



# About CESTEL

## CESTEL

- Established in 1978.
- Located in Slovenia, EU.
- 100% private company.
- Main business areas:
  - Dynamic weighing (SiWIM)
  - Static weighing & vehicle dimensions control
  - Exceptional transport control
  - Environment monitoring
  - ...



# About SiWIM

SiWIM the Bridge Weigh-in-Motion system:

- bridge used as a weighing platform,
- in-house development and production,
- 20 years on global market,
  
- portability – permanent or short term measurements,
- modulary built,
- highest accuracy level according to ASTM-1318 can be achieved.





America

131

Europe

2467


Africa

first pilot project 2022

Asia

1125

ONE WEEK  
MEASUREMENTS



A world map with a light gray background and white grid lines. Three red location pins are placed on the map: one in North America, one in Europe, and one in Africa. A red callout box is connected to the North American pin, listing the states of Alabama, Georgia, Mississippi, and New Jersey. Text labels and numbers are placed near each continent: 'America 131' near the North American pin, 'Europe 2467' near the European pin, and 'Africa first pilot project 2022' near the African pin.

America  
131

**Alabama**  
**Georgia**  
**Mississippi**  
**New Jersey**

Europe  
2467

Africa  
first pilot project 2022

## Problem?



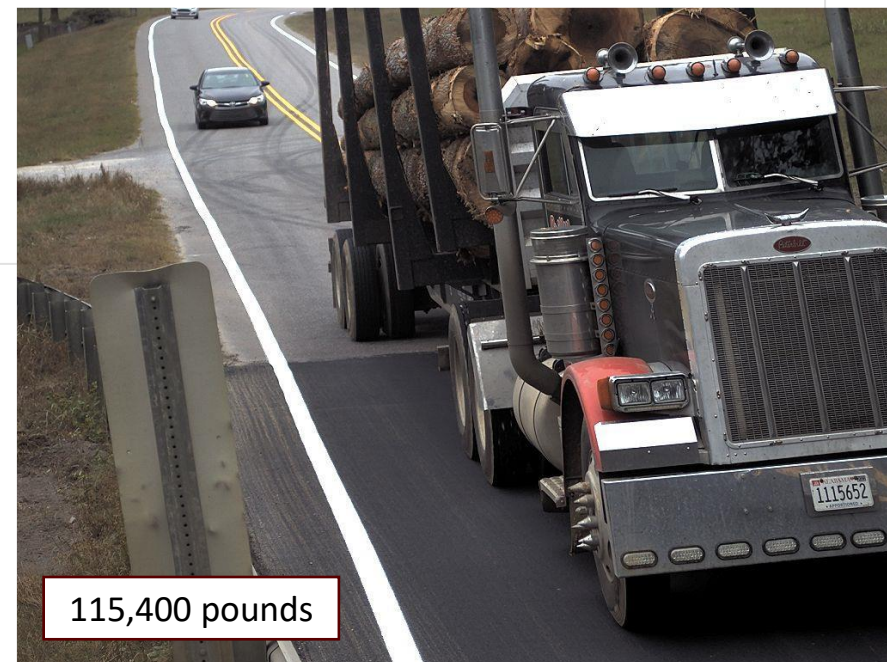
## Consequences!



## Safety?



# Every-day traffic



115,400 pounds



87,000 pounds

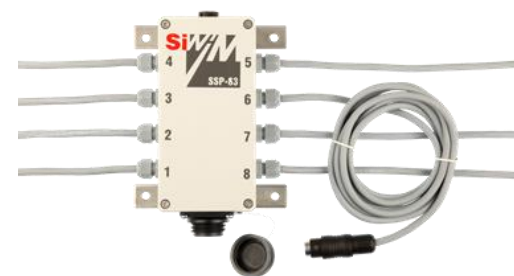


80,000 pounds

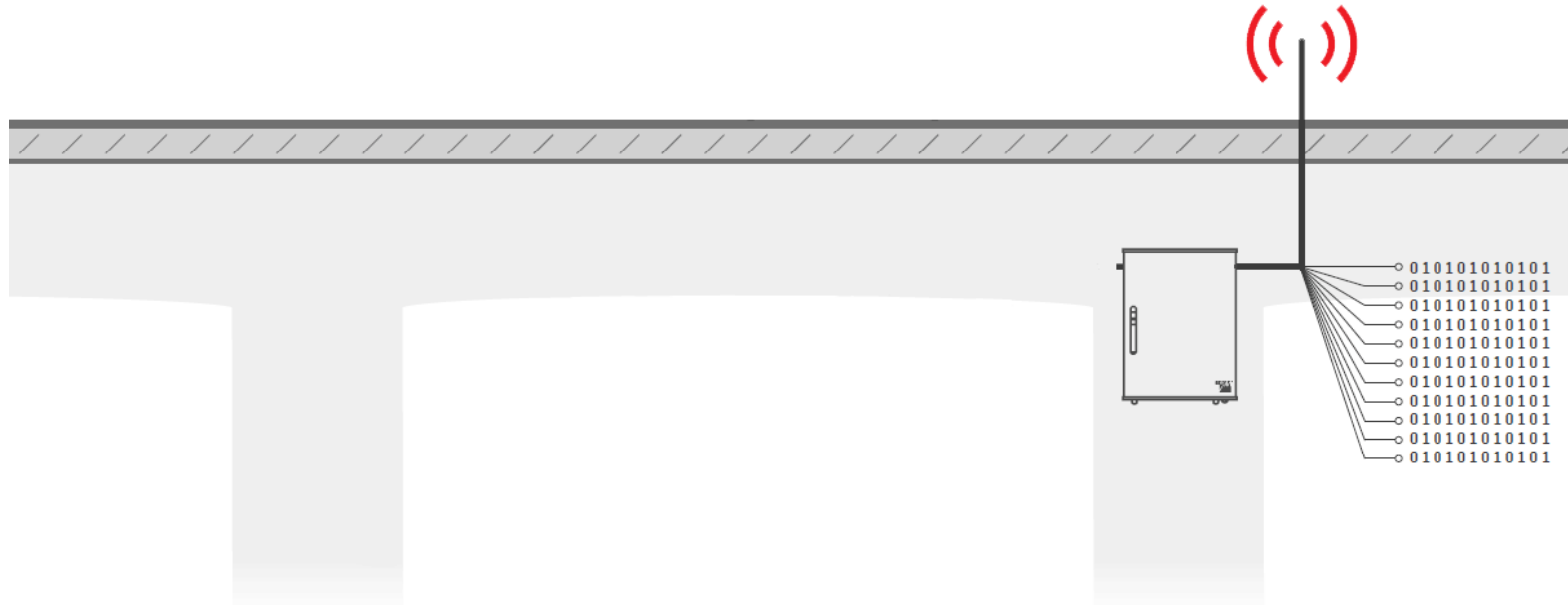


82,700 pounds

# Modular built HW – SiWIM MkIV



# SiWIM® – how does it work



# SiWIM installation procedure



**Measure**



**Drill**



**Install**



## Placement of sensors



# Beam bridge



# Slab bridge



## Steel structure bridge



# Work duration

- **Installation**



+

calibration  
fine tuning

- **Deinstallation**



# Calibration

Precise measurement of:

- Axle loads (**not** GVW)
- Axle distances

Calibration is done under same conditions as for all other WIM technologies.



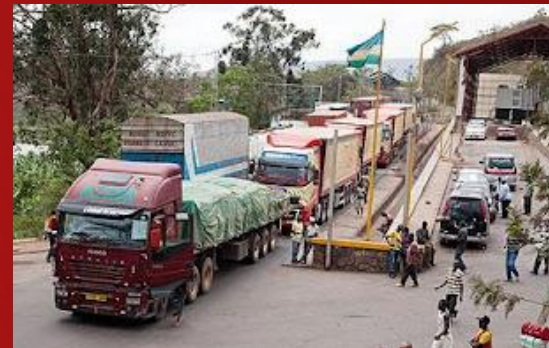
# SiWIM concept 'nothing on the road'.



## Standard road WIM technology



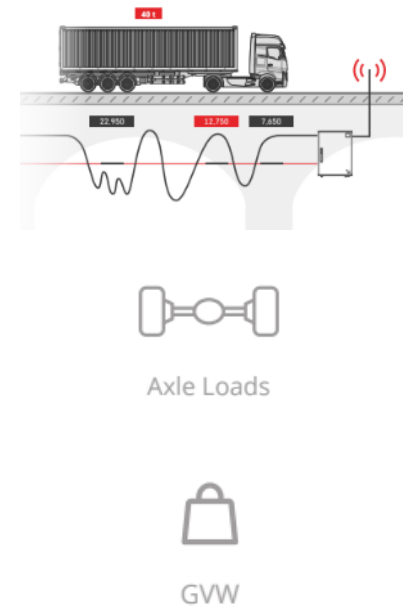
## Weighbridge system



# Collected data

## B-WIM data:

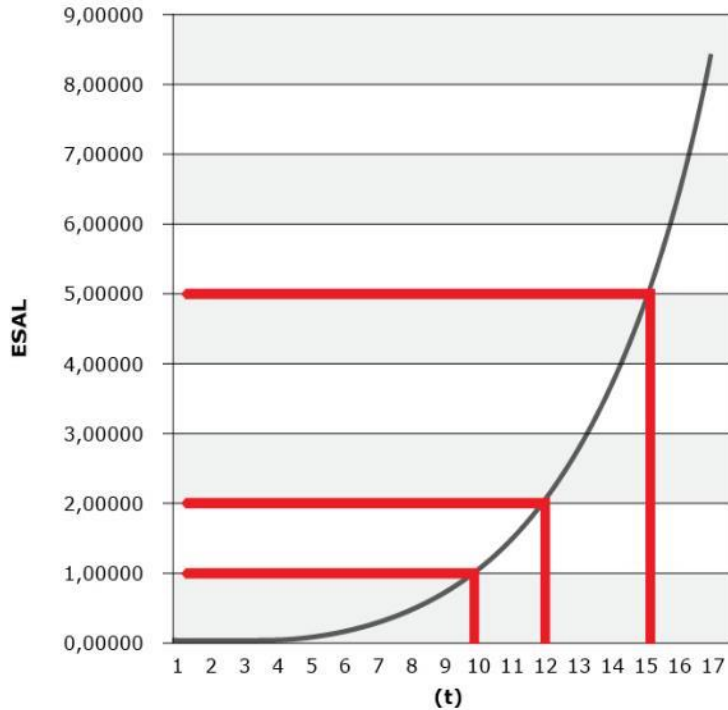
- Axle loads
- GVW
- Vehicle classification
- Axle distances
- Vehicle photo
- Speed
- Load distribution
- Timestamp
- Driving direction



# ESAL vs TONS

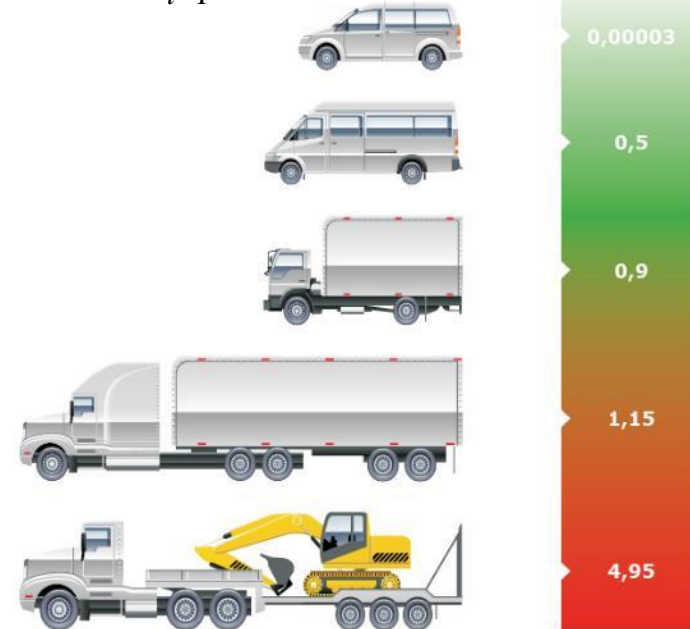


TON vs. ESAL



$$ESAL = 10^{-8} \times \sum_{i=1}^N f_o \times (f_k \times A_i)^4$$

ESAL



TON	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ESAL	0,0001	0,0016	0,0081	0,0256	0,0625	0,1296	0,2401	0,4096	0,6561	1,0000	1,4641	2,0736	2,8561	3,8416	5,0625	6,5536	8,3521	10,4976	13,0321	16,0000

- 10t axle = 1 ESAL, 12t axle = 2 ESAL
- 20% heavier axle has 100% higher impact on the road

# Web based SW for Monitoring and Supervision

- Real-time traffic monitoring.

The screenshot shows a web-based traffic monitoring interface. On the left, there is a list of vehicles with columns for weight, lane, and time. The selected vehicle is highlighted in red. On the right, an 'Event details' panel shows a video feed of the selected vehicle and its technical specifications.

Weight	Lane	Time
30.48 t	Lane: 4 (LENDAVA)	21. 2. 2019 14:58:38
39.37 t	Lane: 4 (LENDAVA)	21. 2. 2019 14:58:15
7.37 t	Lane: 1 (MB)	21. 2. 2019 14:58:12
48.39 t (34%)	Lane: 1 (MB)	21. 2. 2019 14:57:48
47.21 t (18%)	Lane: 4 (LENDAVA)	21. 2. 2019 14:57:44
38.65 t (7%)	Lane: 4 (LENDAVA)	21. 2. 2019 14:57:42
72.64 t (102%)	Lane: 4 (LENDAVA)	21. 2. 2019 14:57:40
91.01 t (120%)	Lane: 4 (LENDAVA)	21. 2. 2019 14:57:10
73.93 t (105%)	Lane: 4 (LENDAVA)	

**Event details**

**Vehicle:**

**Mass:** 48.39 t  
**Distribution:** 9.09 t – 11.90 t – 12.33 t – 15.07 t  
**Axis length:** 3.84 m – 4.78 m – 2.84 m

**Time:** 21. 2. 2019 14:57:48  
**Classification:** 62  
**Direction:** MB  
**Speed:** 91.86 km/h

lopc\_2\_AC\_2\_A1\_0040\_21 SIWIM-SI-027



**Vehicle:**



**Mass:** 35.59 t

**Distribution:** 7.06 t – 8.29 t – 6.75 t – 6.75 t – 6.75 t

**Correction factor:** 93 %

**Axle distance:** 3.65 m – 5.57 m – 1.34 m – 1.34 m

**Tyre types:** 1 – 2 – 1 – 1 – 1

**Time:** 22. 10. 2024 10:13:41

**Classification:** 306

**Axle group:** 1-1-3

**Lane:** 1

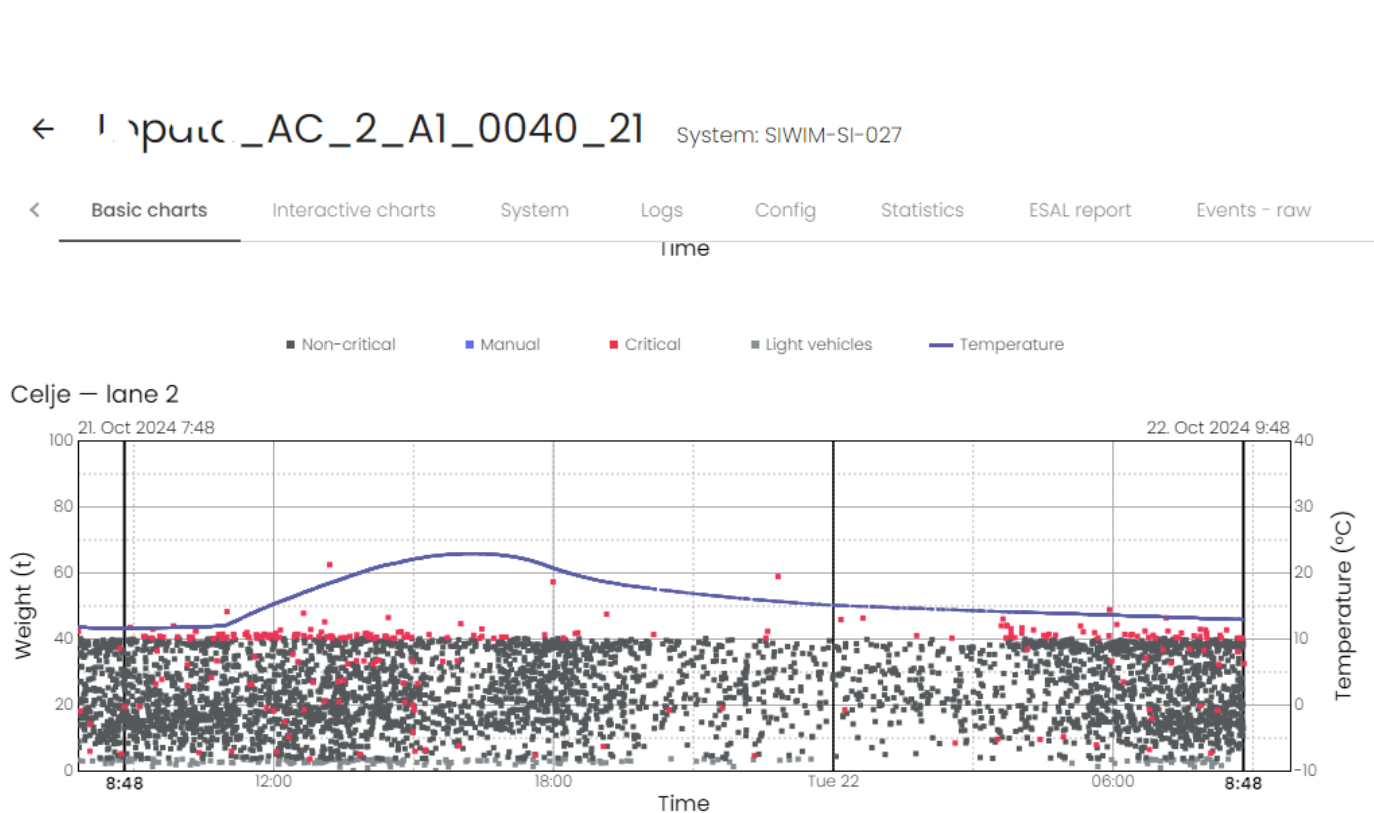
**Direction:** Ljubljana

**ANPR – front:** SOK-97

**Speed:** 89.82 km/h

# Web based SW for Monitoring and Supervision

- Control and off-site analysis of the connected systems.



← Input AC\_2\_A1\_0040\_21 System: SIWIM-SI-027

Basic charts Interactive charts System Logs Config **Statistics** ESAL report Events

Select time period for statistics:

Show details

### Summary

Statistics period: 21. Oct 2024, 00:00 - 22. Oct 2024, 00:00

Vehicles	Ljubljana		Celje		Sum	%
	Lane 1	Lane 2	Lane 3	Lane 4		
Light	178	53	110	357	698	6.85 %
Heavy	5555	76	74	3781	9486	93.15 %
└ Classified heavy	5517	59	69	3732	9377	98.85 % OF HEAVY
└ Unclassified	38	17	5	49	109	1.15 % OF HEAVY
						92.08 % OF ALL
						1.07 % OF ALL

### Vehicles by class

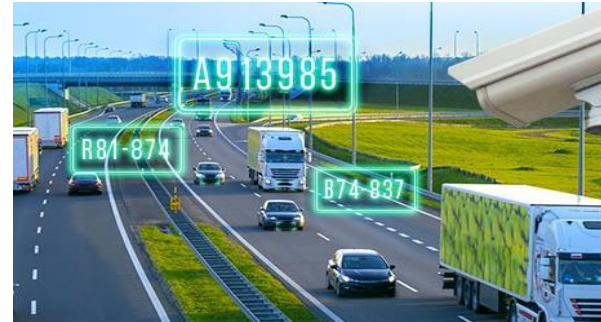
Subclass	Ljubljana		Celje		Sum	%
	Lane 1	Lane 2	Lane 3	Lane 4		
20	8	2	10	5	25	0.25 %
21	0	0	0	1	1	0.01 %
22	0	0	0	1	1	0.01 %

# Data from SiWIM can be used for:

- **Traffic studies** (number of vehicles, vehicle classes, overloading,...)
- Road infrastructure analysis:
  - **pavement design and maintenance,**
  - **bridge assessment and monitoring.**
- **Pre-selection for enforcement.**
- Remote monitoring and supervision.
- Calculation of the traffic pattern.

# SiWIM +

- ANPR (license plate recognition)
- ADR (dangerous goods recognition)
- VMS (variable message sign)
- Traffic counter
- Traffic control center
- Structural Health Monitoring



**Thank you for your attention!**

**SiWIM you soon!**

