DLMS INSIGHTS GAINED BY TENAGA NASIONAL BERHAD IN AMI PROJECT ROLLOUTS

Sharmala Satiaseelan, Tenaga Nasional Berhad, +601 9331 8182, sharmalasa@tnb.com.my
Balagopalan Mathoor, Kalkitech, +91 94975 94390, balagopal@kalkitech.in

Abstract

DLMS/COSEM (IEC 62056) is currently the most popular metering protocol with many European utilities having already implemented large scale DLMS meter roll outs and several Asian utilities in the process of starting significant rollouts or pilot projects with DLMS. Tenaga Nasional Berhad (TNB) has been one of the leading utilities in Asia to embrace DLMS based meter roll out.

DLMS ecosystem is comprised of multiple products which typically includes a Meter, Communication Modem, Data Concentrator, Head End System, Security Key Management System, Meter Data Management System, Meter Test bench and DLMS Test Suite. Each of the products is often supplied by different vendors from different countries. While DLMS is a comprehensive metering protocol, it offers multiple choices for data models, communication profiles and media, data security and OBIS codes. Hence the implementation of DLMS may not be the same across all vendors which can result in interoperability issues, adversely affecting the time, cost and sometimes even the success of a project.

Based on the experience of TNB's DLMS meter rollout and companion specification development, this paper discusses the systematic approach required for DLMS adoption to avoid interoperability issues and ensure utility business and operational objectives are met.

Introduction

The emergence of a new liberalized energy market and introduction of digital energy meters in the 1990s, led to a strong case for an open standards-based communication protocol for power meters. Only a system ein compliance with a to standard communication protocol would allow to have meters from multiple vendors, other communication devices and data center applications to coexist and seamlessly interoperate and read/write data. The open standards available at the time were not specifically developed for meters and hence had huge gaps in addressing utility data requirements as well as in ensuring interoperability. As a work around, while some utilities accepted manufacturer defined proprietary protocol-based solutions, it ended up as vendor locked systems, which were costly in the long run and difficult to maintain. It was during this time some industry players in Europe formed the DLMS User Association (DLMS UA). What was originally started as the "Distribution Line Message Specification" was soon recognized that it could be a common language for all kinds of meters and associated communication media and hence changed the name to a more generic name - "Device Language Message Specification".

DLMS UA works closely with various Technical Committees of IEC such as TC57(Power System Control and Associated Communications), WG9(Distribution Automation using Distribution Line Carrier Systems), TC13(Equipment for Electrical Energy and Load Control), WG14 (Data exchange for meter reading, tariff and load control). A Special Joint Working Group SJWG 13/57 was formed for effective coordination between the two Technical Committees. DLMS UA also works with TC294 (Communication System for Remote reading of meters) and a coordination with CENELEC TC13 via JWG RRM (Joint Working Group Remote Reading of Meters) was initiated. IEC 62056 DLMS/COSEM series of standards are developed by IEC TC13 with support of the DLMS User Association.

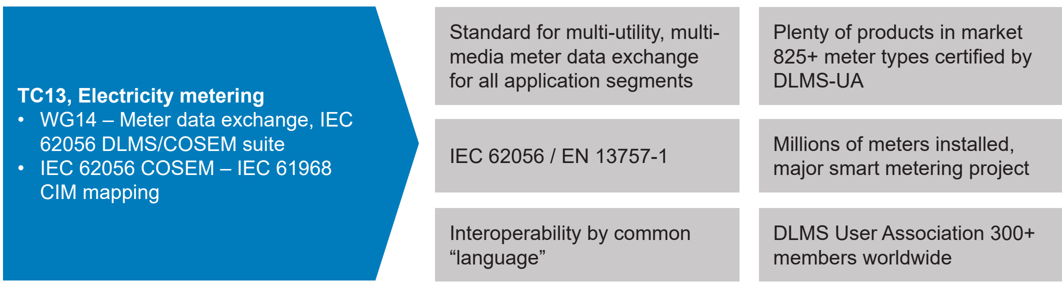

Fig. 1: DLMS overview

As of today, DLMS/COSEM is the most popular metering protocol used in the world with millions of DLMS/COSEM meters deployed successfully. There are close to one thousand DLMS meter types certified by DLMS User Association and DLMS meter development capability is available for small/medium enterprises and big multinational corporations alike. This offers a choice for breadth in selection of vendors and products for utilities.

The increasing needs of the energy market and smart grid is creating more business use cases which require new kinds of data and functions to be supported in meters. The DLMS protocol fares well as it supports not just the consumption data for billing purpose, but it also caters to the new needs of the smart grid such as asset management, outage management, demand response, supply automation and contract management, power quality monitoring, net metering for integrating renewable energy resources, non-technical loss detection, etc. All these are made possible because DLMS offers a vast array of building blocks called COSEM interface objects suitable for modelling all modern smart grid data and use cases.

In an AMI system, data security is an important aspect that needs to be addressed because security vulnerabilities in AMI can have far reaching damages ranging from monetary loss for utilities to bigger and wider social issues in the form of mass power supply interruption or theft of sensitive customer information. Information security in DLMS/COSEM is based on parts of NIST (National Institute of Standards and Technology) documents and provides authentication as well as data security using field proven symmetric as well asymmetric cryptographic algorithms.

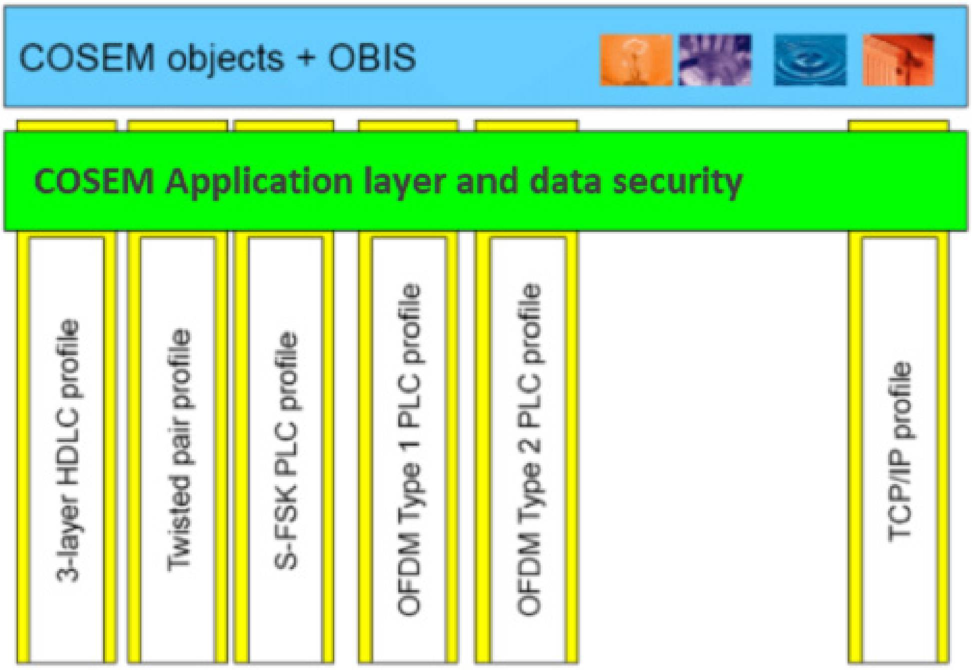

Fig. 2: DLMS/COSEM and Communication Profiles

Companion Specification

While DLMS/COSEM by itself is a standard, the mere inclusion of DLMS/COSEM in a project specification would not really achieve the interoperability objectives envisaged because:

- Characteristics of objects are not defined in DLMS and left for project specific authorities to define
- For some use cases, DLMS offers multiple options leading to different implementation by different vendors
- There could be certain utility specific requirements which are not supported in DLMS
- Non-functional requirements such as security, communication optimization may vary from manufacturer to manufacturer

While DLMS offers a vast set of building blocks namely COSEM interface classes, these interface classes specify only up to modelling of a meter functionality and encoding/decoding for data exchange with Head End System (HES). But the characteristics of an instantiation of a standard DLMS data model is the responsibility of the utility and is not defined in DLMS standard. Lack of utility standards can cause interoperability issues as shown with an example of event reporting in Figure 3.

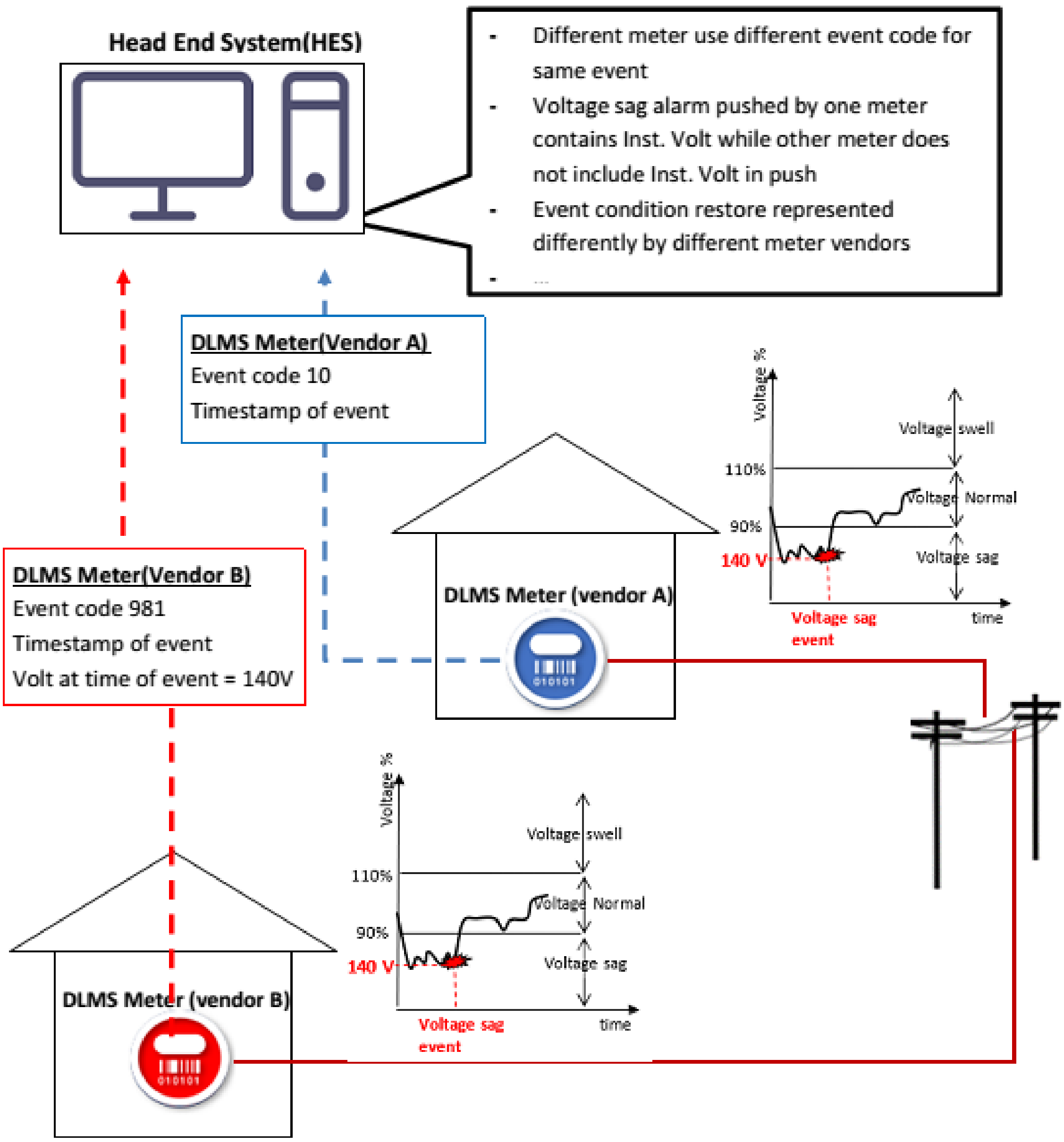

Fig. 3: Interoperability issues - Event example

Since definition of such characteristics for each object are out of the DLMS scope, this need to be done by each utility. Otherwise, each manufacturer might have their own implementation which could result in having different variants of DLMS across the utility resulting in interoperability issues.

DLMS being a global standard offers flexibility by offering different choices such as different data types and different interface classes for same data/functionality. Leaving these multiple choices as open also results in different manufacturers choosing different options and resulting in different DLMS implementations to with which to contend.

There could also be some utility specific requirements that may not support in DLMS (e.g. kWh during magnetic tamper, load switch auto reconnect). DLMS acknowledges such possibilities of gaps and reserves ranges in OBIS codes for utilities to define objects for their specific requirements. Without utility specific definitions, such requirements might either be left unimplemented or implemented differently by different manufacturers.

Thus, the backbone for successful DLMS adoption is defining a companion specification. The companion specification should be customized for a specific set of utility or regional requirements and can also be used as a basis for interoperability testing to reduce issues which may arise at the time of integration of multi-vendor systems or devices.

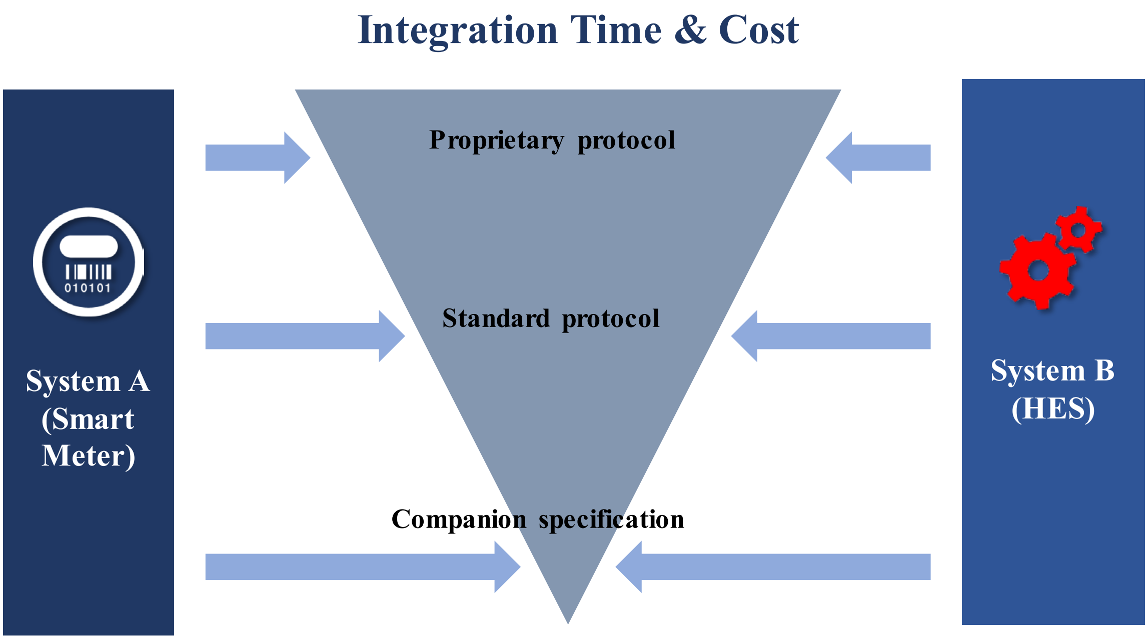

Fig. 4: Need for companion specification

DLMS Adoption – Recommended Process

A DLMS adoption process covering different stages of a meter rollout and maintenance is shown in Figure 1. DLMS companion specification shall be ready during the planning stage itself and all involved vendors are educated of the companion specification at this stage. Once the companion specification is completed, a test specification and test tools developed, and a test lab can be setup for verifying the meters during the tender evaluation stage and later at the lot acceptance stage. Post deployment, a working group with DLMS consultants and utility stake holders should conduct periodic reviews of the existing specification to asses if there are any new requirements or updates of the IEC standard that require revision of the companion specification. Similarly, DLMS tools can be used in the Operation and Maintenance (O&M) stage for analyzing any interoperability issues that might be reported from the meters deployed as well as checking the accuracy of data collected.

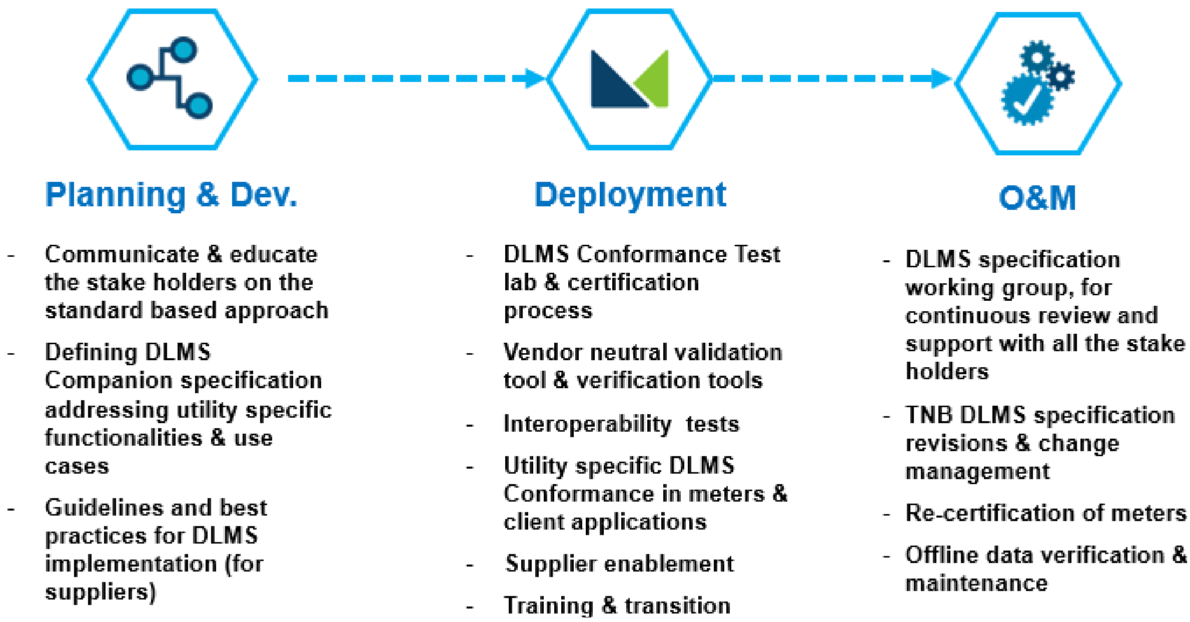

Fig. 5: DLMS Adoption process

Requirement Gathering

The first stage of the companion specification development involves requirement gathering. This stage can be started by reviewing existing system, specifications and business requirements. A business blueprint document can be very useful in terms of understanding the larger picture and requirements of various interconnected systems (such as Meter Data Management System, Billing and Customer Relation Management, Outage Managements etc.) which will use meter data or meter functions for fulfilling their tasks. Further in this study phase, a requirement workshop is conducted with different utility stake holders as well as different suppliers including meter manufacturers, communication solution suppliers and other system suppliers. The purpose of the requirement workshop is to collect requirements as well as arrive at a consensus on ambiguous or disparate requirements. All requirements are finally captured in a requirement specification document which is presented to the utility. The requirement specification document will have a detailed account of all functional as well as non-functional requirements. Functional requirements include meter data or functions which are directly required for business functions such as load profile, billing profile, different events to be supported, meter identification parameters, load limit/demand response requirements. Non-functional requirements may not be directly related to business functions but are required for the interoperability, scalability and maintenance of the AMI system. Non-functional requirements include association types, security requirements, packet encoding requirements, packet size / timing optimization requirements etc.

The requirement gathering process is shown in Figure 6.

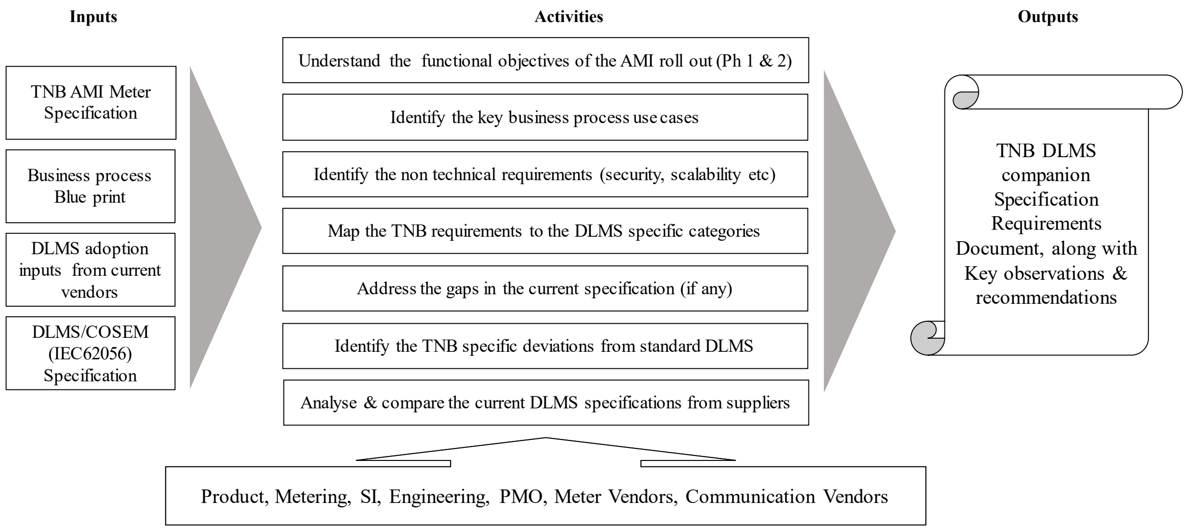

Fig. 6: Requirement gathering process

Companion Specification

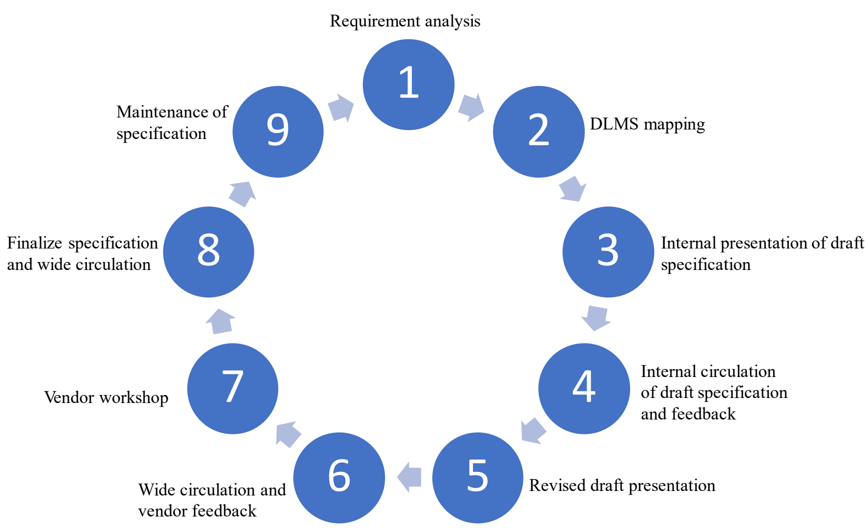

Fig. 7: Companion Specification development

Companion Specification development starts with analysis of the requirement specification document prepared in the requirement gathering phase. Business requirements are then mapped to COSEM objects. This includes standard objects as well as some utility specific custom objects. The draft of the companion specification is presented to the utility and then circulated internally for utility stakeholders to review and provide feedback. This may be an iterative process depending on the feedback. Once the specification is finalized after considering all feedback, is widely circulated to all vendors for their feedback. A vendor workshop is conducted to present the companion specification to all vendors, discuss the feedback and clarify any doubts that vendors have. The process is shown in Figure 7.

Test Setup

Test setup for validating the meter for conformance with companion specification is a must to achieve the interoperability objectives envisaged from DLMS adoption. A test process for conformance testing is shown in Figure 8. The basis for conformance testing is a conformance test plan document covering all functional areas of the companion specification. For each functional area, multiple test cases for checking the conformance are defined. A test case template is shown in Figure 9. Executable test cases are selected and parameterized based on functional test information furnished by manufacturer of meter under test. The test output includes a test report which summarizes the list of tests executed with result as well as supporting evidence of test such as test tool log and communication protocol traffic. Laboratories equipped with a functional evaluation tool can also serve as an enabler for meter manufacturers in terms of offering development testing which can speed up their companion specification implementation.

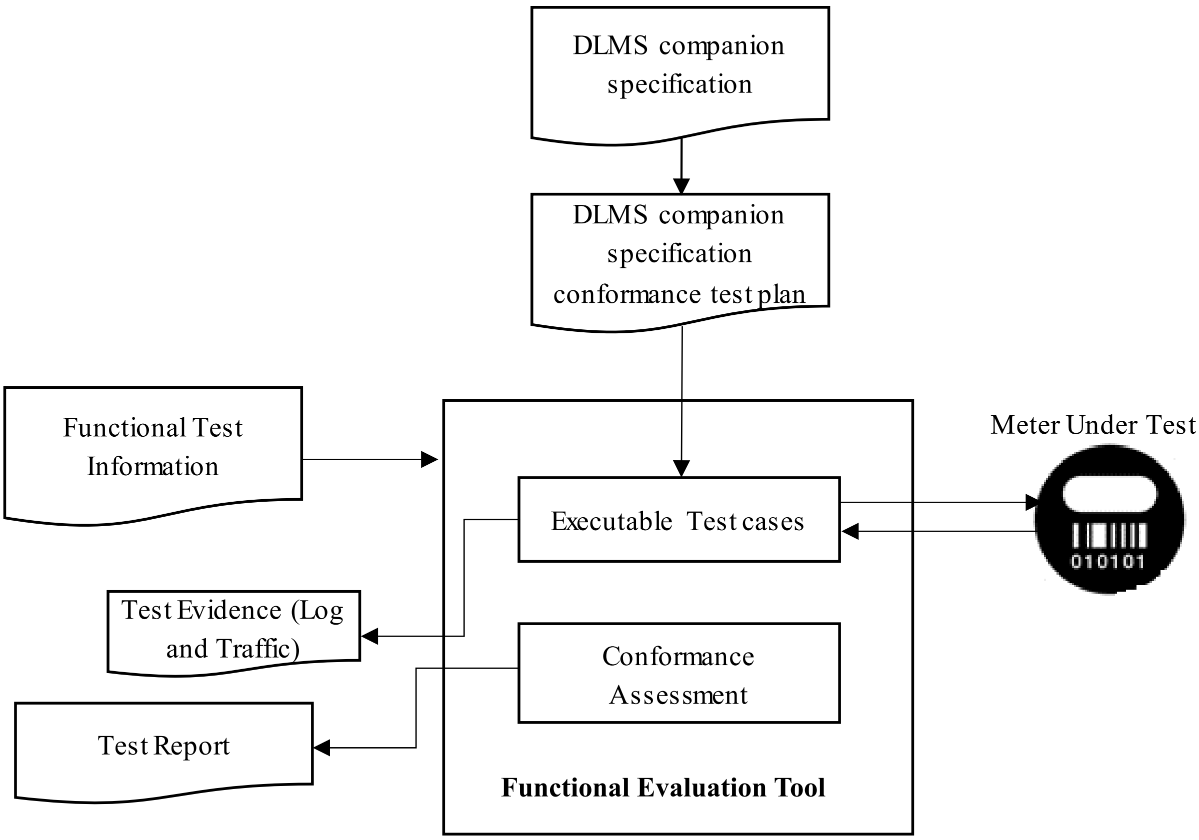

Fig. 8: Companion conformance test process

Test case ID: *<Unique coded identifier for test case>*	
Purpose: *<Brief description of test case purpose>*	
Companion Specification Reference: *<Sections of companion specification referred in test case>*	
Type: *<Positive or Negative>*	**Applicable on:** *<List of communication interfaces on which test case is applicable>*
Do	**Check**

Fig. 9: Test case template

Vendor Enablement

Participation and support of vendor is crucial for the success of DLMS adoption. The role of the vendor in various stages of the DLMS adoption is shown in Figure 11. During each stage of the process there should be a mechanism to collect vendor inputs and feedback. Periodic vendor enablement workshops are conducted to educate vendors on the companion specification and to align vendors with the objectives of companion specification. Conformance test setup can be utilized by vendors for developmental testing/pre-testing thereby speeding up the product development process and reducing issues and delays during actual conformance testing.

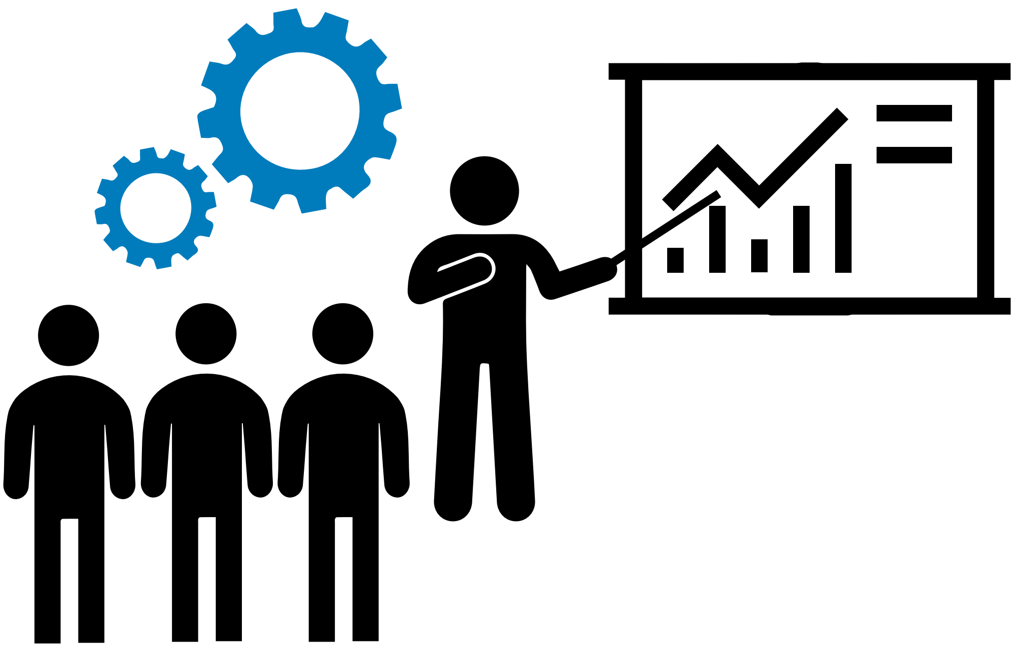

Fig. 10: Vendor workshop

A Technical help desk shall also be in place so that any stakeholder from utility or from vendors can avail technical assistance at any stage of the project for clarifying DLMS related technical doubts as well as to get assistance in trouble shooting of interoperability issues during integration or deployment.

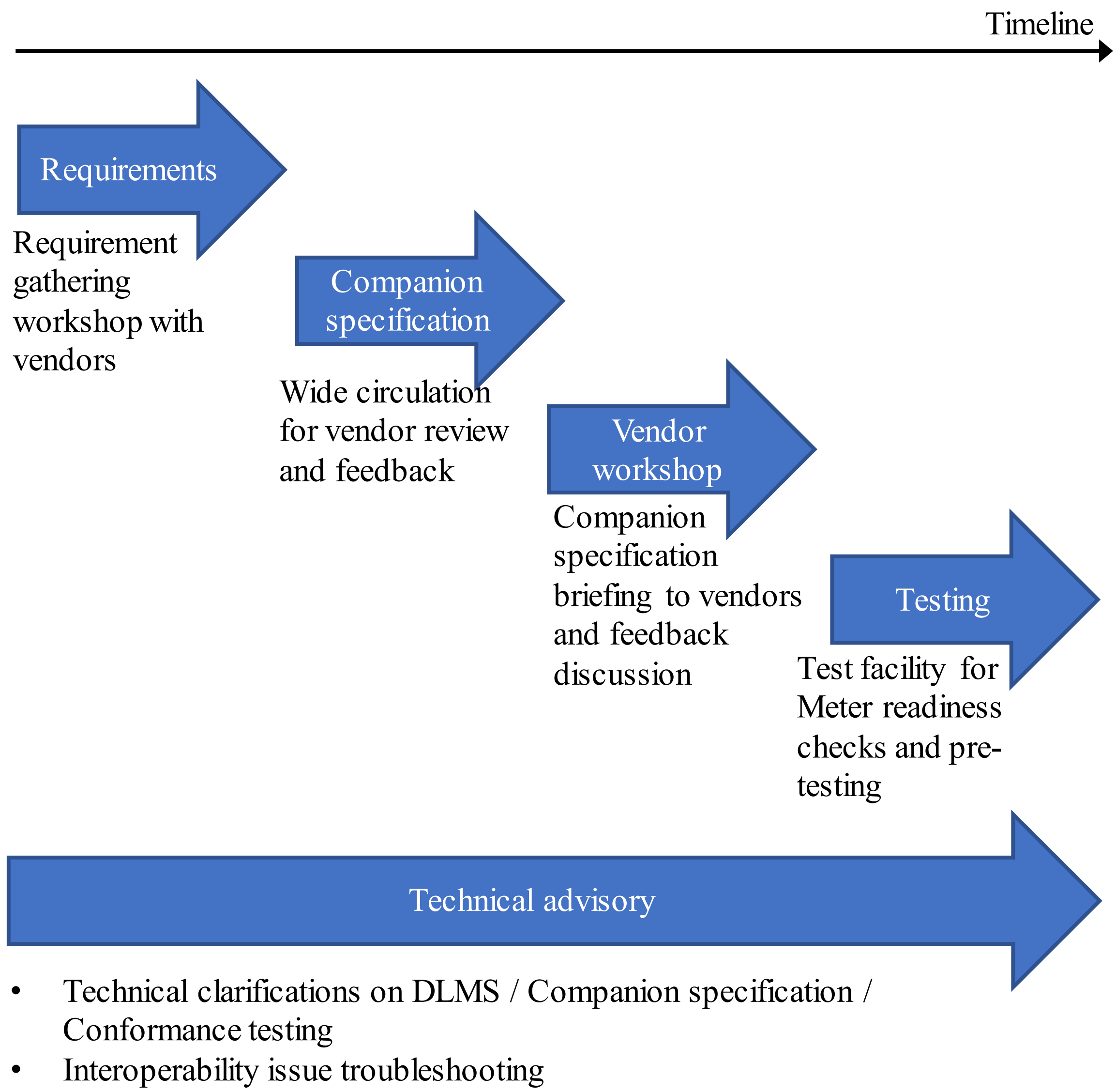

Fig. 11: Vendor participation stages

Maintenance

As the AMI system evolves, there are chances for modification in the existing business use cases as well as addition of new use cases. Similarly, based on the advances happening globally in the field of AMI, there might be new business use cases or requirements such as cybersecurity, communication technology related updates etc., some of which might be relevant to the existing AMI system. DLMS UA publishes newer versions of DLMS specifications at regular intervals. To address these issues, a maintenance process should be in place for periodic review of the companion specification to identify any gaps in terms of supporting the changes or additional business requirements or DLMS standard revisions. The gaps are then presented to all utility business owners and other stakeholders and assessed for criticality and planning for revision of the companion specification. Revising the companion specification will follow the standard process explained in Figure 5 as this needs to go through all the sub-processes such as vendor enablement, upgrading test specification and test setup.

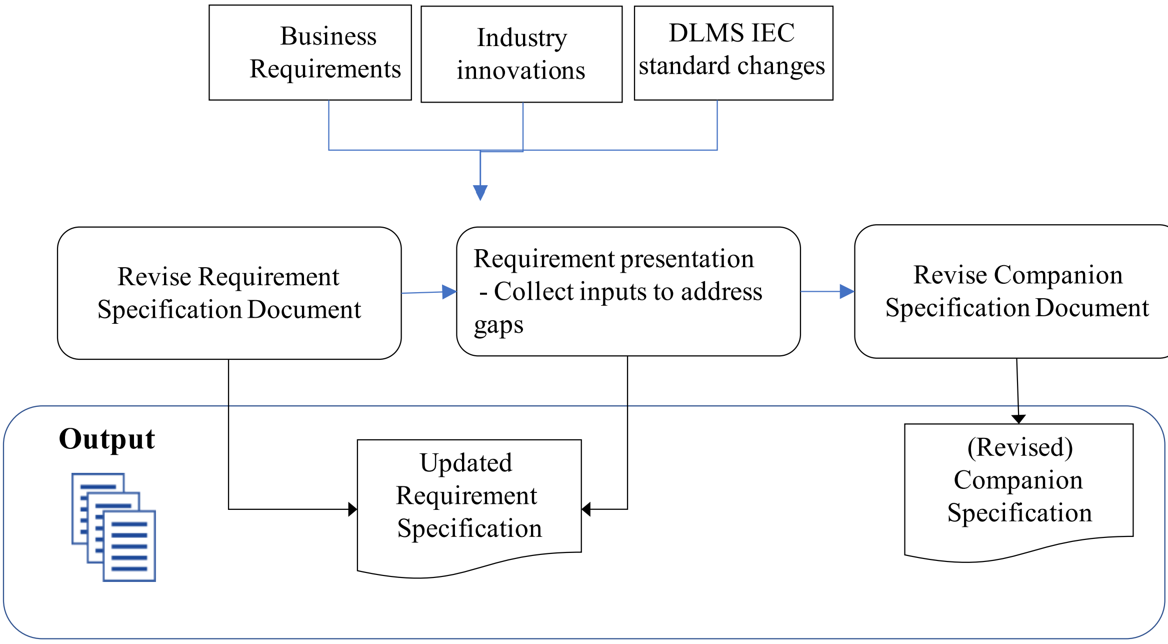

Fig. 12: Standard governance process

Conclusion

In its first large scale smart meter rollout pilot, TNB had specified that all meters should be DLMS compliant with the assumption that it would suffice the interoperability and smart grid requirements. But from the experience during system integration it was clear that even though the meters, communication modules, data concentrators and head end system from different vendors were all DLMS, they could not fully interoperate because of the differences in their respective interpretation and implementation of DLMS. Some interoperability issues were resolved after months of discussions with all vendors thereby affecting the overall project timeline and cost. There were a few other interoperability issues that were severe enough to drop the integration as the resolution of issues required hardware changes that could not be approved because of cost and time constraints involved in repeating the testing cycle. The take away from the whole experience of TNB is that mere inclusion of DLMS or giving a free hand to vendors and letting each vendor define their own DLMS specification does not bring the real advantages of standardization to the utility. The utility must take ownership of DLMS adoption by defining their own companion specification and build an ecosystem including test setup for verifying compliance and technical help desk for enabling vendors with the right knowledge to fast track their product readiness for utility requirements.

References

- DLMS colored book – Green book, Blue book, Yellow book and White book
- TNB DLMS companion specification

Biography

Balagopalan Mathoor has thirteen years of experience in communication protocol domain and now works as AVP, Metering Services in Kalkitech, India. He is a member of DLMS UA Protocol Maintenance Group as well as the Bureau of Indian Standards. As a lead DLMS consultant to TNB, Balagopalan has drafted the TNB DLMS Companion specification. He has working experience on various DLMS companion specifications such as TEPCO, IS15959, Iberdrola, DSMR, CIG and SEC. Over the years he has conducted more than fifty DLMS trainings across the globe for meter manufacturers, meter test laboratories and utilities.

Sharmala Satiaseelan has 13 years of experience working in the electricity utility and is now working as a Senior Engineer with the Smart Billing Project in Tenaga Nasional Berhad. She has been directly involved in developing the TNB DLMS Companion Specification and TNB DLMS Test Specification. She also has involvement in the development of the AMI Meter Specification, smart meter features and the functional testing of the smart meters for this project.