



International Organization of Legal Metrology

Organisation Internationale de Métrologie Légale

Traceability of Results used for Billing Purposes, possible Approaches

**R. Kramer, B. Mickan, P. Kieseewetter;
Physikalisch Technische Bundesanstalt,
Bundesallee 100,
38116 Braunschweig;
Germany**

***OIML Seminar on Smart Meters
Brijuni, Croatia – 2-5 June 2009***





Content

Introduction

Available technical solution

Questions in respect to legal metrology

General approaches for solving

Regulations and aspects MID

Activities of WELMEC

Conclusions



Introduction

- **Energy efficiency directive (ESCO) 2006/32/EC** requires better information of customer about consumption → need of a remotely readable communication interface → smart meters
- Majority of currently used meters for domestic applications have no electronic communication interface and no connect/disconnect feature
- Introduction of smart meters will lead to a replacement of large numbers of electricity and gas meters in the next years, (future prove solutions are needed)
- Whether a definition nor a European standards is available for smart functionality (or at least not well established)
- **Smart meters** are clearly **in the scope** of European Measuring Instrument Directive (**MID**) → **standardisation mandate by EC**
- **MID** contains essential requirements and special requirements → smart meter functionality are to consider as “additional functionality”



Aims of smart meter

- Electronic communication interface, remote reading of consumption values, receiving and displaying of information on the meter
- Introduction of new functions or improvement of functionality like connect disconnect device or pre payment
- Control of grids by new rate structures
- Improvement of competition between energy retailers ?



Introduction

Issues

- Interoperability of interfaces and data protocols → standardization
- Different rates (tariffs) for controlling grids or as competition feature between gas sellers is to expect
- Measurement of correct consumption data is needed for billing
- billing based on „power (load)“ figures is not to expect for domestic consumers
- Data privacy protection is to consider
- Software is much more complex, bidirectional communication is to handle (software assessment, inadmissible influences)



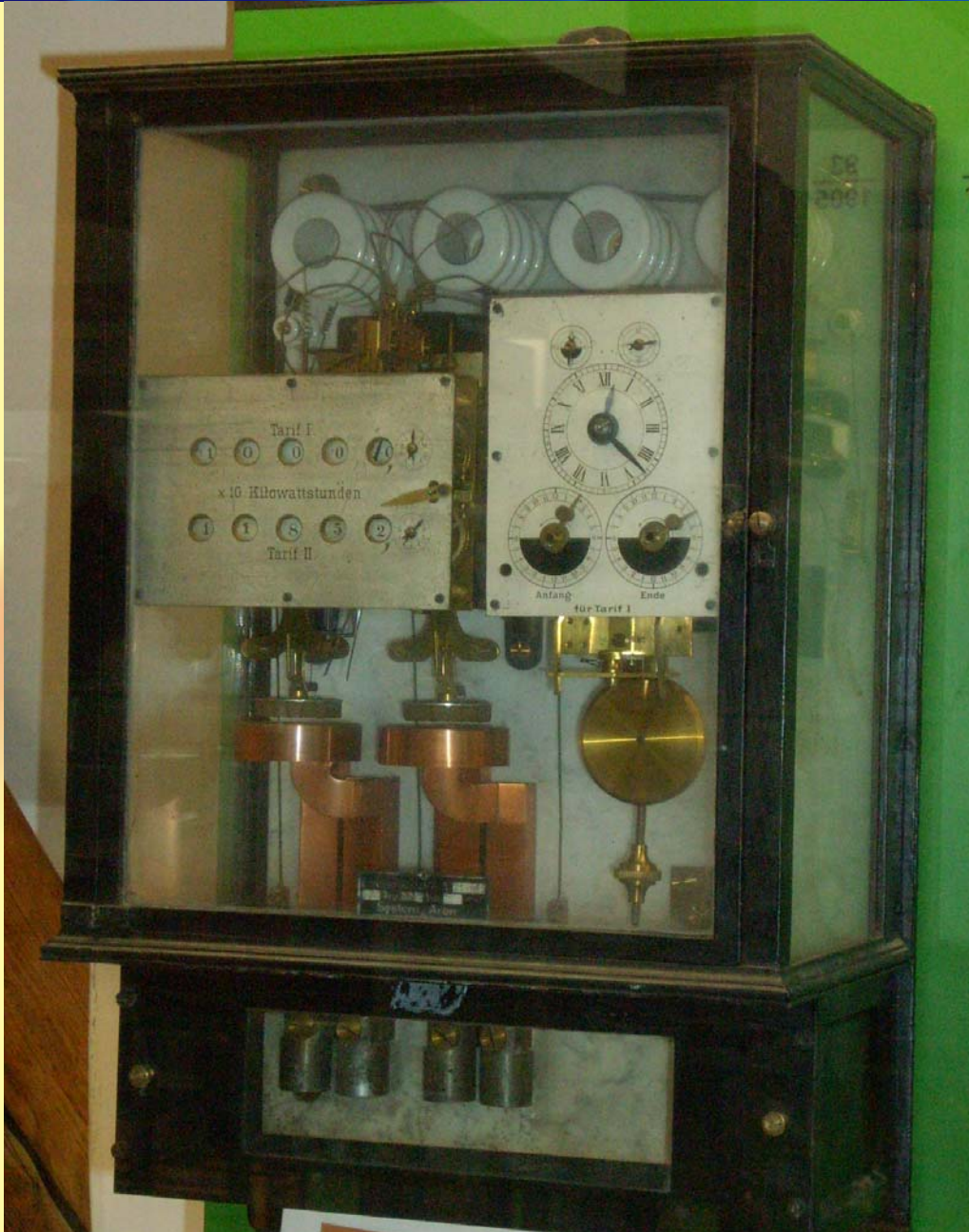
What is meant by this?

Quality of measurement

- Traceability to SI units (national standards) usually by calibrated test equipment
- measurement shall provide results which are appropriate to the problem (the bill shall be based on the same value)
- for commercial transactions (custody transfer) the system of legal metrology provides high level quality

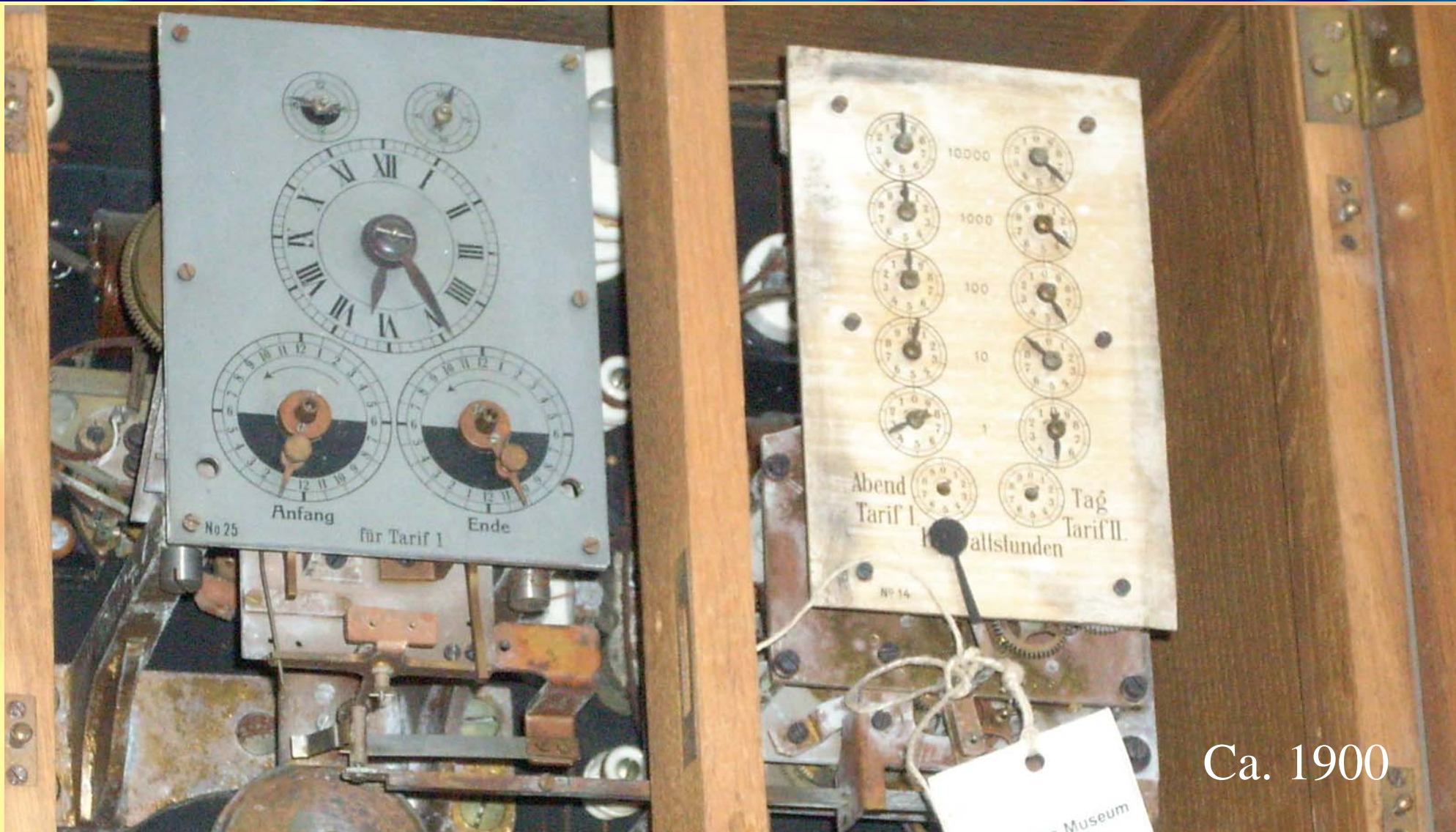
Main points of legal metrology system

- requirements on measuring instruments (including application)
- System for the assessment of the meters (approval and verification)
- market surveillance, in service surveillance
- re-verification



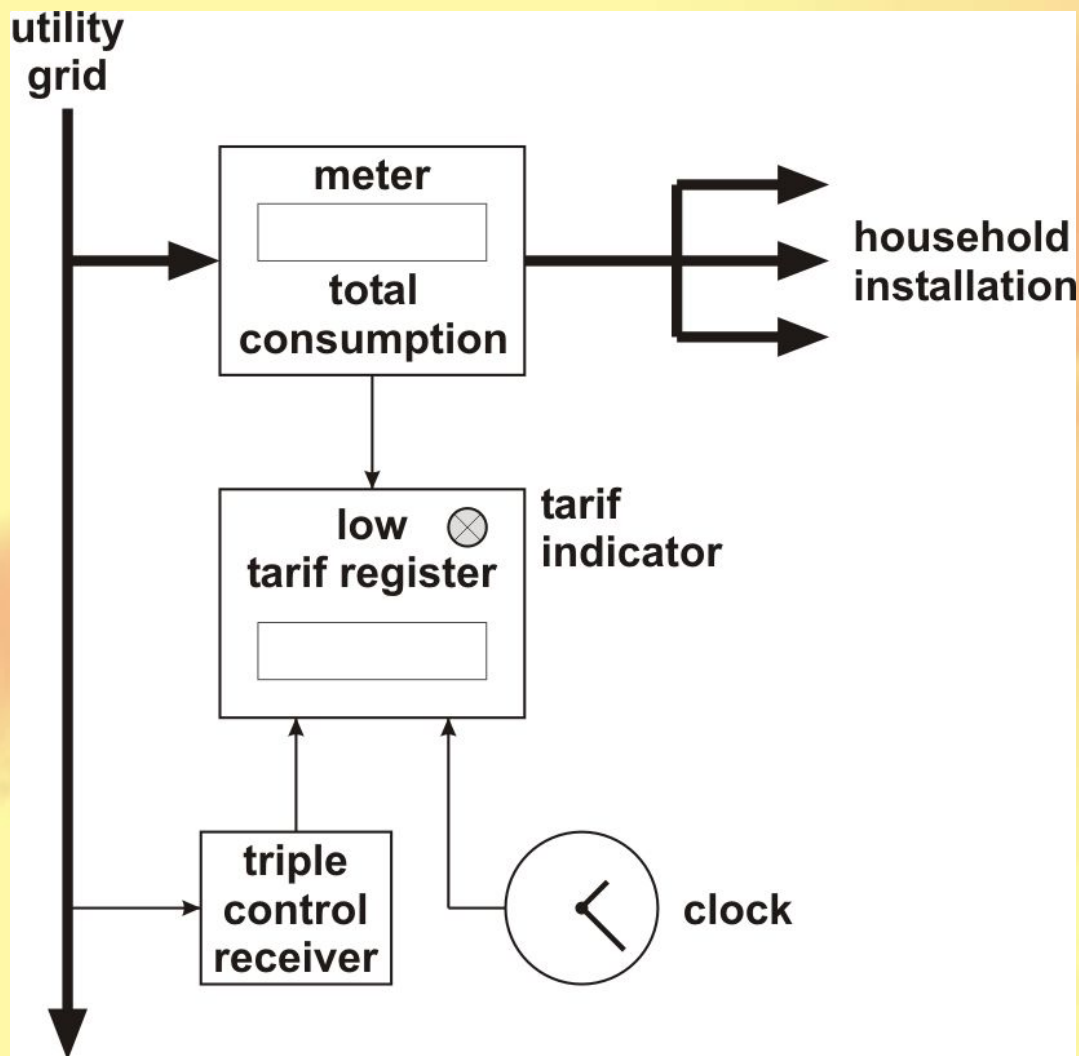
Meter for measurement of total consumption

- Use of electricity was already wide spread for lightening purposes
- Usage of electricity for other applications was not sufficient
→ Introduction of rates
- Different registers
- Clock inside the meter
- Masterpieces of engineering



Ca. 1900

- clock was checkable by both parties
- 2 different registers
- Time of use was to set on site



Meter for measurement of total consumption

- ripple control or clock is used for switching between different registers
- currently active rate shall be indicated
- Reading of consumption by authorized persons

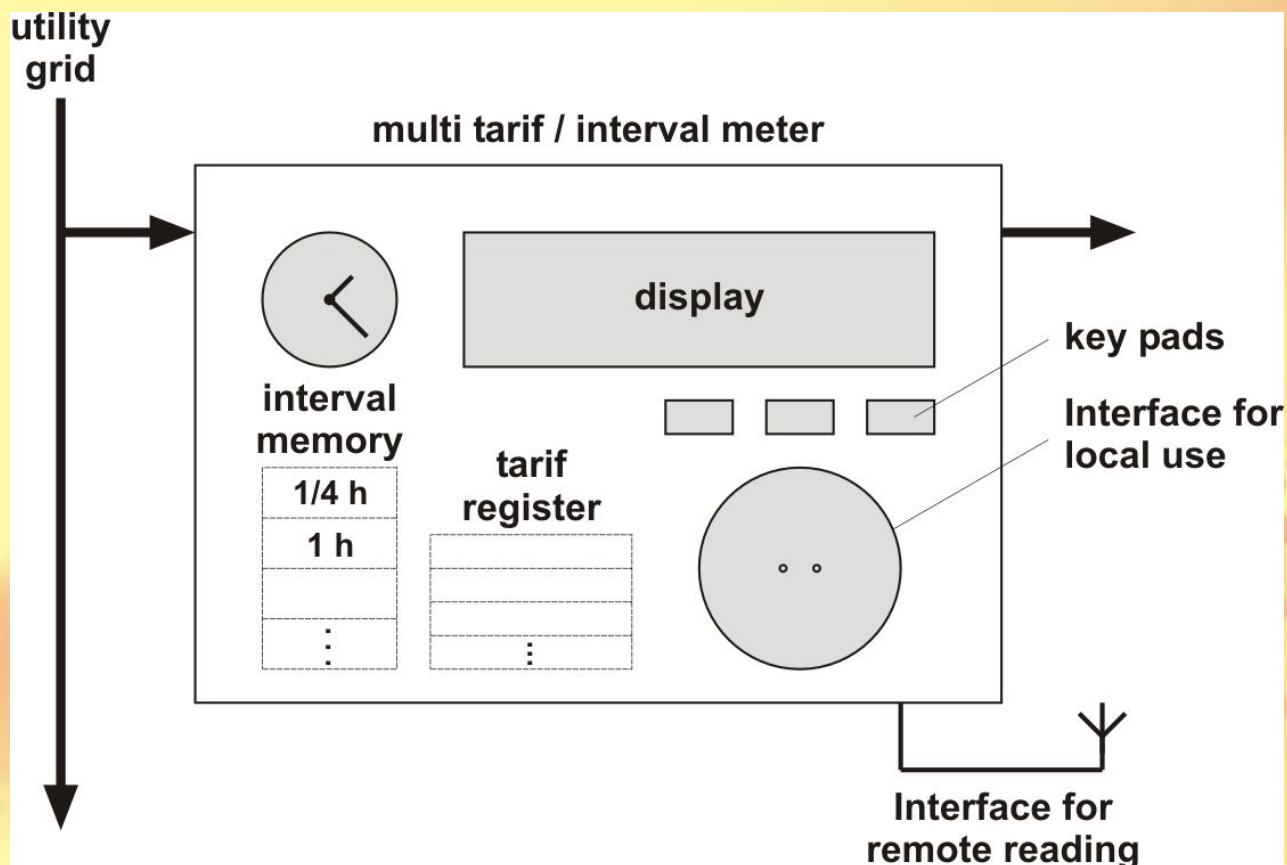
Contract is important for billing

- rates
- guaranteed time of low rate
- basic costs
- selling conditions (provision of lower order)
-



mechanical 3 tariff meter

- External clock is used for switching between different registers
- Reading of consumption by authorized persons



Interval meter

- Internal clock
- memory for consumption in subsequent intervals (available for sufficient time)
- display for indication of consumption data, parameters and log books entrances
- Synchronization of clock (via communication interface)

National regulations available

Contract

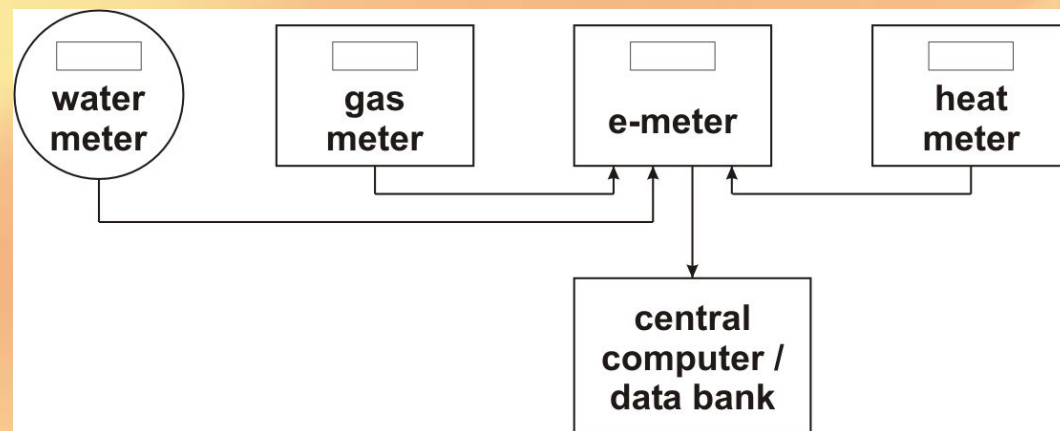
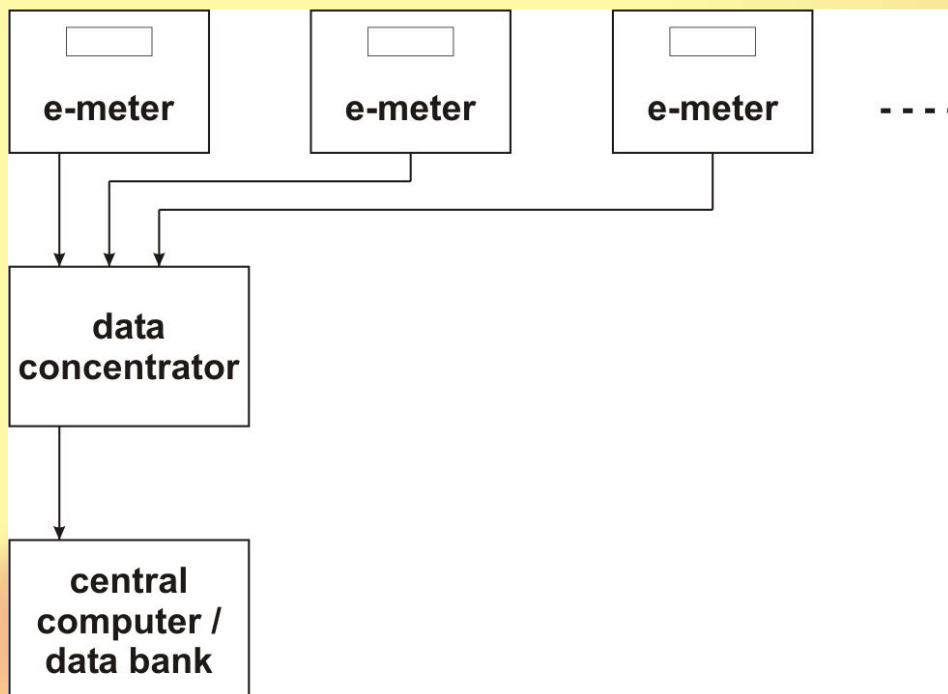
- Complicated rates possible
- Usage of load figures for billing



ca. 1980

Combination of a mechanical / electronic meter

- Basic meter with mechanical counter
- Internal clock
- Interval meter inside (memory for consumption in subsequent intervals)
- User interface (buttons and display) for indication of consumption data, parameters and log books entrances



Multi utility solution

- Different kind of interfaces and protocols
- Communication by line or RF
- Different kind of instrument energy supply (mains, battery)
- Responsibilities need to be settled if different “stakeholder” be involved



Traceability of values used for billing purposes

- How is the correctness and authenticity of data used for billing safeguarded?
 - Which data and measured values are needed or used for correct billing?
 - Is the determination of values (data) under legal control?
 - In which manner data may be checked by the consumer?

How inadmissible influences on legally functions are avoided?

quality of software → OIML D 31

- requirements on design, documentation
- procedures for assessment / examination



data needed for billing rates

the **consumption during the time related to each rate** inside the billing period (for instance the consumption inside a month during the time where the “low tariff” was active)

Possible approaches:

1) different cumulating registers for each rate are inside the meter

- at the end of the billing period the registers are read
- the difference to the registers at the end of the billing period before is the needed value
- Active rate shall be indicated

2) interval meter for the determination and storage of the consumption in subsequent fixed periods: quarter of hours (electricity), hours (gas),

- consumption for the different rates is calculated by summation of the concerned intervals
- Requirements on the clock and data communication between meter and interval meter
- Active rate may be indicated or is given by contract

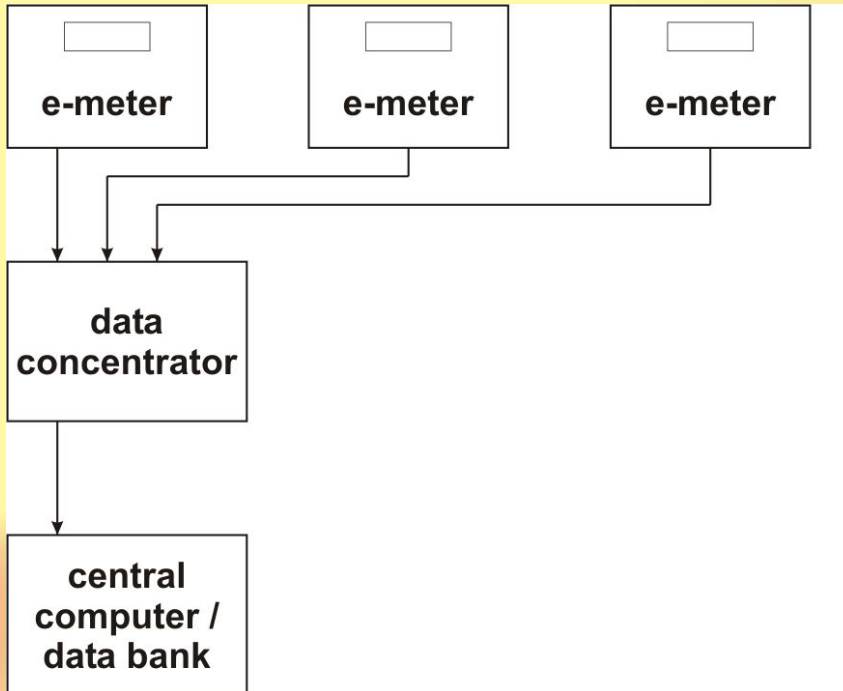


3) Registration of the total consumption at each change of the active rate

- the differences of the total consumption figures may be used for sum up the consumption during the used rates
- the readings of the total consumption need to be coincident to the time when the change of rate happened

4) estimation of the consumption during the time related to each rate based on

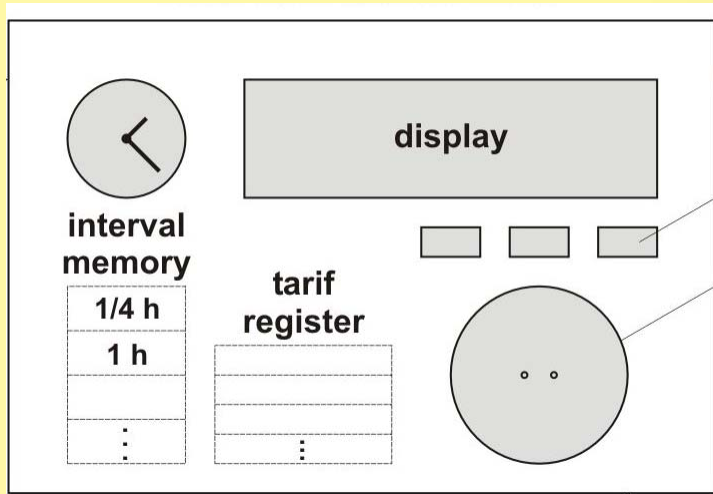
- reading of the total consumption in a fixed time frame for instance daily
- estimation of the consumption in the different rates under usage of a standard behavior (load profile) of the type of consumer (heating, cooking)



the measurement and storage of the data is realized inside the

- 1) meter,
- 2) data concentrator,
- 3) central computer

- Opportunity to check the results on an instrument under legal control
- Efforts to guarantee the Authenticity
- Requirements on the reliability, security and reaction time of the interfaces



- data are measured and stored in an instrument under legal control
 - authenticity of data used for billing may be checked on the display of this instrument by comparison
- 1) the display is able to show all relevant data via user interface
 - 2) the meter is only able to display basic data which need further processing for checking the bill,
 - 3) all data are available via a local communication interface in combination with additional hard and software
 - 4) A legally controlled display is remotely realised → data are secured by advanced information technologies



Meter provides data sets secured by advanced information technology “cryptographically secured data”

- Based on cryptographically methods, namely private and public key (similar to secure internet communication)
- Meter measures interval data, sign it by the private key (→ comparable to a legally seal) and send the data to central data base
- Billing is based on this data, legally controlled display for checking the bill will be realised on a PC using the data (from the data bank) and the public key

Advantages:

- reduced efforts for the user interface of the meter
- Authenticity of data is given by the public key

Disadvantage:

- Infrastructure for handling of cryptographic keys is necessary
- Acceptance of the solution by the end users
- MID is not fully in agreement



Regulations on smart meter functionality

- Requirements on utility meters given by Measuring instrument directive (MID)
- MID provides general requirements and special requirements (like minimum flow rate ranges, MPE, requirements on battery and power supply), but no special requirements available for additional functionality
- National regulations interval meters and other legally important figures (like reactive energy) in some countries in force, scope and requirements are different
- WELMEC is a platform to co-ordinate activities of authorities



WELMEC activities

- Regional (European) organization of authorities/organisations working in the field of legal metrology
- www.welmec.org
- deals with issues in respect to European Directives (NAWI and MID)
- supports European Commission
- WELMEC developed guidance as best practice approach
- Working group 11 is responsible for utility meter (water, gas, electricity and heat meters)
- discussed handling of additional functionality since the beginning of work (2002)
- takes part in the co-ordination group on smart meter standardisation



Guidance on **MID Annex 1, 10.5, indication of result**

...an utility meter shall be fitted with a metrologically controlled display accessible without tools...

The reading of this display is the measurement result that serves as the basis for the price to pay.

If different rates shall be used (smart meters) then

- The customer shall have the opportunity to check the values on a legally controlled display
- Interval metering or registers for different rates shall be used

Role of notified bodies in respect to assessment of interval metering is not fully clarified

- assessment of additional functionality in respect to inadmissible influences is to do and to certify
- Assessment of the correct work of functions itself, the requirements used and the statements in the certificates are still under discussion



Conclusions

- From the view of legal metrology the main issues of smart metering are
 - functionalities which provide values for billing purposes
 - software design (interface, protocols) and evaluation
- Measurement of values used for billing purposes shall be under legal control in order to guarantee the quality of measurements
- Depending on the communication structure different solutions are possible
- Measurement and indication of consumption values based on interval metering or registers for each rate by the utility meter is state of the art and fulfils the requirements of legal metrology
- Advanced technologies (cryptographic secured data sets) may allow to realise a “internet based” display, which provides the same security as local display