary
certificate, can therefore be constantly monitored during the journey. The impact assessment on the navigation system carried out by JRC (see http://awt.jrc.it) demonstrated that a central, Community wide receiver and database would have clear advantages compared to other options (the least expensive with most advantages). However, the final scenario on the architecture of data transmission (local/national/community Database, communication standards, etc.) still needs to be discussed and approved in the appropriate forum.

Overview on the features of the final system

Any navigation system conforming to the requirements of Regulation (EC) 1/2005 consist of a global navigation satellite system, which locates the vehicle and provides precise timing. These data shall be regularly recorded and stored in an on-board unit which can collect, record and store the regularly monitored temperature in the animal compartment, the status of the loading doors and can finally generate warnings when reaching predefined temperature thresholds. Through an interface, the driver of the transport shall be able to enter into the onboard unit predefined sets of information, such as –for instance- category, species and number of animals loaded, start and end of a journey, number of animals injured/dead during transport, TRACES number of the batch, etc. The interface shall also provide warnings to the driver when the temperature in the animal compartment reaches permitted thresholds. The onboard unit shall be able to continue operating when disconnected from the external power supply for a predefined time span. It shall store data collected during a journey at least for 4 weeks and allow authorized users the downloading of the stored data. A communication system shall be able to send the stored data at regular intervals and/or when certain events occur to a remote site. By standardizing the data format, animal welfare data for specific journeys could be made available (e.g. through web services). The integrity of the data shall be assured.

Data to be regularly collected, logged and communicated to a remote receiver

The following data shall be collected, logged and transmitted in regular intervals:
- Positioning of the vehicle,
- Time,
- Temperature in the compartment where animals are transported.

The data blocks shall be distinguishable by time stamp and OBU ID.

Events to be communicated to a remote receiver at occurrence.

The following events can be collected, logged and transmitted when they occur or once be entered into the system:
- Journey event (start, rest, resume, end of journey, loading ad unloading of an animal batch -i.e. the group of animals accompanied by a specified veterinary certificate and identified by a specified TRACES number: more than one batch can be transported in the same vehicle)
- Species and category of animals loaded for each batch,
- Number of animals loaded for each batch,
- Opening/closing of the loading doors,
- Coupling /uncoupling of semi-trailer/tractor or truck/trailer,
- Number of animals injured or dead during or after journey,
- Login event or download event (servicing, inspection),
- Tamper or malfunctioning event, such as disconnection from power, sensor failure, low battery status, opening, removing the on-board unit.

The Project Prototype

Since 2006, JRC and IZSAM are collaborating in a project aimed to verify the feasibility of a system where data collected from an equipped vehicle fleet are transmitted to a predefined remote database. The navigation system is designed to collect, record and transmit a defined set of data as specified in the DG SANCO working document [DG SANCO]. It consists of the following hardware components for the required functions, such as:

- The Onboard Unit (OBU, see fig. 1). It is equipped with:
  - GPRS module: allows the transmission of the acquired data to a remote receiver.
  - GPS module: acquires time stamped vehicle position data and in the system time reference.
  - Memory: for the internal data storage;
  - Serial ports: for the connection with additional devices (for instance, RFID readers, etc.)
- Temperature sensors
- Loading door sensor
- Trailer sensor

The present configuration allows establishing up to 32 connections with sensors.

- The Cabin User Interface (CUI): informs about the status of the system, including warnings. In addition, it provides the driver with the possibility for data input to enter additional information.
All parts are interconnected. The hardware allows expansion for further sensors, e.g. for measurement of humidity. The system is autonomous and operates in both presence and absence of external power found on the truck/trailer, thanks to a rechargeable batteries system.

The On Board Unit (OBU) transmits data collected from the GPS module and from the truck sensors to the remote receiver via the GPRS module. The stored data can be sent at regular intervals and/or when certain events occur (asynchronous events are high or low temperature, open or close status of loading doors, tamper or malfunctioning event). Each data block is distinguished by a journey identification, data block identifier, name and authorization of transporters.

**OBU transmissions**

Communication between the OBU and the remote receiver is performed using XML and Webservices technologies. Details on these technologies can be found in the references [WS] and [XML]. The OBU performs a webservice call sending data as an XML data stream. Afterwards, the XML format is validated using an XSD file, which contains rules for accepting or refusing information transmitted by the OBU. In particular, it describes the node and related attributes that is allowed in the XML data stream. The picture below shows the basic elements of the XSD file.

More precisely, the blk node is the root node of the XML data, the “vin” attribute stores the OBU identification number. A blk node contains:

- A pos child node. It stores the geographical position of the OBU.
- An obu child node. It stores data related to the OBU.

The OBU sub-tree is reported in the picture below.

The tre node specifies the information about the journey status. In particular, the js attribute (journey status) indicates the state of the journey: started or finished. The tan node provides the information about transported animals. In the same figure, the list of all possible values for the tan node is reported. Each value
indicates a different category (e.g., “tan=pu3u” corresponds to “pigs weight < 30 kg;”).
The remote database receiving the OBU transmissions has been realized at the “Italian Animal Identification and Registration System” database (BDN) managed by IZSAM. The communication with the OBU is ensured by the interoperability system at BDN site [MEI2007].

**Web application**

The data transmitted by the OBU and received by the BDN are real-time accessed and analyzed via WEB using a WEB-GIS application.

Data are presented only to authorized users. In particular, a transport company can see the data related to the trucks of its fleet. An authorized organization of a EU member state can see the data related to the trucks passing on the territory of the state. The administrator can see any data.

These ready and up-to-date information are available through a visual and intuitive user interface. In this way, the decision process can be faster, more efficient and targeted to the spatial area of interest. Indeed, the application provides a number of functionalities, which are very useful for the analysis of data: position data can be filtered by interval of date, by truck, by transport company and by state (See fig. 6). Moreover, data can be seen through a WEB-GIS interface, graphically showing:

- the path of a journey,
- the position where the truck is in motion and where is standing,
- the position where the loading door of the truck is open,
- the position with anomalies of any nature, e.g., where loading door of the truck is open and the speed is greater than zero.

**Journeys**

An animal transportation starts with an empty truck and a load of animals at a given site and ends when the last animal is unloaded.

From our system point of view, the driver manually sets the start of a journey interacting with the CUI. This triggers an OBU transmission notifying the start. Afterwards, during the journey, the OBU reads position and sensor’s value and regularly sends them to the BDN. At the end of the journey, the driver manually sets the stop of the journey interacting with the CUI. This triggers an OBU transmission notifying the stop.

In the web application, the journeys are reported indicating dates and times of starting and stopping points.

The detail part of a journey shows the whole set of OBU transmission between the start and the stop of a journey.
The technology used to graphically report points related to OBU transmissions on a map is based on two main software frameworks: Google Maps [GOOGLE] and Openlayers [Openlayers]. The most important difference between the two technologies is essentially that Openlayers is an open source project, while Google Maps requires a license for commercial purposes.

Another important feature of the web application is the log view tool. Each message sent to the web service, is stored into the database. The complete list of data transmitted can be filtered by the transmission date. This functionality can show which transmission has been accepted, correctly validated or refused. An “error” field reports possible anomalies.

The figure below shows an example of accepted transmissions and a refused one, because the XML data has not been validated with respect to the XSD file. The error reported is: “XML document invalid”.

This feature is an essential tool in such an asynchronous and decentralized environment. It helps in debugging possible communications problems, like wrong XML format, delay in transmissions, unpredictable OBU behaviour and much more.

References


[TRACES]: TRAde Control and Expert System.

[GOOGLE]: The Google Maps API. http://www.google.com/apis/maps/


