European Agricultural Machinery

CEMA

CEMA position paper

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Cyber Security and Software Update Management Systems for agricultural vehicles

Summary

In the context of digitalization, also the digital connectivity of vehicles is increasing. Besides the passenger car sector, agricultural vehicles are increasingly being equipped with assistance systems. In addition, control units and functions are being activated or updated both, by cable and "over the air". The regulations UNECE R155 and R156 were published at the beginning of 2021:

- R155 Cyber Security und Cyber Security Management System (CSMS) and
- R156 Software Update und Software Update Management System (SUMS).

Currently, these regulations are not yet mandatory, but can become mandatory, for example, with a reference in the EU type approval for agricultural machinery in the countries that implement these regulations. Specifically, in the UNECE R156 (SUMS) it concerns the vehicle categories R, S and T, under which many agricultural vehicles fall. Considering the low level of participation in road traffic and the small size of the industry compared to the automotive sector, the additional effort required is enormous and many manufacturers are unable to handle it. In addition, the area of application of the assistance systems is mainly off road, in-field, and a large number of vehicles offered do not have any assistance systems at all.

Therefore, given the different industry and usage structures of agricultural vehicle and component manufacturers, a more graded, differentiated view is requested.

1 Situation

The following agricultural vehicle categories are covered by the scope of UNECE R156 (SUMS):
- Trailers (R),
- Interchangeable Towed Equipment (S),
- Tractors (T).

The remaining agricultural vehicles are classified as self-propelled machinery, for which, however, there is no vehicle category within the UNECE regulations. These vehicles are covered by the EU Machinery Directive. Currently, there are efforts to include requirements for cyber security and artificial intelligence as part of a revision of this directive.

As a result, there are different legal framework conditions for agricultural machinery manufacturers depending on the type of vehicle. In addition, there is the particular problem that the vehicle categories R and S also fall

within the scope of the Machinery Directive, leading to a risk of overlapping legislation.

A disadvantage compared to the UNECE regulations is that the area of implementation of the Machinery Directive is limited to the member states of the EU and EFTA. This results in disadvantages in the marketing of the equipment outside this area of application.

The vehicle categories R, S and T are covered by UNECE R156 (SUMS), but not by UNECE R155 (CSMS). However, there is a causal relationship between Software Update Management and Cyber Security.

The following statements are made for agricultural vehicles:

- Hazards linked to the use of agricultural vehicles are classified as low in road traffic:
  - Low speeds on public roads,
  - Assistance systems almost exclusively in field use, not for use on public roads,
  - Peripheral components (cutterbar, mower...) are mainly not usable in public road traffic (transport position/mode).
- Many SMEs active in agricultural technology
- Industry-specific supplier structures
- Longer lifetime of architectures in agricultural technology applications
  - Development processes or hardware changes amount to 8 to 10 years development and introduction time (system change-over)
- High diversity in agricultural technology
- Low scalability of potential attacks
- Turnover of the entire agricultural machinery industry is comparable to the turnover of only one large automotive OEM

2 Manufacturer and suppliers

The UNECE regulations address vehicle categories that are linked to different industries and applications. In particular, the automotive industry and the agricultural machinery industry differ fundamentally. Here, a differentiation must be made both, in the basic structure of the industry for agricultural vehicles with their OEMs and suppliers and also in the different use, in agricultural applications compared to automotive applications. In addition to many agricultural vehicles being produced in very small series, many suppliers specialize in these small series. In total, around 150,000 permanent employees work for the 7000 agricultural machinery manufacturers in Europe. The agricultural machinery sector is not only made up of large multinationals offering the entire product range of agricultural machinery and tractors. There are also many medium-sized specialists on the market, many of which are family-run businesses. On average, European manufacturers and suppliers of vehicles, machines, components and software systems represent 34 % of the global trade.

In 2019, approximately 170,000 new tractors were registered in the EU28, which is only about 1 % compared to the 16 million new passenger car registrations from 2019. The automotive industry is characterized by many large OEMs that sell a high number of vehicles per year or to give the example for some types they produce the same volume for one type as all yearly produced tractors for the EU28.

3 Positioning of agricultural industry on the application of UNECE R155 and R156

This position paper acknowledges the need for regulations in the agricultural machinery industry, but as well it shows a clear need for industry-specific differentiation:

The automotive industry develops assistance systems and autonomous functions exclusively for use on public roads. Manufacturers of agricultural vehicles, on the other hand, develop assistance systems and autonomous functions for use in the field, which serve the intended use in agriculture of the machine.

Figure 1 provides an overview of functions, their intended use, and a chronological, industry specific consideration of the areas of application of UNECE R155 and R156.

Furthermore, the categories R and S are only equipped to a limited extent with electronic systems whose function is relevant for public roads, see Figure 1 Level 4. For these categories, the agricultural machinery industry for electronic functions with regard to functional safety, has been subject to the European harmonized regulatory framework for many years, under the conformity procedure of self-certification (e.g., CE marking), This functional safety is constantly adapted and extended considering the systems used. This self-certification does not require an additional audit by a notified body as described in UNECE R155 and R156.

3.1 Objectives

Software update (SUMS) and cyber security (CSMS) management systems must be introduced in an industry-specific manner. A step-by-step plan for agricultural vehicles must be defined, which takes into account a gradual approach, timewise, and from technical and organizational level, see Figure 1, compared to the other involved industries:

The target must be a gradual introduction of measures suitable for the sector within the framework of adapted regulations of UNECE R155 and R156 for vehicles of categories R, S and T for agricultural applications.

3.2 Need for action

The existing regulations will be adapted with requirements suitable for the industry.

Here, the following gradations are defined for vehicles for agricultural requirements:

- **Technical**
  (e.g., "level of electronic complexity" - Figure 1)
- **Timewise**
  (implementation dates providing lead time)
- **Organizational**
  (e.g., self-declaration, vehicle categories
  "vehicle categories" - Figure 1).

In future, an additional informal document would be provided, which explains the industry-specific solutions and measures by means of concrete examples.

Level of electronic complexity / Vehicle categories	No electronic functions **on road**	Safety relevant electronic functions **on field**	Safety relevant electronic functions **on road**	Electronic assistance functions **on field**	Electronic assistance functions **on road**	Autonomous functions **on field**	Autonomous functions **on road**
	0	**1**	**2**	**3**	**4**	**5**	**6**
R	not homologation relevant	not homologation relevant[1]	To be assessed	not homologation relevant[1]	/	not homologation relevant[1]	/
S	not homologation relevant	not homologation relevant[1]	To be assessed	not homologation relevant[1]	/	not homologation relevant[1]	/
T	not homologation relevant	not homologation relevant[1]	To be assessed	not homologation relevant[1]	To be assessed	not homologation relevant[1]	/
Automotive	out of date	/	mandatory	/	state of the art	/	relevant according to autonomy level

1 – Usage on the road excluded

Figure 1: Gradations in the area of application of UNECE R155 and R156 for the agricultural vehicle categories compared with the automotive industry.

Annex

UNECE R155 and R156

In the course of digitalization, agricultural vehicles face increasing complexity. The introduction of the regulations on Cyber Security Management Systems UNECE R155 (CSMS) and Software Update Management Systems UNECE R156 (SUMS) have the following objectives, among others:

- Prevention of accidents due to manipulation
- Protection of users and bystanders
- Traceability of safety-relevant system changes (e.g., variant management)
- Data protection.

A.1 UNECE R155 (CSMS)

The UNECE Regulation R155 includes the implementation of a Cyber Security Management System (CSMS). The vehicle manufacturer and supplier can be guided e.g. by ISO 21434. General requirements include:

- Requirements for the manufacturer's organization (processes, responsibilities, measures)
- Requirements for the development processes of the manufacturer (risk assessment, documentation, testing, ...)
- Requirements for the documentation to be made available to the authorities.
- Information on the measures that will be taken in case of non-compliance.

In order to be allowed to operate a CSMS, external certification must be carried out every three years.

- These processes require additional integration and cannot be implemented with existing resources.

A.2 UNECE R156 (SUMS)

The UNECE Regulation R156 includes the implementation of a Software Update Management System (SUMS). Vehicle manufacturers and suppliers can be guided by ISO AWI 24089, for example. General requirements include among others:

- Update Management Organization & Management
- Software Update Management
- Stakeholder Management
- Software Update Ecosystem
- Requirements for the documentation to be made available to the authorities.

Both regulations, R155 and R156, are linked in that a SUMS cannot be implemented without a CSMS.

In order to be allowed to operate a SUMS, an external certification is required for the operation of each SUMS used (production, workshop, vehicle) every three years.

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