

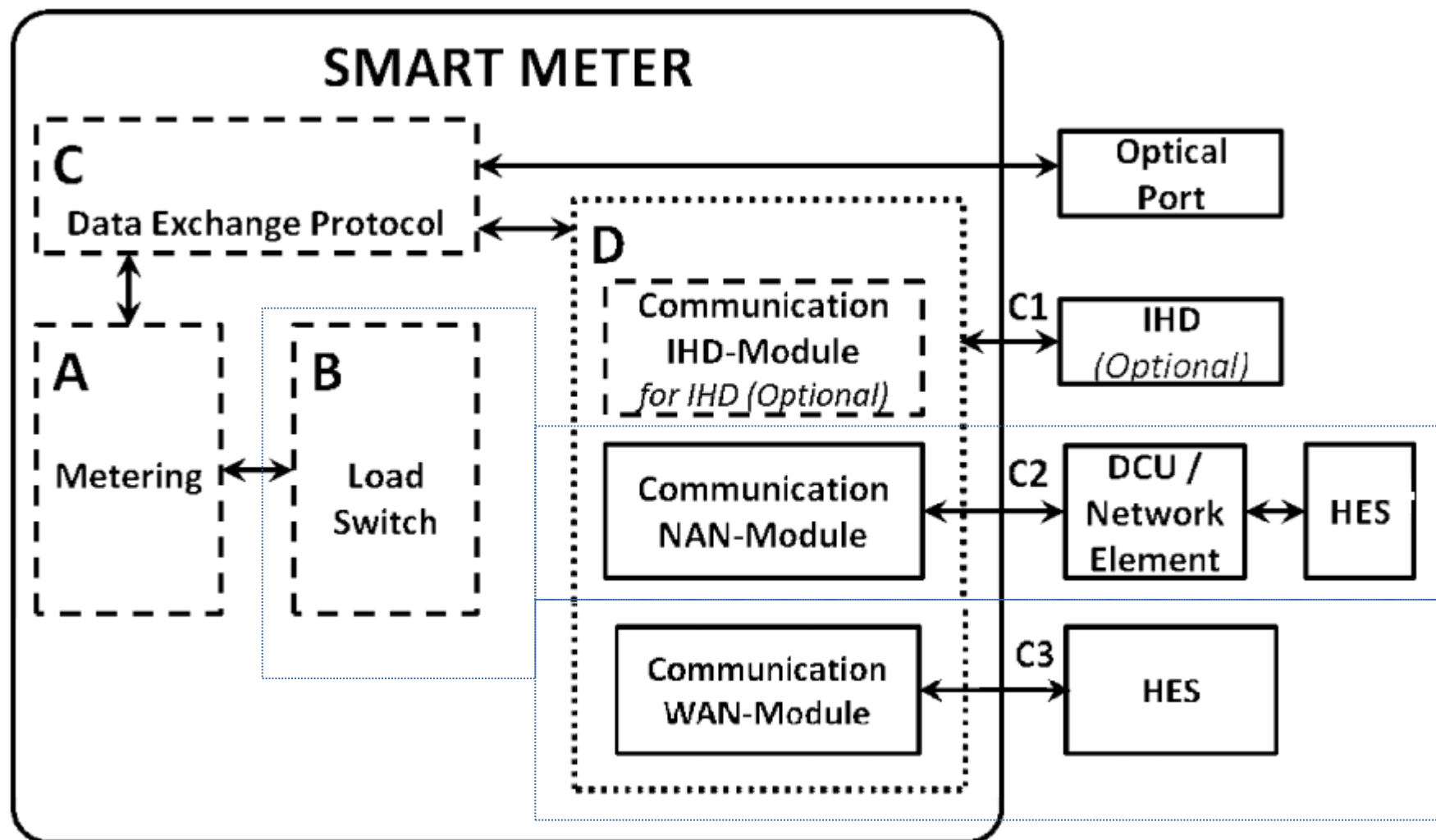
Function Evaluation Test Tool (FET) at CPRI Bangalore

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

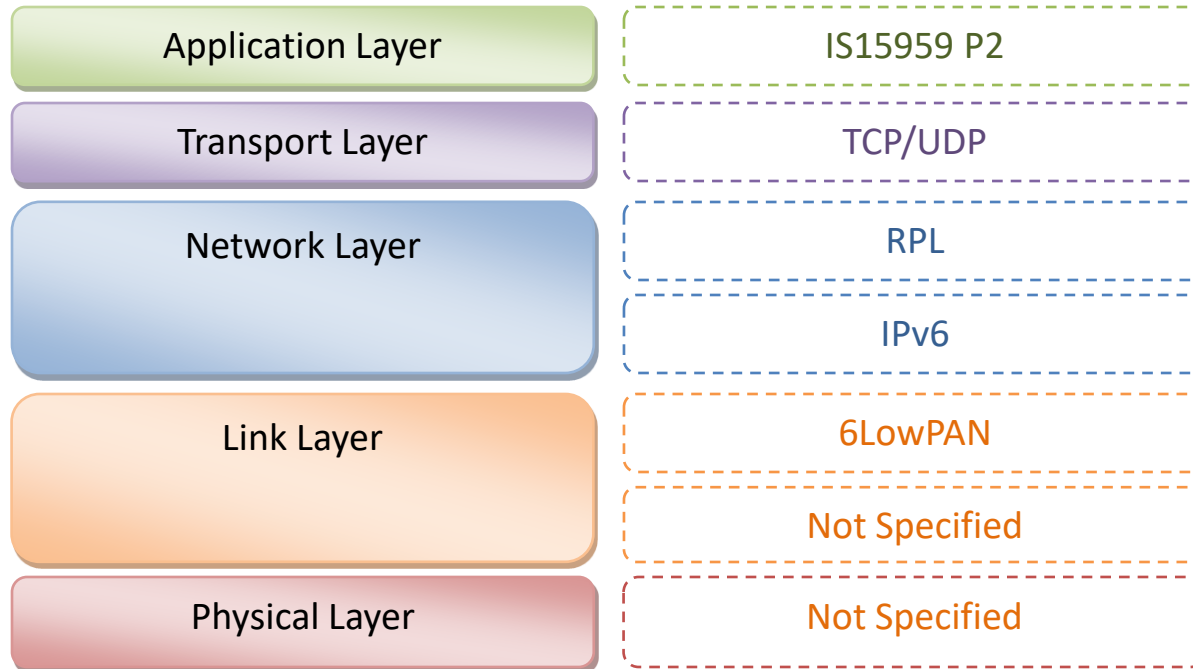
By Kamaldev K R ,Nobin Mathew
Kalki Communication Technologies Pvt Ltd

Workshop on
'Technical and Testing Challenges for Smart Meters'
2-3 November 2017, New Delhi

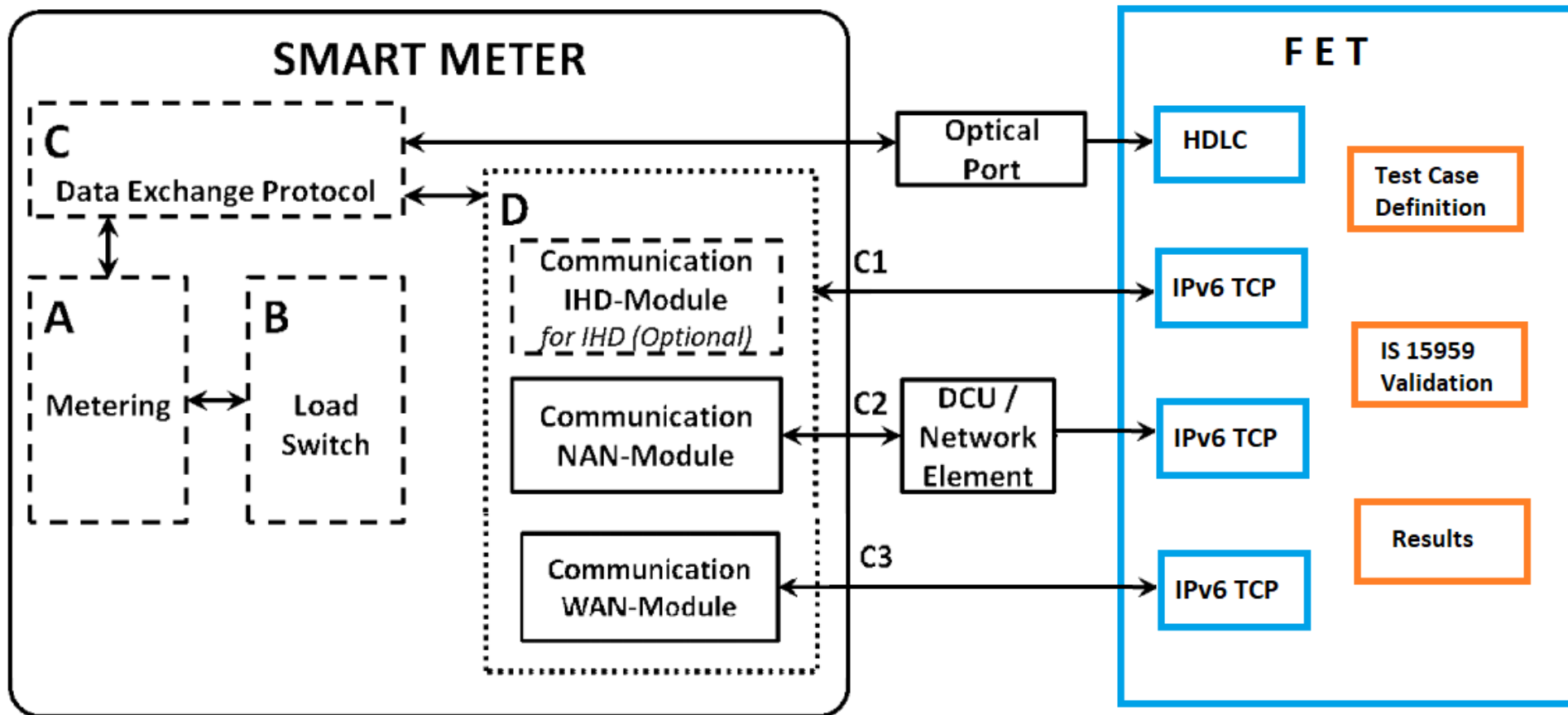
IS15959-2 & 3 Smart Meter Block Diagram



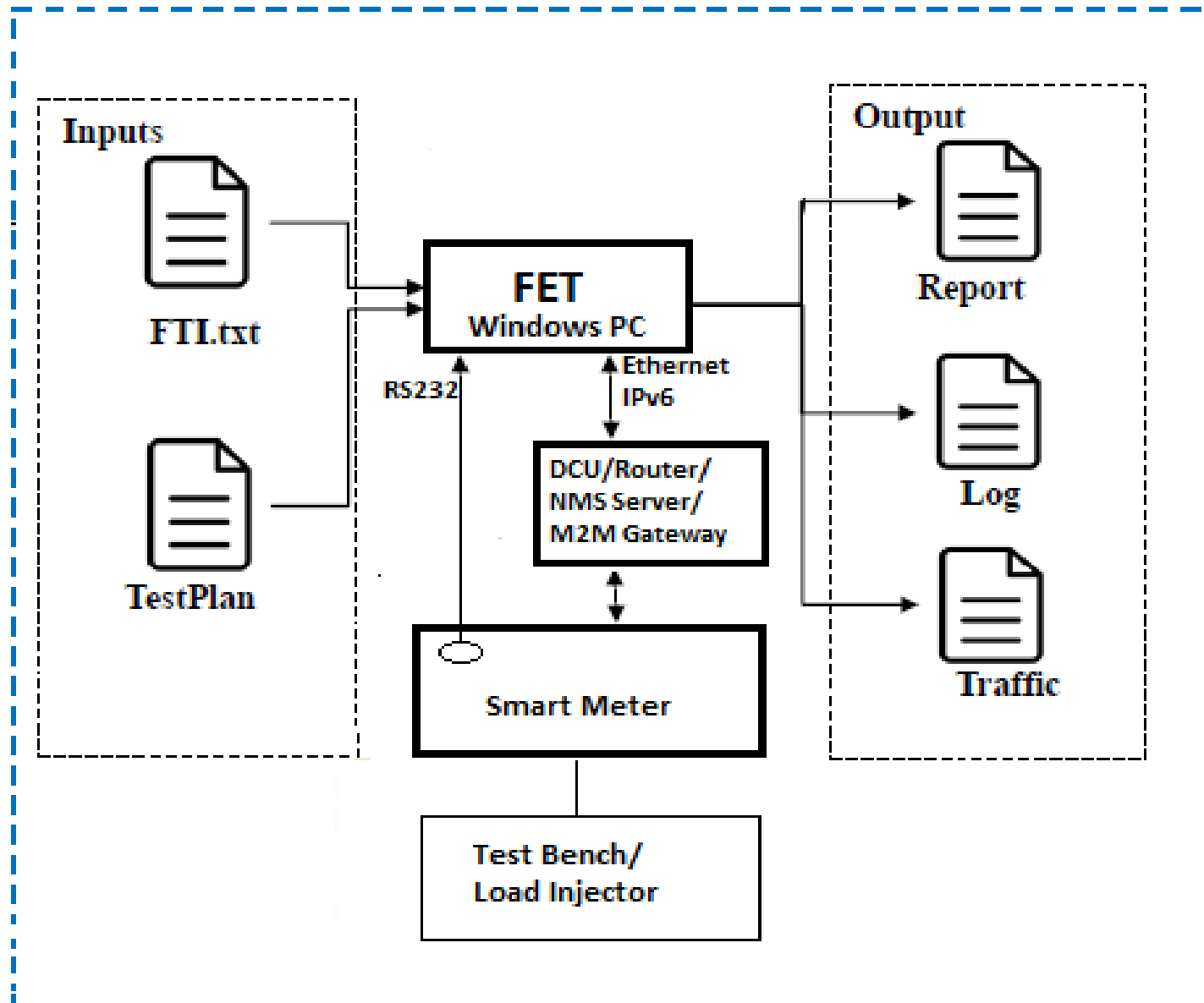
IS 16444 Communication Protocol Layers



Smart Meter – FET Interface Block Diagram



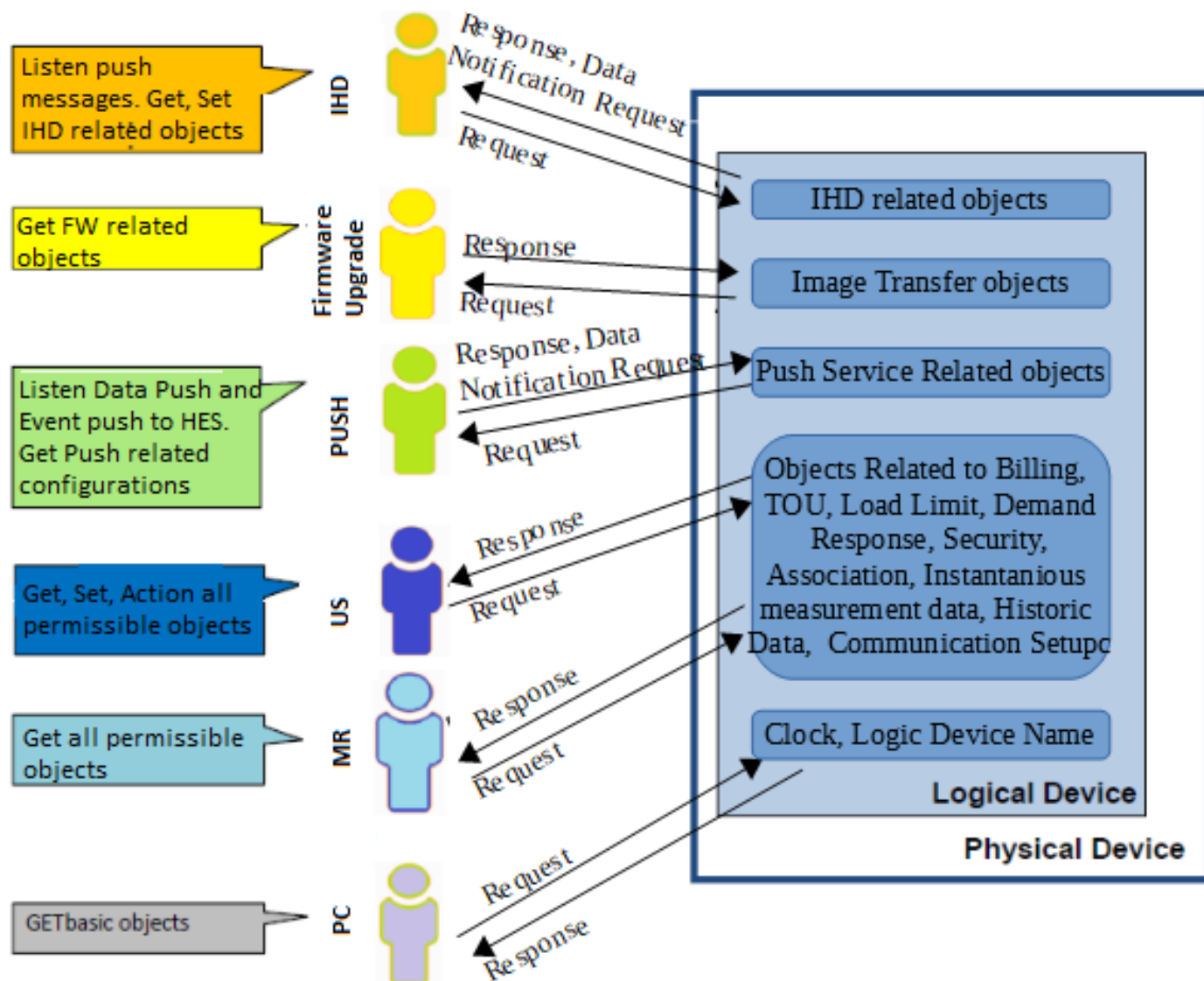
IS 15959 Functional Evaluation Test Setup



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

<input type="checkbox"/> Instantaneous parameters and profiles	<input type="checkbox"/> Name plate details
<input type="checkbox"/> Billing	<input checked="" type="checkbox"/> Programmable parameters
<input checked="" type="checkbox"/> Firmware upgrade	<input checked="" type="checkbox"/> Data notification
<input type="checkbox"/> Basic data readout	<input type="checkbox"/> Selective access
<input type="checkbox"/> ObjectList Download	<input type="checkbox"/> Event code & Event logging

☐ Select All ☐ Select None

Advanced..

Ok Cancel

Programmable Parameters

<input type="checkbox"/> TOU	<input type="checkbox"/> Current Balance Amount
<input type="checkbox"/> Billing Date time	<input type="checkbox"/> Current Balance Time
<input type="checkbox"/> Clock	<input type="checkbox"/> LLS Secret
<input type="checkbox"/> Profile Capture Period	<input type="checkbox"/> HLS Key
<input type="checkbox"/> Demand Integration Period	<input checked="" type="checkbox"/> Global Key Change
<input type="checkbox"/> Metering Mode	<input type="checkbox"/> Image Activation Single Action Schedule
<input type="checkbox"/> Payment Mode	<input type="checkbox"/> ESWF
<input type="checkbox"/> Last Token Recharge Amount	<input type="checkbox"/> MD Reset
<input type="checkbox"/> Last Token Recharge Time	<input checked="" type="checkbox"/> Load Limit
<input type="checkbox"/> Total Amount At Last Recharge	<input type="checkbox"/> 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

[illegible]

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	
<hr/>		
19: 13: 08: 293	<=== : 04 08 7D 18 33 2E 26 86 8C 8B CF 91 99 C8 00 4C C3 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 18 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 85 74 86 08 76 10 85 FA 4C 42 C1 59 AD B6 A6 41 D8 85 BC 2B F6 1D 09 87 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 18 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 85 74 86 08 76 10 85 FA 41	
	42 C1 59 AD B6 A6 41 D8 85 BC 2B F6 1D 09 87 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

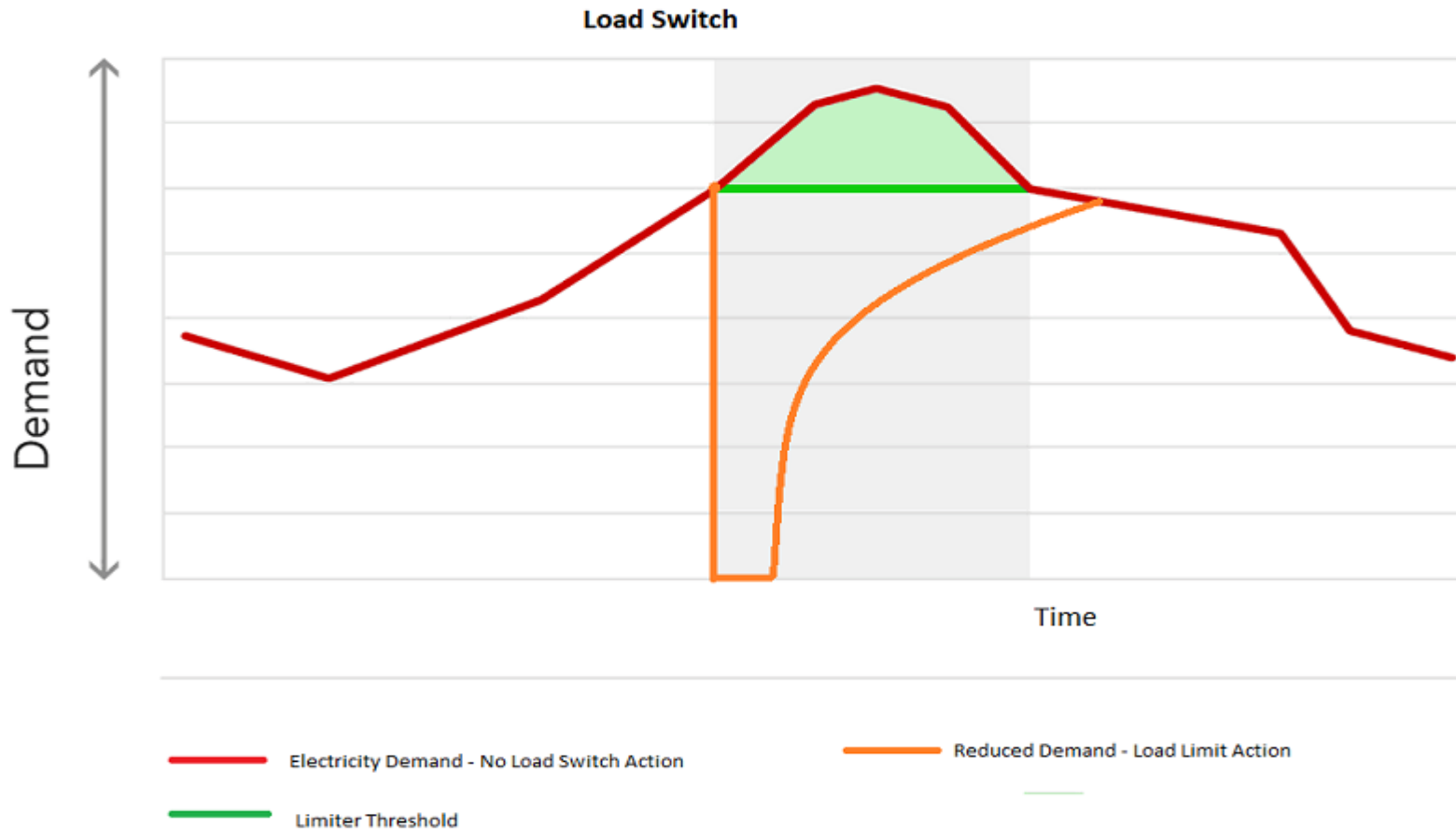
FTI		Log_Traffic		Report			
Test House		fh		IUT Serial Number		d	
Date And Time		Tue Oct 24 2:15 PM 2017		IUT Rating		d	
IUT Manufacturer Name		d		IUT Category		d	
IUT Model Name		dd		CPRI Sample Code		d	
— 1Byte Addressing test(PC Association)							
Link Layer Test							PASSED
Application Layer Associate 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 Limiter Test with Meter Explorer

METER EXPLORER

METER-1 (DLMS-TCP)

ASSOCIATION-1

Add Objectlist
Edit
Delete
Download Object List
Test Configuration

OBJECTLIST

- Billing period counter [1](0-0-0-1-0-255)
- No. of available billing periods [1](0-0-0-1-1-255)
- Time stamp of the billing period [1] VZ [last reset](0-0-0-1-2-255)
- Clock(0-0-1-0-0-255)
- Push script table(0-0-10-0-108-255)
- Push(0-0-15-0-4-255)
- Limiters(0-0-17-0-0-255)**

Demand Scan

 - 0-0-17-0-0-255_logical_name [A]
 - 0-0-17-0-0-255_monitored_value [A]
 - 0-0-17-0-0-255_threshold_active [A]
 - 0-0-17-0-0-255_threshold_normal [A]
 - 0-0-17-0-0-255_threshold_emergency [A]
 - 0-0-17-0-0-255_min_over_threshold_duration [A]
 - 0-0-17-0-0-255_min_under_threshold_duration [A]
- IEC HDLC setup(0-0-22-0-0-255)
- TCP-UDP setup(0-0-25-0-0-255)

Parameter	Value
Push obis code	0.0.0.0.0
Push Index	0
Secret Type	Visible String
Secret	
Client Maximum Receive PDU size	65535
DLMS Version	6
Quick Object List Download	Disabled
Proposed Conformance	11-block-transfer-with-get-or-read, 12-block-transfer-with-set-or-write, 19-get...
Association Object Version	0
Server Maximum Receive PDU Size	0
Negotiated Conformance	
Invocation Counter	0
Security Policy during AA establishment	No Security

Date time display format
☐ DLMS octet string ☒ dd/mm/yyyy HH:MM:ss.ff

Register values
☒ Apply scalar and unit

Name	Value	Time Stamp	DataType	Access Right
logical_name [A]	0,0,17,0,0,255	10:48:47	OCTET_STRING	Read Only
monitored_value [A]	Click Here	10:48:47	STRUCTURE	Read Only
threshold_active [A]	51840	10:48:47	DOUBLE_LONG_UNSIGNED	Read Only
threshold_normal [A]	51840	10:48:47	DOUBLE_LONG_UNSIGNED	Read Write
threshold_emergency [A]	51840	10:48:47	DOUBLE_LONG_UNSIGNED	Read Only
min_over_threshold_duration [A]	0	10:48:47	DOUBLE_LONG_UNSIGNED	Read Only
min_under_threshold_duration [A]	0	10:48:47	DOUBLE_LONG_UNSIGNED	Read Only

Date time display format
☐ DLMS octet string ☒ dd/mm/yyyy HH:MM:ss.ff

Register values
☒ Apply scalar and unit

Load Limiter Test with Meter Explorer

- ⊞ Clock(0-11-1-0-1-255)
- ⊞ Modem configuration(0-11-2-0-0-255)
- ⊞ Register monitor(0-11-16-0-1-255)
- ⊞ Register monitor(0-11-16-0-2-255)
- ⊞ Limiter(0-11-17-0-3-255)
 - 0-11-17-0-3-255_logical_name [A]
 - 0-11-17-0-3-255_monitored_value [A]
 - 0-11-17-0-3-255_threshold_active [A]
 - 0-11-17-0-3-255_threshold_normal [A]
 - 0-11-17-0-3-255_threshold_emergency [A]
 - 0-11-17-0-3-255_min_over_threshold_duration [A]
 - 0-11-17-0-3-255_min_under_threshold_duration [A]
 - 0-11-17-0-3-255_emergency_profile [A]
 - 0-11-17-0-3-255_emergency_profile_group_id_list [A]
 - 0-11-17-0-3-255_emergency_profile_active [A]
 - 0-11-17-0-3-255_actions [A]

Write

Name	Value	Time Stamp	DataType	Access Right
threshold_normal [A]	5464	19 : 08 : 04	DOUBLE_LONG	Read Write

Date time display format

☐ DLMS octet string ☒ dd/mm/yyyy HH:MM:ss.ff

Register values

☒ Apply scalar and unit

- ⊞ Event Status Word(0-0-94-91-18-255)
- ⊞ EventStatusWordFilter(0-0-94-91-26-255)
- ⊞ Device ID 1, manufacturing number(0-0-96-1-0-255)
- ⊞ Device ID(0-0-96-1-1-255)
- ⊞ Device ID(0-0-96-1-4-255)
- ⊞ No. of configuration program changes(0-0-96-2-0-255)
- ⊞ Disconnect control(0-0-96-3-10-255)
 - 0-0-96-3-10-255_logical_name [A]
 - 0-0-96-3-10-255_output_state [A]
 - 0-0-96-3-10-255_control_state [A]
 - 0-0-96-3-10-255_control_mode [A]
 - 0-0-96-3-10-255_remote_disconnect(data)
 - 0-0-96-3-10-255_remote_reconnect(data)

Demand Scan

Name	Value	Time Stamp	DataType
logical_name [A]	0,0,96,3,10,255	10 : 48 : 47	OCTET_STRING
output_state [A]	1	10 : 48 : 47	BOOLEAN
control_state [A]	1	10 : 48 : 47	ENUM
control_mode [A]	6	10 : 48 : 47	ENUM
remote_disconnect(data) [M]	0	10 : 48 : 47	INTEGER
remote_reconnect(data) [M]	0	10 : 48 : 47	INTEGER

IS15959-2 & 3 Specific Test Cases

Advanced Security Test

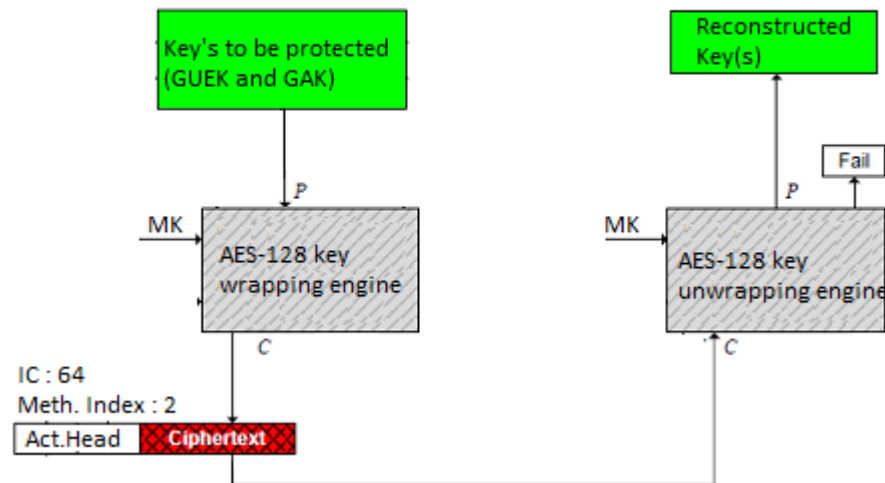
Objectives

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

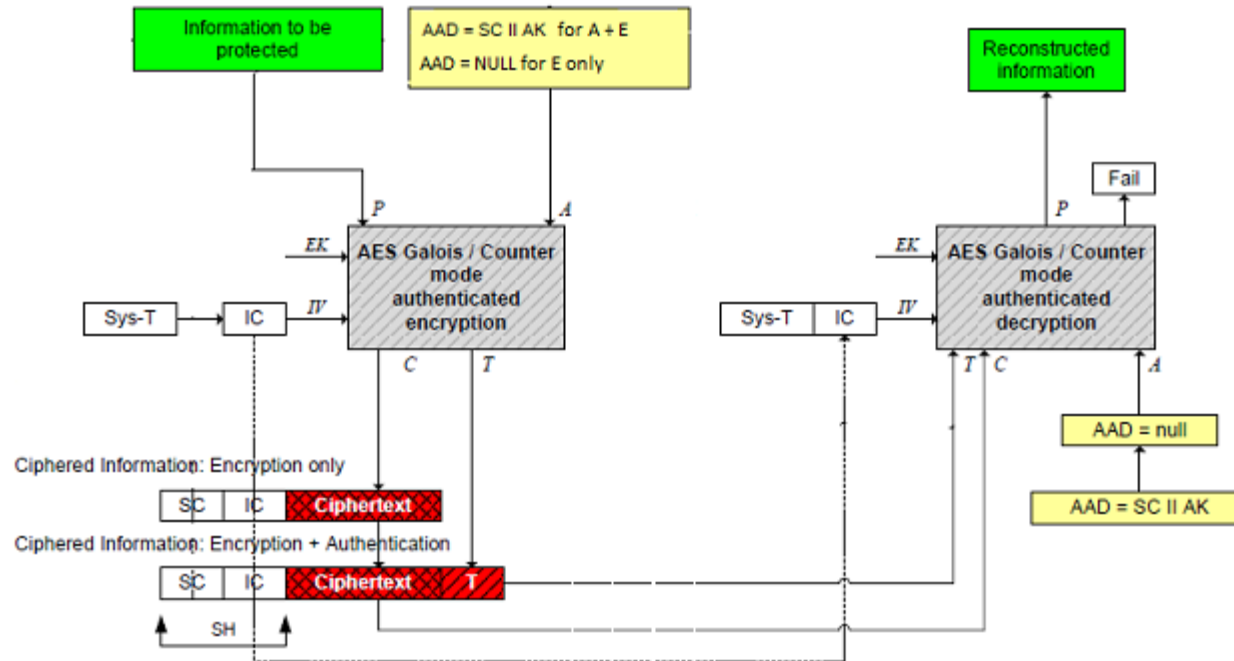
Requirements for security

- 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

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

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

The screenshot displays the Meter Explorer application interface. On the left, a tree view shows a hierarchy of security settings. The 'Security setup(0-0-43-0-2-255)' node is selected, revealing a list of sub-entries: '0-0-43-0-2-255_logical_name [A]', '0-0-43-0-2-255_security_policy [A]', '0-0-43-0-2-255_security_suite [A]', '0-0-43-0-2-255_client_system_title [A]', '0-0-43-0-2-255_server_system_title [A]', '0-0-43-0-2-255_security_activate [M]', and '0-0-43-0-2-255_global_key_transfer [M]'. On the right, a table displays the values for the selected node's properties:

Name	Value	Time Stamp
logical_name [A]	0,0,43,0,2,255	20 : 39 : 32
security_policy [A]	0	20 : 39 : 32
security_suite [A]	0	20 : 39 : 32
client_system_title [A]		20 : 39 : 32

A 'Key transfer' dialog box is open in the foreground. It features a 'Key ID' dropdown menu set to '(2) authentication key'. Below this, there are radio buttons for 'Unwrapped Key' (selected) and 'Wrapped Key'. The 'New key (Plain)' field contains 'MASTER_KEY_AAA' and the 'Master Key' field contains 'ENC_AUTH_KEY_AB'. Both fields have a dropdown menu set to 'ASCII'. 'Apply' and 'Cancel' buttons are at the bottom right. At the bottom of the dialog, a red 'Key ID' label is followed by the text: 'User shall enter Key ID to specify the key type.'

The bottom of the Meter Explorer window shows a 'Traffic View' tab and a 'Event/Data Notification' tab. Below these are checkboxes for 'Physical Layer', 'Link Layer', 'Transport Layer', 'Application Layer', and 'Enable Comments', all of which are checked. To the right of these checkboxes are buttons for 'Log To File', 'Clear', and 'Pause'.

IS15959-2 & 3 Specific Test Cases

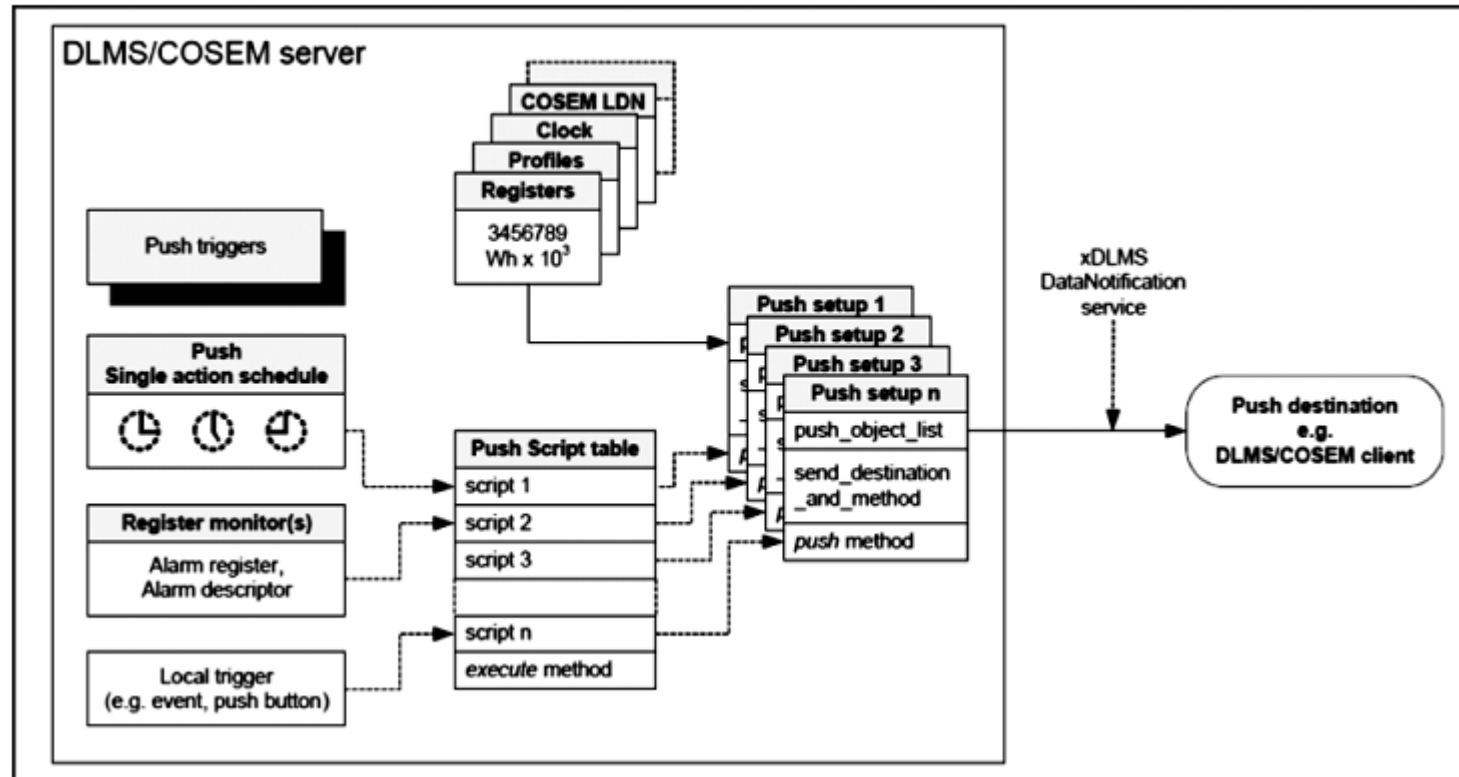
DataNotification Test

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

The screenshot displays the Meter Explorer application interface. On the left, a tree view shows a hierarchy of objects under 'METER-2 (DLMS-TCP)' and 'METER-3 (DLMS-TCP)'. The object 'PUSH_OBJECT_0-4-25-9-0-255' is selected. The main pane shows details for this object, including a table with columns: Name, Value, Time Stamp, and Data Type.

Name	Value	Time Stamp	Data Type
PUSH_OBJECT_0-4-25-9-0-255	Click Here	2017-10-25T10:32:16.68	STRUCTURE

A sub-window titled 'PUSH_OBJECT_0-4-25-9-0-255' is open, showing a detailed view of the object's structure. It includes a tree view on the left and a table on the right.

Name	Value	Data Type
L1_Subvalue[0]	LINTER300 PRIDE	VISIBLE_STRING
L1_Subvalue[1]	0,4,25,9,0,255	OCTET_STRING
L1_Subvalue[2]	7/13/2017 12:49:59 PM	OCTET_STRING
L1_Subvalue[3]	00000000000000000000000000000000...	BIT_STRING

At the bottom, the 'Event/Data Notification' tab is active, showing a table of events.

TimeStamp	Type	Meter	OBIS	IC	Attribute
5/10/2017 10:45:59	PUSH	METER-3	0,0,25,9,0,255		
5/10/2017 10:45:19	PUSH	METER-3	0,0,25,9,0,255		

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

The screenshot displays the Meter Explorer application interface. On the left, a tree view shows the 'Image transfer(0-0-44-0-0-255)' node selected. The right pane shows a table of variables for this node:

Name	Value	Time Stamp
logical_name [A]	0,0,44,0,0,255	20 : 39 : 32
image_block_size [A]	467	20 : 39 : 32

An 'Image Transfer' dialog box is open, showing the following settings:

- Choose image file: C:\Program Files (x86)\Kalkitech\Meter Explor...
- Image identifier string type: ☒ ASCII ☐ Decimal
- Image identifier string: TEST_IMAGE
- Read Image block size from meter: ☒ Yes ☐ No
- Image block size: (empty field)
- Buttons: Transfer

At the bottom, the 'Traffic View' tab is active, showing a list of events:

TimeStamp	Meter	Data
20 : 40 : 58	METER-1	COSEM OUT DATA
20 : 40 : 58	METER-1	====>Tx 62 03 80 01 00
20 : 40 : 58	METER-1	SENDING WRAPPER FRAME
20 : 40 : 58	METER-1	====>Tx 00 01 00 10 00 01 00 05 62 03 80 01 00
20 : 40 : 58	METER-1	RECEIVED WRAPPER FRAME

