

# *Software v legální metrologii / Software in legal metrology*

*Mezinárodní metrologický seminář / International Metrology Seminar*



**DIGITÁLNÍ  
VĚK  
VÁŽENÍ**

**PRAHA**

**2024**

*Ing. Martin Koval Ph.D.*

# What is SW?

SW in measuring instruments is almost everywhere today



Without SW

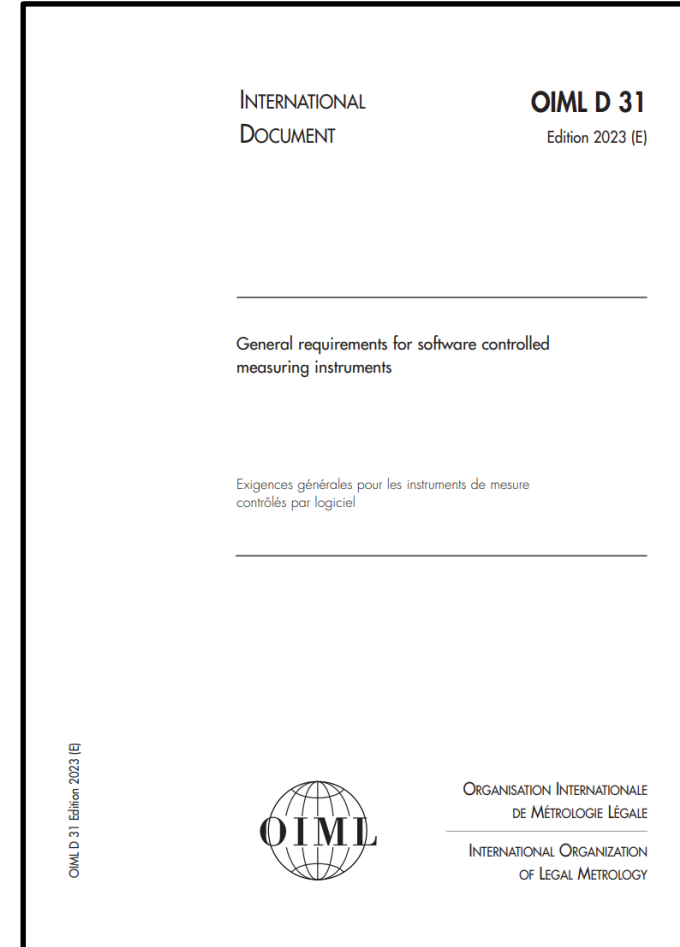
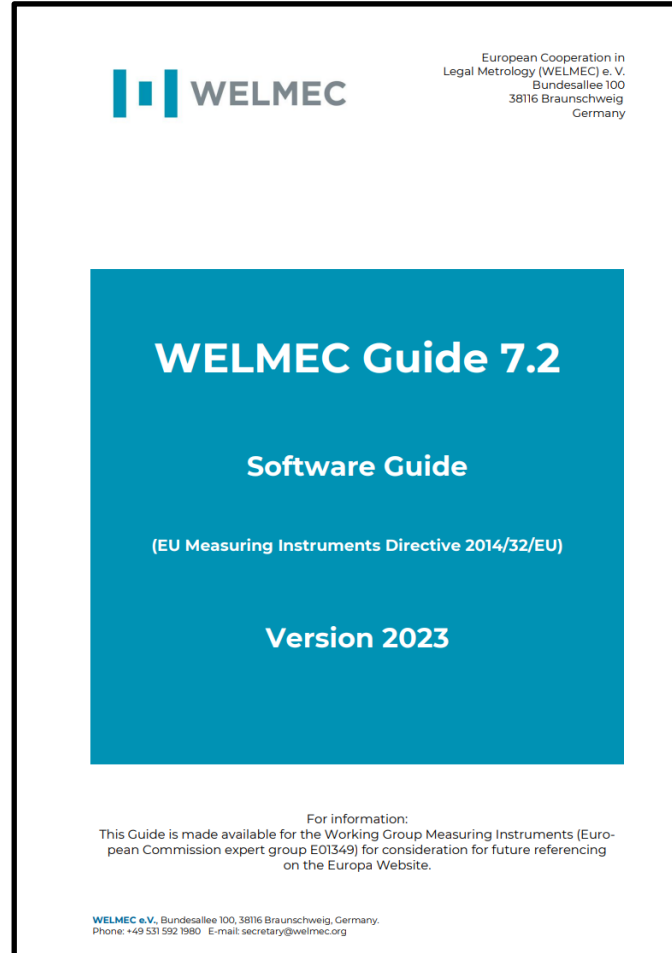
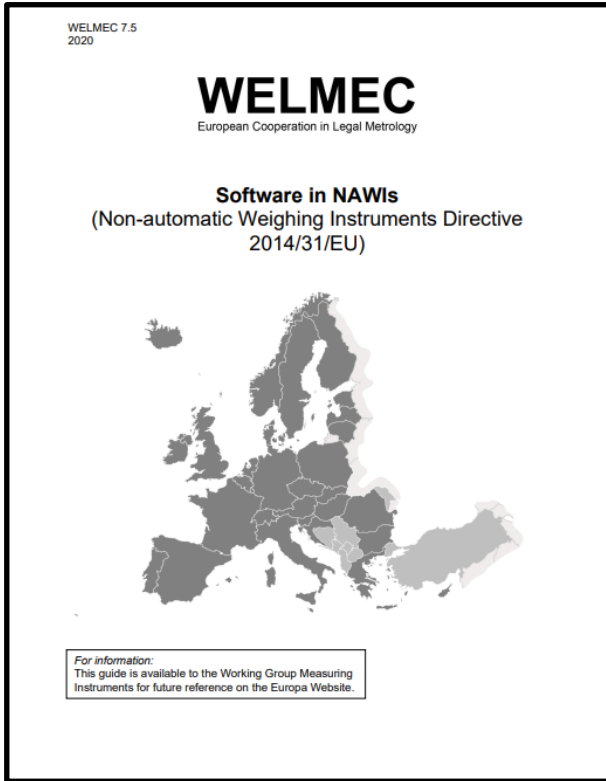


Simple SW



Advanced SW

Year	Acronym	Name
2014/2015	<b>MID 2014/32/EU</b>	<b>Measuring Instruments Directive</b>
2014	<b>NAWID 2014/31/EU</b>	<b>Non-Automatic Weighing Instruments Directive</b>
2014	OIML R50	Continuous totalizing automatic weighing instruments (belt weighers)
2006	OIML R51	Automatic catchweighing instruments
2021	OIML R60	Metrological regulation for load cells
2017	OIML R61	Automatic gravimetric filling instruments
2006	OIML R76	Non-automatic weighing instruments
2007	OIML R106	Automatic rail-weighbridges
2007	OIML R107	Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)
2006	OIML R134	Automatic instruments for weighing road vehicles in motion and measuring axle loads
2020	OIML R150	Continuous totalizing automatic weighing instruments of the arched chute type



Year	WELMEC Guide 7.2	OIML D31
2005	Welmec Guide 7.2, Issue 1	-
2007	Welmec Guide 7.2, Issue 2	-
2008	Welmec Guide 7.2, Issue 3	OIML D31 (Edition 2008)
2009	Welmec Guide 7.2, Issue 4	
2011	Welmec Guide 7.2, Issue 5	
<b>2016</b>	<b>Welmec Guide 7.2, 2015</b>	
2018	Welmec Guide 7.2, 2018	OIML D31 (Edition 2019)
2019	Welmec Guide 7.2, 2019	
2020	Welmec Guide 7.2, 2020	
2021	WELMEC Guide 7.2, 2021	OIML D31 (Edition 2021)
2022	WELMEC Guide 7.2, 2022	
2023	WELMEC Guide 7.2, 2023	OIML D31 (Edition 2023)

6.2 General requirements	6.3 Requirements for specific configurations
Software identification	Specification and separation of legally relevant components and modules and requirements for interfaces
Correctness of algorithms and functions	Shared indications
Evidence and prevention of intervention	Storage of data
Prevention of misuse	Data transmission
Demands on the user	Compatibility of operating systems and hardware
Support of hardware features	Conformity of manufactured devices to the approved type
Timestamps	Maintenance and reconfiguration
Information regarding dynamic modules of legally relevant software	Remote verification capability

**More than 80 requirements**

## Basic configurations of measuring instruments

**Type P**  
Built-for-purpose  
Measuring Instrument

**Type U**  
Measuring Instruments  
using a Universal  
Computer

**O**  
General-purpose  
operating systems

## Requirements for IT configurations (Extensions)

**L**  
Long-term Storage of  
Measurement Data

**T**  
Transmission of Measurement  
Data via Communication  
Networks

**S**  
SW Separation

**D**  
Download of legally  
relevant SW

## Instrument Specific Software Requirements (MID)

**I1** – Water Meters

**I2** – Gas Meters and Volume  
Conversion Devices

**I3** – Active Electrical Energy Meters

**I4** – Thermal Energy Meters

**I5** – Measuring Systems for the Continuous  
and Dynamic Measurement of Quantities of  
Liquids Other than Water

**I6** – Weighing Instruments (AWI),  
*(WELMEC 2.3 is for NAWI)*

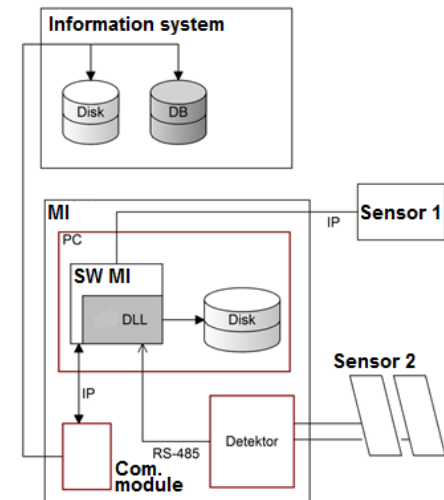
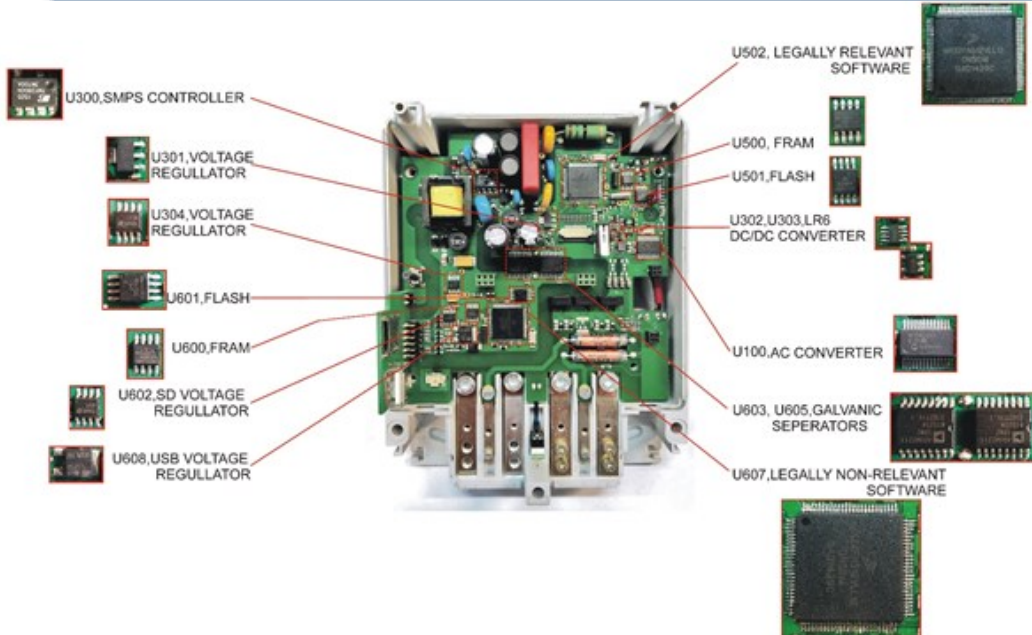
**I7** – Taximeters

# What is the goal..

- ✓ Well prepared technical documentation,
- ✓ Software Identification,
- ✓ Users and communication interfaces,
- ✓ Protection and security aspects,
- ✓ How to trust data,
- ✓ What MI allows,
- ✓ Transfer of information,
- ✓ Storage of information,
- ✓ Visualization of information.



- Description of the measuring instrument.
- Description of HW part of the measuring instrument, *(e.g.: Photo of PCB with a description).*
- The operating manual of the measuring instrument.
- Description of legally relevant SW.
- Overview of the configuration of the operating system, security aspects of the operating system
  - *(e.g.: protection, user accounts, privileges).*



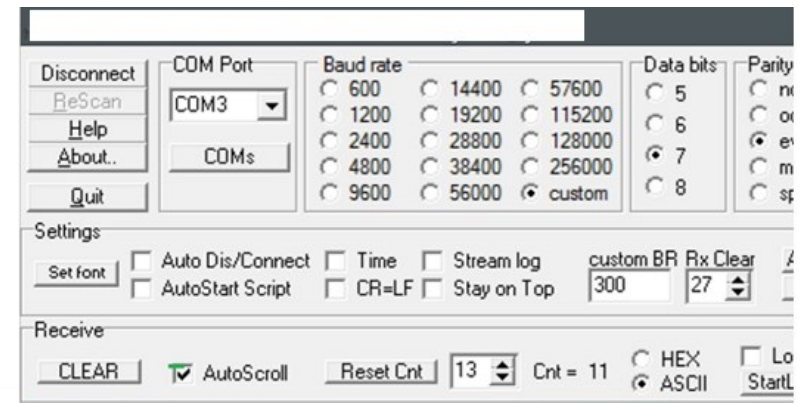
- Identification of SW: numbers, characters, alphabet, their combinations or strings.
  - 01.01 , V01, v01.03.02,
- Identification of the legally relevant SW should be easily presented without requiring an additional tool.
- Identification should be covered by securing means.
- Clear description of the visualization of identification of the legally relevant SW
- Description of the identification structure
  - 01.02: 01 (Major), 02 (Minor)



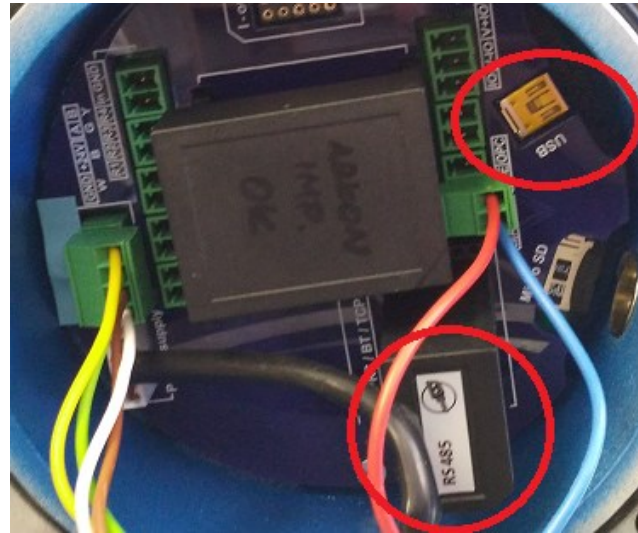
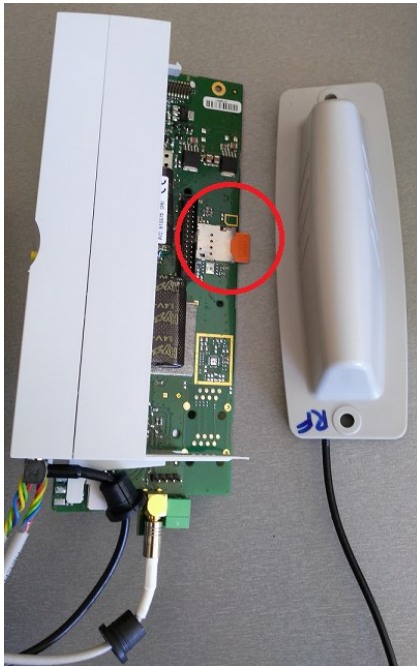
```
Start-up time (UTC): 2017-02-24 15:13:24
ME dll file version: 1.1
ME dll file calculated hash: 8ED7113B5BB9701C5A421EE0274AE0F9
ME dll file given hash: 8ED7113B5BB9701C5A421EE0274AE0F9
ME dll is valid.
```



- User interface (P): everything that is inextricably connected with the measuring instrument
  - LCD, button/s, keyboard, etc.
- Documentation User interface (U): everything that has influence for control, presentation, changes legally relevant data of LRSW or other parts related to LRSW.
  - Monitor, LCD, keyboard, mouse, PC application, etc.
- Documentation should contain description of all the commands and their effect on legally relevant SW, on device-specific parameters and on measurement data
- Interface should have not inadmissibly influence the legally relevant SW.
- The functions of OS for user interface should not have not inadmissibly influence to LRSW, specific parameters, measurement data or configuration OS and related secure measures and other means.



- Communication: interfaces, protocols.
- Documentation should contain description of all the commands and their effect on legally relevant SW, on device-specific parameters and on measurement data.



# Securing and protecting legally relevant software and device-specific parameters

- The software shall be capable to detect changes caused by physical effects.
  - Means shall be implemented to secure from unintentional misuse of the user interfaces.
  - The accidental modification of legally relevant software and device-specific parameters shall be periodically checked by calculating checksum(s) or alternative methods.
- What does detection look like? (eg: error message on the display)
  - The use of the user interface should be foolproof, that is, there should be no possibilities where someone could enter or set something by mistake and negatively affect MI.
  - How a checksum or alternative method to detect random modification actually works.

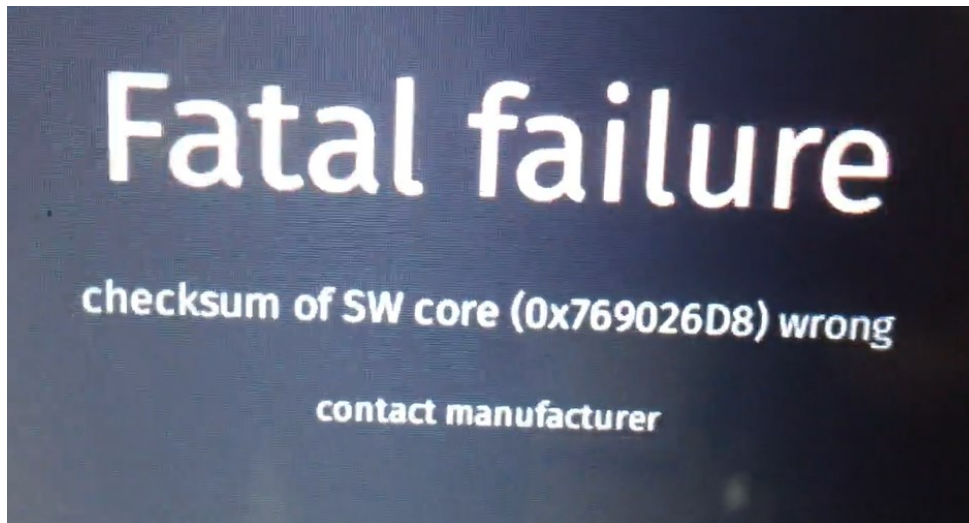
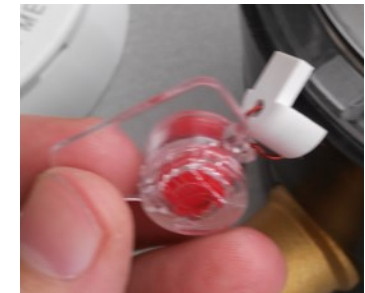
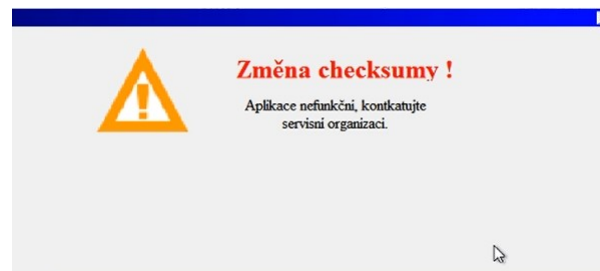


Image were generated using DALL-E, an AI image generation tool by OpenAI under license CC BY-SA

- Measurement data are considered to be sufficiently protected if it is ensured that only legally relevant software can process them.
  - Storage devices that contain software and measurement data shall be protected against exchange
  - A checksum or an alternative method shall be provided in order to support the detection of software modifications.
  - The checksum or the alternative indication is calculated over the legally relevant software
- 
- What does detection look like? (eg: error message on the display)
  - How looks sealing of HW part where is SW/storage in device placed.

ID:	[REDACTED]				
Timestamp:	2021-11-09T10:16:58Z				
Total weight:	78815 kg				
Legally verified:	False				
Valid:	True				
Hash:	15941552aa794d994d19740e6d90b647a58e76a7dff789b71896b14db66ef1ef				
Axle	Left		Right		Total Weight
	Weight	Speed	Weight	Speed	
1	3702 kg	83 km/h	3574 kg	83 km/h	7276 kg
2	5354 kg	83 km/h	5246 kg	83 km/h	10600 kg
3	3493 kg	83 km/h	3831 kg	83 km/h	7324 kg
4	3611 kg	83 km/h	3637 kg	83 km/h	7248 kg
5	3585 kg	83 km/h	3982 kg	83 km/h	7567 kg



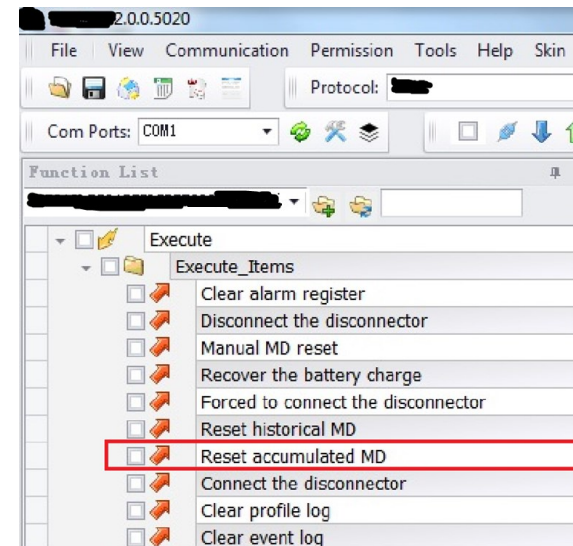
**WRONG sealing!**

# Parameter protection

- Certain device-specific parameters may be set by the user, provided that they are protected by a facility to automatically and non-erasable record any adjustment of the legally relevant device specific parameter,
  - If necessary for the purpose of verification of a measuring instrument display of the current relevant parameter settings shall be possible
  - The records that provide evidence of an intervention shall be made available via display or printout upon command.
- Complete list of the parameters,
  - Which parameters are fixed, which are possible to set, and how,
  - The way how is possible to read records about changes (e.g. audit trail),
  - Protection of records,

#127 Wednesday, February 12, 2020 3:50:00 PM UTC

Checksums:	
Calc.dll:	0x1BFEB1EF
Calc.dll:	0xF2532F35
	0x7F06F760
AddFunct.dll:	0x18B1811B
Integral settings (depends on 4 below)	0x09EA97F7
Component parameters:	0x954ADC06
Embedded formulas:	0x6EDF4224
Additional formulas:	0x6CBA8755
Functions:	0x12A7AF65



# Authentication of presented measurement data

- It shall not be possible to fraudulently simulate (spoon) legally relevant software for presenting measurement data.
- For each presented legally relevant measurement data the meaning shall be clear.
- Presented legally relevant measurement data shall be clearly distinguishable from not legally relevant data

- To ensure traceability,
- How is ensure trustworthy of presentation data,
- How to read correct data,

ID:	[REDACTED]				
Timestamp:	2021-11-09T10:16:58Z				
Total weight:	78815 kg				
Legally verified:	False				
Valid:	True				
Hash:	15941552aa794d994d19740e6d90b647a58e76a7dff789b71896b14db66ef1ef				
Axle	Left		Right		Total
	Weight	Speed	Weight	Speed	
1	3702 kg	83 km/h	3574 kg	83 km/h	7276 kg
2	5354 kg	83 km/h	5246 kg	83 km/h	10600 kg
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4	3611 kg	83 km/h	3637 kg	83 km/h	7248 kg
5	3585 kg	83 km/h	3982 kg	83 km/h	7567 kg

PGC IP

**Firmware data**

**FW version** 3.0.1

**Check Sum** 0xA580C7A5

**Superior** 42,026424

Sim 2231

User Modbus

MD5: CB1B5ADEA935C9D684A1E18BF894FDF0

16:44 10.4.2019

DUPLIKAT DUPLIKAT DUPLIKAT

[REDACTED]

Vozidlo: [REDACTED]  
 Vyrobní c.: [REDACTED]  
 Řidič: [REDACTED]  
 Datum: [REDACTED]  
 Zpracovatel: [REDACTED]  
 Konec: [REDACTED]

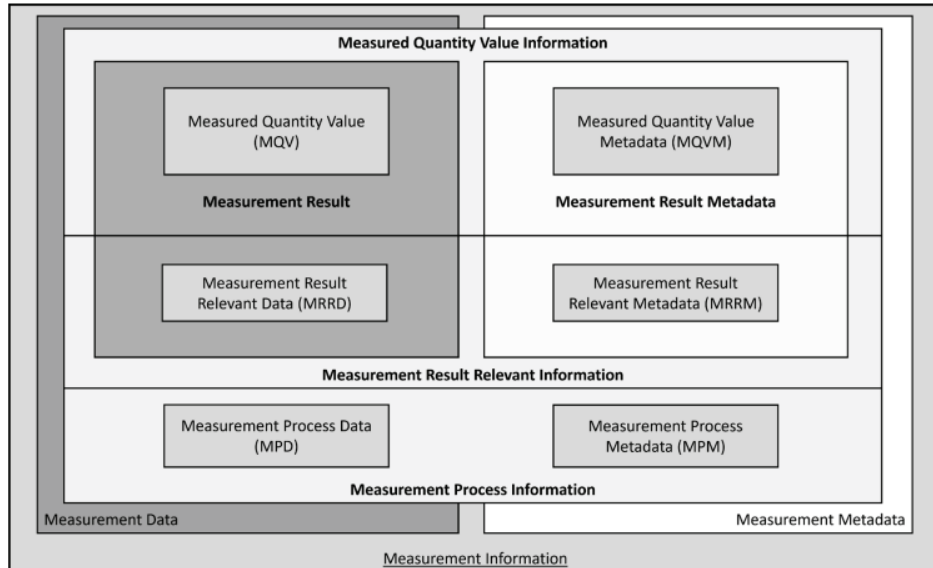
Učtenka c.: [REDACTED]  
 Kapalina: [REDACTED]  
 Kvalita P/B: [REDACTED]  
 Konv. Hustota: [REDACTED]  
 Teplota: [REDACTED]

Konv. Objem: \*398,1 L/15°C\*  
 Total Objem: \*410,4 Litr\*  
 Total Hmotnost: \*213,4 kg\*

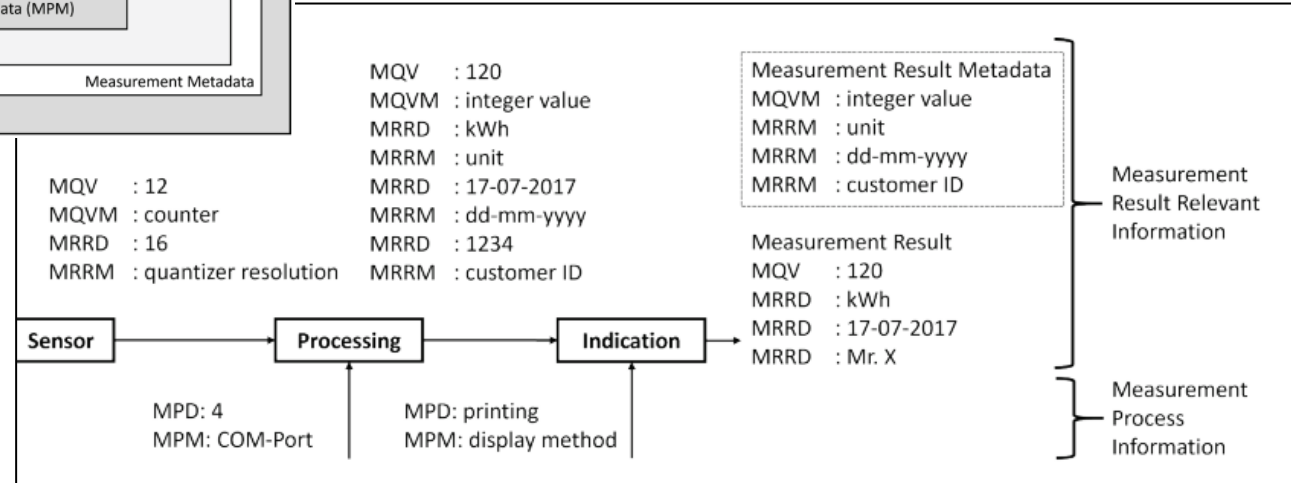
Metrologicky schvalene udaje  
 Jsou uvedeny mezi znaky \*  
 DUPLIKAT DUPLIKAT DUPLIKAT



- What is stored measurement data in digital age?



Value and unit is not enough



- Configuration of transmission network

Closed network: Only a fixed number of participants with clear identity, functionality and location are connected. All devices in the network are subject to legal control.

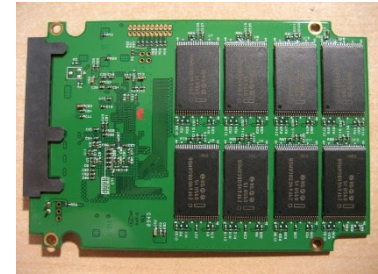


Open network: Arbitrary participants (devices with arbitrary functions) can be connected to the network. The identity and functionality of a participating device and its location may be unknown to other participants. Any network that contains legally controlled devices with infrared or wireless network communications interfaces shall be considered to be an open network.



- What could be storage?

Integrated storage Simple instrument, built-for-purpose, no externally usable tools or means available for editing or changing data, integrated storage for measurement data or parameters, e.g. RAM, flash memory, hard disk



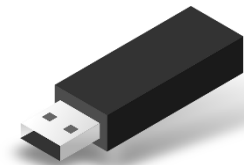
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Storage for universal device Universal device, graphical user interface, multitasking operating system, tasks subject to legal control and not subject to legal control exist in parallel, storage can be removed from the device or contents can be copied anywhere inside or outside the device



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Removable or remote (external) storage Arbitrary basic instrument (built-for-purpose device or universal device), storage can be taken from the instrument. These can be, for example, USB stick, flash cards, or remote databases connected via network.



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- Which key aspects are necessary to take into account

What everything is stored/transmitted:

- Measurement data,
- Timestamp,
- Metadata,
- Information about integrity (e.g. checksum)

Retrieval of stored data:

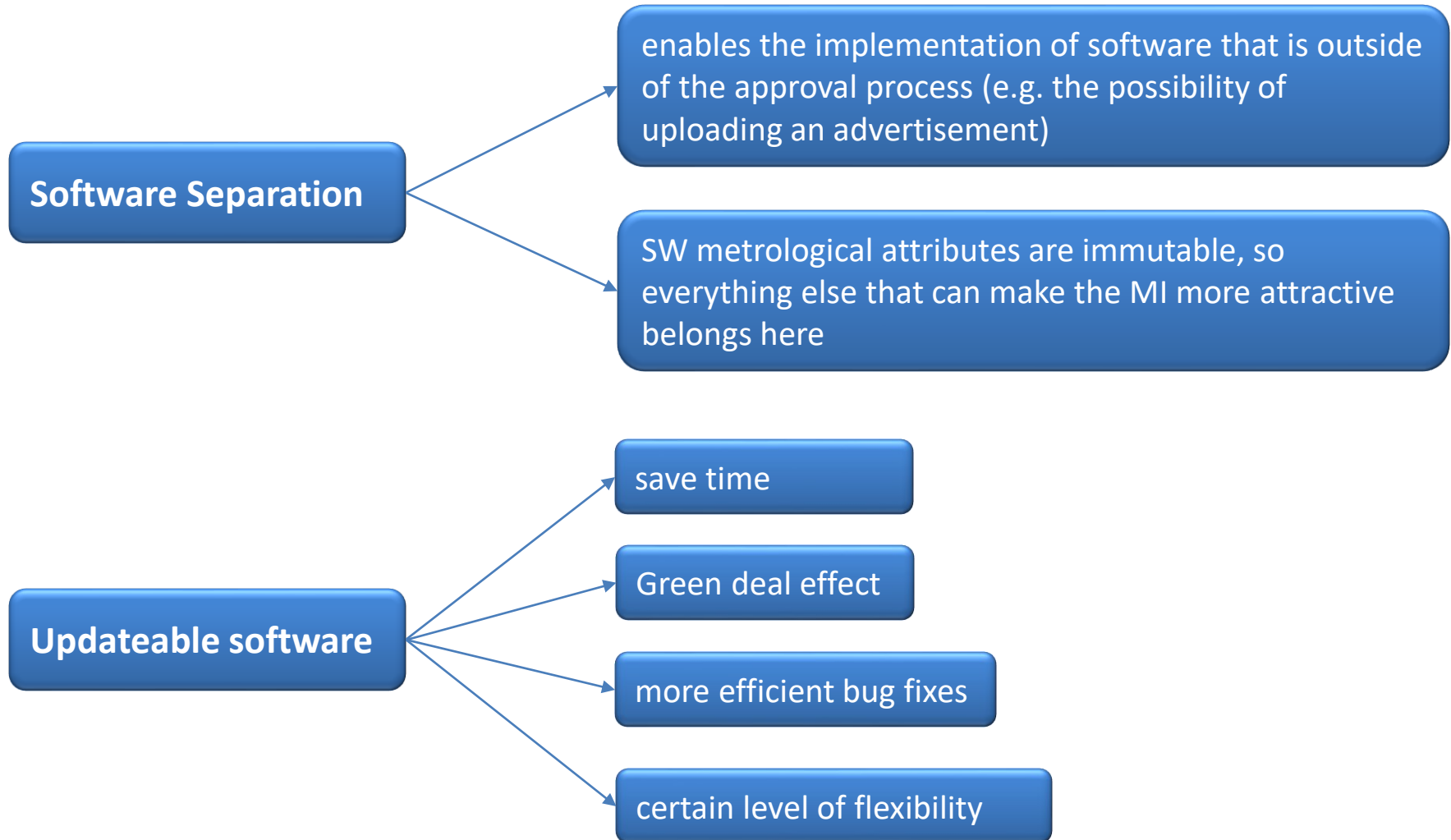
- Readability,
- Internal or external device,
- Trustworthiness of SW for retrieval  
(traceability, verification..)

Protection and security:

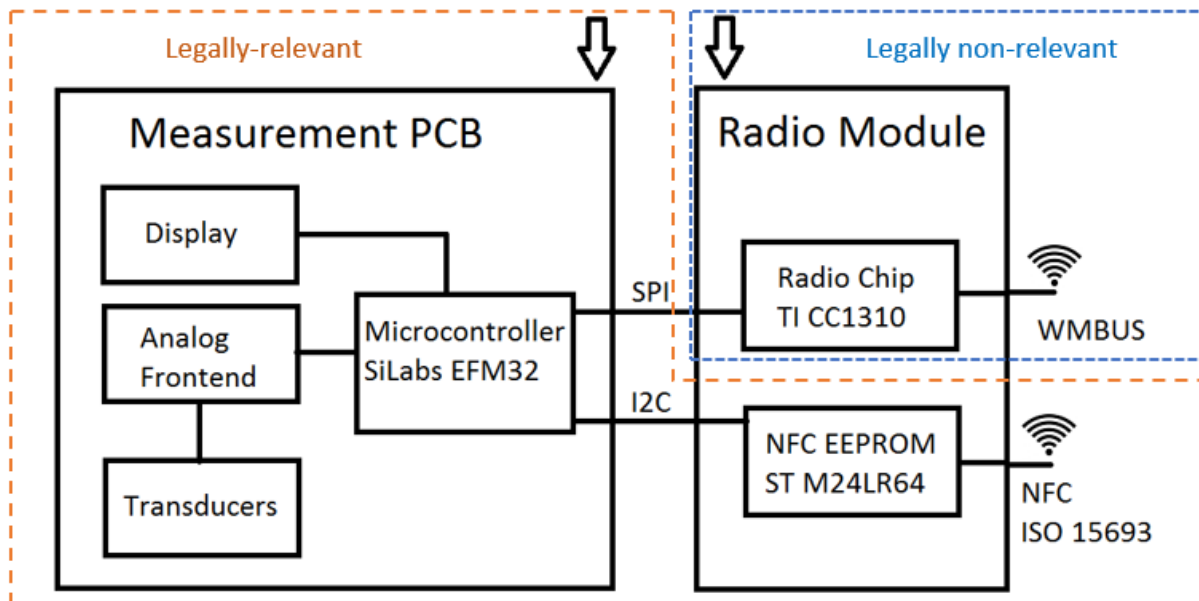
- Integrity of stored/transmitted data,
- Protection against delete/reset or modification,
- Roles and permissions,
- Lost/damaged data.

Capacity and continuity:

- Automatic storing,
- Availability of transmission services,
- Enough capacity,
- Management of storage (FIFO or fixed amount of records)



S1	Realization of SW separation	What everything belong to the legally relevant SW
S2	Mixed indication	Distinguish between information from legally relevant SW and legally non-relevant SW
S3	Protective SW interface	Securing of communication between legally relevant SW and legally non-relevant SW



## WELMEC Guide 7.2: Download software

- Allows instruments to be equipped with facilities for software download without breaking a seal.
- Not deal with legally non-relevant software.

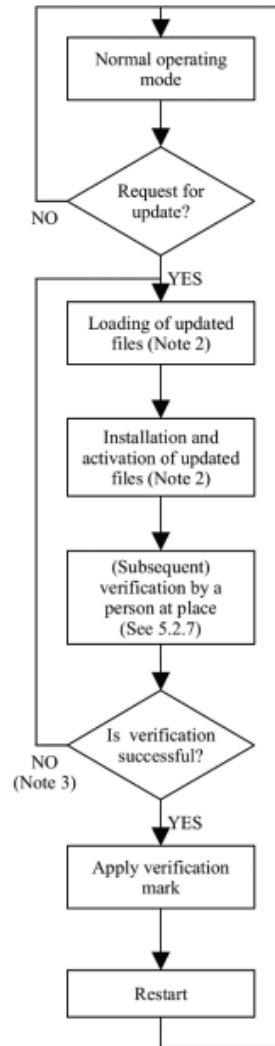
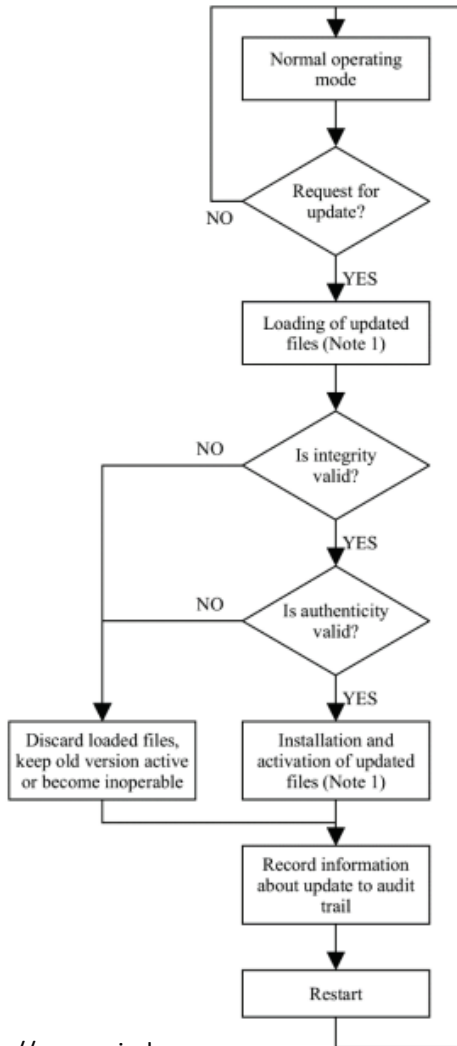
## OIML D31: update software

- **Verified Update** is the procedure of changing software in a verified device or component after which the subsequent verification is necessary.
- **Traced update** is the procedure of changing software in a verified instrument or component after which a subsequent verification is not necessary.

**Depends on national legislation if SW can be updated without breaking the seal!**

**Traced Update  
(6.3.8.4)**

**Verified Update  
(6.3.8.3)**

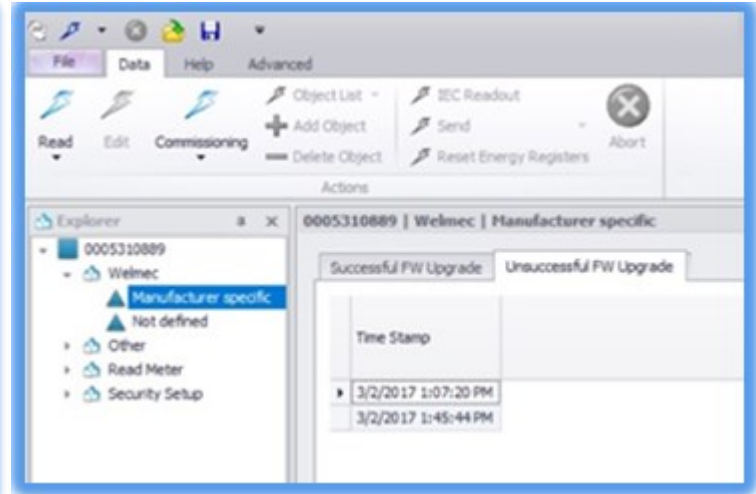
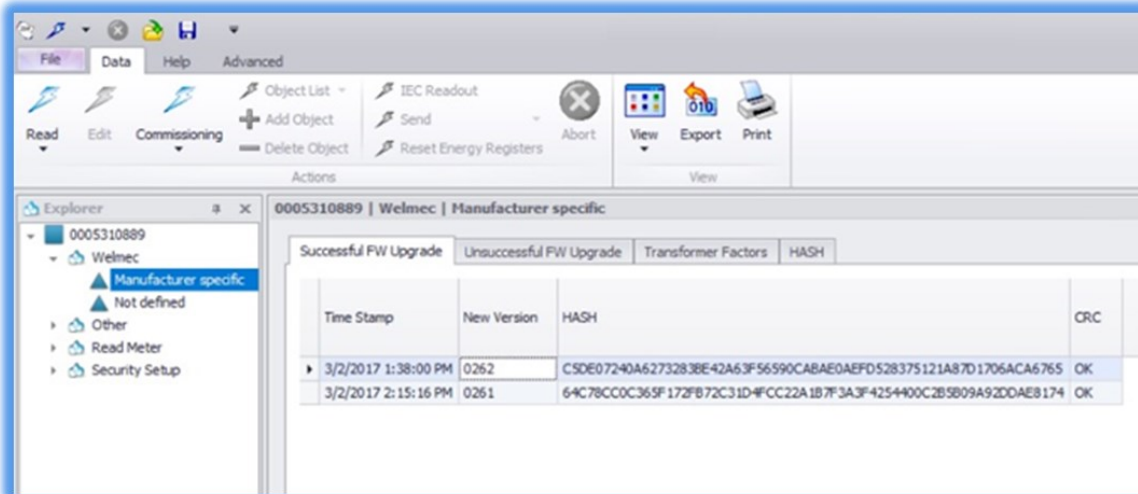


SW update procedure according to OIML D31:2023

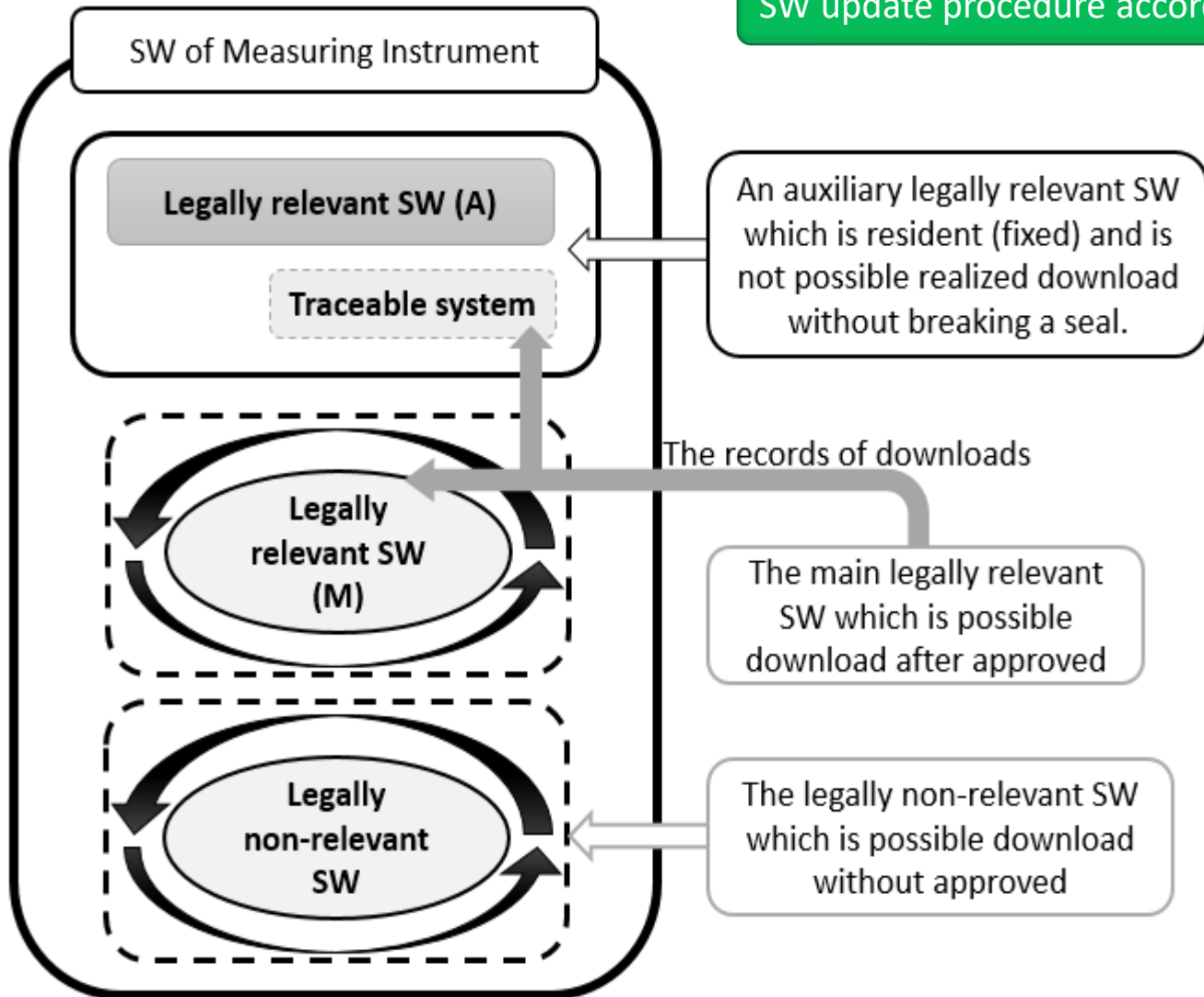


**SW update procedure according to WELMEC Guide 7.2,2023**

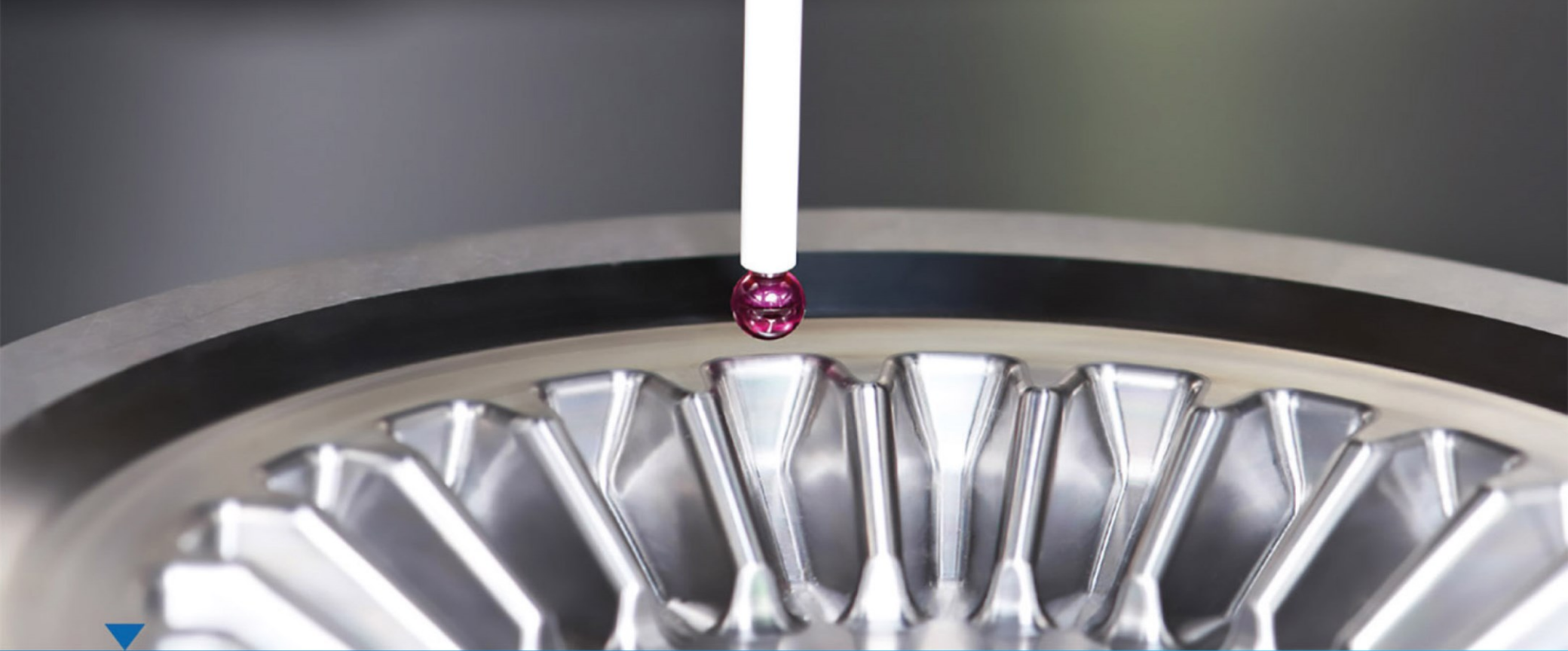
D1	Download mechanism	Description of method for download process
D2	Authentication of transmitted SW	Description of method for authenticity for transmitted SW
D3	Protecting downloaded SW	Description of means for protect against not allowed changes
D4	Traceability of legally relevant SW download	All relevant data making a download or a download attempt traceable shall be recorded and protected



SW update procedure according to WELMEC Guide 7.2,2023



- SW is one of key aspect of MI.
- SW is dynamic (what was yesterday is old).
- Even if there do not exist pure standards, there exist approaches how to handle SW in MI.
- WELMEC Guide 7.2 and OIML D31 are constantly evolving.
- Wrong SW means wrong MI.
- It is necessary to be consistent when designing SW and not to underestimate,



Thanks for your attention. Questions ?



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