Interoperability Challenges in AMI

Indian Context

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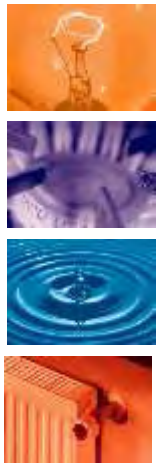
Agenda

- Background Information
  - Communication Standards – Data Model and protocol services, Layering
  - Interoperability and Interchangeability
  - Smart Grid Network Topology
- Interoperability Challenges
- Q&A

The DLMS/COSEM standards

Kalkitech intelligent energy systems



COSEM interface object model
OBIS identification system

Class name		Cardinality
Attribute(s)		***Data Type***
1. logical_name	(static)	octet-string
2. …..	(..)	…..
3. …….	(..)	…..
Specific Method(s) (if required)		***m/o***
1. …..		…..
2. …..		…..

- Data
- Tariff functions
- Access control
- Comm. setup

PROTOCOL

COSEM application layer

- Connection
- **DLMS** Messaging

TECHNICAL REPORT
Companion Specification for Energy Metering
COSEM
Identification System and Interface Objects
DLMS User Association

TECHNICAL REPORT
Companion Specification for Energy Metering
COSEM
Three Layer Connection Oriented Architecture
DLMS User Association

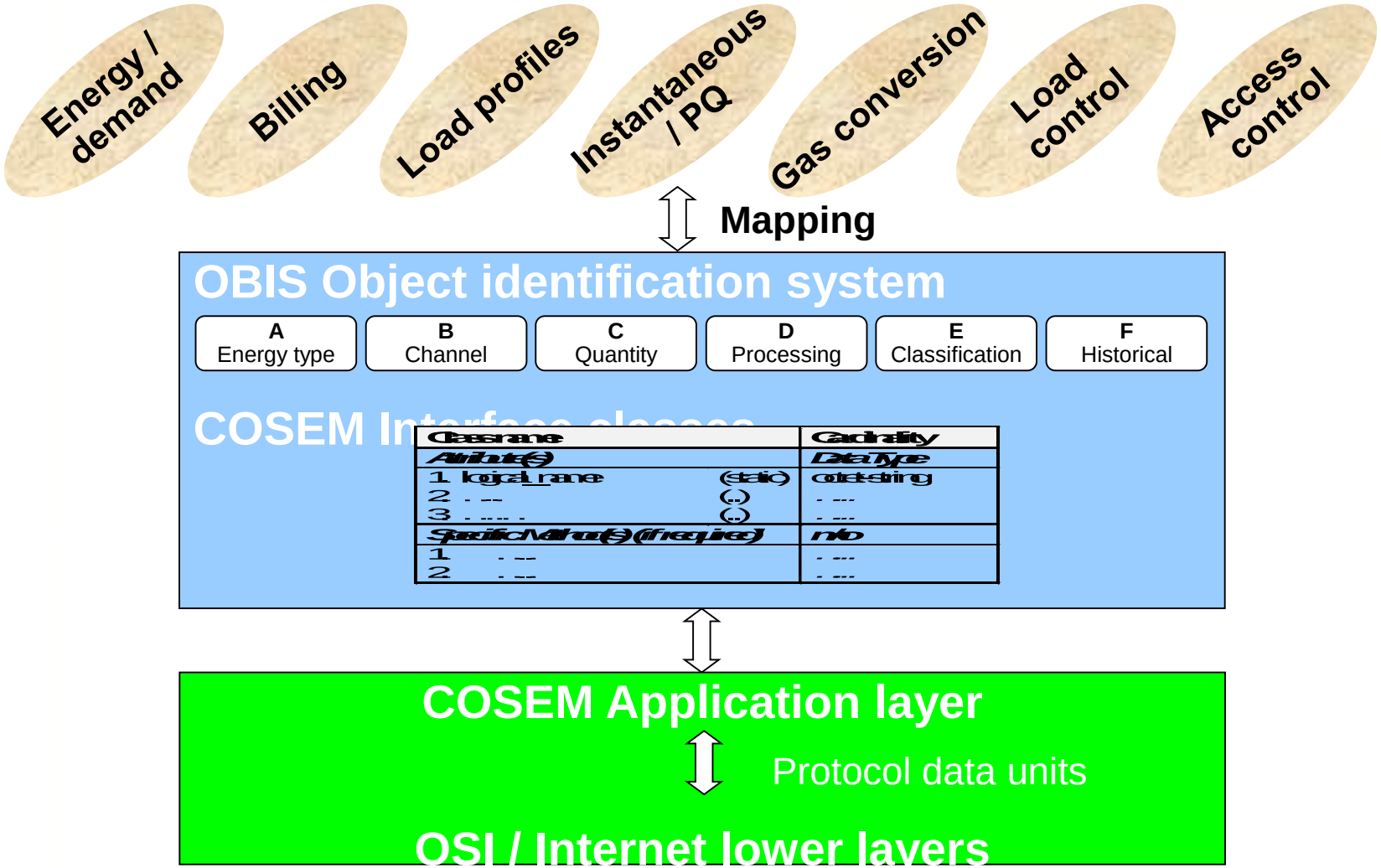
TECHNICAL REPORT
Companion Specification for Energy Metering
COSEM
Conformance Test Tool - Specification
DLMS User Association

IEC
62056
-61
-62

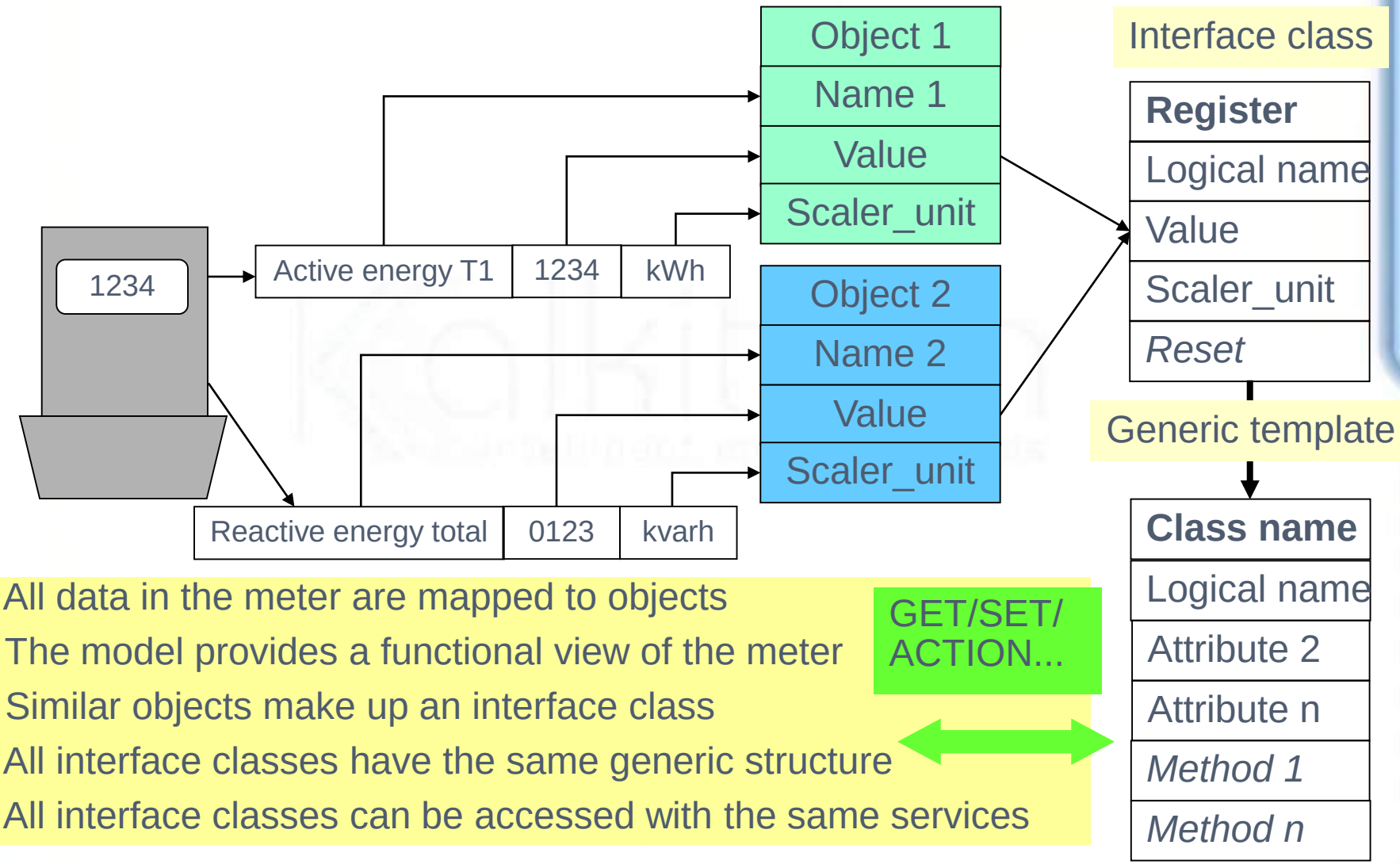
-42
-46
-47
-53

EN
13757
Part1

Application – Model - Protocol



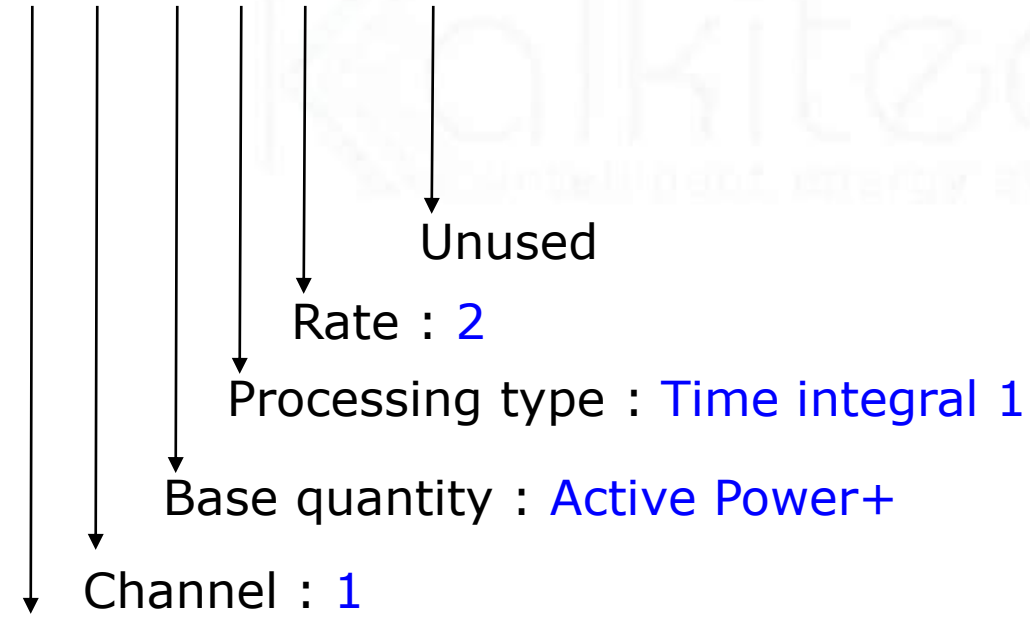
Data Modeling



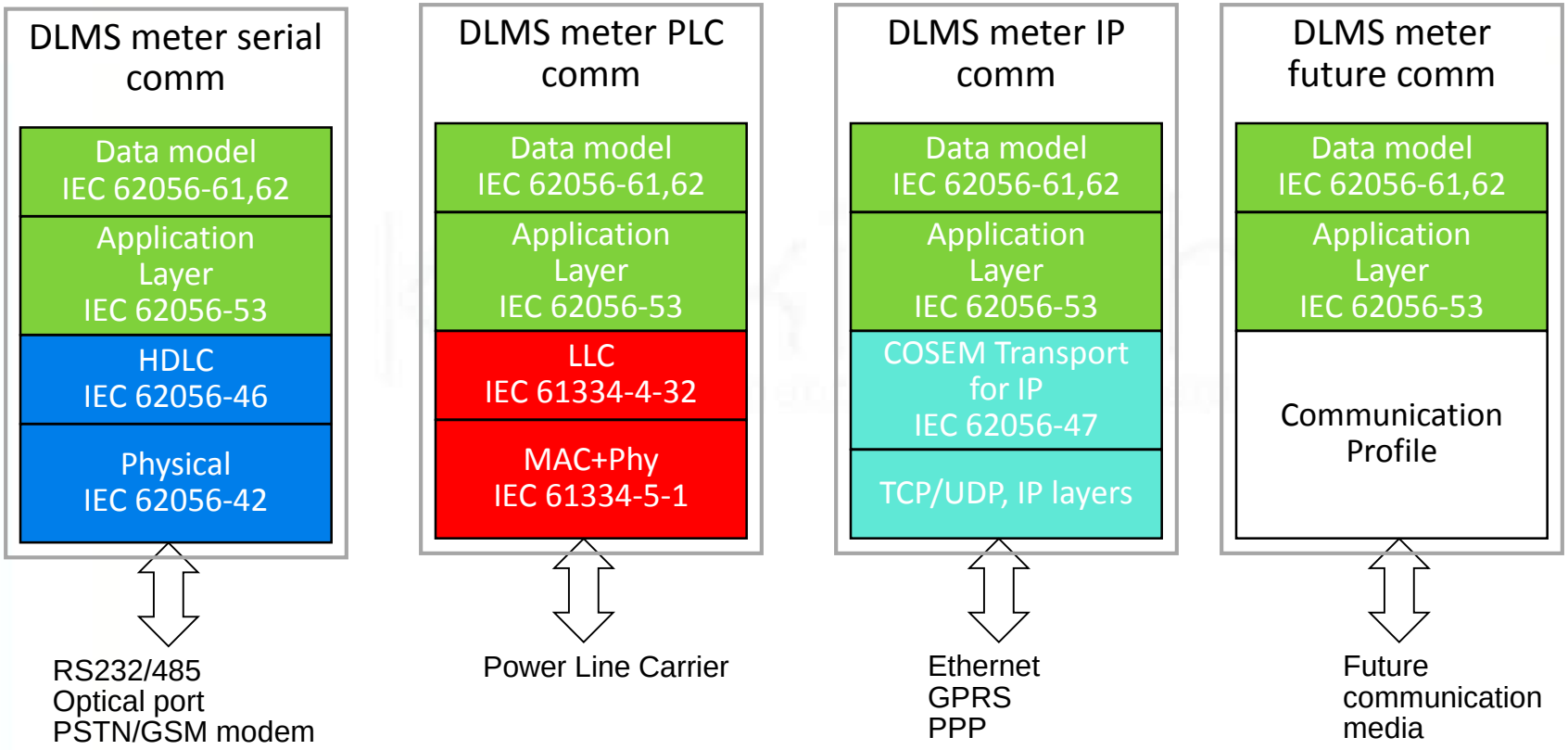
- All data in the meter are mapped to objects
- The model provides a functional view of the meter
- Similar objects make up an interface class
- All interface classes have the same generic structure
- All interface classes can be accessed with the same services

Object Naming - OBIS Codes

- Electrical ***ΣLi*** active energy import, rate 2, current billing period
- 1.1.1.8.2.255



Protocol Layering



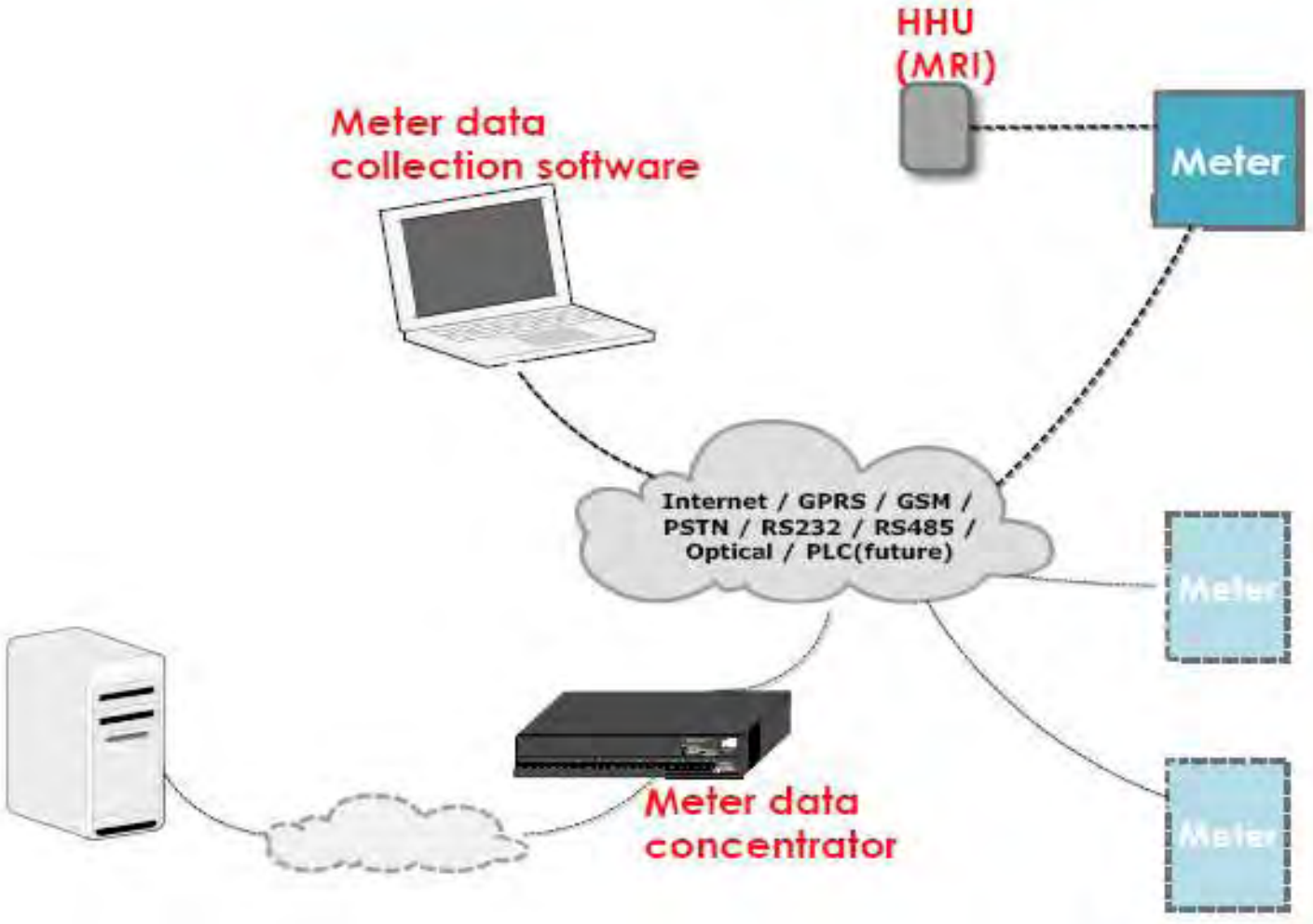
Interoperability Vs. Interchangeability

- Open Standards like DLMS/COSEM already provide for Interoperability due to
  - Standard data models
  - Standard services
  - Unambiguous data naming
- However since DLMS/COSEM has to cater to a global scale it often supports multiple options for the same features – flexibility of models and services
- This can hinder Interchangeability – hence the role for Companion Specifications

Role of Companion Specification

Roles	IS-15959 Examples
Lists of elements, features or functions required	Object-lists, required Interface Classes and Services
Choices to be taken where the international standard offers alternatives	Activity Calendar class for tariff instead of Schedule class
Fixing some parameter values	Number of tariff timezones to be supported, Number of associations and association properties, default password …
Elements, where the international standard leaves freedom for country specifications	India specific OBIS codes, India specific Event codes

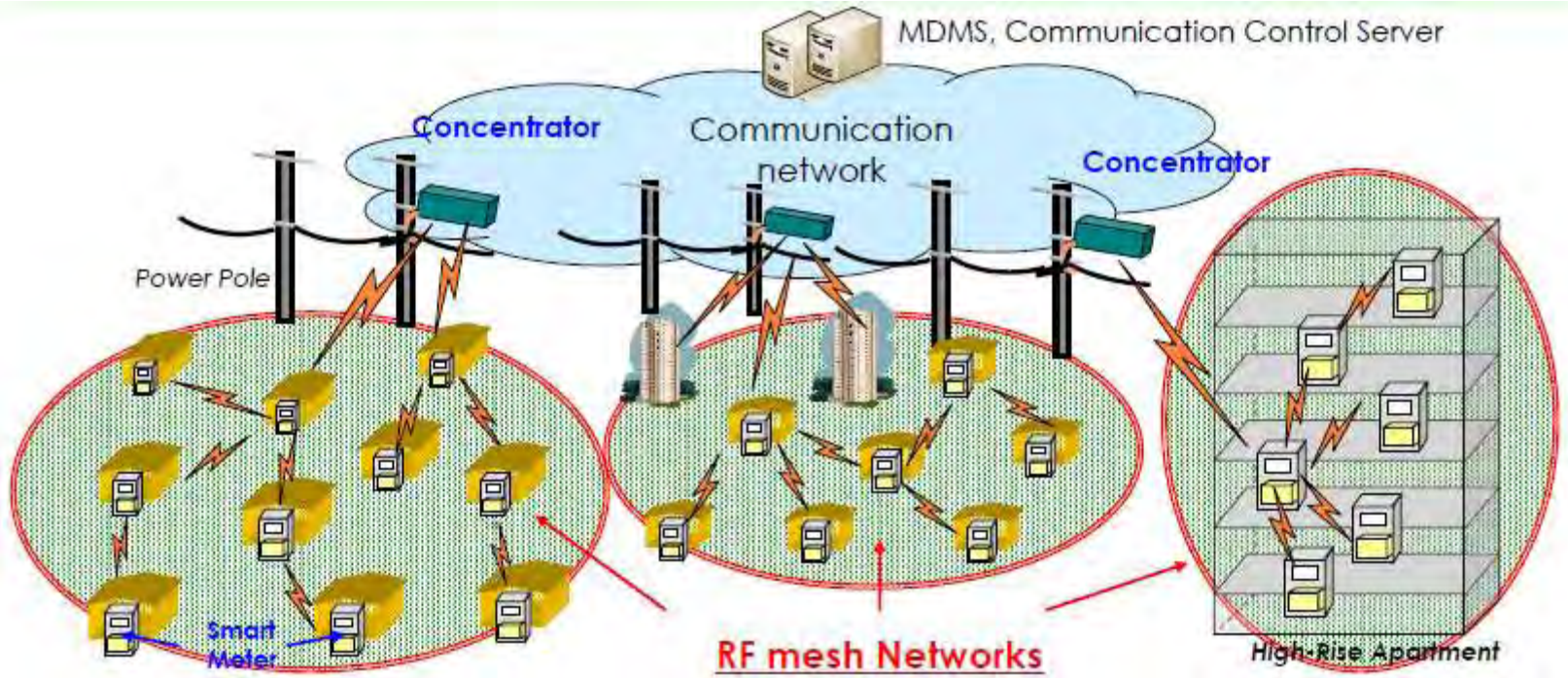
Conventional Networks topology



Layering in Conventional Networks

- Modem example
  - COSEM PDU (protocol data unit)
  - DLMS/COSEM Wrapper for IP Networks (IEC62056-47)
  - TCP Frame
  - IPV4 PDU
  - PPP/SLIP
  - Modem carrier (GSM/GPRS ….)
- Interoperability issues in carrier layers handled by separate forum and evolved into mature standards over time

Smart Grids Network Topology



Source *www.tepco.**co**.jp*

Layering in Smart Grid networks

Data Plane traffic protocol layering – RF example

- COSEM PDU (protocol data unit)
- DLMS/COSEM Wrapper for IP Networks (IEC62056-47)
- TCP Frame
- IPV6 PDU
- 6loWPAN Convergence layer
- IEEE802.15.4e MAC Layer
- IEEE802.15.4g PHY Layer
- The above represents just one protocol stack profile. There could be dozens.

- In addition to data plane traffic, different layers will have control-plane traffic to manage the layer-specific setup and configuration

Layering in Smart Grid networks

Control Plane traffic protocol layering

- RPL (Routing Protocol for Lossy networks) – Mesh setup and reconvergence
- 6loWPAN – neighbour detection and header-compression setup
- IEEE802.15.4e MAC Layer – L2 security setup, Mesh join authentication, dynamic key setup
- EAP/EAPOL authentication protocol
- The above represents just one protocol stack profile. There could be dozens.

Security - Smart Grid networks

- In addition to Application Layer security, there are options for securing and authenticating messages at the L4 layer (eg: TLS), L3 layer (eg: VPN) and even at the L2 layer
- Systems can elect to use any of these options or even to combine one or more, or all, these options
- Decision to use security at a layer can be different for the WAN and for the NAN. For example, at the NaN, a DoS attack can be more effective since the network resources and bandwidth are more constrained.

Security – Cipher suites

- Key Agreement – Handshaking and setup of keys for encryption and authentication
  - RSA, Diffie-Hellman, ECDH, SRP, PSK …
- Authentication – RSA, DSA, ECDSA …
- Block Ciphers – RC$, Triple DES, AES …
- Message Authentication Code – SHA, MD5, MD4 …
- Example of a cipher suite:
  - TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256
- There are hundreds of possible cipher suites.

Interoperability Challenges in Smart Grid Networks

- Some protocol layers have inter-dependencies with other protocol layers – RPL with IP, RPL with 6loWPAN, EAP with MAC Layer etc.
- Each of these protocols have as much (if not more) complex parameters, settings and choices as DLMS/COSEM has. This would require a companion-specification like exercise to be performed for each layer to remove ambiguity and interoperate
- Some situational data in the LAN control-plane traffic may need to be interfaced through the WAN all the way to the Head End. This requires rigorous modelling of that data

Thank You!