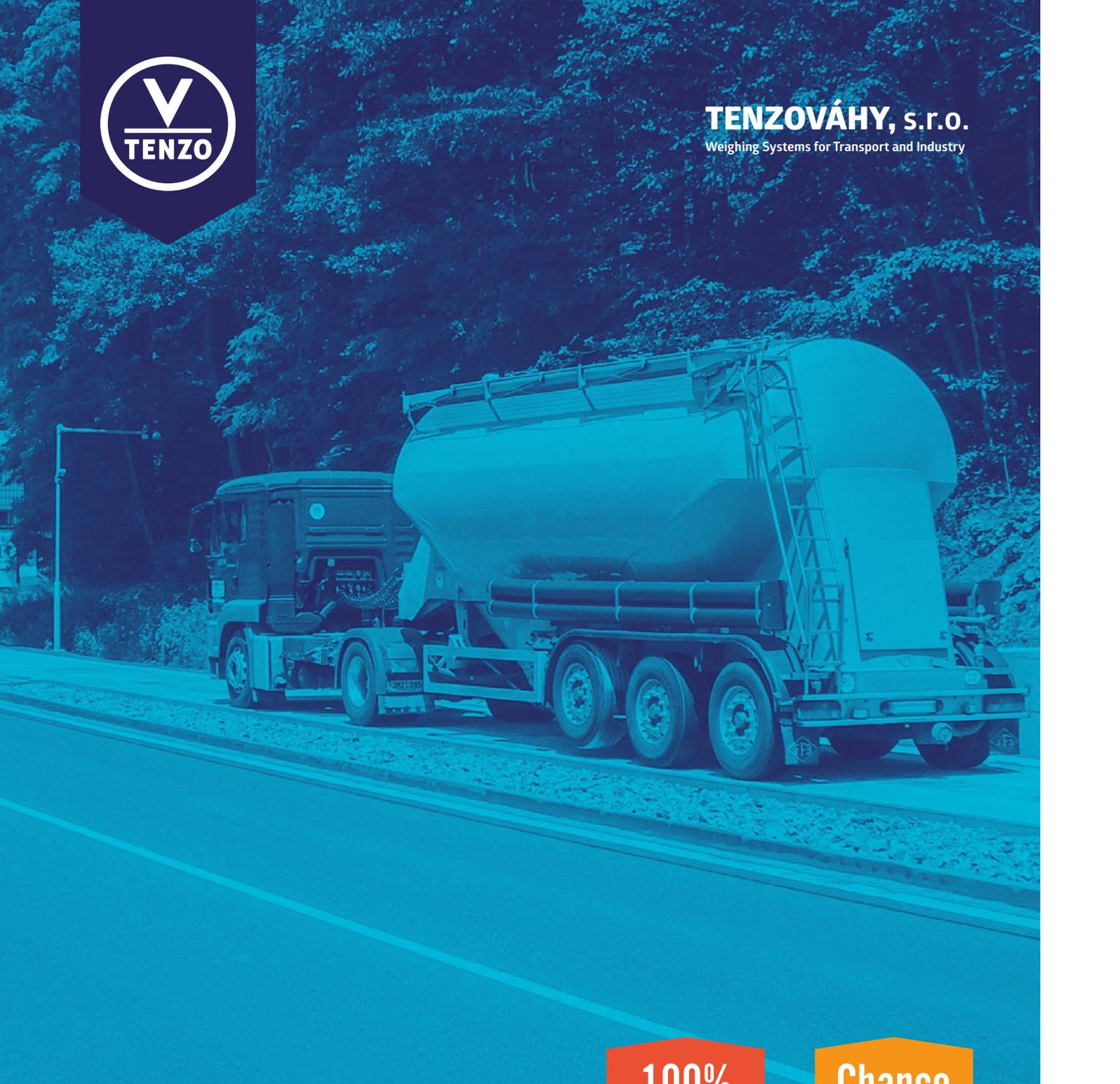




TENZOVÁHY, s.r.o.
Weighing Systems for Transport and Industry



100%

Enforceability
of detected
offenses

Chance

for states, counties,
cities and municipali-
ties to limit the traffic
of congested vehicles

Reliable WIM solution
for law enforcement

www.tenzovahy.com

Introduction of the company TENZOVÁHY, s.r.o.

For more than 25 years, we have been instrumental in aiding the prevention of overloading of road heavy goods vehicles.

The products of TENZOVÁHY meet on a long-term basis national and international standards applicable in the EU, including the strict International Recommendation OIML R 134.

Our clients in the public administration sector can thus safely rely at all times on that penalties for cargo vehicle

overloading offences are 100% enforceable. Our weighing systems work reliably in many countries in Europe, Asia and Africa. We permanently take care of the many of these devices either ourselves or through a network of authorized partners.

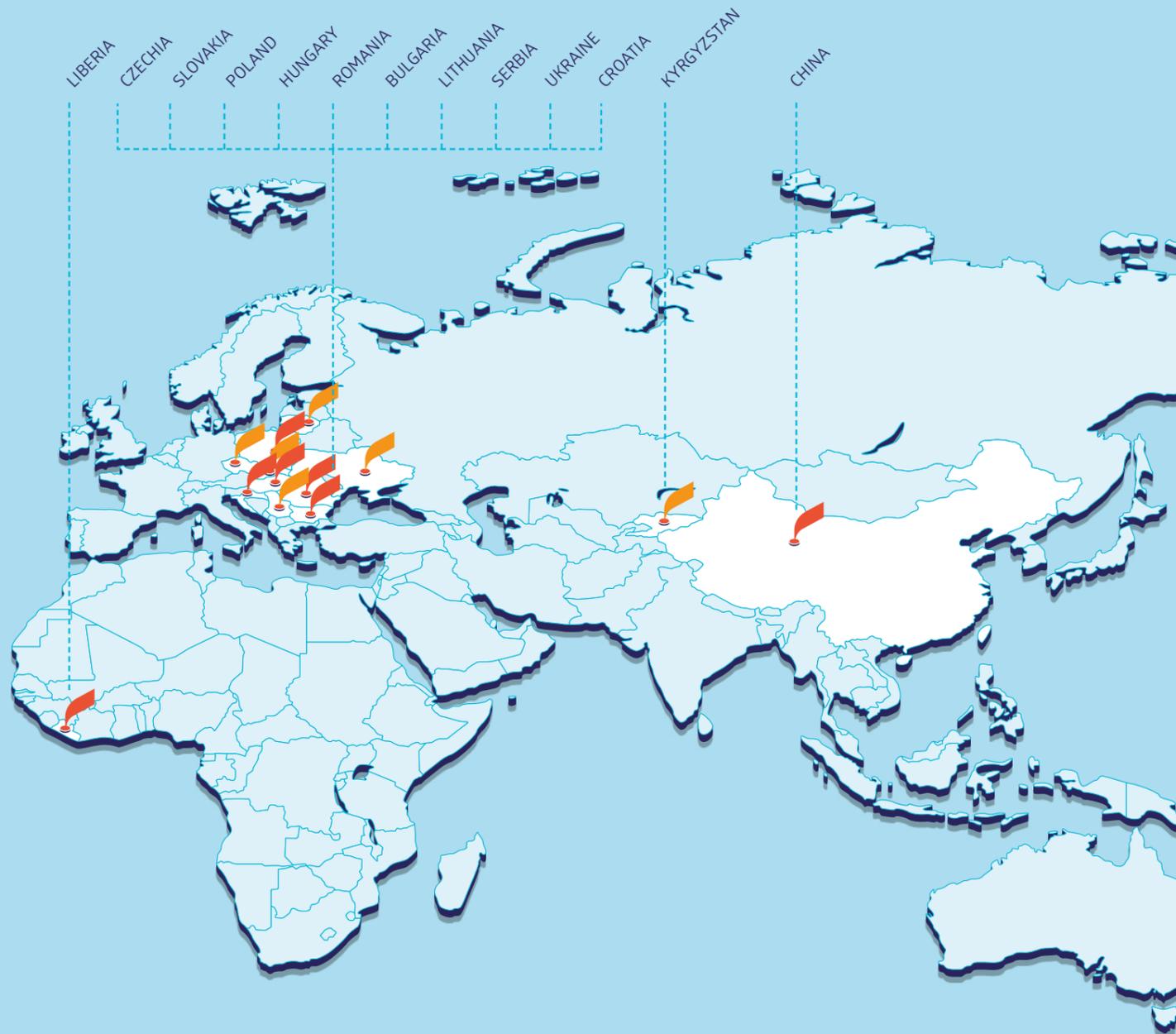
In addition to many industrial companies, our customers also include state supervision institutions dealing with weighing for law enforcement in traffic.

In the Czech Republic, these are, for example:

- the Police of the Czech Republic,
- the Customs Administration of the Ministry of Finance of the Czech Republic,
- regional authorities of the Czech Republic.

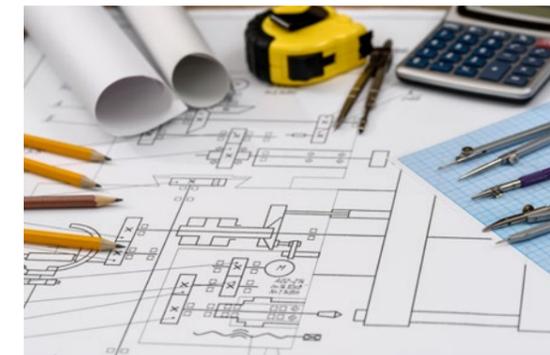
We carry out similar cooperation in other countries through our business partners, to whom we provide technical and methodological support. The common goal of such cooperation is to ensure the long-term operability of the systems we supply.

TENZOVÁHY is ready to participate in the preparation of infrastructure projects for new generation networks of fully unattended checkpoints for weighing vehicles, or to assist with the establishment of pilot installations in the Czech Republic and other countries.



Contents:

- 2 Introduction of the company TENZOVÁHY, s.r.o.
- 4 Consequences of overloaded vehicles in traffic
- 5 How to prevent more damage to road infrastructure?
- 6 Two-stage vehicle weighing
- 8 Unattended vehicle weighing system on a 2nd stage
- 9 Example of an unattended weighing station for lower vehicle traffic density
- 10 Example of a larger weighing station for higher vehicle traffic density
- 11 Example of a mobile weighing station
- 12 Strategy for building a network of weighing stations
- 14 Certified Precision Axle Systems for Weighing Vehicles for Law Enforcement
- 16 Services for System Partners



Consequences of Overloaded Vehicles in Traffic

All states are increasingly facing a very consequential problem that has significant social, health, economic, road traffic safety and environmental implications for their citizens and local government authorities at all levels.

This is the operation of overloaded cargo vehicles on roads and motorways.

- The owner of the road or motorway has to spend substantial funds for road repair and maintenance much more often.
- In particular for busy transit roads, such costs reach enormous amounts.

Damage to roads and bridges

Repeated loading of the road at the limit or over the limit of their elasticity, when the surface is not able to return to its original state after the passage of a heavy axle and permanent deformations of the surface layers occur, is very critical for roads. A typical example of this is the so-called "ruts".



Endangering other road users

Overloading even in smaller vehicles escalates the risk of collision, especially in poor weather conditions. The longer braking distance of the vehicle, along with potential driver fatigue, substantially increases hazard to other road users.



Damage to property and the environment

Unnecessary damage caused by crashes due to or higher emissions from overloaded vehicles can be easily prevented by observing the maximum permissible weight for all types of vehicles.



How to Prevent More Damage to Road Infrastructure?

So-called vehicle axle overloading occurs more often than total overloads. Exceeding the axle load from 10 t to 11 t, i.e. by 10%, will increase the fatigue wear of the road by 46%. Increasing the load to 12 t (by 20%) increases fatigue wear by more than 100%.

As it is specifically axle overloading that causes damage to roads and because it is also far more common than total overloading, the easiest way to detect these offences is through the use of axle weighing systems.

Typically it is necessary to weigh a substantial number of passing vehicles.

Weighing can be done either in the through lane without any need to limit the speed of the passing vehicle with **high-speed weigh-in-motion (HS-WIM) weighing systems**, or in the parallel lane at a lower speed with weighing systems sometimes referred to as **low-speed weigh-in-motion (LS-WIM)**.

Each of these methods has its pros and cons. **If either of them is used on a standalone basis, the negative aspects may manifest that reduce the weighing efficiency with any single of these weighing methods or even preclude the enforcement of potential penalties against drivers or operators of overloaded vehicles.**

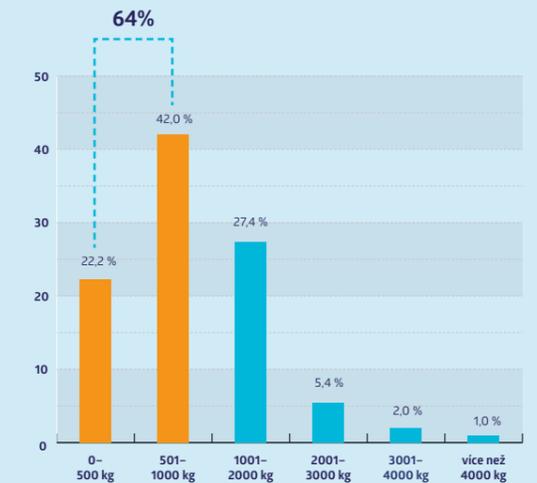
This inevitably translates into less prevention and more continued damage to roads and hazard to other road users.

A very effective method to substantially reduce all of the above impacts is **to ensure regular weighing for law enforcement on roads and motorways through a network of Two-stage Stationary Axle Weighing Stations**, including in collaboration with the national toll system of the state concerned.

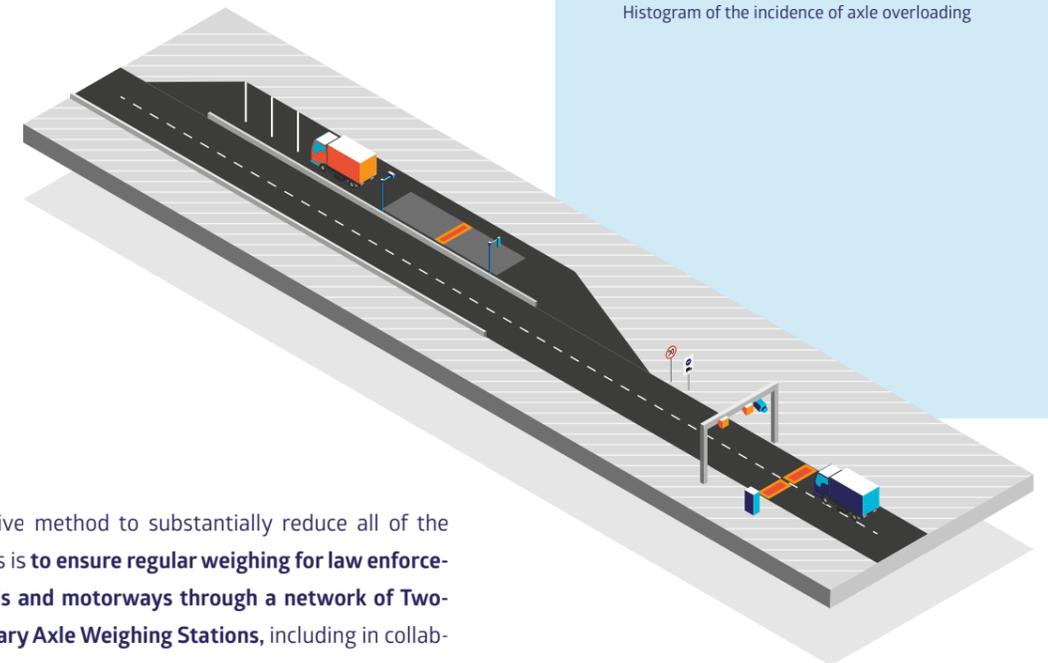
Statistical Example from Actual Weighing

The graph below shows the incidence of overloading on the axles of cargo vehicles detected at the weighing station in Starý Hrozenkov on the Czech-Slovak border between 2017 and 2019. The histogram implies that most of the weight offences (about 64%) are in the up to 1.000 kg overload category, followed by 27% in the up to 2.000 kg category.

If lower accuracy weighing systems were used, then these offences would not be meaningfully assessed.



Histogram of the incidence of axle overloading



Two-Stage Vehicle Weighing

Two-Stage Vehicle Weighing

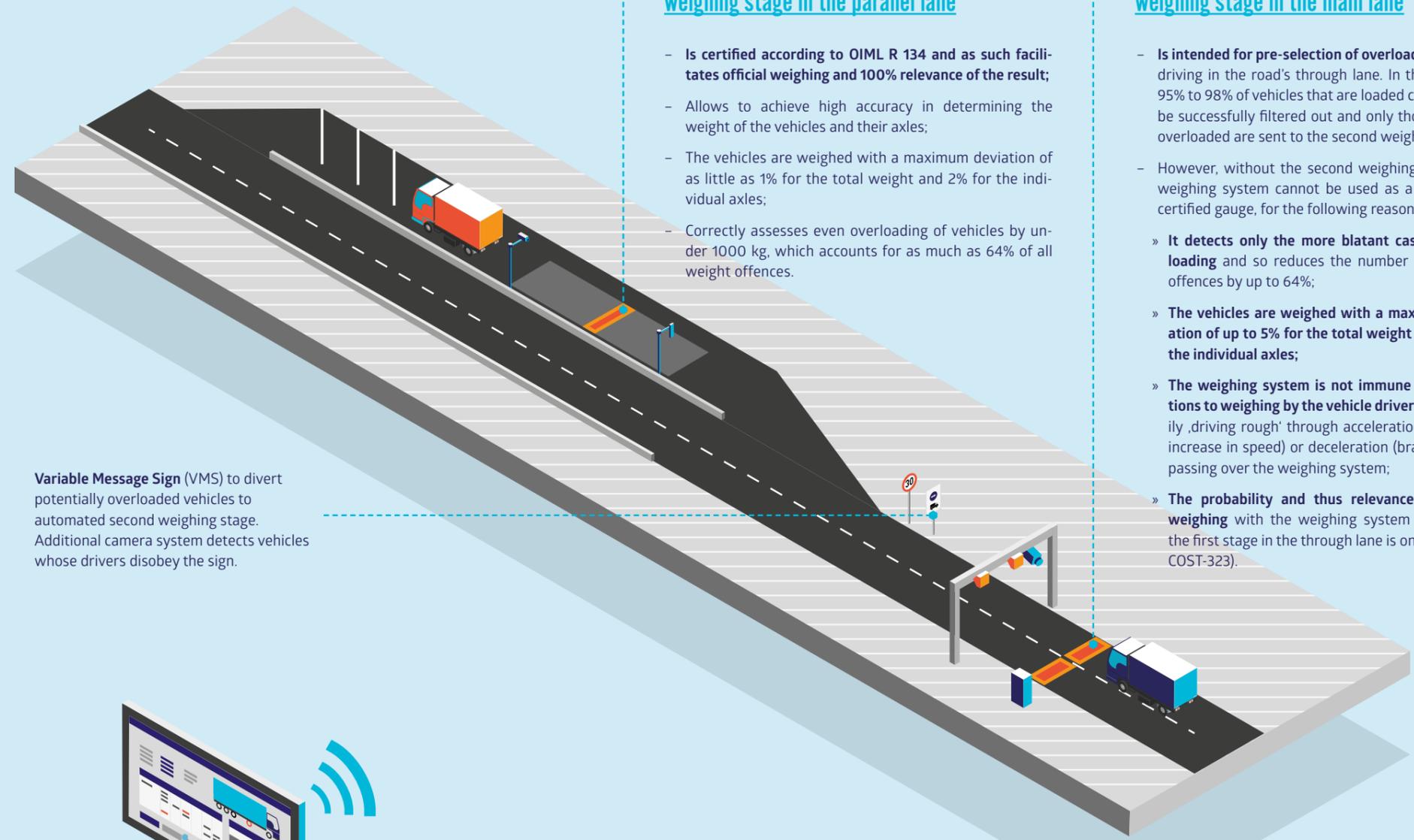
For better reliability and efficiency, weighing systems therefore are built in sets of two-speed, also referred to as two-stage, weighing stations.

The first stage of the weighing system is used to detect vehicle overloading and quickly pick such vehicles for the next stage of weighing. This first weighing system is installed directly in the main lane. In this way, 95% to 98% of vehicles that are loaded correctly can be successfully filtered out and only those that are overloaded are sent to the second weighing stage.

The second stage then operates in the parallel lane at lower vehicle speeds. Typically there are two types of weighing systems:

- **Stationary, which is a weighing system built directly into the road or weighing zone.** Such weighing systems are certified for official weighing according to OIML R 134;
- **Portable (mobile) Weighing Systems, which are ideal for use especially in temporary locations** where setting up Stationary Weighing Stations is not possible or economically viable.

The high measurement accuracy and 100% reliability in the second weighing stage reduces the number of administrative appeals and significantly increases operational efficiency of the station as a whole.



Variable Message Sign (VMS) to divert potentially overloaded vehicles to automated second weighing stage. Additional camera system detects vehicles whose drivers disobey the sign.



Information about overloaded vehicle is then automatically sent to municipalities with extended competences covering the detected offence(s), or to the national offence register (see legislation of the respective country).

OIML R 134 is an International Recommendation specifying the requirements and test methods for automatic instruments for weighing road vehicles in motion (WIM tools) used to determine the vehicle weight and loads on axles and axle groups.

The weighing system installed in the second weighing stage in the parallel lane

- Is certified according to OIML R 134 and as such facilitates official weighing and 100% relevance of the result;
- Allows to achieve high accuracy in determining the weight of the vehicles and their axles;
- The vehicles are weighed with a maximum deviation of as little as 1% for the total weight and 2% for the individual axles;
- Correctly assesses even overloading of vehicles by under 1000 kg, which accounts for as much as 64% of all weight offences.

The weighing system installed in the first weighing stage in the main lane

- Is intended for pre-selection of overloaded vehicles driving in the road's through lane. In this way, the 95% to 98% of vehicles that are loaded correctly can be successfully filtered out and only those that are overloaded are sent to the second weighing stage.
- However, without the second weighing stage, this weighing system cannot be used as a standalone certified gauge, for the following reasons:
 - » It detects only the more blatant cases of overloading and so reduces the number of detected offences by up to 64%;
 - » The vehicles are weighed with a maximum deviation of up to 5% for the total weight and 11% for the individual axles;
 - » The weighing system is not immune to obstructions to weighing by the vehicle driver by arbitrarily 'driving rough' through acceleration (a sudden increase in speed) or deceleration (braking) when passing over the weighing system;
 - » The probability and thus relevance of correct weighing with the weighing system installed in the first stage in the through lane is only 95%. (see COST-323).

Key Strengths of Two-Stage Weighing in Accordance with OIML R 134



Better prevention rate with significant cost savings as a result for the state on funds that otherwise would have to be spent on premature road and motorway repairs



Quick return on investment and operational costs for human operators of the weighing system, high enforceability of all weight offences



Protection of other road users and the living conditions of residents living next to roads



Levelling the playing field for freight transport – effective control of both domestic and foreign vehicles



Environment protection



Usable for all types of roads from motorways to class 2 roads

Unattended weighing system on a 2nd stage operated according to OIML R.134

Weighing vehicles in the presence of the operator and its shortcomings

Weighing vehicles in the presence of the operator at the second stage of the weighing station is a traditional, historically established operating regime, which is commonly enshrined in the legislation of a number of countries *). This weighing is also commonly called „low speed“.

Its main purpose is accurate and relevant weighing in the presence of an operator who ensures that **overloaded vehicles are diverted to the parking area to discuss the offense and, if necessary, do not continue driving until their excess load is transferred to another car.**

If the capacity of the parking area or the capacity of members of the state supervision is filled in the service mode, other overloaded vehicles are not checked in. These cars either wait in line for consideration or are only registered and then continue driving back on the road without stopping.

Note: *) employees of state authorities in the Czech Republic performing service, i.e. low-speed weighing, are governed by Act No. 13/1997 Coll. on Roads and its section concerning weighing vehicle for law enforcement, namely § 38 b and § 38c, which states that the driver is obliged to subject the vehicle to low-speed weighing at the request of a police officer or customs officer and to follow its instructions.

General requirements for unattended weighing technology

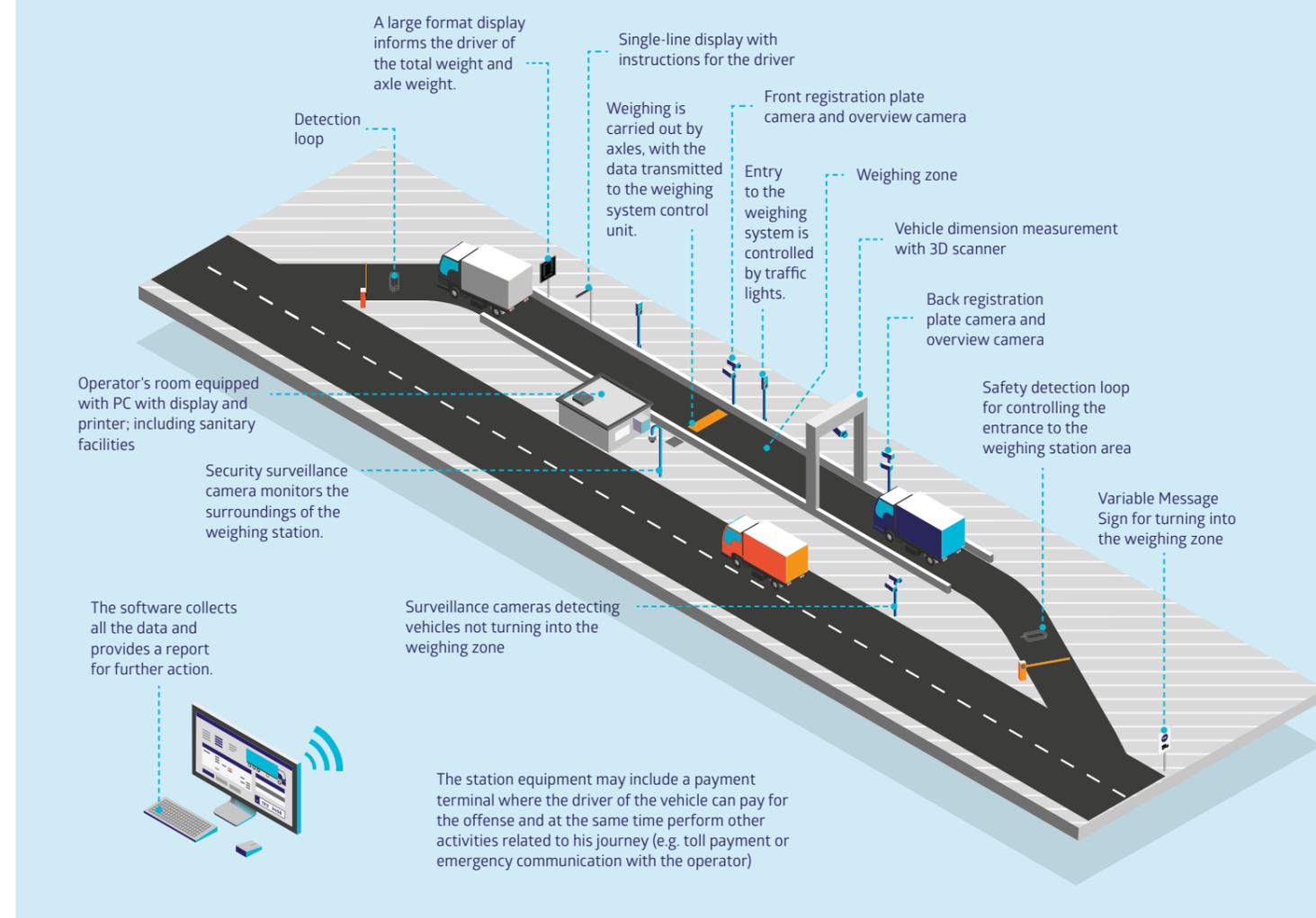
- **Effective truck overload control**
- **Minimization of the influence of the human factor on the weighing** by the driver of the vehicle
- **Maximum automation of the weighing process** with limited human operator presence in order **to achieve minimum operating costs**
- **Maximum weighing reliability with 100% relevance measured values** and thus with the maximum enforceability of sanctions for all weight offenses
- **Year-round operability of the technology** even in demanding climatic conditions
- **Year-round operation**, ie removal of the weighing campaign only at a certain time of day or day of the month

Unattended weighing according to OIML R.134 and its advantages

- with an unattended weighing system, the vehicles are not diverted for a personal hearing of the offense, but **information about their overload is automatically sent to the national offense register** or to a specific office dealing with detected offenses
- by respecting International Recommendation OIML R.134, **vehicles are weighed accurately and relevantly similarly to weighing vehicles in the presence of the operator**
- **weighing is performed completely without the presence of the operator, ie on weekdays and outside working hours and also on non-working days, ie in the 24/7 mode. Compared to service weighing, the efficiency increases up to ten times.**
- all vehicles are checked in. Therefore, there is no danger of congestion on parking areas or limiting weighing according to the capacity of the member of the state supervision.
- **preventive role of weighing - weighing is performed continuously. If the weighing stations sufficiently cover the territory of a given region or state, the number of congested vehicles will decrease as well as the degree of their congestion.**



Example of weighing according to OIML R.134 on the second stage of an unattended weighing station



Second stage of a high-accuracy weighing station with automatic operation according to OIML R 134

The figure shows the optimal configuration of the second stage of the weighing station operated in unattended mode and approved according to the international recommendation OIML R. 134, i.e. with high weighing accuracy and 100% relevance of weighing results.

The previously picked vehicle is guided by Variable Message Signs to the second stage weighing zone and then weighed automatically without stopping in automatic operation.

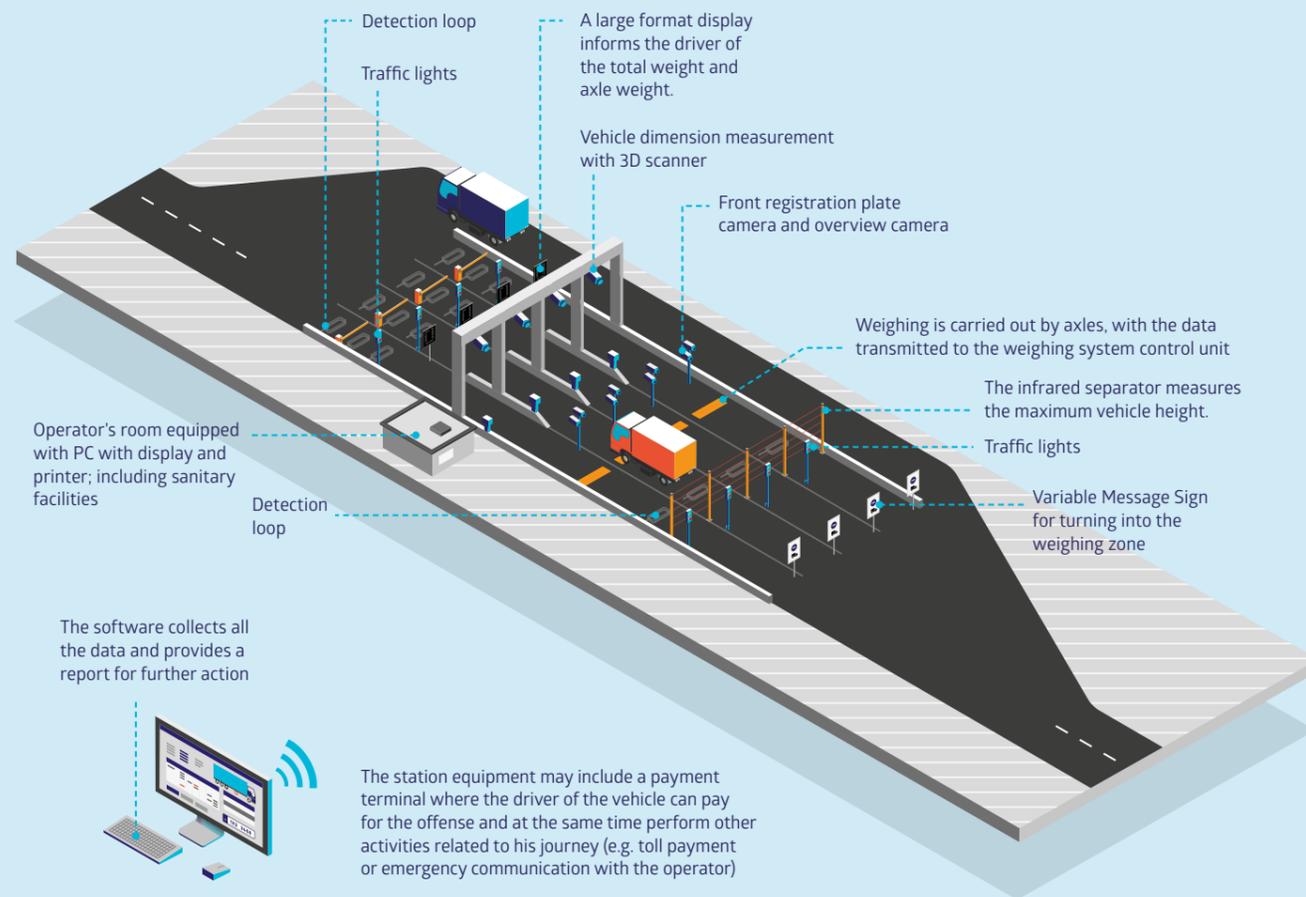
Thanks to advanced technologies, it is possible not only to reliably identify the vehicle, but also to find out other data, such as exceeding its dimensions.

Information about overloaded vehicle is then sent directly to the national offence register (see legislation of the respective country) or the specific competent authority for the offence(s) at hand.

This station is a one-way design intended for first and lower class roads. If used in attended operation, it can be complemented by a cargo transfer station.

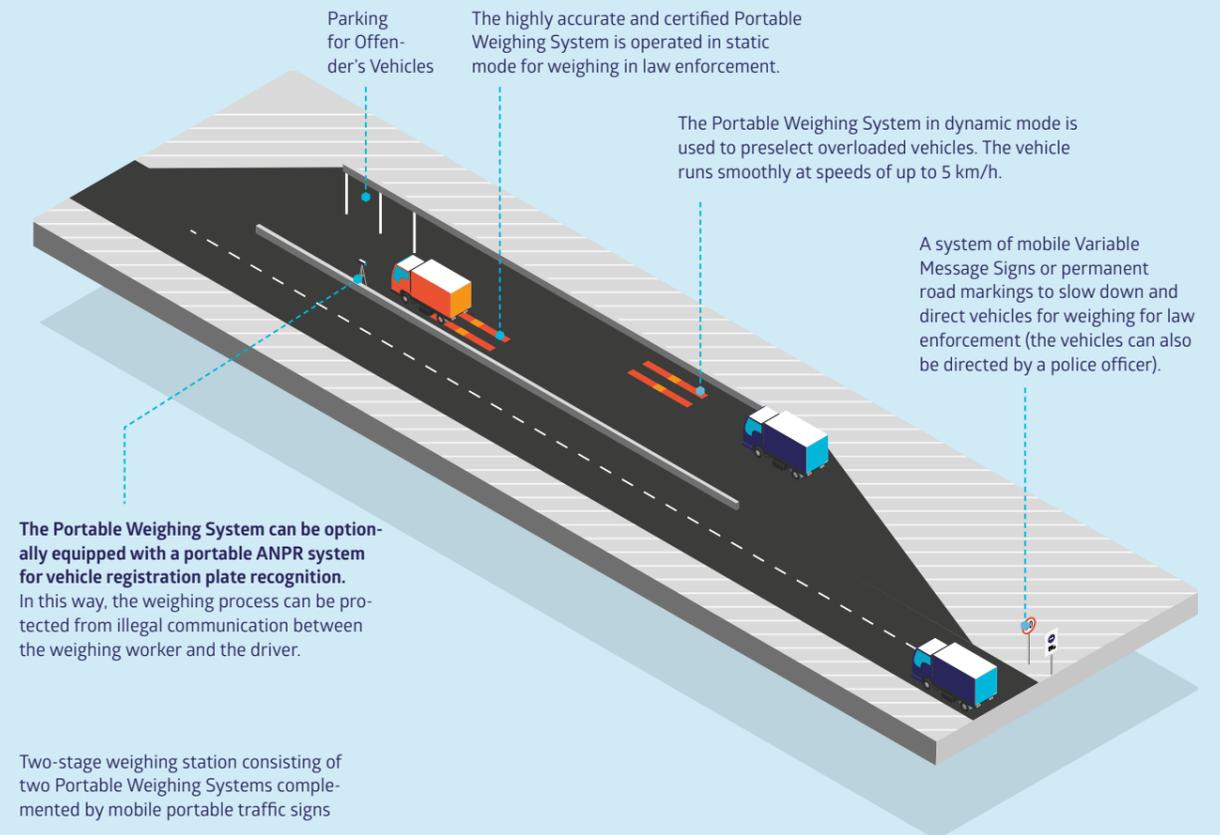
The undeniable advantage is the coverage of almost all passing trucks. **A driver who refuses to respect traffic signs and enter the lane to be weighed commits an offense, which is subsequently resolved in administrative proceedings.**

An example of a larger weighing station for higher vehicle traffic density



Example of a mobile service weighing station for temporary stations

Weighing operations with the Portable Weighing System are possible in either single-stage or two-stage mode. The advantage of both methods is the high flexibility in installing the weighing assembly.



Weighing station designed for:

- **Electronic toll collection (ETC)**
- **Weighing at border crossings**
- **Weighing on roads with heavy traffic**

Weighing when passing through a toll station or a station located on a high-traffic road requires smooth operation and fast clearance of vehicles. The detection and evaluation of possible overloading of vehicles must not only be fast, but also very accurate. Any more substantial deviation distorts the weighing results and thus also the basis for the collection of tolls or penalties for overweight cargo.

A larger number of lanes for parallel entry of vehicles also allows to operate roads with higher traffic density.

Information about the vehicle weight or overload as applicable is either sent directly into the respective database for toll collection or evaluation of offences, or can be used to immediately stop the vehicle.

This station is a one-way design intended for roads with heavy traffic. If used in attended operation, it can be complemented by a cargo transfer station.

Single-Stage Weighing Operated in Static Mode

- Vehicles are picked from the traffic stream and stopped by a person authorized to stop the vehicle under the Road Traffic Act.
- The selection is usually based on visual assessment or information from Stationary High-speed WIM Weighing Systems located in the main lane of the road.
- Stopped vehicles are weighed in the static mode, i.e. by the axles in the start-stop system.
- Particularly suitable for random weighing and thus as prevention or as a campaign complement to the network of Stationary Weighing Stations.

Two-Stage Weighing in Static Mode with Dynamic Pre-Selection

- To increase the efficiency of the use of Portable Weighing Systems, these can be used with pre-selection. This is relevant particularly for temporary locations where setting up stationary weighing stations is not possible or economically viable.
- Weighing in the 1st stage is dynamic with a maximum speed of 5 km/h.
- Weighing in the 2nd stage is static using fully certified mobile scales designed for accurate weighing with the possibility of generating a weighing ticket serving as a basis for imposing a sanction on an overloaded vehicle.

Strategy of planning and construction of a network of weighing stations

Why create a strategic plan?

The aim of weighing in law enforcement should not be collection of sanctions, but the prevention leading to the protection of:

- state investments in the construction and repair of roads
- other road users
- movable property and the environment

Only consistent prevention can fully fulfill these points. These measures, which are taken at the level of states or their regions, are of an infrastructural, i.e. nationwide nature.

By adopting local or partial measures, it is possible to demonstrate a certain determination of the state to weigh vehicles, but the resulting effect will be rather small with elements of ineffective campaigning.

Specific conditions for strategy creation

The answers to the following questions can help you create a strategy:

- the state of legislation in the country related to vehicle weighing - how does the state deal with the issue of unattended / service weighing?
- how is the weighing specifically operated?
- how and whether tolls are collected from truck operation?
- to what extent is the country a transit area for freight transport?
- how dense is the road network - motorways, first and lower class roads?
- what is the traffic intensity on these roads?
- what is the traffic at the borders of a particular state?
- is it state of the Schengen area?
- how will the volume of road freight transport in a given country or territory grow in the future?

An example of the ideal structure of a weighing station network

The ideal network of weighing stations in a given state or region should be created from Stationary Two-stage Weighing Stations mainly at the following nodes:

- key border crossings for freight
- a limited number of large checkpoints on high-traffic roads, usually backbone motorways for key transit
- a larger number of smaller stations on busy first class roads and at sources of permanent congestion of freight traffic (manufacturing, mining, landfills, forestry)

The network of weighing stations should ideally be expanded to capture the maximum of freight traffic and thus fulfill its main preventive function.

Selection of suitable locations for weighing

The installation of weighing equipment intended for the first and second stage is subject to strict criteria and minimum requirements that determine their location. These criteria result both from the manufacturers' recommendations, which define the conditions for the installation, operation and maintenance of weighing systems, and from the very logic and meaning of vehicle weighing.

The most important conditions include:

- flatness of the road at the weighing point
- the absence of an alternative option to bypass the checkpoint so that drivers cannot avoid first- and second-stage weighing
- for the first stages of weighing, a guarantee of smooth passage of vehicles on straight sections, where the occurrence of dynamic phenomena (braking, acceleration, change of lanes, etc.)
- for the second weighing stages, the possibility of building a parallel strip (sometimes also a bay) for accurate weighing at lower speeds. The resulting weighing accuracy in the second stage depends on the flatness and quality of the so-called weighing zone
- avoid collisions with other road or other traffic

Experienced ideas, mistakes and myths

1. MYTH - so-called high-speed scales located in the main lane are enough to prevent and directly penalize overloaded vehicles; saves operating costs and investment costs for a parallel strip or bay for scales installed in the second weighing stage.

Why does it not work?

- The scales in the main lane are fast and fully unattended, but are not immune to obstruction of the driver's acceleration or deceleration and especially to vertical vehicle oscillations related to its dynamics caused by, for example, road roughness multiplied by vehicle speed.
- the higher the speed of passage through the scales, the lower their accuracy. This prevents the axle overload from being measured effectively from 2,000 kg below. Overloading 2,000 kg increases road fatigue wear by 100%.
- in the light of the above, COST 323 determines the relevance of the weighing results at 95%. It cannot therefore be used for direct fines. If the vehicle operator has good legal representation, the dispute over a possible sanction is very likely to win.

These scales should only be used to pre-select potentially overloaded vehicles.

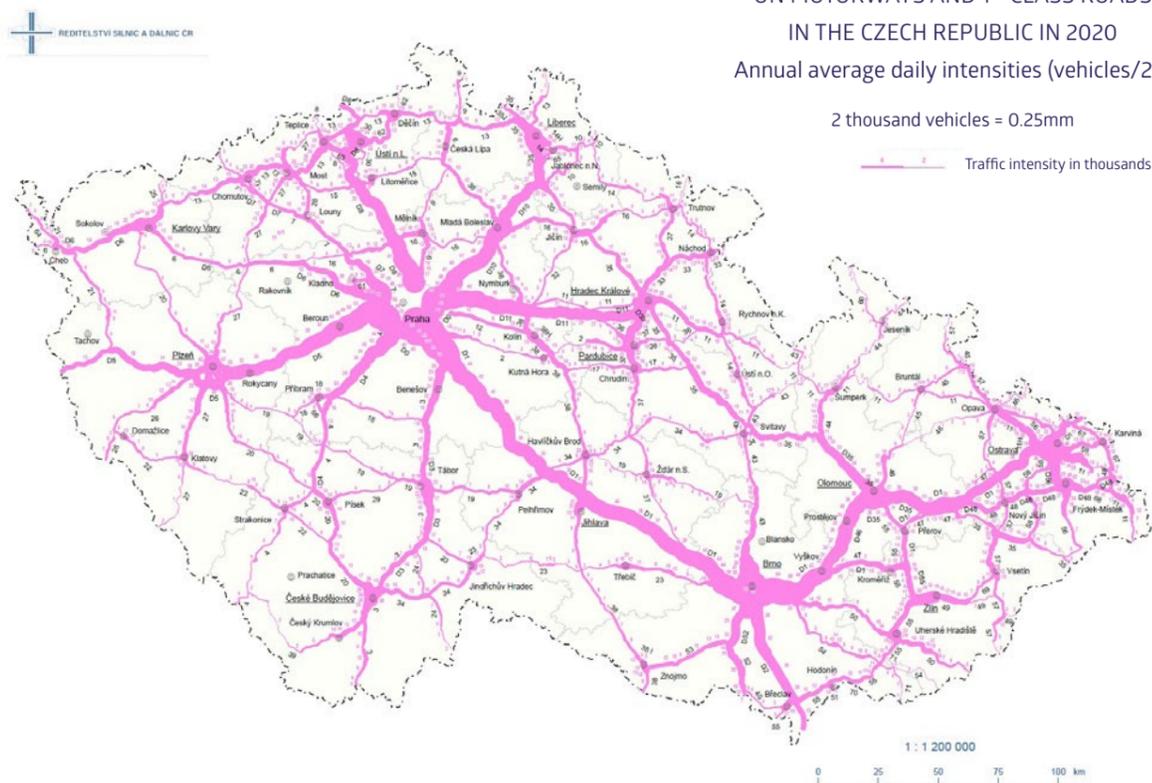
2. MYTH - portable / mobile scales and a random selection of weighing vehicles are sufficient to prevent overloaded vehicles

Why does it not work?

- the average frequency of truck overload is 2 to 5%. By limiting the control of these cars to random selection only, the likelihood of detecting such an offense is dramatically reduced.
- as vehicle drivers are usually in radio contact with each other, it is not a problem for them to draw attention to each other's ongoing campaign and either wait for the weighing to end or choose a detour. This further reduces the weighing efficiency.
- if there is no possibility of pre-selecting potentially congested vehicles, the detection of the offender becomes unlikely.

Independent weighing without pre-selection of potentially overloaded vehicles using portable scales is suitable for random weighing and thus especially for prevention, or as a campaign-based addition to the network of Stationary Weighing Stations.

TRAFFIC INTENSITIES
ON MOTORWAYS AND 1ST CLASS ROADS
IN THE CZECH REPUBLIC IN 2020
Annual average daily intensities (vehicles/24)



Example of traffic density on the map of the Czech Republic issued by the Directorate of Roads and Motorways of the Czech Republic with an indication of traffic intensity on roads in 2020

Certified Precision Axle Systems for Weighing Vehicles for Law Enforcement

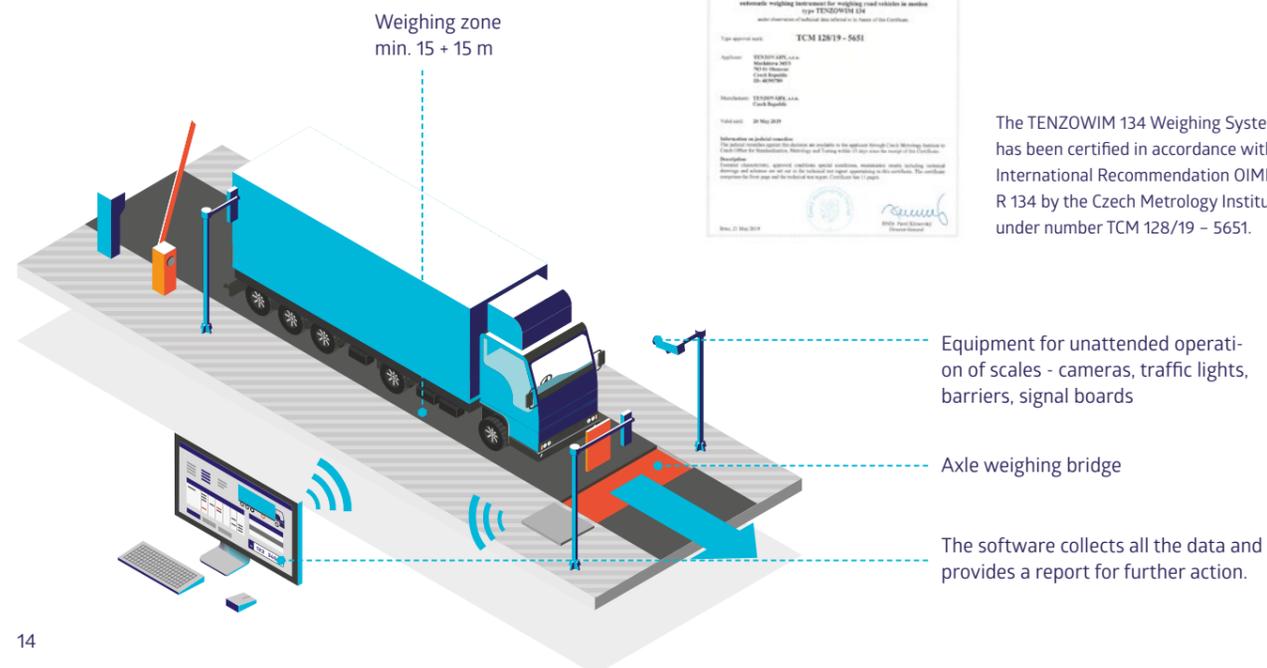
TENZOWIM 134 Stationary Axle Weighing System



The TENZOWIM 134 Axle Weighing System is used for automatic weighing of road vehicles driving at lower speeds (about up to 30 km/h) without the need to stop. This is a dynamic weighing system. It is distinguished by low operating costs and high accuracy. Its use is in weighing for law enforcement by state authorities and in many sectors of industry.

As the vehicle is passing over the weighbridge, it is weighed by the axle weighing system, which evaluates the load on individual axles and axle groups and the total weight.

By using additional accessories such as cameras, traffic lights, barriers, etc., the weighing system can be operated in unmanned mode. The highest accuracy typically is achieved in the 1 to 6 km/h speed range.



Declaration of Weighing Accuracy

The company TENZOVÁHY, s.r.o. declares that the weighing system TENZOWIM 134, which has been certified by the Czech Metrology Institute according to International Recommendation OIML R 134 (2006) and obtained type approval No. TCM 128 / 19-5651, is capable of operation in the following accuracy classes:

Operating speed	Total vehicle weight	Axles and axle groups
1–6 km/h	1	B
6–10 km/h	2	C
10–20 km/h	2	D
20–30 km/h	2; 5	D; E
30–50 km/h	10	F

The final accuracy class assignment is based on the result of verification of the weighing system carried out at the specific weighing location. The operating speed may be limited according to the specific conditions at the weighing site.

Type Approval Certificate



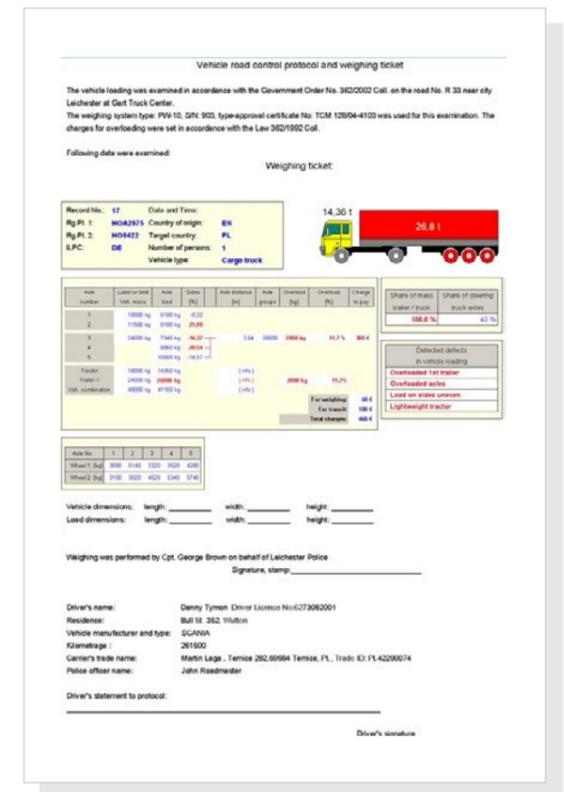
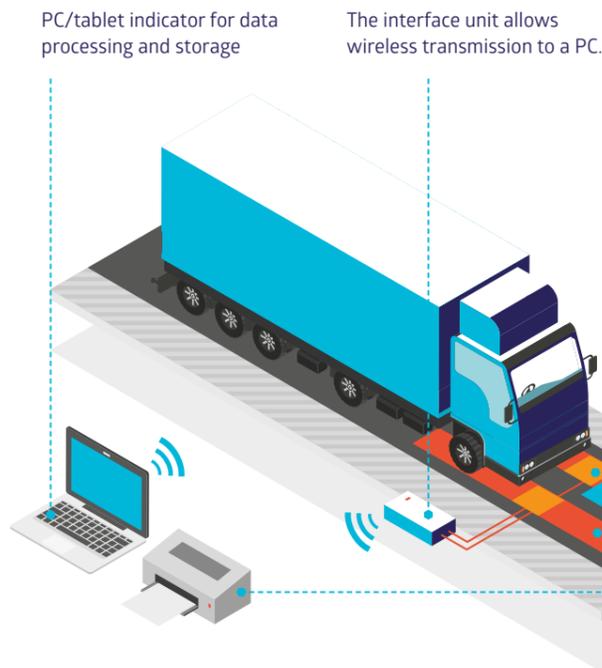
The TENZOWIM 134 Weighing System has been certified in accordance with International Recommendation OIML R 134 by the Czech Metrology Institute under number TCM 128/19 – 5651.

PW-10 Portable Axle Weighing System



The mobile wheel and axle weighing system is designed for weighing road cargo vehicles, their wheels and axles. The capacity of this weighing system is not limited either by the length of the vehicle combination or its total weight, only the weight of each axle must be less than 20 tons, which is sufficient by a large margin for weighing road vehicles and vehicle combinations on the road.

The vehicle to be weighed is guided smoothly through the weighing zone consisting of a pair of weighing pads and four rolling levelling mats. This weighing system allows weighing both in static mode (by individual axles) and also and much faster in dynamic mode when driving at speeds up to 5 km/h. Though in the dynamic mode, the weighing is only indicative, it is very fast.



The protocol on the weighing of the PW-10 system serves as a basis for imposing a sanction on the driver of an overloaded vehicle

Type Approval Certificate



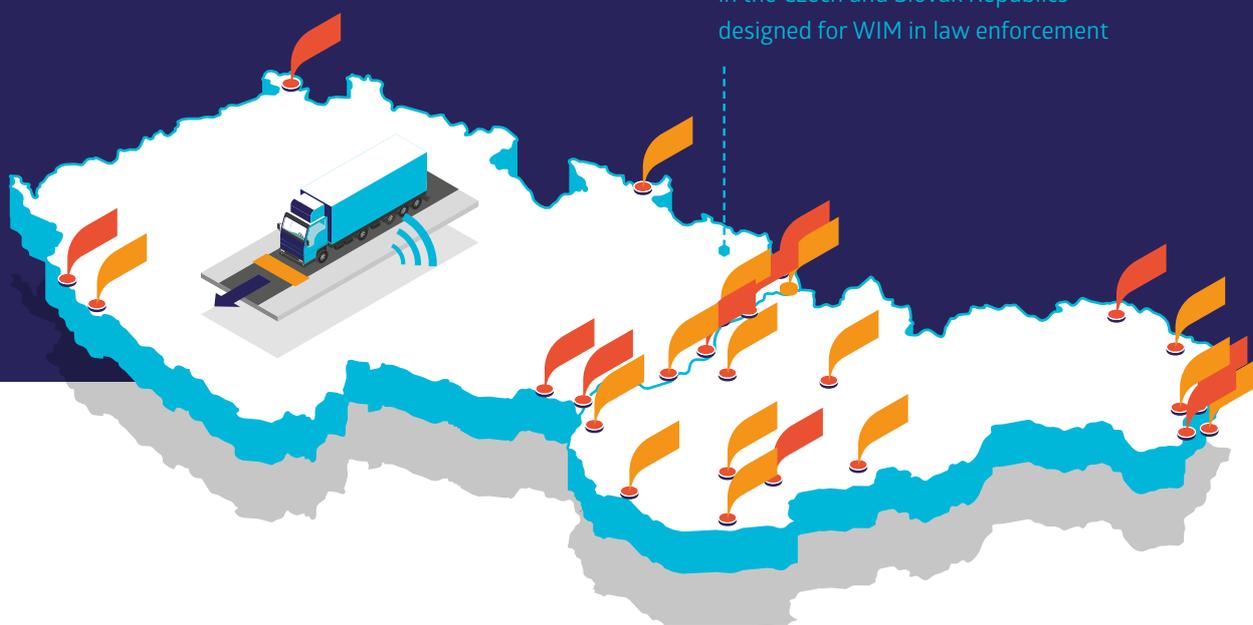
The PW-10 Weighing System has been certified under number TCM 128/04 – 4103, Revision 2.



Services for System Partners

For more than 25 years,
we have been instrumental
in aiding with weighing vehicles

- **Selection of the fitting product** including extensive documentation and sample project documentation for planning, installation and operation of weighing systems
- **Production and supply of weighing systems**
- **Product modifications** as may be needed according to client or project requirements
- **Software** for installation and diagnostics
- **Online or on-site training, including support** with first-time installation of weighing systems
- **Warranty and post-warranty service** including technical support with official verification
- **Helpdesk**
- **Remote diagnostics** of supplied equipment
- **On-call service, including on a 24/7 basis**



Map of stations built by TENZOVÁHY
in the Czech and Slovak Republics
designed for WIM in law enforcement

Contact address

TENZOVÁHY, s. r. o.
Machátova 345/3
783 01 Olomouc
Czech Republic

+420 730 167 153 (WhatsApp)
+420 585 428 186
tenzovahy@tenzovahy.cz
www.tenzovahy.com

Don't wait,
start weighing!