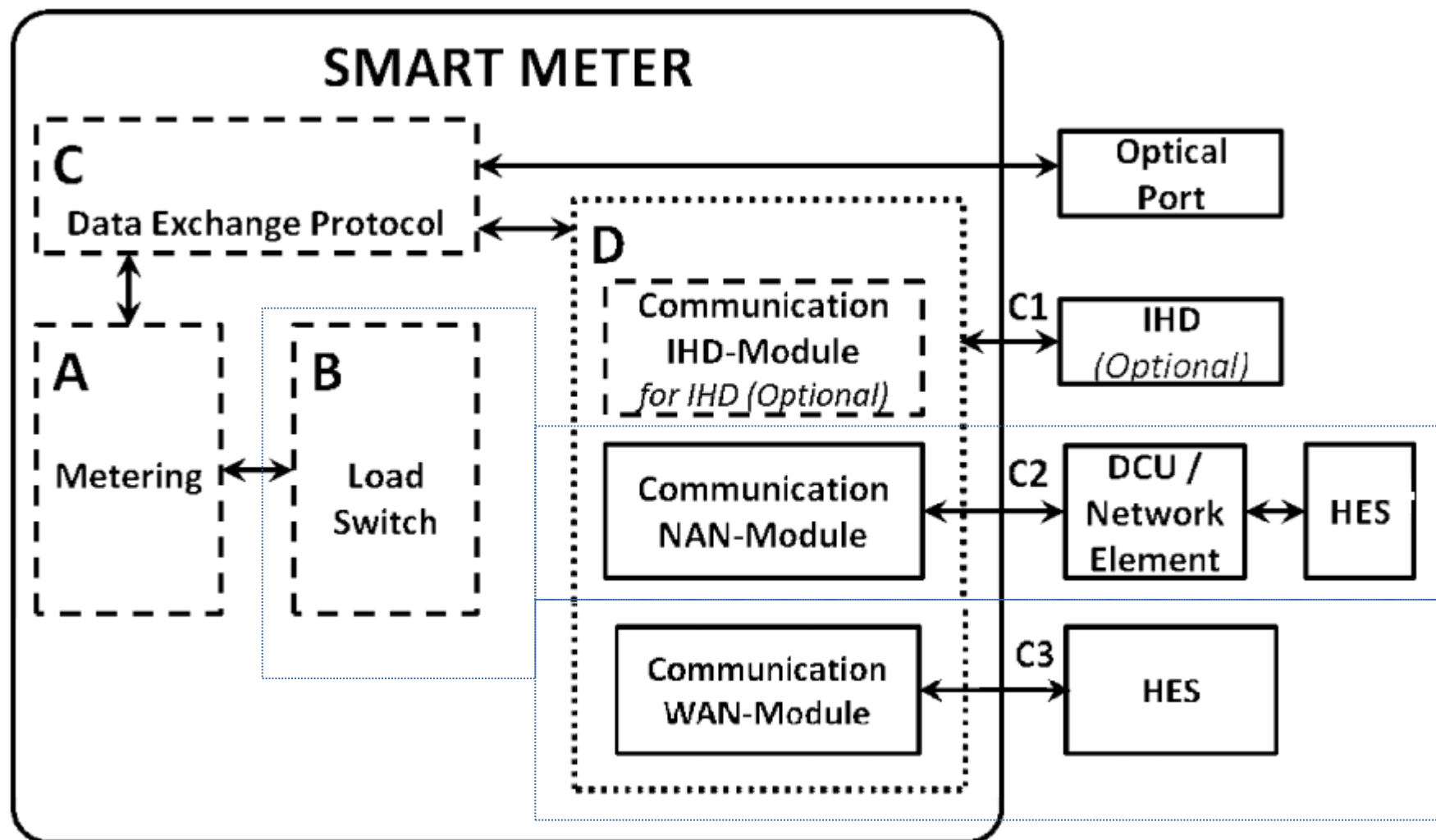# Function Evaluation Test Tool (FET) at CPRI Bangalore

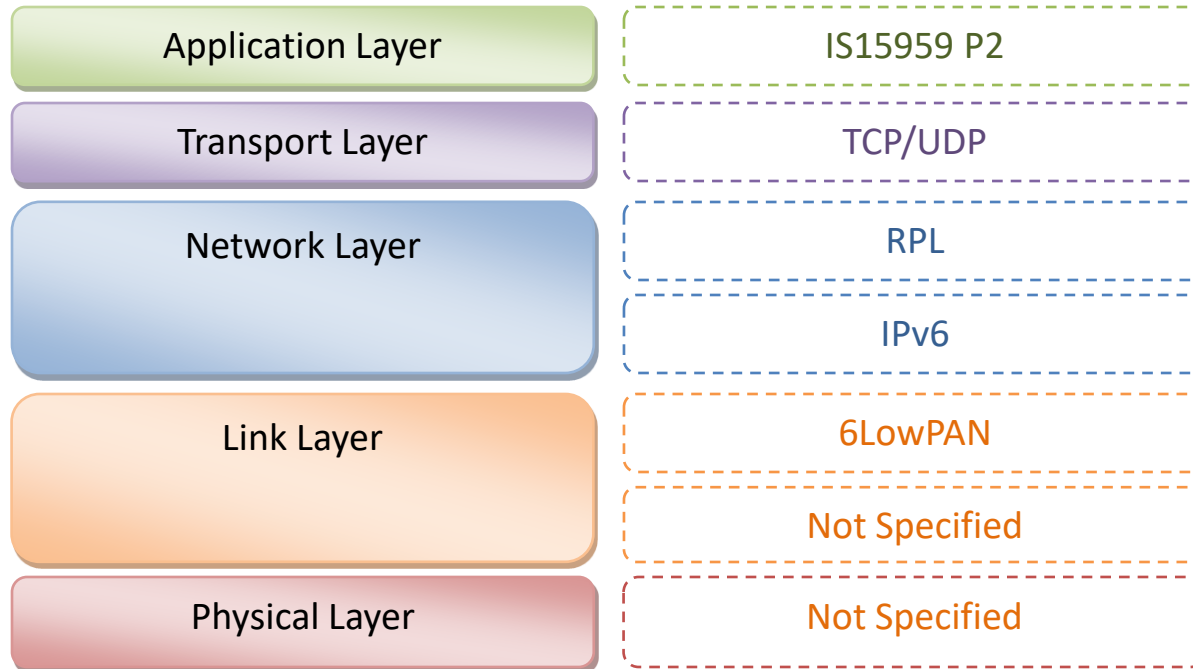## For Smart Meter Testing as per IS 15959 part 2 and Part 3

By Kamaldev K R ,Nobin Mathew
Kalki Communication Technologies Pvt Ltd

Workshop on
'Technical and Testing Challenges for Smart Meters'
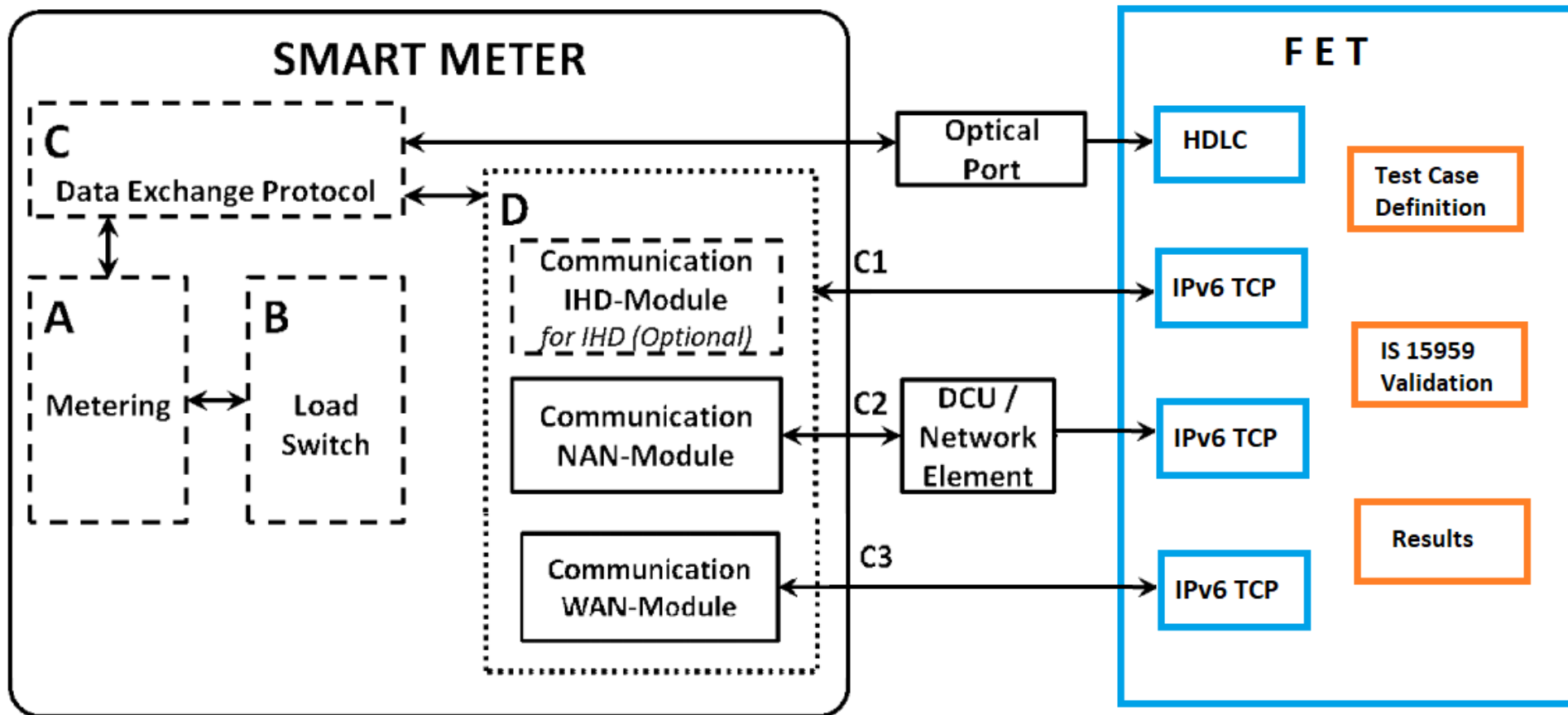2-3 November 2017, New Delhi
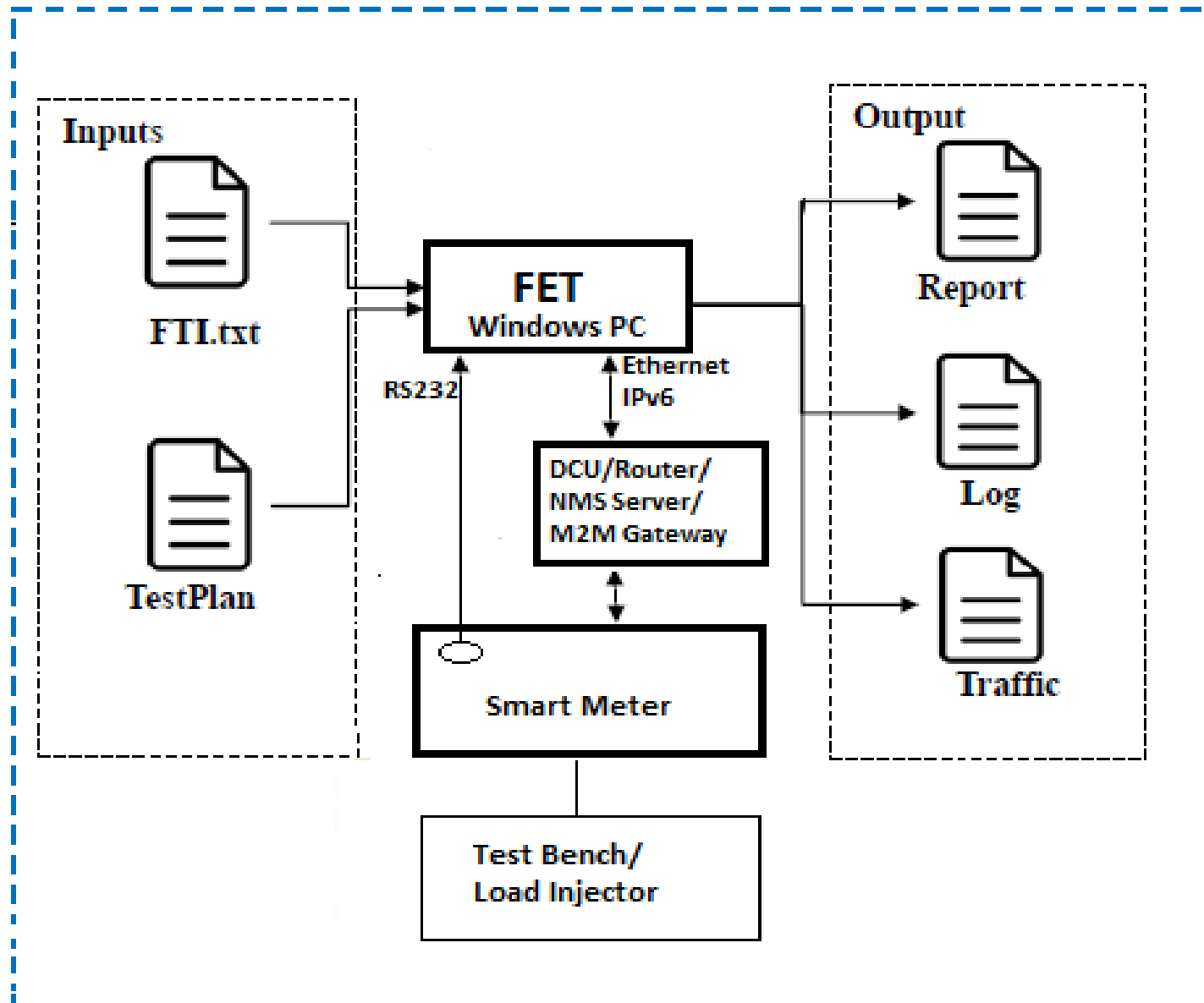
IS15959-2 & 3 Smart Meter Block Diagram

IS 16444 Communication Protocol Layers

|	
Application Layer	IS15959 P2
Transport Layer	TCP/UDP
Network Layer	RPL
	IPv6
Link Layer	6LowPAN
	Not Specified
Physical Layer	Not Specified

Smart Meter – FET Interface Block Diagram

IS 15959 Functional Evaluation Test Setup

IS15959-2 & 3 Specific Tests: Categories

Test present in IS 15959 Part 1		Test present in IS 15959 Part 2 & 3
sign on authentication (HLS)	Billing & TOU	Advance Security
Tamper Logs	Disconnect Control	Tamper Reporting and Data Push
Programmable Parameters	Selective Access	Firmware Upgrade
Load Profile	Instantaneous Parameters	Limiter and Load Switch
		IHD

IS15959-2 & 3 Associations
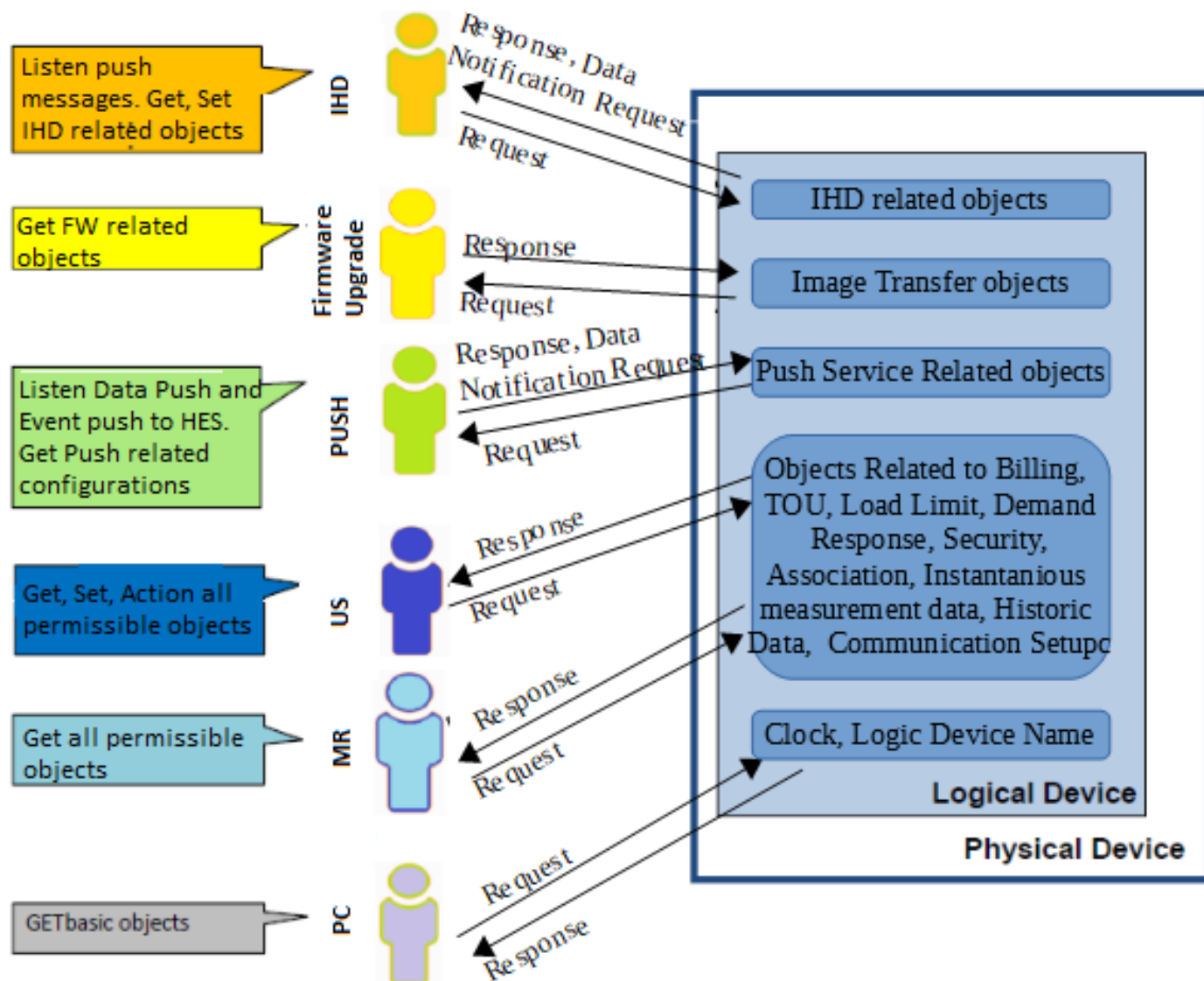
FET Test Selection

Configuration Settings

Test Case Selection   Communication

☐ Instantaneous parameters and profiles	☐ Name plate details
☐ Billing	☑ Programmable parameters
☑ Firmware upgrade	☑ Data notification
☐ Basic data readout	☐ Selective access
☐ ObjectList Download	☐ Event code & Event logging

☐ Select All   ☐ Select None   Advanced..

Ok   Cancel

Programmable Parameters

☐ TOU	☐ Current Balance Amount
☐ Billing Date time	☐ Current Balance Time
☐ Clock	☐ LLS Secret
☐ Profile Capture Period	☐ HLS Key
☐ Demand Integration Period	☑ Global Key Change
☐ Metering Mode	☐ Image Activation Single Action Schedule
☐ Payment Mode	☐ ESWF
☐ Last Token Recharge Amount	☐ MD Reset
☐ Last Token Recharge Time	☑ Load Limit
☐ Total Amount At Last Recharge	☐ Enable/Disable Load Limit Function

☐ Select All   ☐ Select None   Ok   Cancel

FTI Input file

- FTI file is prepared by meter manufacturer

- Contents
  - Meter SN
  - Flag ID
  - Association Details
  - Security Keys
  - Comm Setup Properties
  - Event definition
  - DLMS Object details

```
CommunicationProfilesSupported = [TCP]
ApplicationContextsSupported = [LONG_NAMES,LONG_NAMES_WITH_CIPHERING]
SecurityLevelsSupported = [NO_SECURITY, LOW_LEVEL_SECURITY]
MediaIdentifiers = [ABSTRACT,ELECTRICITY]

LogicalDevice[0] = {
  Enabled = TRUE                     Logical Device Configuration
  Name = "\XYZaaabbbcccdddd"
  ServerSAP = 1

  Association [0] = {
    Enabled = TRUE
    ClientSAP = 16
    ApplicationContextName = LONG_NAMES
    AuthenticationMechanismName = NO_SECURITY
    Conformance = [ GET]
    DlmsVersionNumber = 6
    ServerMaxReceivePduSize = 65535
    MediaIdentifiers = [ABSTRACT, ELECTRICITY]
        SystemTitle = "\systitle"
        MasterKey = "11223344556677881122334455667788"
        GUEK = "303030303030303030303030303030"
        GAK = "303030303030303030303030303030"
        SecurityPolicyMinimum = NO_SECURITY
        SecurityActivateMethodSupported = TRUE
        GlobalKeyTransferMethodSupported = TRUE
        SecurityPolicyWritable = FALSE
        UseDedicatedKey = FALSE
        RLRQSupported = FALSE
        PreEstablished = FALSE
  }

HDLCProfile = {
  PhysicalLayer = {
        HdlcBaud = 9600
        OpeningMode = MODE_E
        ModeEIdString = "\aS"
        ModeEDelay1 = 0
        ModeEDelay2 = 300
        ModeEDelay3 = 1000
        LastOutputToWakeUpDelay = 30000
  }
  DataLinkLayer = {
        AddressingSchemes = [ONE_BYTE_ADDRESSING, FOUR_BYTE_ADDRESSING]
```

Association Properties

HDLC communication configuration

FET Traffic Monitor

FTI | **Log_Traffic** | Report

```
19: 13: 08: 406    RLRQ Not Supported
19: 13: 08: 408    ClosePort to close current Association
19: 13: 08: 535    initPort
19: 13: 08: 538    Association Release Success
19: 13: 20: 379    RLRQ Not Supported
19: 13: 20: 382    ClosePort to close current Association
19: 13: 20: 520    initPort
19: 13: 20: 523    Association Release Success
19: 13: 20: 525    Close Port
19: 13: 20: 527    Test Push Port
19: 13: 20: 529    IPv6 communication :28
19: 13: 20: 531    plafListenConnection :4059
19: 14: 25: 399    accept new connection
19: 14: 25: 502    *** event Push Frame ***
19: 16: 16: 058    Close Port
```

```
19. 13. 08. 293    <---    .. 04 D8 7D 1B 3J 2E 2B B8 8C BB CF 91 99 CB 00 4C CJ 00 C3 E8 FD
Channel-0 :: Application Layer ::
     **SecurityInfo** Plain Text
Channel-0 :: Application Layer ::
19: 13: 08: 348    <===    :: C4 01 41 00 01 01 02 02 09 04 FF 03 FF FF 09 05 FF FF FF FF FF
Channel-0 :: Application Layer ::
19: 13: 08: 371    <===    :: D4 26 30 00 00 00 00 C4 01 41 00 01 01 02 02 09 04 FF 03 FF FF 09 05 FF FF FF FF FF
Channel-0 :: Transport Layer ::
19: 14: 25: 488    <---    :: 00 01 00 01 00 40 00 7B DB 08 4C 4E 54 45 52 33 30 30 70 20 00 00 00 07 F3 E1 03 04 79 75 80 1B 73 1E 5A 38 66 64 A9 AB 62 EE C0 EF 92
                           19 17 3C 14 52 28 86 42 74 7D 8E E0 97 42 20 B5 74 86 08 76 10 85 FA 4C 42 C1 59 AD B6 A6 41 D8 85 BC 2B F6 1D 09 B7 7B A8 AA F3 C7 1E
                           68 9B 66 BD 0F BC 85 A1 F3 8D 38 74 D8 87 4A F4 EF D4 CA 91 30 F7 56 EC B1 A3 04 E6 AF EC 8F C6 08 99 36 75 07 6F C2 98 4A
Channel-0 :: Application Layer ::
     **SecurityInfo** SC :20     FrameCounter:00000007
Channel-0 :: Application Layer ::
     **SecurityInfo** EncKey:1234567890123456 AuthKey:1234567890123456
Channel-0 :: Application Layer ::
     **SecurityInfo** Cipher Text
Channel-0 :: Application Layer ::
19: 14: 25: 585    <===    :: F3 E1 03 04 79 75 80 1B 73 1E 5A 38 66 64 A9 AB 62 EE C0 EF 92 19 17 3C 14 52 28 86 42 74 7D 8E E0 97 42 20 B5 74 86 08 76 10 85 FA 4(
                           42 C1 59 AD B6 A6 41 D8 85 BC 2B F6 1D 09 B7 7B A8 AA F3 C7 1E 68 9B 66 BD 0F BC 85 A1 F3 8D 38 74 D8 87 4A F4 EF D4 CA 91 30 F7 56 EC
                           B1 A3 04 E6 AF EC 8F C6 08 99 36 75 07 6F C2 98 4A
Channel-0 :: Application Layer ::
     **SecurityInfo** Plain Text
Channel-0 :: Application Layer ::
19: 14: 25: 642    <===    :: 0F 00 00 00 01 0C 07 E1 0A 1E FF 13 11 12 00 08 00 00 02 0D 0A 0F 4C 4E 54 45 52 33 30 30 20 50 52 49 44 45 20 09 06 00 00 19 09 00 FF
                           09 0C 07 E1 0A 1E 02 13 11 12 FF 01 4A 00 05 00 00 00 00 05 00 00 00 00 05 00 00 00 00 05 00 00 00 00 05 00 00 13 88 05 00 00 00 00 05
                           00 00 00 00 06 00 00 01 D0 06 00 00 02 7D 12 00 00
Channel-0 :: Transport Layer ::
```

FET Test Report

Test House	fh		IUT Serial Number	d
Date And Time	Tue Oct 24 2:15 PM 2017		IUT Rating	d
IUT Manufacturer Name	d		IUT Category	d
IUT Model Name	dd		CPRI Sample Code	d

— 1Byte Addressing test(PC Association)	
Link Layer Test	PASSED
Application Layer Associate Test	PASSED
Link Layer Disconnect Test	PASSED
Object List Download Test	PASSED
— 1Byte Addressing test(MR Association)	
Link Layer Test	PASSED
Application Layer Associate Test	PASSED
Link Layer Disconnect Test	PASSED
Object List Download Test	PASSED
— 1Byte Addressing test(US Association)	
Link Layer Test	PASSED
Application Layer Associate Test	PASSED
Link Layer Disconnect Test	PASSED
Object List Download Test	PASSED
— 1Byte Addressing test(PUSH Association)	
Link Layer Test	SKIPPED
Application Layer Associate Test	SKIPPED
Object List Download Test	SKIPPED
Link Layer Disconnect Test	SKIPPED
— 1Byte Addressing test(Firmware Association)	
Link Layer Test	SKIPPED
Application Layer Associate Test	SKIPPED
Object List Download Test	SKIPPED
Link Layer Disconnect Test	SKIPPED

IS15959-2 Specific Test Cases

Test with limiter object

Objectives

- To verify the Load Switch implementations in the meter.

Load Switch

Demand (y-axis) vs Time (x-axis)

Legend:
- Electricity Demand - No Load Switch Action
- Reduced Demand - Load Limit Action
- Limiter Threshold

Load Limiter Test with Meter Explorer

Load Limiter Test with Meter Explorer

IS15959-2 & 3 Specific Test Cases

Advanced Security Test

Objectives

- To test the advance security implemented in data access..
- To test the Key change process.

Requirements for security

- Assurance of Confidentiality, authenticity and integrity
- man-in-the-middle attack & replay attack

Global Key Transfer
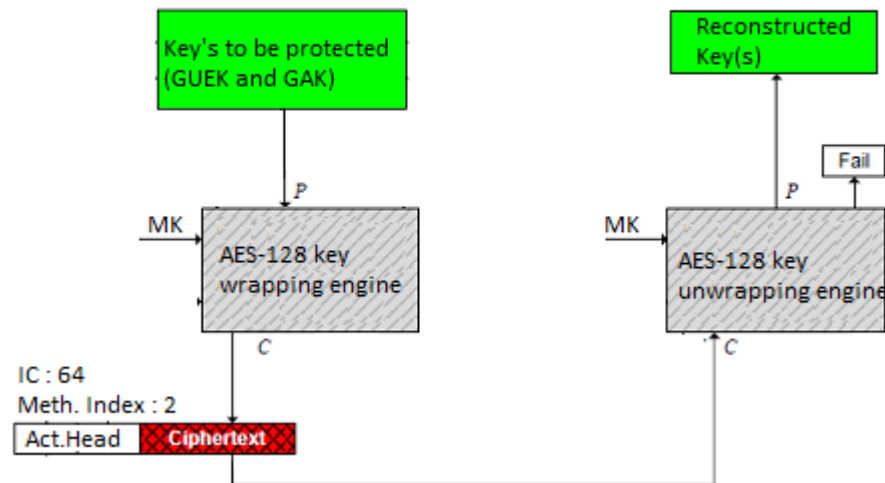
Authentication and Encryption
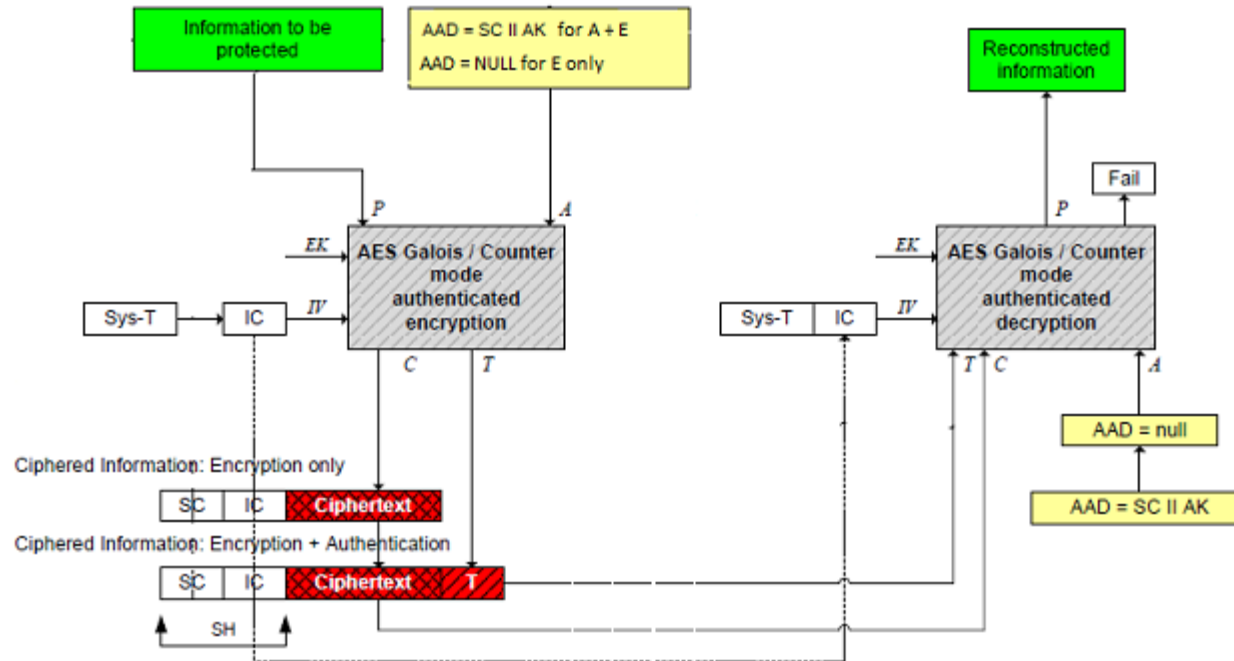
Advance Security Configuration in Meter Explorer

Association (left panel)

Client ID	48
Logical Device ID	1
Application Context	Logical Name with Ciphering
Pre established Association	False
Authentication mechanism	High Level
Push Configuration	Disable
Push obis code	0.0.0.0.0.0
Push Index	0
Secret Type	Visible String
Secret	Test_HLS_KEY_xxx
Client Maximum Receive PDU size	65535
DLMS Version	6
Quick Object List Download	Disabled
Proposed Conformance	11-block-transfer-with-get-or-read, ...
Association Object Version	0
Server Maximum Receive PDU Size	0

OK | Cancel

Association (right panel)

Negotiated Conformance	
Invocation Counter	600
Security Policy during AA establishment	Authentication and Encryption
Encryption Key Type	Visible String
Encryption Key	TEST_ENC_KEY_XXX
Authentication Key Type	Visible String
Authentication Key	TEST_AUTH_KEY_XX
System Title Type	Visible String
System Title	
Server System Title Type	Visible String
Server System Title	
Use Dedicated Key	False
Dedicated Key Type	Random
Dedicated Key	0000000000000000
Security policy within AA	Authentication and Encryption
Use General Global Ciphering	No

OK | Cancel

Key Change Test with Meter Explorer

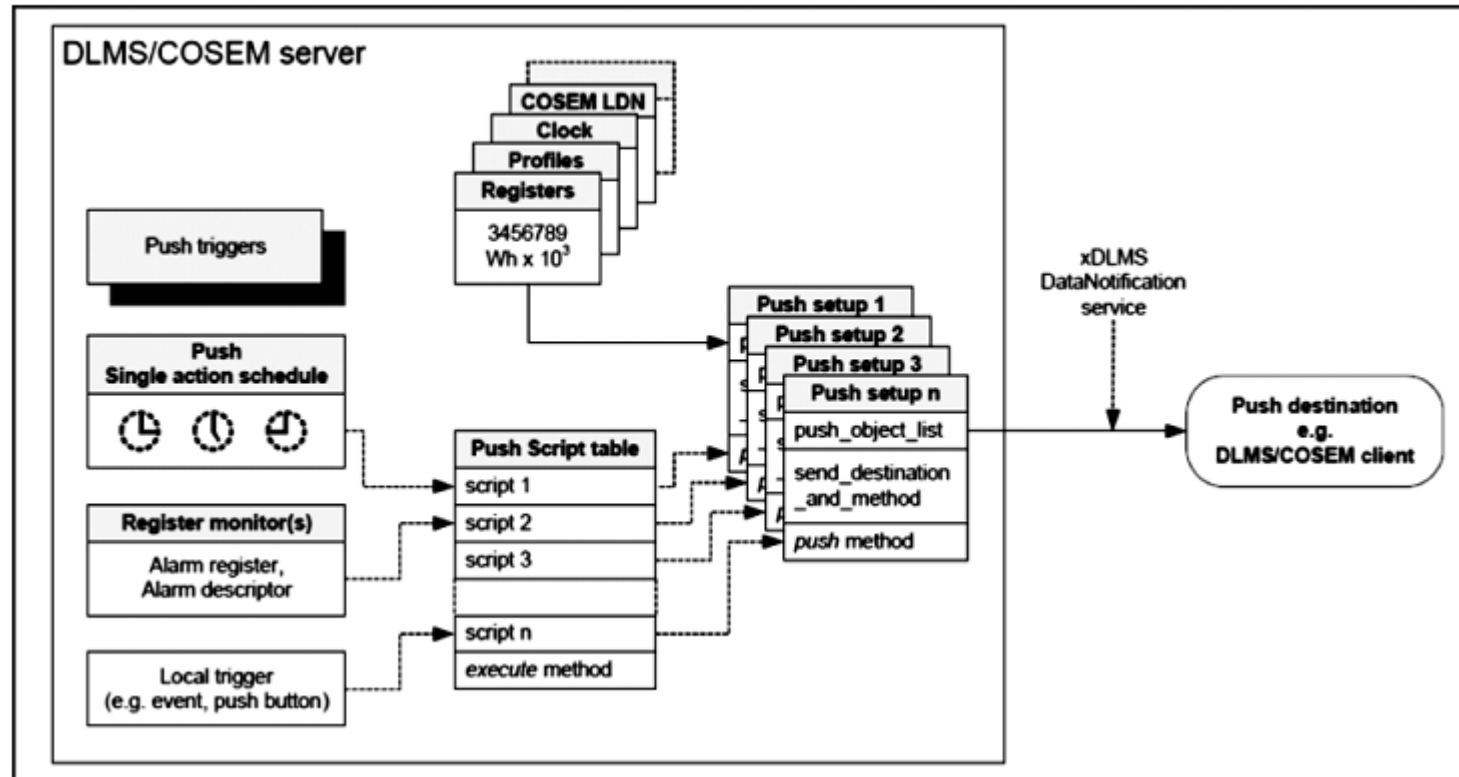# IS15959-2 & 3 Specific Test Cases

DataNotification Test

Objectives

- To test data notification process (Periodic & event based) implementation with different push object instances.
- Test the Configuration of Push operation

  Periodic Push (SM to HES)

  Utility Message (HES to IHD)

  Consumer Message (IHD to HES)

  Periodic Push (SM to IHD)

  Event Push (SM to HES)

Data Notification Service

Data Notification Service

Test Push with Meter Explorer

IS15959-2 & 3 Specific Test Cases

Firmware Upgrade Test

Objectives

- Validation of firmware upgrade implementation in meter.
- Instant activation and scheduled activation of image also shall be verified.

The steps of the image transfer process

- Step 1: (Optional): Get ImageBlockSize;

- Step 2: Client initiates Image transfer;

- Step 3: Client transfers ImageBlocks;

- Step 4: Client checks completeness of the Image;

- Step 5: Server verifies the Image (Initiated by the client or on its own);

- Step 6 (Optional): Client checks the information on the images to activate;

- Step 7: Server activates the Image(s) (Initiated by the client or on its own).

Firmware Upgrade Operation with Meter Explorer

Thank You