SENA
ITS Strategies

15 August 2009

From: Michael L. Sena
To: Ven Pedro
Telematics Update
Ref: ADASDATA_TU_29JL7
Re: Proposed Article – ADAS for Trucks: New Data Sources – Two Pages

There are indications today that digital map data used for in-vehicle ADAS applications will be supplied by current navigable map data providers, and that the data will be delivered to system integrators in a form consistent with the structure of navigation systems. There is a geographic data model in wide use by the in-vehicle systems sector, the GDF specification, and it is according to this data model that system developers will most likely expect data to be delivered. Public road sector organisations, particularly the national road authorities, regularly collect data that could be of high value for ADAS applications if it could be delivered in a form acceptable to all market players. This data includes slope, curvature, banking, bridge heights, speed limits, vehicle type restrictions and much more. The SOLVI (Safe Operation for Large Vehicles Initiative) Project within the Swedish IVSS (Intelligent Vehicle Safety Systems) Programme is proving that this public data source can be tapped.

A new class of in-vehicle applications, called Advanced Driver Assistance Systems (ADAS), is beginning to make its way into vehicles. Most of the ADAS systems already developed use radar and motion sensors to deliver signals to the applications so that they can perform their specialised functions, such as stabilising the vehicle around turns (Electronic Stability Control), warning the driver not to change lanes if a car is approaching from behind in its blind spot (Lane Departure Warning), or keeping a safe and constant driving distance to the vehicle in front (Adaptive Cruise Control). Map data is being viewed as an important—and in some cases vital—aid to providing the information for many safety and environmentally friendly driving applications, such as assisted braking on steeply sloping and curving roads, assisted acceleration and braking on hilly terrain, assisted steering and safe speed maintenance on winding roadways with many intersections.

Information contained in the current navigable map databases is, in some cases, necessary, but not sufficient to perform the required vehicle control and driver assistance functions. Because of the precision demanded by the applications, requiring higher positional accuracy and a greater level of detail about the physical

MICHAEL L. SENA CONSULTING AB
ÅSA STATIONSVÄG 22 • S-430 31 ÅSA • SWEDEN
PHONE: 46 340 656 880 • FAX: 46 340 656 880
E-MAIL - ml.sena@mlscab.se

VAT NUMBER : SE5564891892 01
REGISTRATION NUMBER: 556489-1892
REGISTERED OFFICE: KUNGSBACKA
F-SKATTESEDEL

attributes of the geographic features, new sources of data must be identified, and new, more complex methods of integrating this data must be developed. Slope data is an example of new data requiring a high level of accuracy. Slope is the difference in height between two points, and the distance between these points. Within the SOLVI Project, for a fuel economy and brake management application for heavy trucks, it has been shown that 0.1% positional accuracy over a distance of twenty feet is required. This is necessary in order to estimate the vehicle drag caused by gravity on small gradients.

Application	Slope range	Slope accuracy	Scope
Longitudinal velocity control (optimized for slope profile)	High resolution range ~[-3%, 3%]. Low resolution range ~[-6%,6%]	High resolution range requires error < ~0.1 % slope. Low resolution range requires error ~0.5% slope	Highways and main roads where it is feasible to run a truck on cruise control > ~70 km/h. (Determined by functional class?)

Table 1 SOLVI Use Case: "Longitudinal velocity control" (Project Partner, Scania Trucks)

Methods currently used by map data suppliers to the navigation systems market to record the altitude coordinate from which slope is derived are not sufficiently accurate for achieving the desired level of accuracy. There are two problems with these methods: The resolution of the heights of points is too coarse; and, the distance between the collected points is too far apart.

Alternative Data Sources for ADAS

ADAS applications will require more detailed versions of data than are currently collected, and they will need new types of data, such as slope, that are not presently part of the standard data collection routines used by navigation map data suppliers. There are potentially many sources of enhanced or new data, including direct data collection by ADAS users, airborne systems, and public data sources.

Among the best potential sources of high accuracy data are the national road authorities in many countries around the world. There are over 100 countries represented in the World Road Association (PIARC). Most of these organisations have the responsibility for specifying and overseeing the building and maintenance of the national road network, and for establishing the standards for all roads that are built and maintained by the counties and or municipalities. The National Road Authorities' design engineering drawings and as-built drawings can be excellent sources of data for updating existing databases and for providing highly accurate curve and slope data. In addition to recording data, there are other processes used by the road authorities that generate useful data. For example, there is a road measurement method used in Sweden based on a vehicle fitted with special sensors. The vehicle is used primarily for road surface testing. Although the intention of its measurements is to show precise surface profiles, slope, curvature and banking data are delivered as a "bonus". The measuring vehicle can travel at approximately 80 km/h, making it a highly efficient data collection method.

Tests were conducted by the SOLVI partners with a sample set of the SRA data, and results were very positive. The slope data met the 0.1% accuracy requirements, and the data set worked as well as the data collected by Scania for its initial tests of engine management. Work is in progress to incorporate this sensor-collected data into the Swedish National Road Database which will then make it possible to deliver slope data along with all of the other attributes that are incorporated into NRDB.

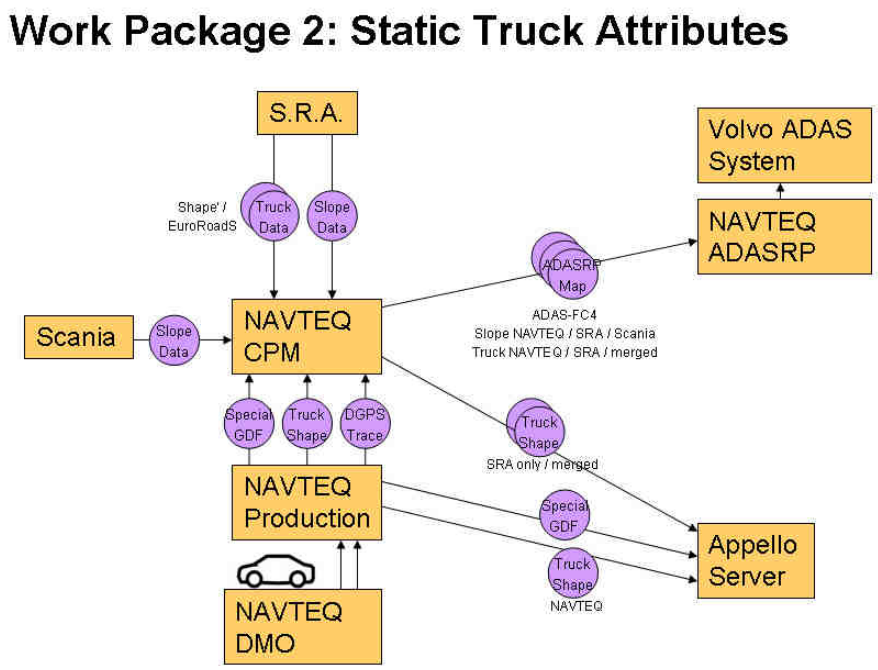
Issues with Public Data Usage

Issues that are of principal concern to national road authorities and their municipal counterparts are quite different from those of the navigation system developers. The authorities gather and store information in order to build and maintain the infrastructure so that it provides for safe travel by its users and the lowest possible maintenance costs for the public. The principal technical problems with public data usage are how the data is structured in the public authorities' databases, compared to the structure of the map data suppliers' data, including both the logical data model and the geographic reference system; and the different requirements for the data resulting in widely different specifications for the types of data that are collected, and the frequency that the data is collected and updated. The lack of compatibility between public and private sector approaches to representing the physical world has been one of the most important reasons that direct data usage has not been practical.

Each of these issues on its own would be a major hurdle to using public authority data in an advanced driver assistance system. Taken together, they offer a formidable hindrance. Nevertheless, the advantages of accessing the wealth of data available from the national road authorities are a significant incentive to resolving these varied issues. The lessons learned thus far in the SOLVI Project are offered as a possible model for future cooperation between the road authorities and the map data suppliers for ADAS applications. Navteq currently serves as the supplier of a complete navigable and ADAS-compatible database to many navigation system and ADAS applications developers. SRA has data that complements and supplements the data that Navteq collects with its own staff.

One objective of the SOLVI Project was to determine whether it is possible to incorporate data from the SRA data set into the Navteq data set in a way that would make it feasible to use the process in a production process. A set of attributes was used to match SRA to Navteq data. Several iterations of the matching process were necessary until a proper mix of attributes was determined, and the data sets could be matched precisely.

Once the two data sets were referenced geometrically, it was possible to compare and contrast the different attributes. A combination of automatic and visual matching was made for each of the overlapping attributes, such as bridge heights and signage. In some cases, the SRA data was selected, and in others Navteq's data was used. An example of the former was speed limit data, which could be taken from the SRA data set into the Navteq data.



The diagram above is from the SOLVI Project work package related to developing a complete set of data that would be used for truck-based ADAS applications. It shows the flow of special attribute data and slope data from SRA into the Navteq compilation processing module. This data is first processed by SOLVI partner, Triona AB. Data collected by Scania directly in its trucks is also compiled as a secondary reference. This data is combined with data that is collected by the Navteq Digital Maintenance Organisations in each country, and is then delivered the ADAS Research Platform, Navteq's electronic horizon provider used in the truck applications (shown here with the Volvo application). Dynamic data, such as variable speeds and traffic congestion, is delivered to SOLVI partner Appello. There is an on-board client application provided by Appello used in for truck-specific navigation.

Conclusions

While the SOLVI Project has addressed only the technical issues, the results have been encouraging. It has been shown that there are methods that can be used for creating compatibilities between the different data models by using attributes of features that are common to both data sets, and that by first converting the road authority data to the international standard WGS84 geographic reference system, the matching task can be accomplished more easily and more accurately.