Smart metering
- standardization

Mr. Gyozo Kmethy

President, DLMS User Association

Secretary, IEC TC13, Electricity metering

Convenor, CLC TC13 WG02, Smart metering

The M/441 standardization mandate

The European OPEN meter project

IEC – CENELEC TC13

DLMS/COSEM: IEC 62056 / EN 13757

Conclusion

The good thing about standards is that there are so many to choose from.

Dr. Tanenbaum

....and what the M/441 Mandate says

The Competitiveness Council on 25 September 2008 underlined that, in general, lack of standards, or the slow updating of existing standards hamper the uptake of innovation, whilst standardisation that is lively and strong has the power to accelerate the access of innovation to both domestic and global markets.

However, the involvement of many different parties in the absence of harmonisation could result in a multitude of competing technological solutions, which although not fundamentally different, may nonetheless be mutually incompatible thereby fragmenting competition on the internal market. On the other hand, from a competitiveness point of view, Europe could become a market leader should harmonised solutions be developed, hence the need for European standardisation.

The European vision

- Create a European infrastructure for providing energy and related services
  - Electricity and gas market directives
- Standards are needed to create this market

M/441 Standardization Mandate

- Given in 2009 to CEN, CENELEC and ETSI
- Objective: create European standards enabling interoperability of (multi-) utility meters
- Scope: from meters to Head End Systems
  - with interface to Smart Homes and Smart Grids
- Deliverables
  - a) standards for communication
  - b) harmonized solutions for additional functions
- Smart Meter Coordination Group (SM-CG)
  - brings all stakeholders around the table
  - coordinates the activities of Technical Committees
- Status May 2011
  - SM-CG Technical Report on communications for vote July 2011
  - Draft standards are being launched

Cooperation between TCs and SIGs
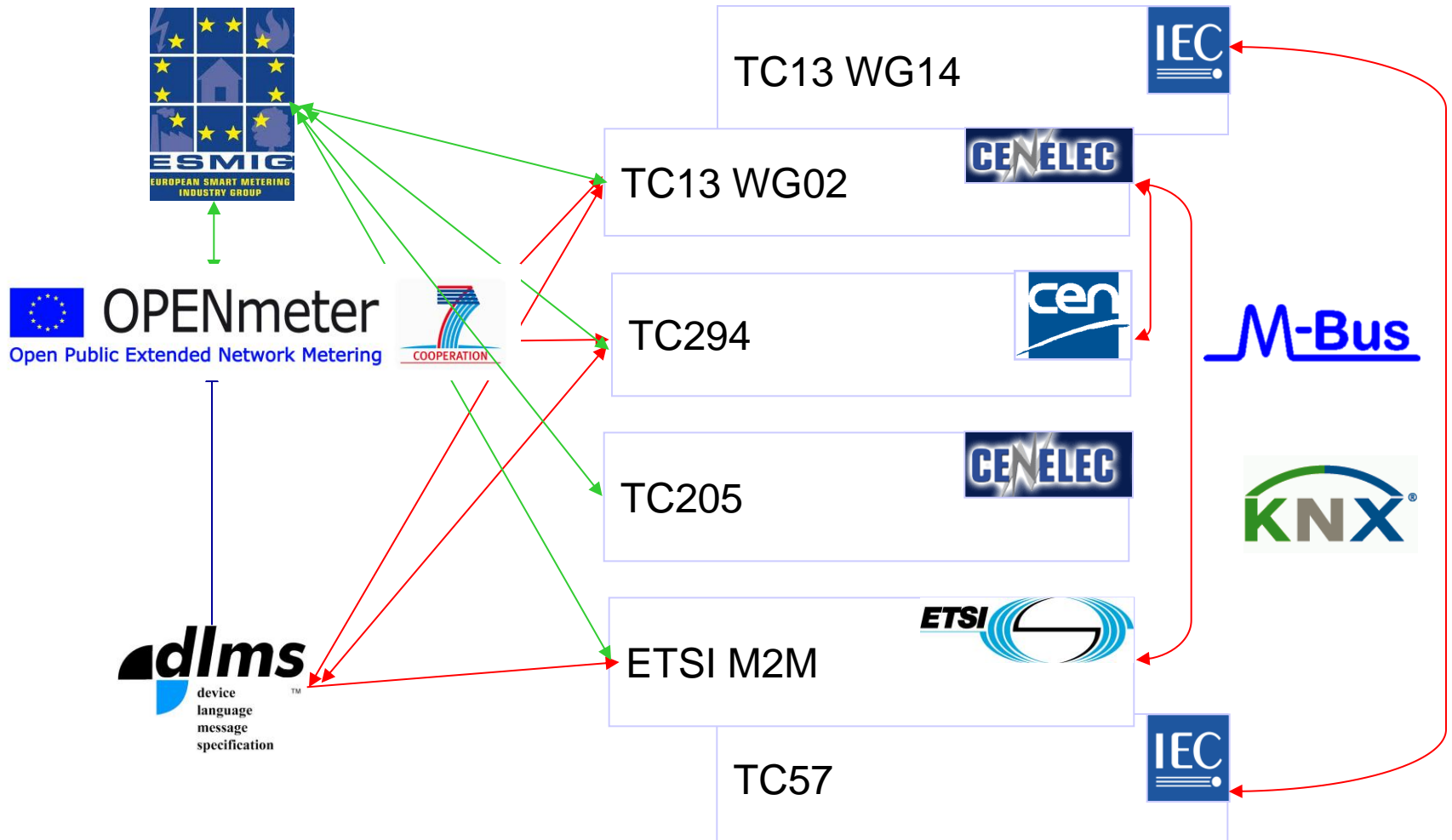
SM-CG Technical Report on communications

- Context of the Mandate M/441 – Energy related Directives
- Relation to smart grids
- Data security and privacy
- High level additional functions
- Functional reference architecture
- Interfaces and functional entities
- Responsibilities of ESO TCs
- List of current and future standards
- Interoperability
- High level use cases
- Glossary

- To be endorsed by CEN, CENELEC and ETSI

- **Anything beyond basic metrology**
  - Those functions are subject to the Measuring Instruments Directive (MID)

- **F.1 Meter reading for billing, export / import**
- **F.2 Two-way comm-s for PQ, tamper, firmware update, customer info**
- **F.3 Prepayment, advanced tariffs**
- **F.4 Remote disablement / enablement / limitation of supply**
- **F.5 Smart meter to export metrological data**
- **F.6 Provide info via web portal / gateway**

SM-CG TR: Functional reference architecture
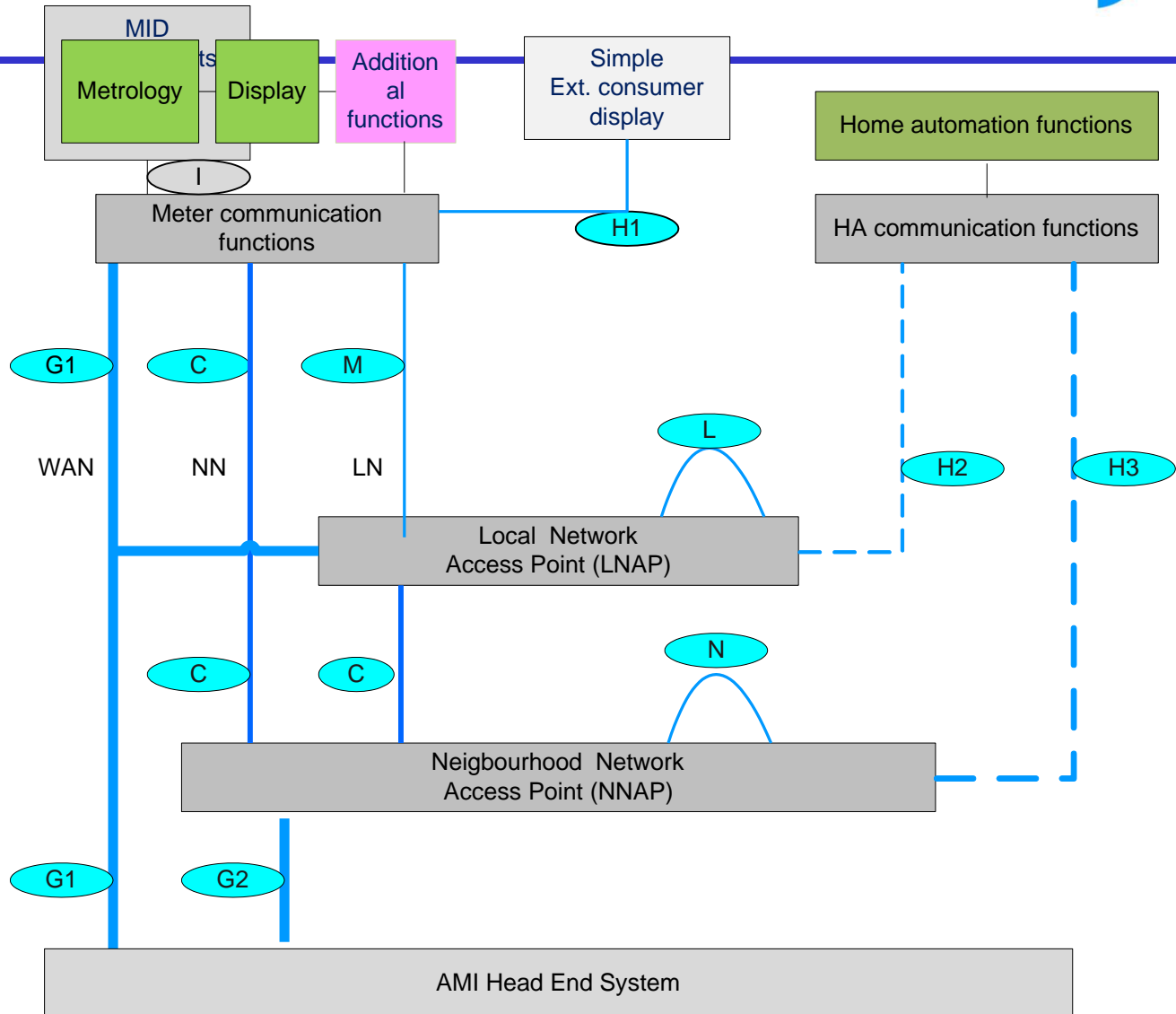
		Metrology impact	Technology types	Lower layer protocol responsibility	Upper layer protocol responsibility	Data model responsibility
I	*Link between MID meter part and meter comms functions*	Yes	*integrated, wired, optical*	*Used by mandate but defined outside*		
M	**Link from Meter comms functions to Local Network Access Point (LNAP)**	No	integrated, wired bus, wireless, PLC, optical	TC 13 / TC 294 /	TC 13 / TC 294	TC 13 / TC 294 /
C	**Link from Meter comms functions / LNAP to Neighbourhood Network Access Point (NNAP)**	No	integrated, wired bus, wireless, PLC	TC 13 / TC 294	TC 13 / TC294	TC 13 / TC294 / TC 57
G1	**Link from Meter comms functions to LNAP / AMI head end system**	No	IP based	ETSI	TC 13 / TC294	TC 13 / TC294
G2	**Link from NNAP to AMI head end system**	No	IP based	ETSI	TC13 / TC294 / ETSI M2M	TC 13 / TC294 / TC57
H1	**Link from Meter comms to support simple external display**	No	wired bus, wireless, PLC, optical	TC 205	TC 205	TC 205
H2 / H3	**Link from LNAP / NNAP to support home automation end device(s)**	No	wireless, PLC, wired bus	TC 205	TC 205	TC 205

SM-CG TR: Use cases

- Describe how actors use the system
  – Written by involving the actors
  – Help capturing requirements
  – Allow identifying gaps in standards
  – Can be used in country projects
- Joint effort of TCs led by SM-CG
  – Initial list in SM-CG TR, coming from actual projects
  – Detailed use cases developed by TCs
  – Will be mapped to functions of the standards
- Detailed specs by end of 2011

User

Smart metering system

User
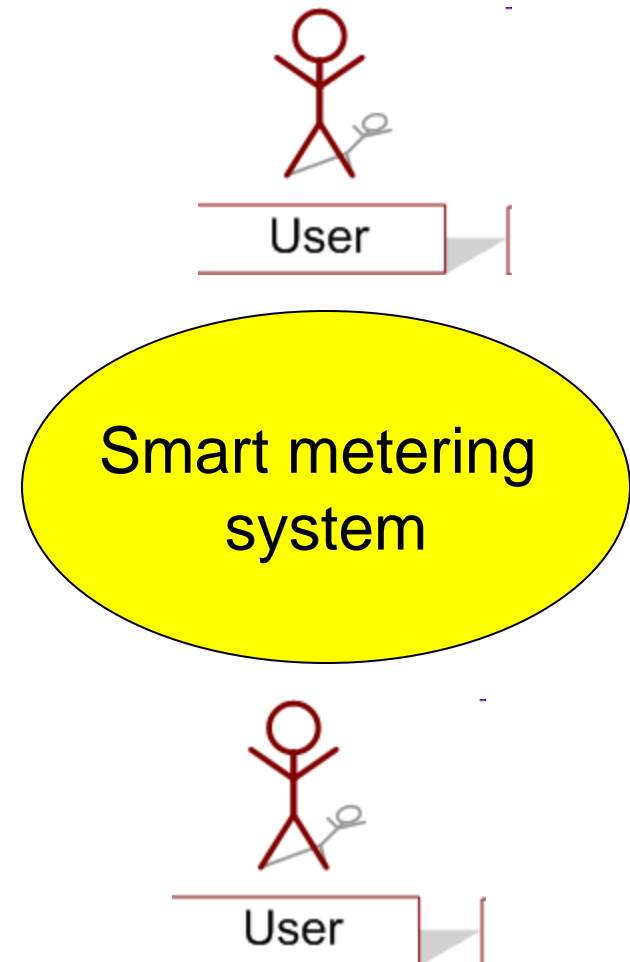
Smart metering and smart grids
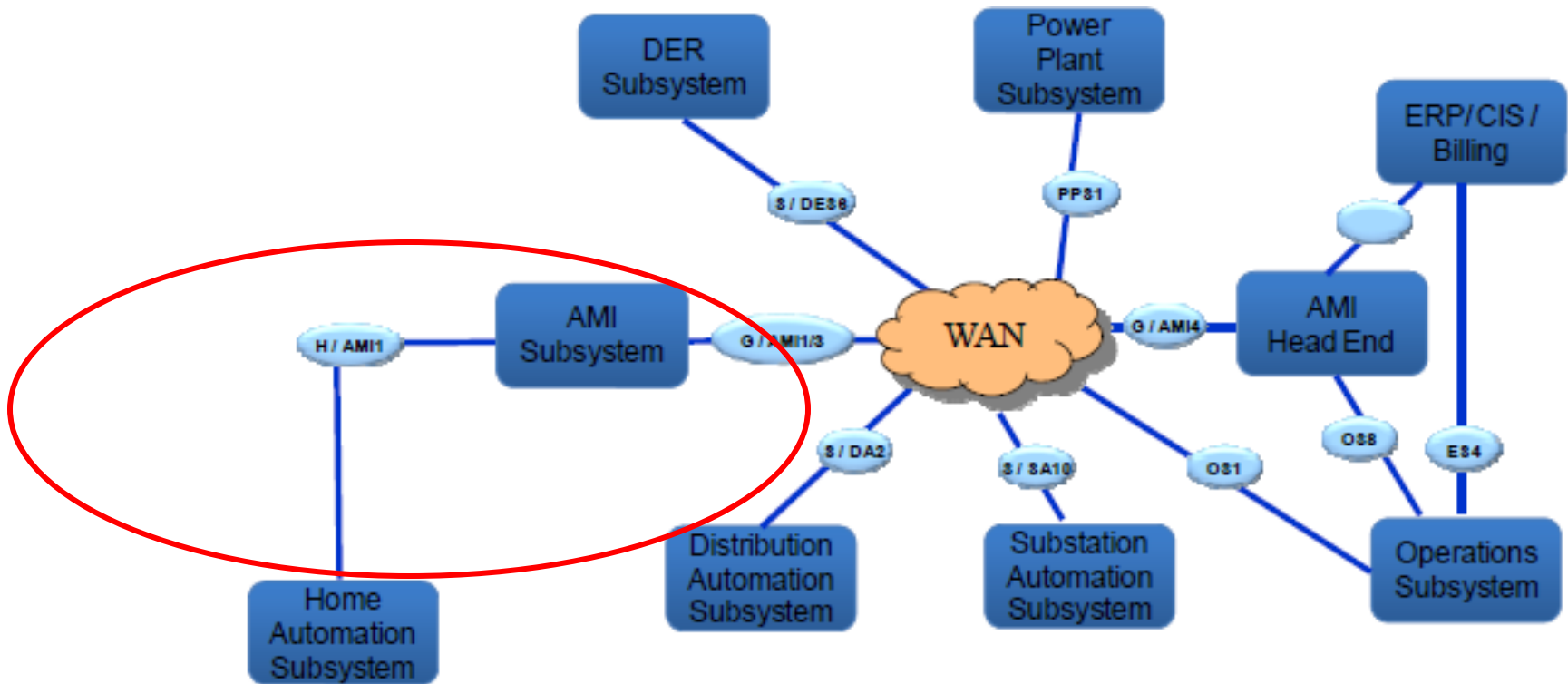
Smart Grid standardization is carried out under the Mandate M/490, issued 1st March 2011

Presentation program

The M/441 standardization mandate

The European OPEN meter project

CENELEC – IEC TC13

IEC 62056 DLMS/COSEM

Conclusion

- European collaborative project in 7th Framework Programme
  - Topic Energy 2008.7.1.1
  - Project Number 226369
- Project duration 30 months: Jan 2009 - June 2011
  - Closing conference 16th June 2011, Brussels
- Project budget: € 4,2 MM, EC funding: € 2,4 MM
- Consortium with 19 participants
- Total effort committed: 339 person-months
- Project co-ordinator:
- Project Technical co-ordinator:
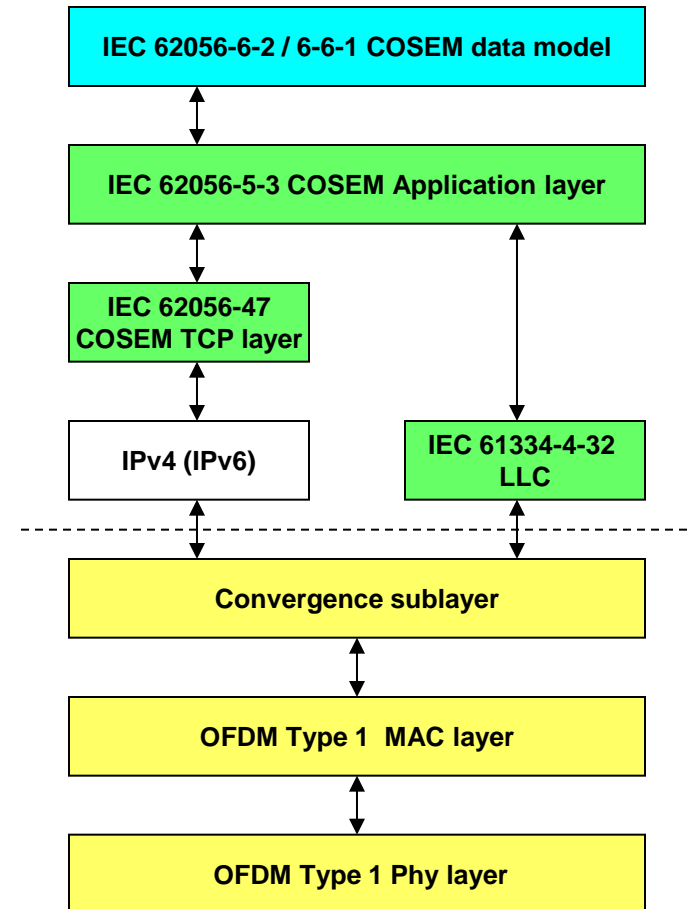- All deliverables available at:
  - http://www.openmeter.com
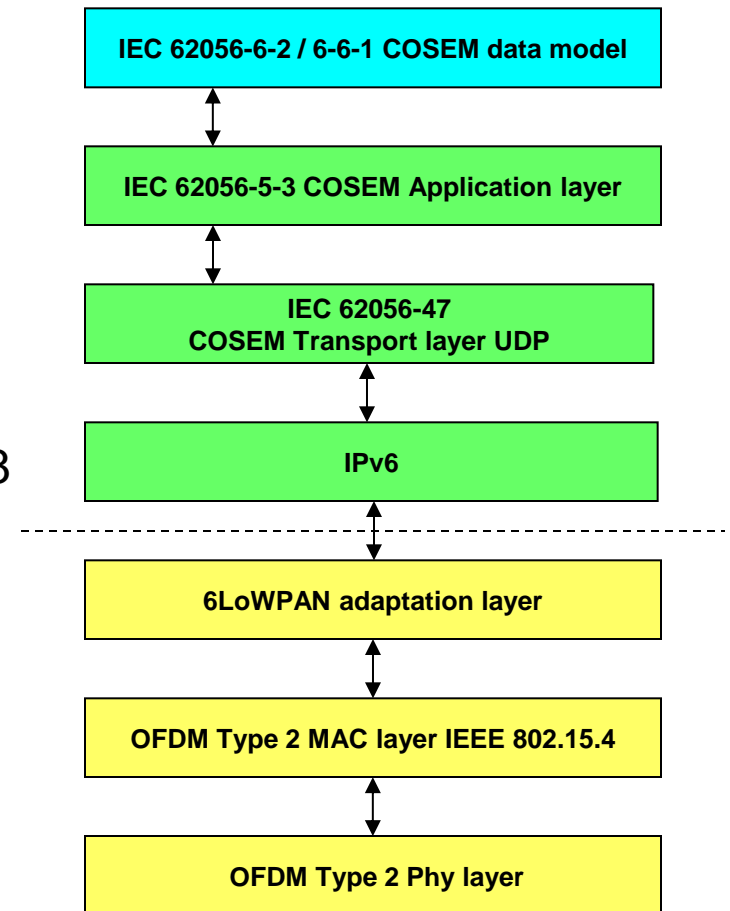
OPEN meter proposal for standards
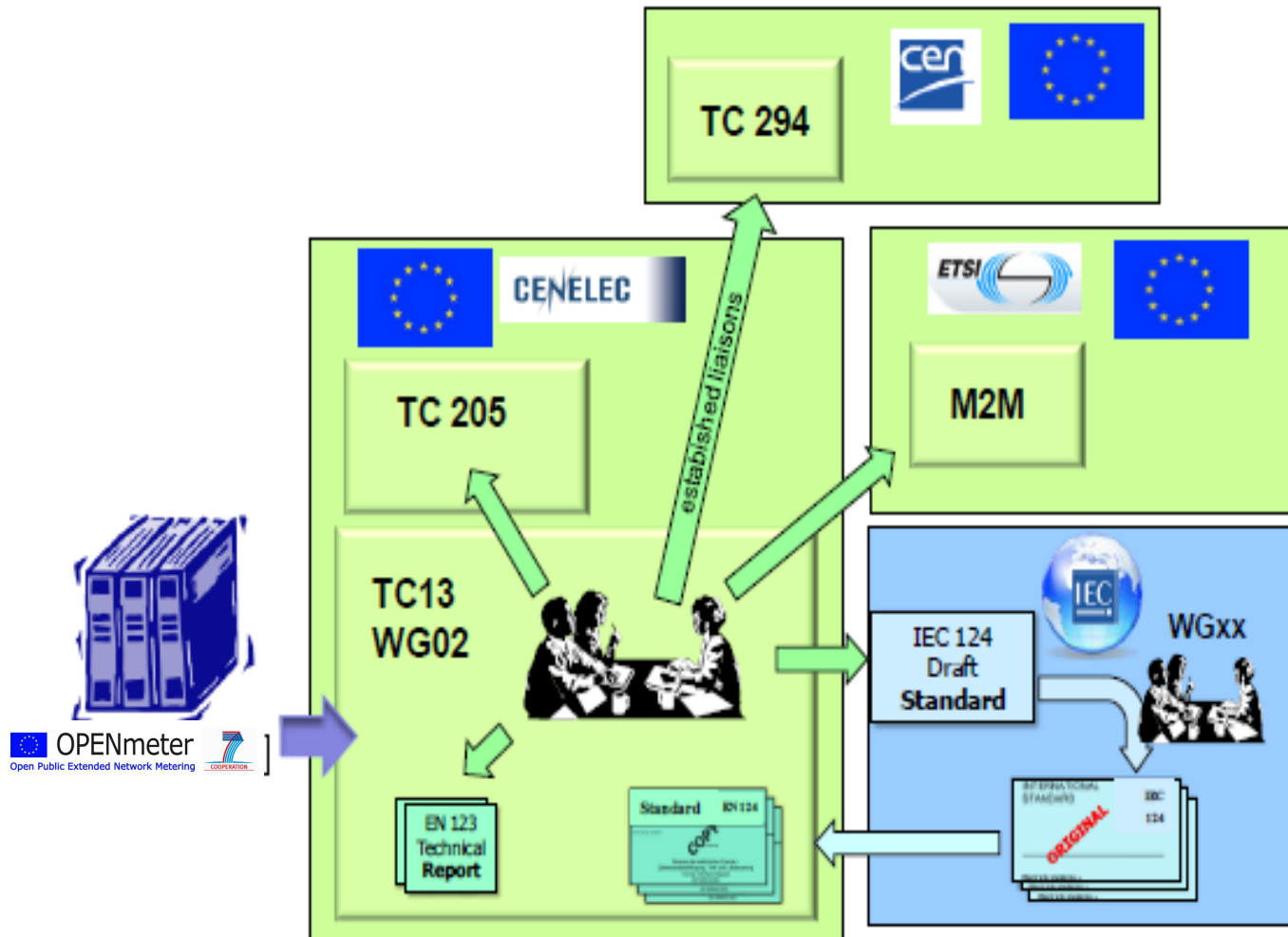
PLC OFDM Type 1 (AKA PRIME) technology

- Phy layer
  - CENELEC A-Band 41,992 to 88,867 kHz
  - robust and high-performance OFDM modulation
  - DBPSK, DQPSK, D8PSK, 21,4 – 128,6 kbps
- MAC layer
  - network self assembly / configuration
  - security: AES-128 encryption ECB
- Convergence layers
  - IEC 61334-4-32 LLC layer or
  - IPv4 network layer TCP transport layer IEC 62056-47
- Application layer and data model DLMS/COSEM IEC 62056
- Technical specifications
  - prEN/TS 5VVVV-1: OFDM Type 1 Phy+MAC
  - prEN/TS 52056-8-4: DLMS/COSEM OFDM Type 1 PLC Profile
  - Circulation of drafts in May 2011
- Rollouts in Spain: 50 k >> 400 k
- Supported by PRIME Alliance

IEC 62056-6-2 / 6-6-1 COSEM data model	
IEC 62056-5-3 COSEM Application layer	
IEC 62056-47 COSEM TCP layer	
IPv4 (IPv6)	IEC 61334-4-32 LLC

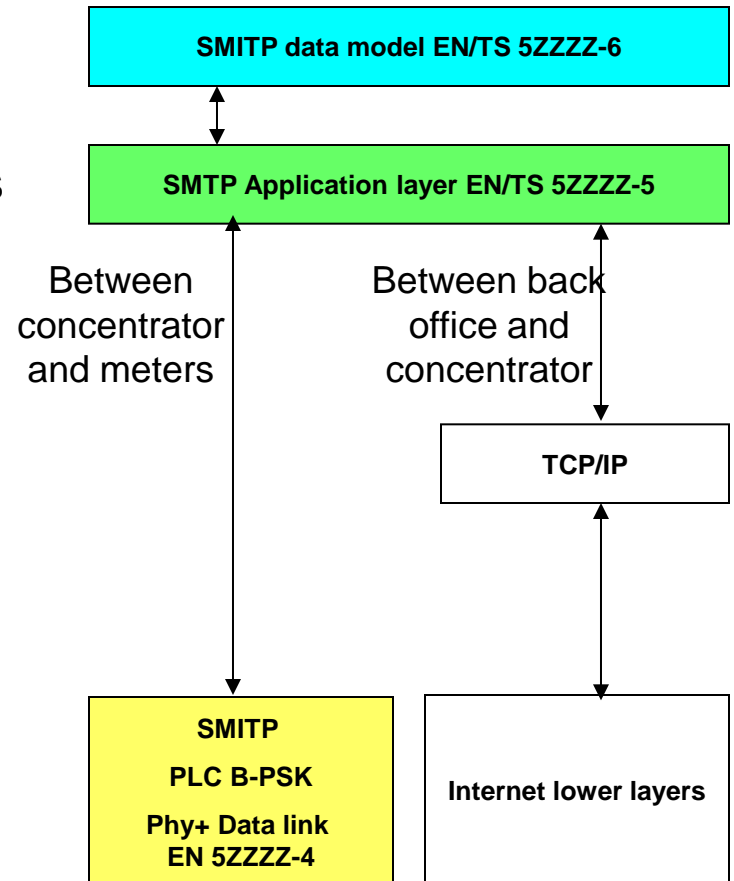| Convergence sublayer |
|---|
| OFDM Type 1 MAC layer |
| OFDM Type 1 Phy layer |

PLC OFDM Type 2 (AKA G3) technology

- Phy layer
  - CENELEC A, B, C and D bands
  - robust and high-performance OFDM modulation, up to 42 kbps in A-band
  - can pass MV/LV transformer (robust mode)
  - frequency notching for S-FSK co-habitation
- MAC layer based on IEEE 802.15.4
- Adaptation sublayer 6LoWPAN
- MAC and 6loWPAN layer security AES-128
- Technical specifications
  - prEN/TS 5VVVV-2: PLC OFDM Type 2 Phy+MAC
  - prEN/TS 52056-8-5: DLMS/COSEM PLC OFDM Type 2 Profile
  - Circulation of drafts in May 2011
- Trials by ERDF

| IEC 62056-6-2 / 6-6-1 COSEM data model |
| IEC 62056-5-3 COSEM Application layer |
| IEC 62056-47 COSEM Transport layer UDP |
| IPv6 |
| 6LoWPAN adaptation layer |
| OFDM Type 2 MAC layer IEEE 802.15.4 |
| OFDM Type 2 Phy layer |

SMITP (AKA Meters&More) technology

- Phy layer using B-PSK, 9 600 bps max
- LLC layer based on IEC 61334-4-32
- Application layer to read and write tables and to execute commands
- Table-based data model supports electricity metering
  - Standard tables
  - Custom tables for flexibility
- Data security: encryption and authentication AES-128
- Technical Specifications
  - EN/TS 5ZZZZ series
  - Circulation of drafts in May 2011
- Stems from Italian Telegestore project
- Supported by Meters&More Association
- Deployed un Spain / Endesa

| SMITP data model EN/TS 5ZZZZ-6 |
| SMTP Application layer EN/TS 5ZZZZ-5 |

Between concentrator and meters

Between back office and concentrator

| TCP/IP |

| SMITP PLC B-PSK Phy+ Data link EN 5ZZZZ-4 | Internet lower layers |

Presentation program

The M/441 standardization mandate
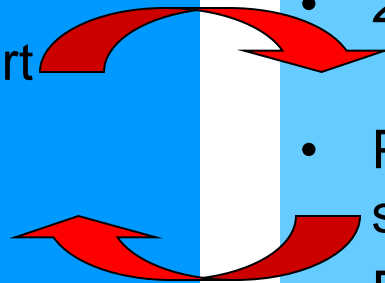
The European OPEN meter project

CENELEC – IEC TC13

IEC 62056 DLMS/COSEM

Conclusion

IEC TC 13 WG14 / CLC TC13 WG02

- IEC TC13 WG14
  - Global responsibility for meter data exchange
  - Main standard IEC 62056 DLMS/COSEM
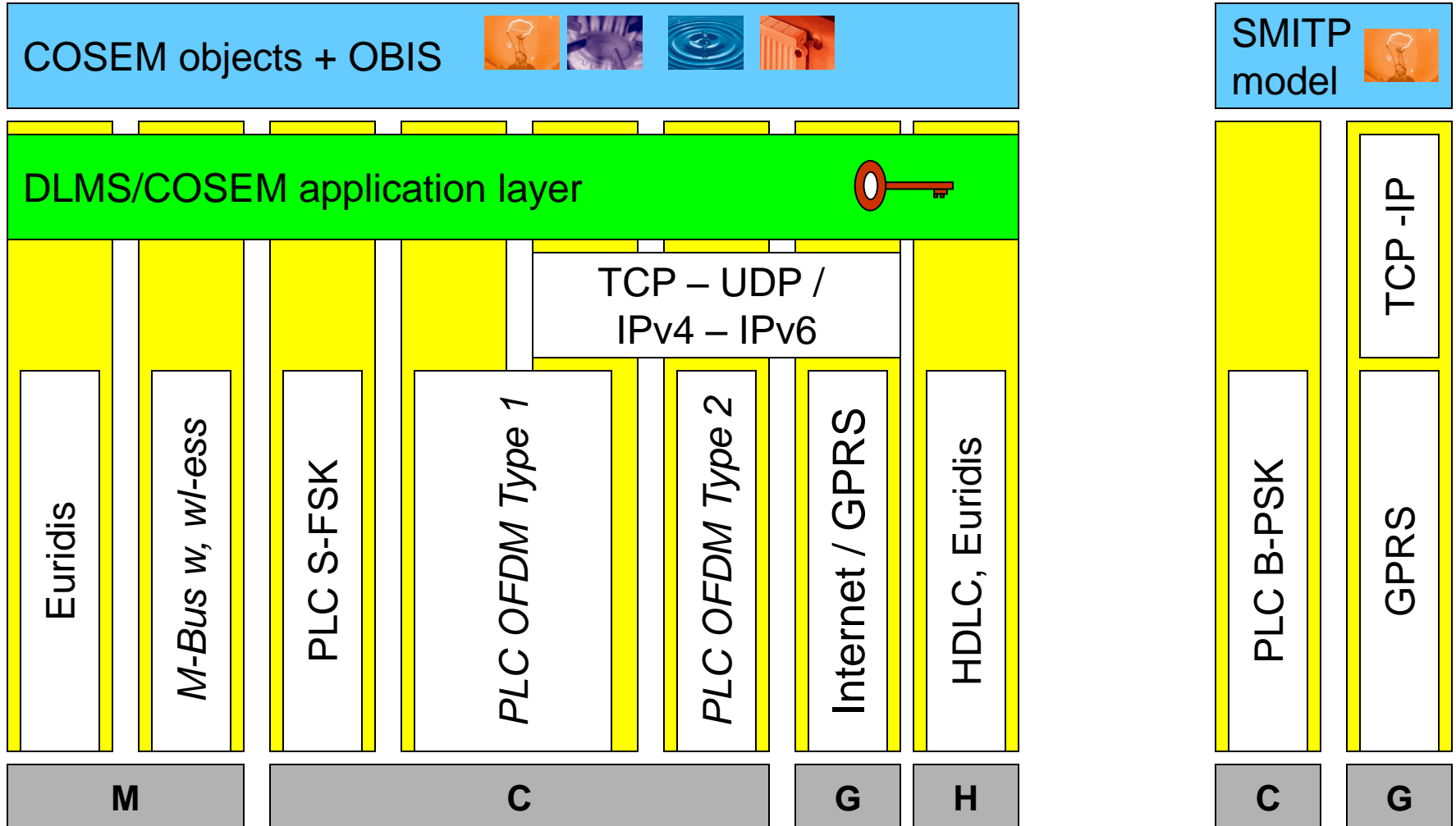- Extends corpus of smart metering standards

- CLC TC13 WG02
  - Established in March 2010
  - Carries out M/441 mandate specific work
- 25 experts from 14 countries
  - 3 meetings per year
- Prepares technical specifications
- Proposes standardization to IEC TC13
- Adopts IEC standards as EN standards

Standardization program

dlms

	prTR 5XXXX: Smart metering standardization framework		EN/TR 5ZZZZ-1: Mapping use cases to the SMITP data model
General	prTR 5YYYY: Smart metering use cases and functions		
	EN 62056-1-0 Electricity metering data exchange – The DLMS/COSEM suite - Standardisation framework		
	EN/TR 52056-1-1: Mapping use cases and functions to the COSEM data model		

		M	C	G1	G2	H1	H1, H2	G1		C	G2

Data model: EN 62056-6-1 OBIS, EN 62056-6-2 COSEM interface classes — Electricity – Gas – Water – Heat

EN/TS 5ZZZZ-6 Electricity meter data base and data structures

Communication profiles:

EN 62056-21 Direct local data exchange

- *EN 62056-7-1 Comm. profile for twisted pair with carrier signalling*
- *EN 52056-7-2 The wired M-Bus profile*
- *EN 52056-7-3 The wireless M-Bus profile*
- *EN 62056-8-3 The PLC S-FSK profile*
- *EN/TS 52056-8-4 The PLC OFDM Type 1 profile*
- *EN/TS 52056-8-5 The PLC OFDM Type 2 profile*
- *EN 62056-9-7 The TCP-UDP/IP profile*
- *DLMS/COSEM The G2 IF profile under consideration*
- *EN 62056-7-6 The 3-layer CO HDLC profile*
- *EN 62056-7-2 Customer interface using TP with carrier signalling*
- *EN 62052-9-8 The SML profile*

EN/TS 5ZZZZ-2 Local data exchange opto — *EN/TS 5ZZZZ-8 The PLC B-PSK profile* — *EN/TS 5ZZZZ-9 The public IP networks profile*

Upper layers:

EN 62056-5-3 DLMS/COSEM application layer
+ EN 61334-4-511 CIASE

EN 62056-5-8 SML container services

EN/TS 5ZZZZ-5 Application layer

- EN 62056-3-1 Use of LANs on twisted pair with carrier signalling
- EN 13757-3 M-Bus application layer (used as a wrapper)
- EN 62056-46 CO HDLC data link layer
- EN 61334-4-32 LLC layer
- EN 62056-4-7 COSEM transport layer TCP-UDP/ IPv4 – IPv6
- EN 62056-46 CO HDLC data link layer

EN/TS 5ZZZZ-4 PLC B-PSK Phy + MAC + LLC — TCP/IPv4

Lower layers:

- EN 13757-2 wired M-Bus Phy + MAC
- EN 13757-4 wireless M-Bus Phy + MAC
- EN 61334-5-1 The S-FSK profile Phy + MAC
- *EN/TS 5VVVV-1 OFDM Type 1 „PRIME" Phy + MAC + Conv*
- *EN/TS 5VVVV-2 OFDM Type 2 „G3" Phy + MAC + Adapt*
- *GPRS / Ethernet lower layers*
- EN 62056-42 Phy layer
- GPRS / Ethernet lower layers

EN 62056 / EN 52056 / EN 13757-1 DLMS/COSEM suite
EN 62056 established by IEC TC13. EN 52056 established by CENELEC TC13. EN 13757 established by CEN TC294.

EN 5ZZZZ SMITP „Meters&More" suite

Standardisation program

dlms

COSEM objects + OBIS

SMITP model

DLMS/COSEM application layer

			TCP – UDP / IPv4 – IPv6						TCP -IP
Euridis	*M-Bus w, wl-ess*	PLC S-FSK	*PLC OFDM Type 1*	*PLC OFDM Type 2*	Internet / GPRS	HDLC, Euridis		PLC B-PSK	GPRS
M		**C**			**G**	**H**		**C**	**G**

Presentation program

The M/441 standardization mandate

The European OPEN meter project

CENELEC – IEC TC13

IEC 62056 DLMS/COSEM

Conclusion

DLMS/COSEM basics

Standard for multi-utility, multi-media meter data exchange for all application segments
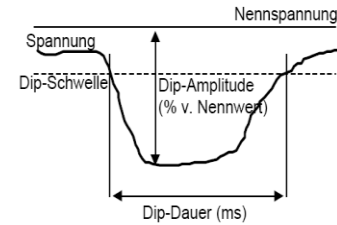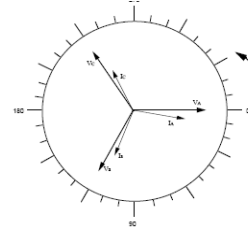
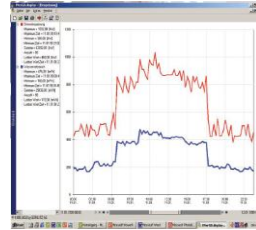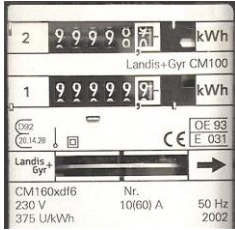50+ manufacturers have 175+ meter types certified

IEC 62056 / EN 13757-1

Chinese and Indian standard

Millions of meters installed, major smart metering project

Interoperability by common "language"
>> common data model

DLMS User Association 200+ members worldwide, 1/3 in Asia
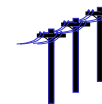
DLMS/COSEM scope

All energy types

A host of applications
– pace of change relatively slow, but
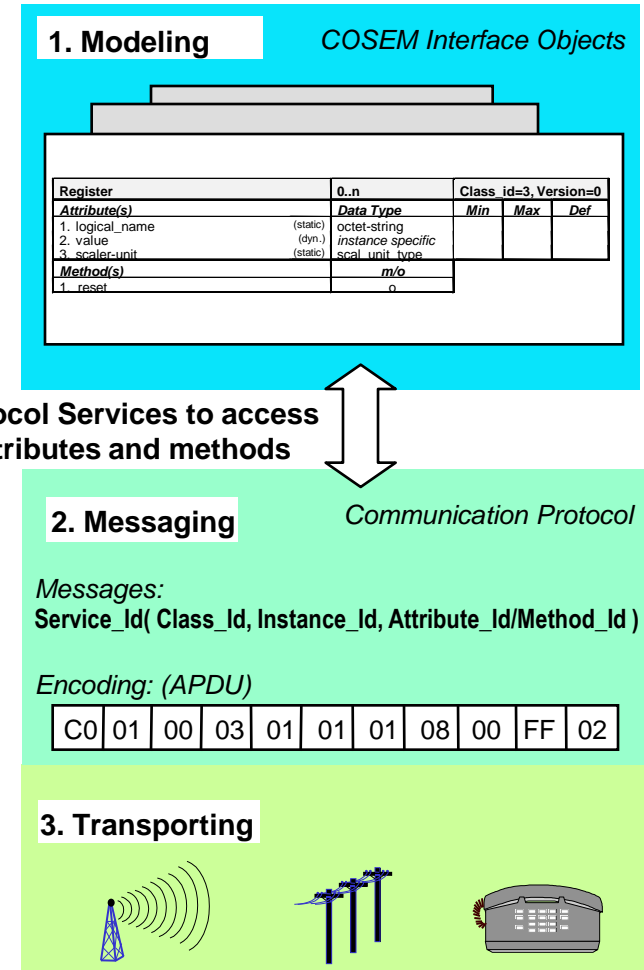differences in requirements

All market segments

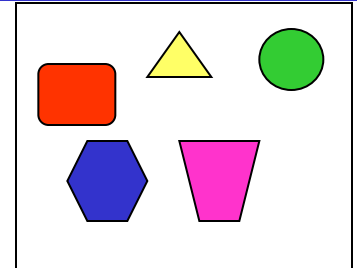Multiple media
- pace of change very fast

The 3 step approach

- *Data model*, to view the meter functionality at its interface(s)
  - *COSEM objects*
  - *OBIS Identification system*
- *Messaging* method to communicate with the model and to represent data as a series of bytes (APDUs)
- *Transportation* method to carry the messages between the metering equipment and the data collection system

Separation of application model and protocol: "orthogonality"

1. Modeling — *COSEM Interface Objects*

Register		0..n	Class_id=3, Version=0		
Attribute(s)		*Data Type*	*Min*	*Max*	*Def*
1. logical_name	(static)	octet-string			
2. value	(dyn.)	instance specific			
3. scaler-unit	(static)	scal_unit_type			
Method(s)		*m/o*			
1. reset		o			

Protocol Services to access attributes and methods

2. Messaging — *Communication Protocol*

Messages:
Service_Id(Class_Id, Instance_Id, Attribute_Id/Method_Id)

Encoding: (APDU)

C0	01	00	03	01	01	01	08	00	FF	02

3. Transporting

Modelling the application: COSEM objects

dlms

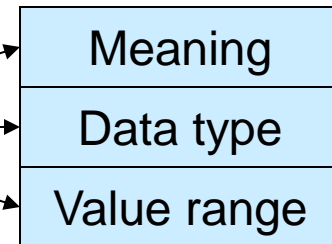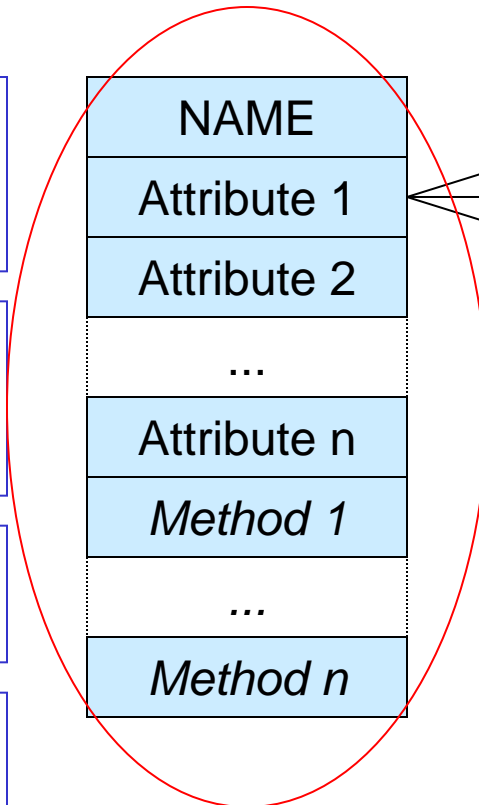The NAME attribute identifies the data

Any real-world things can be described by some *attributes*

Each attribute has a *meaning*, a *data type* and a *value range*

Methods allow performing operations on attributes

Attributes and methods constitute an *object*

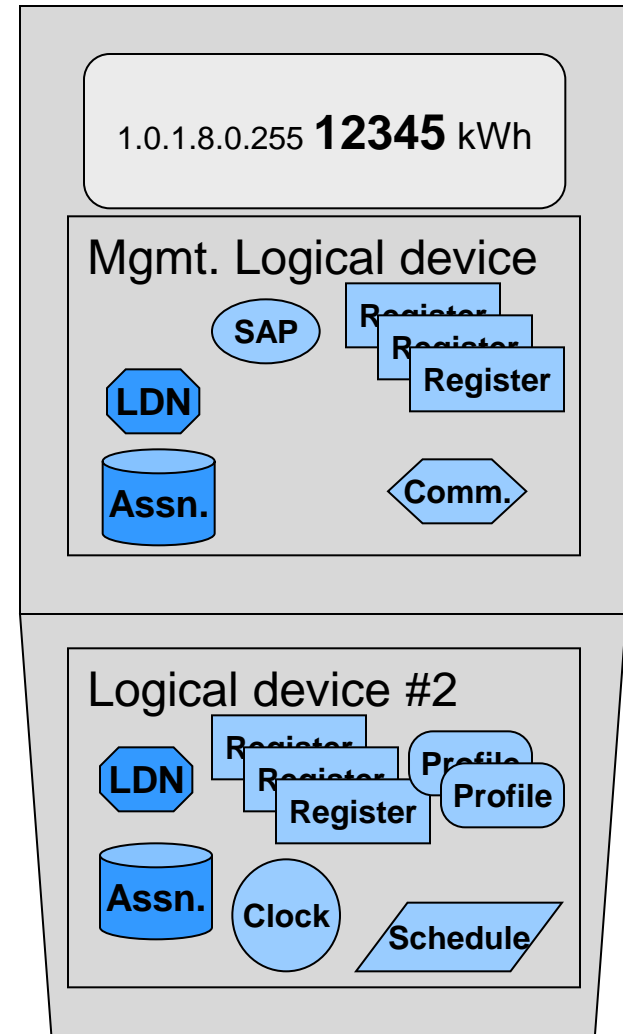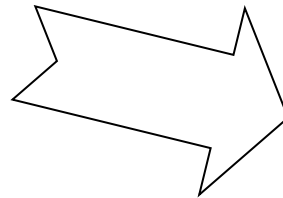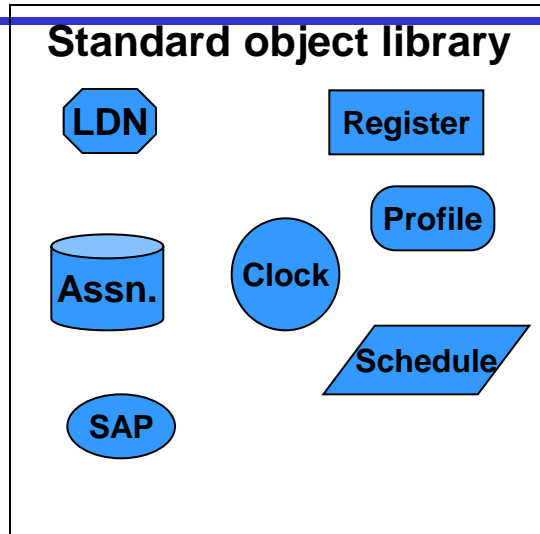| NAME |
| Attribute 1 |
| Attribute 2 |
| ... |
| Attribute n |
| *Method 1* |
| *...* |
| *Method n* |

| Meaning |
| Data type |
| Value range |

Using the object means:

...to read or write the attributes

...to invoke the methods

Flexibility: Tailor made meters from standard blocks

Standard object library

LDN · Register · Profile · Clock · Assn. · Schedule · SAP

1.0.1.8.0.255 **12345** kWh

Mgmt. Logical device

SAP · Register · Register · Register · LDN · Assn. · Comm.

Logical device #2

LDN · Register · Register · Register · Profile · Profile · Assn. · Clock · Schedule

- Standard building blocks to build simple or complex meters
- Mandatory objects: 2
  - Logical Device Name, Association
- Residential meters: few 10 objects
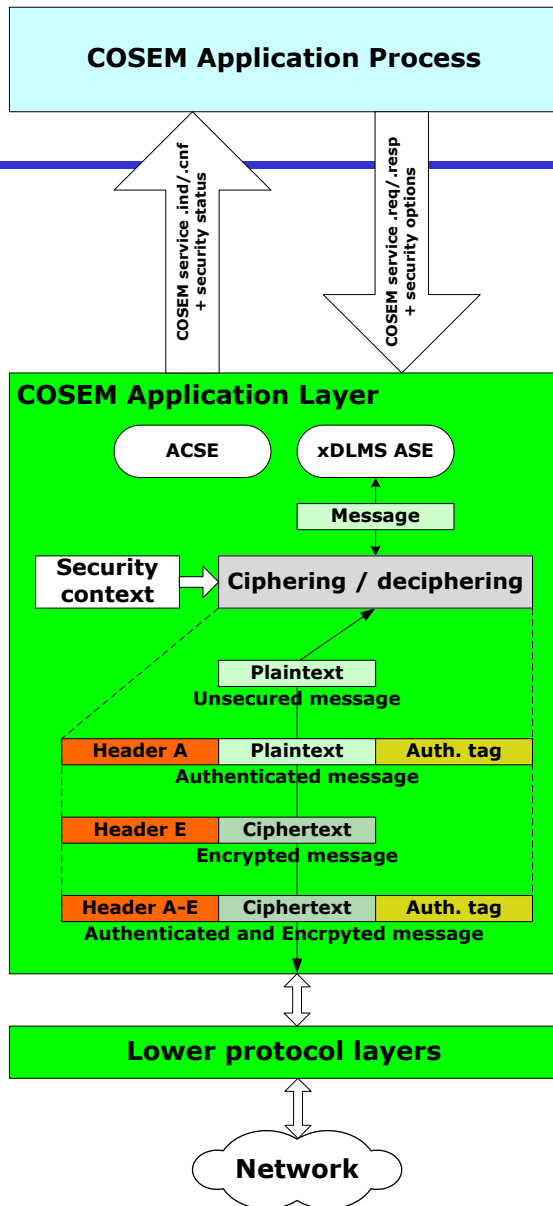- Industrial meters: few 100 objects

Data access security

Metering Asia Indonesia, Bali
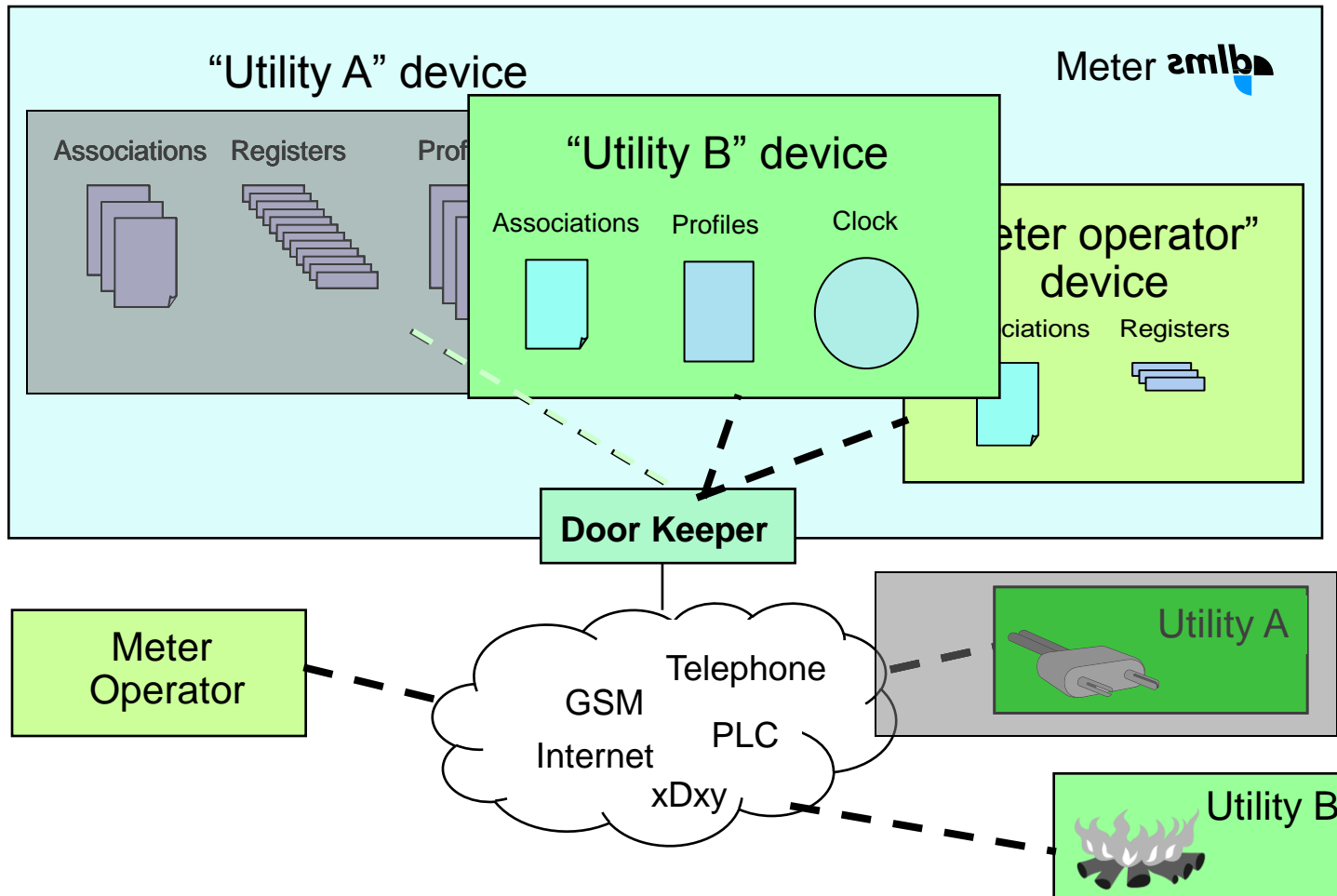
Data security *and* privacy

- Key requirements identified by OPEN meter project
  - Identification and authentication
  - Access control: role based access
  - Protection of data stored, including firmware
    - Integrity and confidentiality
  - Protection of data transported
    - Authentication, Encryption, Digital signatures
    - Anti-replay mechanisms
- The DLMS UA works together with Dutch security experts
  - DLMS/COSEM will be assessed by third party
  - Initiated by Netbeheeer / The Netherlands
- New asymmetric key algorithms have to be added
  - needed for digital signature, key management
  - problems with IP rights (using ECC) must be overcome

COSEM Application Process

COSEM service .ind /.cnf + security status

COSEM service .req/ .resp + security options

COSEM Application Layer

ACSE

xDLMS ASE

Message

Security context

Ciphering / deciphering

Plaintext
Unsecured message

| Header A | Plaintext | Auth. tag |
Authenticated message

| Header E | Ciphertext |
Encrypted message

| Header A-E | Ciphertext | Auth. tag |
Authenticated and Encrpyted message
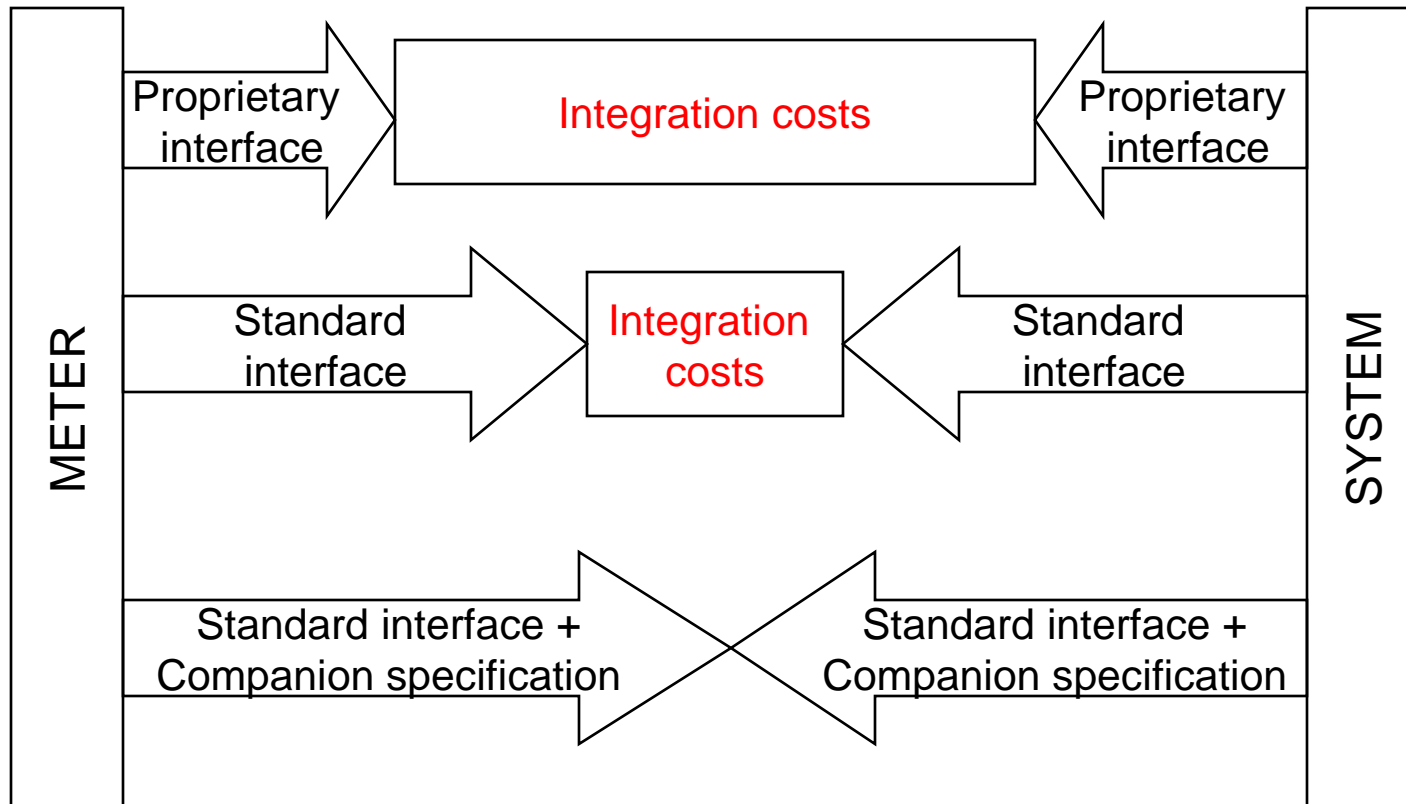
Lower protocol layers

Network

- Cryptographic protection can be applied to APDUs

  - Symmetric key algorithm: Advanced Encryption Standard (AES), 128 bit key, Galois/Counter Mode (NIST SP 800-38D)

    - plain message or

    - authentication for integrity and/or

    - encryption for confidentiality

    - or both authentication and encryption

- AES Key wrapping for key transport

Interoperability

- **Open, complete, unambiguous specification**
- **Semantically clear data model, covering all use cases**
- **Self description of capabilities**
- **Companion specifications**
  - General or by project
- **Conformance testing and certification**
- **Interoperability testing**

Closing the gap with companion specifications

METER

Proprietary interface → Integration costs ← Proprietary interface

Standard interface → Integration costs ← Standard interface

Standard interface + Companion specification → ← Standard interface + Companion specification

SYSTEM

# Companion spec. example - The IDIS project

- Initiated by Iskraemeco, Itron and Landis+Gyr
    - learning from Dutch, French, Spanish projects
- Objective: create a market for standard functionality meters
- Commitment to produce IDIS meters
- Companion specification to IEC 62056 DLMS/COSEM
    - selections made: nothing modified, nothing added
    - DLMS UA will approve it
- IDIS interoperability test
    - IDIS meters pass DLMS conformance test
- Publicly available, anybody can make IDIS meters
- http://idis-association.com/


Interoperability for a secure future

IDIS: Use cases supported in release 1

- UC1 Meter registration
- UC2 Remote tariff programming
- UC 3 Meter reading (on demand)
- UC4 Meter reading (for billing)
- UC5 Disconnection – Reconnection E, G
- UC 6 Clock synchronization
- UC7 Quality of supply
- UC8 Load management by relay (E)
- UC9 FW update
- UC 10 Meter supervision (E meters)

The DLMS User Association
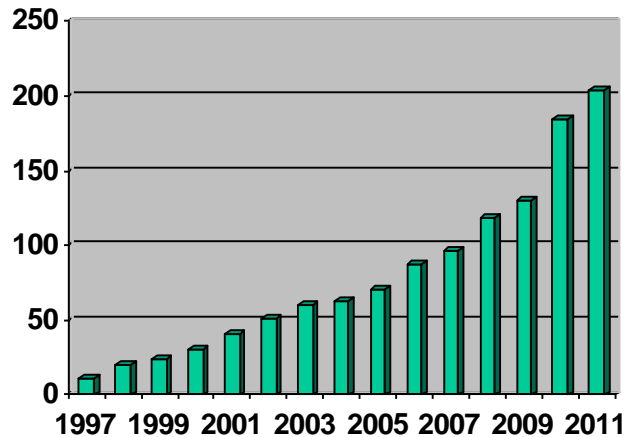
- Formed in 1997

- 200+ members (May 2011)

- 5 continents – 40+ countries

- from all branches of the industry

- 175+ Product Certificates
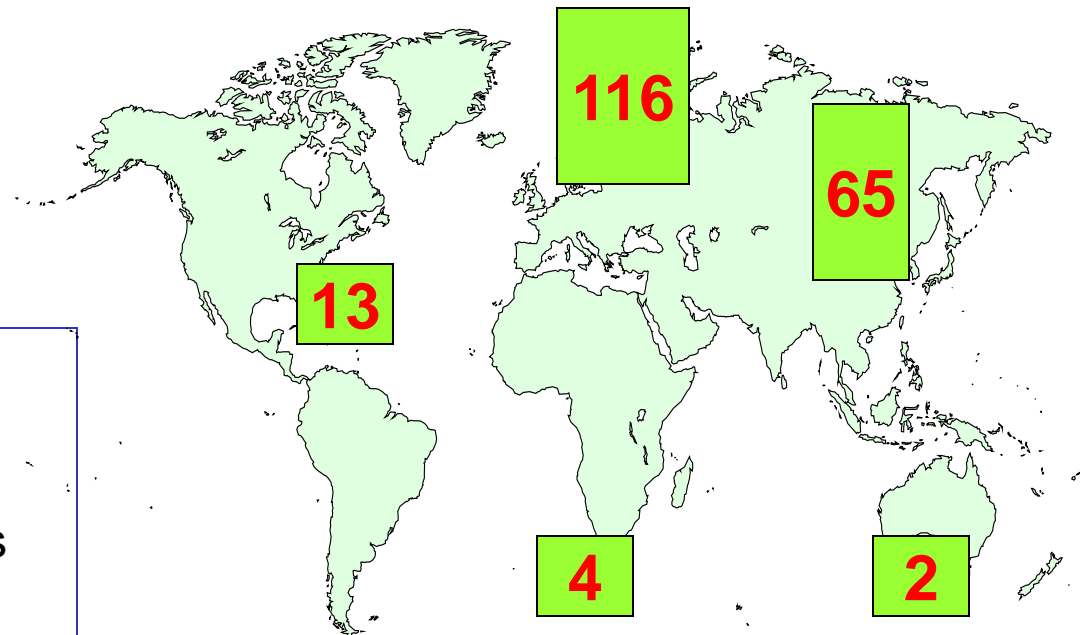
DLMS UA services

- Specification maintenance and development
- Registration of IEC 62056 standard elements
- Training (Seminar for 39 participants on 11/05/09)
- Conformance certification
- Public forum

Modelling of payment metering

- **Important feature of smart metering systems**
- Project team set up to define the objects
  - work is based on IEC 62055-21
  - members from France, Slovenia, South-Africa, Switzerland, UK
- Results expected June 2011

Presentation program

The M/441 standardization mandate

The European OPEN meter project

CENELEC – IEC TC13

IEC 62056 DLMS/COSEM

Conclusion

Conclusion: Standardization is entry ticket to business

- **Many offers – should we standardize all?**
- **A selection must be made:**
  - Openness: depth of specification
  - Fit architecture: interfaces, media
  - Fit use cases: richness of data model, extendibility
  - Performance: data organization, encoding, efficiency
  - Interoperability: object modelling, self description, negotiation of features, conformance testing, certification
  - Access / Transport security: Trusted security algorithms
  - Level of adoption: projects, implementors, chips
  - Support: User Associations, user support, training

Many thanks for your attention!

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