

### **Suggestive Use cases and integration interfaces for Smart Grid Pilot Projects by India Smart Grid Forum(ISGF)**

The Similar approach, as adopted globally, has also been adopted while developing the enclosed use cases and integration interfaces document. The base document with smart grid use cases and integration interfaces thus prepared went through a series of iterations i.e Invited for comments from members of India Smart Grid Forum and ISGTF and a five day workshop where-in few utilities, ISGTF and other stake holders participated and each and every point deliberated upon to arrive at an exhaustive list which is relevant to Indian context.

The enclosed document is output of these deliberations and iterations, and is expected to help utilities implement smart grid technologies and the appropriate use cases/ business scenarios with interoperability aspects duly considered. The use cases and integration interfaces have been grouped into following areas - Advanced Metering Infrastructure, Peak Load Management, Outage Management, Power Quality, Distributed Generation/ Renewable Integration, Micro grids etc.

The use cases cover various business scenarios, the information exchange/ integration interfaces between relevant technologies. For instance, load control can include various business scenarios like load control during peak shortage, or supply disconnect due to tamper event recording.

For these use cases to be covered by smart grid technologies, information needs to be exchanged across system (covered as integration interfaces), this scenario illustrated below:

Information flow from head-end to meter data management – details like meter number, tamper code, occurrence date and time

Information flow from meter data management to billing system and notifying utility personnel – meter number, consumer number and address, tamper details

Analysis identifies this as a case for immediate disconnection and information flows back from meter data management to head-end – meter number, command to be initiated (disconnect), event trigger time (immediate in this case)

The document covers such use cases and integration interfaces in detail, and are aligned with the business objectives of planned smart grid pilot projects. The use cases and integration interfaces are suggestive in nature and details can be seen in the hyperlinks mentioned above

## Integration Interfaces for Acquiring Meter Data

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Multiple Clients Read Demand and Energy Data Automatically from Customer Premises	Meter Data Management	Requesting meter data	Requesting instantaneous, interval and events data from the meters and create profile in Billing. Portal services to view energy data	Meter Data Management	Head-end, CIS/CRM	IEC 61968 Part 9, 11	Meter Number, Scheduled Reading date and time, Period for which data needed
	Meter Data Management	Acquiring meter data	Acquiring instantaneous, interval and events data from the meters by head-end which then reaches Meter Data Management system.	Head-end	Meter Data Management	IEC 61968 Part 4, 9,11	Meter number, Reading date and time, reading parameters (KWh, KVAh, KW etc.)
	Load forecasting	Meter data for load forecasting	Load forecasting system needs meter data for finer load forecasting	Meter Data Management	Load Forecasting/A analytics	IEC 61968	Connected DT, meter reading date and time, reading parameter (KW, KVA)
	Meter	Meter sending the consumption data	Meter at scheduled frequency sends the data to head-end (could be through the DCU if solution is defined so). Consumption details will be 15 minute block data, and data could be incremental to what was sent by meter in the preceding instance	Meter	Head-end		Meter number, reading date and time, KW, KVA, KWH, KVAH, PF
	Meter	Meter sending the billing data	Meter at scheduled frequency sends the billing data to head-end (could be through DCU if solution defined so)	Meter	Head-end		Meter number, reading date and time, KW, KVA, KWH, KVAH, PF

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Utility detects tampering or theft at customer site	Head-end	Capturing tamper events	The tamper events captured by meter are sent to head-end which in turn reaches meter data management for further action.	Head-end	Meter Data Management	IEC 61968	meter number, tamper code/description, tamper occurrence date and time
		notifying utility personnel for immediate site inspection	The meter data management system immediately sends high priority alerts to utility personnel for necessary action as per rules	Meter Data Management	CIS, Enterprise Asset Management System, Email/SMS,	IEC 61968	Customer number, meter number, tamper code, address (in case of interface with Email/SMS gateway), event date and time
		Meter sending the events data	Meter is sending the high priority events to head-end as and when occurred	Meter	Head-end		Meter number, event date and time, event code/description
		Meter sending the non-critical events data	Meter is sending the non-critical events data to head-end as per scheduled frequency.	Meter	Head-end		Meter number, event date and time, event code/description
		Disconnecting connection	As soon a valid tamper event or malfunctioning is detected, connection is disconnected.	Meter Data Management	Head-end, CIS	IEC 61968	Customer number, meter number, action to be triggered (disconnect), action date and time
		Disconnecting connection at meter level	Head-end sends the disconnect command to the meter (could be through the DCU if the solution is defined so)	Head-end	Meter		Meter number, action (disconnect)
		Re- Connecting connection	Once the pre-programmed disconnecting tamper event is NORMAL meter shall automatically perform re-connection and send the notification to HES .	Meter	Head-end		Meter number, action (connect)
		Re-connecting connection at meter level	Head-end sends the re-connect command to the meter (could be through the DCU if the solution is defined so)	Head-end	Meter		Meter number, action (re-connect)

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
		Invoicing customer based on tamper	Once the tamper event is confirmed after some analysis, customer is invoiced for the tamper/theft. For tamper related details to be available in customer information system	Meter Data Management	Customer Information system	IEC 61968	Customer number, meter number, tamper code/description, tamper occurrence date and time
Missed interval readings	Head-end	Missed reading / Gap reconciliation scenario	Missed Interval and Reads Data (Gap Reconciliation)	Head-end	Meter Data Management , CIS	IEC 61968	Meter number, readings with date and time
	Head-end	Missed interval readings acquisition	On identifying the missed interval, head-end will re acquire the data for the missing period from meter	Head-end	Meter		Meter number, from date and time, to date and time (for which data is missing)
	Meter	Missed interval readings sent by meter	On receiving the data request command from meter, meter will send the data to head-end	Meter	Head-end		Meter number, reading date and time, KW, KVA, KWH, KVAH
Power outage events	Head-end	Power Outage / restoration events to Outage management if OMS subscribed from HES for these events.	Power Outage and Restoration Notification (if OMS subscribed for events)	Head-end	OMS	IEC 61968	Meter number, Outage/ Restoration Date and Time, Power On Off count
	Meter Data Management	Power outage information to CIS/CRM	Power Outage and Restoration Notification	Meter Data Management	CIS/CRM	IEC 61968	Meter number, Outage/ Restoration Date and Time, Power On Off count
Voluntary meter reading	CIS/CRM	Customer providing the meter reading	Instantaneous Meter Read (status and data)	CIS/CRM	Meter Data Management	IEC 61968	Meter Number, Readings details, Read Date and time

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Remote maintenance		Firmware Upgrade, Remote programming	User shall be able to maintain the AMI system by remotely programming the system parameters, upgrading the system with new firmware	Meter Data Management, Head-end	Meter		Meter and network equipment firmware, programs etc.

## Integration Interfaces for Load Management

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Utility remotely limits usage and/or connects and disconnects customer	Peak Load Management	Remote load setting	Utility identifies shortage in load, and hence invokes remote load limiting or disconnects customer based on some analysis done by a peak load management system	Peak Load management system	Meter Data Management	IEC 61968	Customer number, meter number, action to be triggered (load restriction, disconnection etc.), action date and time, audit information
	Meter Data Management	Remote load setting	The request received from peak load management system is recorded and passed on to the head-end system for further action	Meter Data Management	Head-end	IEC 61968	Customer number, meter number, action to be triggered (load restriction, disconnection etc.), action date and time
Demand side management	Meter Data Management	Schedule meter reading data to Demand response program	15 minute interval Meter data	Meter Data Management	Demand Response	IEC 61968	Meter number, date and time of intervals, register data
	Demand response	Demand response action confirmation to MDM	Confirm for action taken for demand response	Demand Response	Meter Data Management	IEC 61968	Meter Number, Data and time, Demand response action
	Meter Data Management	Loading / Consumption data to target specific consumer for demand response.	Historical Customer Load Profile	Meter Data Management	Demand Response	IEC 61968	Meter number, load profile data for specified duration
Load monitoring at demand side	Meter Data Management	Midnight read scenarios	Daily Meter Reading, Status and associated details	Meter Data Management	CIS/CRM	IEC 61968	Meter number, date and time of daily reads, register data

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
	Meter Data Management	Customer consumption information to CIS/CRM	Customer consumption data, TOU details, real time trends	Meter Data Management	CIS/CRM / analytics	IEC 61968	Meter number, date and time of daily reads, register data
	Meter Data Management	Load profile data to CIS / CRM /Analytic application	Load profile Details	Meter Data Management	CIS/CRM /Analytics	IEC 61968	Meter number, date and time of intervals, register data
	Meter	Load violation event information to control center	When there is a load violation event recorded in the meter, the information is sent to the control center	Meter	Head-end		Meter number, max demand, date and time of load violation
	Meter						
Meter disconnection/reconnection	Meter Data Management	Reconnecting meter Connect/disconnect switch for supply restoration	Meter Connect operation	Meter Data Management	Head-end	IEC 61968	Meter number, group of meters, instruction to close switch
	Meter Data Management	Disconnecting meter connect / disconnect switch to break electric supply to customer	Meter Disconnect operation	Meter Data Management	Head-end	IEC 61968	Meter number, group of meters, instruction to open switch
	Meter Data Management	Get Current status of Meter Connect / Disconnect switch/relay.	Connection Status Update Request	Meter Data Management	Head-end	IEC 61968	Meter number, group of meters, switch status
Reconnect customer after making defaulted payment	CIS	Reconnect the meter after making payment	Customer is to be reconnected after he makes the payment	CIS	Meter Data Management		Customer number, meter number

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
		against default					
	CIS	Reconnect the meter after making payment against default	Customer is to be reconnected after he makes the payment	Meter Data Management	Head-end		Meter number, action (reconnect)
	CIS	Reconnect the meter after making payment against default	Customer is to be reconnected after he makes the payment	Head-end	Meter		Meter number, action (reconnect)
New meter installed at site	Meter management	Meter installation scenarios	Energization (The trigger showing the meter has energy flowing through)	Meter Management	Head-end	IEC 61968	Meter number, Energization date and time
	Head-end	Meter reading scenarios	Meter Read/commissioning/sync Failures	Head-end	Meter Data Management	IEC 61968	Meter number, date of last successful readings received, last logged date and time

## Integration Interfaces for Tampering (also covered in section on Acquiring Meter Data)

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
<b>AMI System detects alerts, events or tampering at customer site</b>	Head-end	Capturing tamper events	The tamper events captured by meter are sent to head-end which in turn reaches meter data management for further action.	Head-end	Meter Data Management	IEC 61968	Customer number, meter number, tamper code/description, tamper occurrence date and time
		notifying utility personnel for immediate site inspection	The meter data management system immediately sends high priority alerts to utility personnel for necessary action	Meter Data Management	Email/SMS/CRM	IEC 61968	Customer number, tamper code, address, event date and time
		Disconnecting connection	As soon a valid tamper event is detected, connection is disconnected.	Meter Data Management	Head-end	IEC 61968	Customer number, meter number, action to be triggered (disconnect), action date and time
		Invoicing customer based on tamper	Once the tamper event is confirmed after some analysis, customer is invoiced for the tamper/theft. For tamper related details to be available in customer information system	Meter Data Management	Customer Information system	IEC 61968	Customer number, meter number, tamper code/description, tamper occurrence date and time

## Integration Interfaces for Consumer Portal

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
<b>Customers having access to consumption details</b>	CIS/CRM	Provide Customer information to MDM for portal purpose	Customer Data ( Person & Account, Premises and Service Points)	CIS/CRM	Meter Data Management	IEC 61968	Person & Account, address and K Number
	CIS/CRM	Customer load information for exception / theft / Revenue loss scenarios identification	Customer Approved Load Information	CIS/CRM	Meter Data Management	IEC 61968	K Number, Meter Number and Load details
		Customer request for temporary disconnection / re-connection	Operational Command: Connect & Disconnect	CIS/CRM	Meter Data Management	IEC 61968	K Number, Meter Number and Connect / Disconnect command

## 6.1 Integration Interfaces for Smart Metering System Maintenance

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Time synchronization	Head-end	Sync up network device time and other information	Sync up of meters /data concentrators/ master data and Network Hierarchy in case of installation of new meters / data concentrators	Head-end	Meter Data Management	IEC 61968	Network identification information including data concentrators
Metering network changes	Head-end	Network updation / meter-concentrator mapping change scenarios	Change in Meter / Concentrator Network Hierarchy	Head-end	Meter Data Management	IEC 61968	Network identification information including data concentrators
Meter maintenance	Meter Data Management	Field service request	Create Field Service Order (FSO) Request for Meter trouble or exception	Meter Data Management	CIS/CRM	IEC 61968	Meter Number, Problem description
	Meter Data Management	Device events update to CIS/CRM for further update to customer	Device Events	Meter Data Management	CIS/CRM	IEC 61968	Meter number, Date and Time, event type & name, priority
	Meter Data Management	On-demand read scenarios	Instantaneous Meter Reading Request	Meter Data Management	Head-end	IEC 61968	Meter Numbers, Reading duration
Remote firmware upgrades/ meter configuration changes	Meter Data Management	Remote configuration scenarios	Configuration Commands: Change tariff parameters, Synchronize clock, Registers reset (status, maximum, tampering...)	Meter Data Management	Head-end	IEC 61968	meter number, tariff parameters, registers status, event type and priority
	Meter Data	Power Outage /	Power Outage and	Meter Data	OMS	IEC 61968	Meter number, Outage/

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
	Management	restoration events to Outage management if OMS subscribed from MDM for these events.	Restoration Notification	Management			Restoration Date and Time, Power On Off count

## Integration Interfaces for Outage Management

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
Customer connection has an outage	Meter	Meter notifies the outage/restore event	The outage/restore event recorded by meter is sent to head-end as and when event occurs	Meter	Head-end		Meter number, event date and time, event (outage/restoration)
	Head-end	Meter outage scenarios	Power Outage Notification (PON)	Head-end	Meter Data Management	IEC 61968	Meter number, Outage Date and Time, Power On Off count
Customer connection restores from outage	Head-end	Power restoration scenario	Power Restoration Notification (PRN)	Head-end	Meter Data Management	IEC 61968	Meter number, Restoration Date and Time, Power On Off count
	OMS	Reading request from OMS system to identify service restoration	Receive Operational Command from OMS like Instantaneous Meter Read etc..	OMS	Meter Data Management	IEC 61968	Meter Number, Readings details, Read Date and time
	Meter	Meter notifies the outage/restore event	The outage/restore event recorded by meter is sent to head-end as and when event occurs	Meter	Head-end		Meter number, event date and time, event (outage/restoration)
Distribution Grid Control and Monitoring	Distribution SCADA	Control and Monitoring	Telemetry of analog/ digital field Signals and control of field equipment	Station Gateway, FRTUs, FPIs, Energy Meters, Numerical Relays etc.	Distribution SCADA	Standard protocols like IEC-61850, IEC-104, IEC-103, DNP3, Modbus	Voltage, Current, Equipment Status, frequency, protection signals
Distribution Control Center has a view of the transmission system and other	Distribution SCADA	Grid Monitoring	Exchange of Data with other SCADA systems	Transmission SCADA	Distribution SCADA	ICCP	Equipment status, analog values, grid frequency, MU's sent, MU's received

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
interconnected systems							
Utility plans to estimate the load flow in areas where analog data is unavailable (by utilizing the available data)	Distribution SCADA, DMS	State Estimation	Run the state estimation algorithm and identify the possible load flow in certain areas of the distribution grid	SCADA (Analog values and Equipment status)	DMS – State Estimation Application		Feeder code, equipment status, voltage, current
			Fault Isolation and Service Restoration	SCADA (FPI & equipment status and control, analog values) WFM (remote updation by field crew)	DMS – FISR application, OMS	CIM or other acceptable standard	
Volt Var Monitoring and Management			Volt Var Management	SCADA (Cap Bank control, OLTC control etc.)	DMS – Volt VAR Control application	CIM or other acceptable standard	
Effective Load Management and Distribution	Distribution Management System	Feeder Reconfiguration	Reconfigure the feeders and Normal Open Points based on system loading pattern	SCADA (RMU/Isolator status and control)	DMS – Feeder Reconfiguration application	CIM or other acceptable standard	Analog values – Load, Voltage, Current
Restoring network to normal configuration through switch operation	Distribution Management System	Switch order management	Create switch order sequence based on the configuration to be incorporated, and do the necessary action in the field manually	DMS/OMS	Work Force Management / EAM	CIM or other acceptable standard	Feeder code, switch status, date and time of action
Network topology is synchronized in	Geographical Information	Network topology	GIS is considered to be the primary source of network	GIS	DMS, OMS, WFM	CIM or other acceptable	Network connectivity data – feeder to DT, DT

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
all systems	System	synchronization	topology. This topology data is needed by other systems for proper functioning.			standard	to customer
Utility monitors the reliability indices on daily basis	Performance Management System	Performance Management	System reliability data is acquired from multiple utility systems like customer management, SCADA/DMS etc. to calculate the reliability indices.	SCADA, DMS, OMS, Customer Management	Performance Management System	CIM or other acceptable standard	Outage details, billing and collection details, equipment failure details
Network reconfiguration changes to be updated into relevant systems	SCADA/DMS	Network reconfiguration changes	Network configuration changes to flow from SCADA/DMS to GIS	SCADA/DMS	GIS	CIM or other acceptable standard	Feeder number/code, reconfiguration date and time, change in input feeder DT number/code, reconfiguration date and time, change in input feeder
		Network reconfiguration changes	Network configuration changes needed to calculate energy accounting	GIS	Energy Accounting	CIM or other acceptable standard	Feeder number/code, reconfiguration date and time, change in input feeder DT number/code, reconfiguration date and time, change in input feeder
Utility identifies single light out customers	Outage Management System	Identify single light out consumers	Based on outage events captured by AMI, and relating it to transformer and feeder status, utility tries to identify single light out customers	AMI	OMS	CIM or other acceptable standard IEC 61968	Meter number, connected DT, connected feeder, consumer number, outage time and duration
	Outage Management	Identify single light out		DMS	OMS	CIM or other acceptable	Feeder number, feeder status

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
	System	consumers				standards IEC 61968/61970	
Database for Distribution SCADA	Distribution SCADA	Network Model	Distribution Network Model and Land Base data	GIS	Distribution SCADA	IEC 61968-1 or any native format of GIS	SLD, Network Model, Interconnection system
CIS	Distribution SCADA	Circuit Breaker Status table	real-time status of all Circuit breakers, date & time of tripping, cause of tripping, Expected duration of outage	ISR	Customer Care	CIM/XML or any other standard	Circuit breaker status table
Billing System	Distribution SCADA	Daily Energy Values	daily energy values for 15 minute blocks / one hour blocks of a day & shall be stored for each feeder on daily basis alongwith quality codes.	ISR	Billing	CIM/XML or any other standard	Daily energy values fpr each feeder for 15 mins block.
Digital Data Polling from Substation / RMUs	Distribution SCADA	Digital Status update	Digital Status from RTU should be updated within 4 secs and 6 secs from FRTU.	Substation Automation, FEEDER Automation	Distribution SCADA	IEC 60870-5-104	Digital Status
Analog Data Polling from Substation / FRMU	Distribution SCADA	Analog status update	Analog Status from RTU should be updated within 5 secs and 10 secs from FRTU	Substation Automation, FEEDER Automation	Distribution SCADA	IEC 60870-5-104	Analog Status
Distribution Grid Control and Monitoring	Distribution SCADA	Control and Monitoring	Telemetry of analog/ digital field Signals and control of field equipment	Station Gateway, FRTUs, FPIs, Energy Meters, Numerical Relays etc.	Distribution SCADA	Standard protocols likea) IEC-104 for Communication between RTU/FRTU to SCADA/DMS Control Centre. b) IEC-61850,IEC-103	Voltage, Current, Equipment Status, frequency, protection signals.

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
						for Communication between Numerical Relays and RTU c) Modbus for MFT communicating with RTU/FRTU	
DistributionControl Center has a view of the transmission system and other interconnected systems Data Recovery	Distribution SCADA	Grid Monitoring	Exchange of Data with other SCADA systems	Transmission SCADA	Distribution SCADA	ICCP / FTP (for DR)	Equipment status, analog values, grid frequency, MU's sent, MU's received
Utility plans to estimate the load flow in areas where analog data is unavailable (by utilizing the available data)	Distribution SCADA, DMS	State Estimation	Run the state estimation algorithm and identify the possible load flow in certain areas of the distribution grid	SCADA (Analog values and Equipment status)	DMS – State Estimation Application		Feeder code, equipment status, voltage, current
			Fault Isolation and Service Restoration	SCADA (FPI &equipment status and control, analog values) WFM (remote updation by field crew)	DMS – FISR application, OMS	CIM or other acceptable standard	
Volt Var Monitoring and Management			Volt Var Management	SCADA (Cap Bank control, OLTC control	DMS – Volt VAR Control application	CIM or other acceptable standard	

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
				etc.)			
Effective Load Management and Distribution	Distribution Management System	Feeder Reconfiguration	Reconfigure the feeders and Normal Open Points based on system loading pattern	SCADA (RMU/Isolator status and control)	DMS – Feeder Reconfiguration application	CIM or other acceptable standard	Analog values – Load, Voltage, Current
Restoring network to normal configuration through switch operation	Distribution Management System	Switch order management	Create switch order sequence based on the configuration to be incorporated, and do the necessary action in the field manually	DMS/OMS	Work Force Management / EAM	CIM or other acceptable standard	Feeder code, switch status, date and time of action
Network topology is synchronized in all systems	Geographical Information System	Network topology synchronization	GIS is considered to be the primary source of network topology. This topology data is needed by other systems for proper functioning.	GIS	DMS, OMS, WFM	CIM or other acceptable standard	Network connectivity data – feeder to DT, DT to customer
Network reconfiguration changes to be updated into relevant systems	SCADA/DMS	Network reconfiguration changes	Network configuration changes to flow from SCADA/DMS to GIS	SCADA/DMS	GIS	CIM or other acceptable standard	Feeder number/code, reconfiguration date and time, change in input feeder DT number/code, reconfiguration date and time, change in input feeder
		Network reconfiguration changes	Network configuration changes needed to calculate energy accounting	GIS	Energy Accounting	CIM or other acceptable standard	Feeder number/code, reconfiguration date and time, change in input feeder DT number/code, reconfiguration date and time, change in input feeder
OMS Database	OMS	Network Model	Distribution Network Model,	GIS	OMS	IEC 61968-1 or	Distribution Network

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
			Consumer data and Equipment data			any native format of GIS	Model, Equipment data, Consumer data Interconnection system
Real Time Data for OMS	OMS	Real Time Analog Information and Digital Status	real-time status of all Circuit breakers, date & time of tripping, cause of tripping, Expected duration of outage, Analog Values from MFTs	SCADA	OMS	CIM/XML or ICCC	Realtime Analog information and Digital Status.
Customer Care System	OMS	Restoration time and customers affected	Restoration time, type of Outage, customers affected	OMS	Customer Care	CIM/XML or ODBC or any other standard	Restoration time, type of Outage, customers affected
Mobile Workforce Management	OMS	Assignment of Crews	assign a service crew for restoration and equipment to crew for repair	OMS	MWFM	CIM/XML or ODBC or any other standard	Crew assignment and equipments available with Service crew
Summary of currently outaged equipment and customers	OMS	Affected equipment summary	Summary of affected equipment and and customers	OMS	SCADA	CIM/XML or ICCC	
Calculation of Performance indices	OMS	SAIDI, SAIFI Calculation	Performance indices SAIDI, SAIFI are calculated	OMS	SCADA	CIM/XML or ICCC	
Power Supply interruption	AMI	Power Supply interruption from Smart Meters	Power supply or service interruption indication from smart meters	AMI	OMS	CIM/XML or ODBC or any other standard	Equipment status, analog values, grid frequency, MU's sent, MU's received
Switching Operations	SCADA	Network Status update	Telemetered status change indications from switches	SCADA	OMS	CIM/XML or ICCC	
Manual Switching operations	DMS	Network Status update	Manual Switching operations for non telemetered points	DMS	OMS	CIM/XML or ICCC	
Fault detection, outage record creation and	DMS	Fault Isolation and Service & Restoration	Fault location via FPI and FRTU in the field	SCADA	OMS	CIM/XML or ICCC	

Use case	Primary Actor	Name of Process Activity	Description of process/activity	Source Application	Destination Application	Relevant Interoperability Standards	Information Exchanged
SERVICE Restoration							
Planned Outage of electrical equipment	OMS	Planned Outage	Outage Planning execution / maintenance and restoration of service	Asset Management / Field intimation	OMS	CIM/XML or ODBC or any other standard	
Outage Prediction	OMS	Prediction of affected equipment	Assimilation of outages and prediction of the affected equipment	AMI	OMS	CIM/XML or ODBC or any other standard	
Storm Management	OMS	Management of incoming outage requests during EHV outage / force majeure	Management of incoming outage requests during EHV outage / force majeure	AMI	OMS	CIM/XML or ODBC or any other standard	

## Integration Interfaces for Distributed Generation

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
Fault in a circuit with DER connected to healthy section cleared by fast circuit breaker trip and by reverse protection from DER fault injection creating a self-sustainable island	SCADA data base, Relay Protection Schemes, Historical Data Base	Self-sustainable island is created	DERMS/DMS receives the scan of SCADA data and historic load data to be checked for changes in topology and loading during the time of repair.	SCADA	DERMS/DMS		Real-time analog, status data
	DERMS/DMS	Checking the sufficiency of the island during the time of repair	DERMS/DMS determines the sufficiency of the island during the time of repair and enables FLISR for location of the fault within the de-energized section.	DERMS/DMS	FLISR		Instructions to FLISR
	DERMS/DMS	Checking the sufficiency of the island during the time of repair	DERMS/DMS determines the insufficiency of the island during the portion of time of repair and enables FLISR for location of the fault within the de-energized section and solving restoration for the customers connected to the island.	DERMS/DMS	FLISR		Instructions to FLISR
Fault in a circuit with DER connected	SCADA database, relay	Unintentional insufficient island is	DERMS/DMS receives the scan of SCADA data and historic load data to be	SCADA database	DERMS/DMS		SCADA real-time analog, status data

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
to healthy section cleared by fast circuit breaker trip and by reverse protection from DER fault injection, creating an insufficient island	protection schemes, historic database	created, DER is separated with or without balanced load	checked for changes in topology and loading during time of repair.				
	DERMS/DMS	Checking the sufficiency of the island during the time of repair	DERMS/DMS determines the insufficiency of the island during the time of repair and enables FLIR for location of the fault within the de-energized section and solving restoration for the de-energized customers connected to the island.	DERMS/DMS	FLISR		Instruction to FLISR
Fault in a circuit with DER connected to faulty section cleared by circuit breaker and by relay Protection of DER.	SCADA database, relay protection schemes, historic database	The feeder is de-energized, DER is separated with or without balanced load	DERMS receives the scan of SCADA data and historic load data to be checked for changes in topology and loading during time of repair.	SCADA database	DERMS/DMS		DMS real-time Analog, status data.
	DERMS	Checking the topology to ensure that DER is	DERMS/DMS determines the after-fault topology, the loading during the	DERMS/DMS	FLISR		Instructions to FLISR

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
		separated	time of repair, and enables FLIR for location of the fault and solving isolation of the fault and restoration for the de-energized customers connected to the healthy portions of the Feeder.				
Gross and Net metering of Generation - Demand and Energy Data Automatically from Prosumer Premises	Meter Data Management	Requesting meter data	Requesting instantaneous, interval and events data from the meters and create profile in Billing. Portal services to view energy data	Meter Data Management	Head-end, CIS/CRM	IEC 61968 Part 9, 11	Meter Number, Scheduled Reading date and time, Period for which data needed
	Meter Data Management	Acquiring meter data	Acquiring instantaneous, interval and events data from the meters by head-end which then reaches Meter Data Management system.	Head-end	Meter Data Management	IEC 61968 Part 4, 9,11	Meter number, Reading date and time, reading parameters (KWh, KVAh, KW etc.)
	Load forecasting	Meter data for load forecasting	Load forecasting system needs meter data for finer load forecasting	Meter Data Management	Load Forecasting/A nalytics	IEC 61968	Connected DT, meter reading date and time, reading parameter (KW, KVA)
	Meter	Meter sending the consumption data	Meter at scheduled frequency sends the data to head-end (could be through the DCU if solution is defined so). Consumption details will be 15 minute block data, and	Meter	Head-end		Meter number, reading date and time, KW, KVA, KWH, KVAH, PF

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
			data could be incremental to what was sent by meter in the preceding instance				
	Meter	Meter sending the billing data	Meter at scheduled frequency sends the billing data to head-end (could be through DCU if solution defined so)	Meter	Head-end		Meter number, reading date and time, KW, KVA, KWH, KVAH, PF
Contract Management for DG installations (banking, carry over, smart tariffs)	DG Contract Management System/Tool	Mapping of DG Contract and Regulations	Identifying implication of relevant policies and regulations. Mapping existing and new DG contracts on system	DG Contract Management system/ database	Billing system		Contracts Data, Regulations
	MDM	Net flow measurements	Measurement of actual generation data (gross/net) data with the regulations	MDM	Billing System		Meter reading - Gross and Net (Meter number, reading date and time, KW, KVA, KWH, KVAH, PF)
	DG Contract Management System/Tool	Reconciliation of DG generation	Generating reports based on transaction information as per defined periodicity Identification of banking, carry forward/lapse information and sending to billing system	Billing System	Contract Management System/Datab ase, MIS		Billing Summaries per required format
Aggregated distributed generation forecasting for pilot area	Generation Forecasting System/Tool	DG System Availability	Identifying available DG systems based on meter data	MDM	Generation Forecasting System		Meter availability, generation information from gross meter
	Weather forecasting tools/system	Weather influence on generation	Determination of weather patterns and other influencers of demand	Weather forecasting tools/system	Generation Forecasting tools/systems		Weather data (temperature, humidity, sunshine, precipitation)

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
	Generation Forecasting System	DG generation forecasting for pilot area	Forecasting of generation based on DG system availability and weather inputs	Generation Forecasting System	ALDC Systems (Load Management, Scheduling)		Forecasts of generation for identified time blocks
Aggregate demand and net demand forecasting for pilot area	Analytics	Trending of historical demand in area (gross and net)	Identification of likely demand in pilot area for identified time periods based on past trends	Analytics	Demand Forecasting System		Historical consumption trends (varying periodicity) as per forecasting system requirements
	MDM	Identification of recent demand data	Identification of likely demand in pilot area for identified time periods based on immediately preceding periods (week, day, hour)	MDM	Demand Forecasting System		Gross and net demand data (MW) in pilot area as per identified periodicity
	Weather forecasting tools/system	Determination of weather influence on demand	Weather patterns and other influencers of demand	Weather forecasting tools/system	Demand Forecasting tools/systems		Weather data (temperature, humidity, sunshine, precipitation)
	Demand Forecasting System	Gross and Net Demand Forecasting for pilot area	Determination of gross demand in the pilot area based on	Demand Forecast tools/systems , Generation Forecasting System	ALDC Systems (Load Management, Scheduling)		Gross and Net demand forecasts
Transformer level flow monitoring to detect/predict back-flow. Prioritised remote disconnection for backflow	Head-end	Power Outage/Restoration for gross (input from DG) meters in accordance with priority/roster	DG Outage and Restoration Notification	Head-End	OMS	IEC 61968	Meter number, Outage/ Restoration Date and Time, Power On Off count
	Meter Data	Gross meter	DG Outage and Restoration	Meter Data	CIS/CRM	IEC 61968	Meter number, Outage/

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
	Management	outage information to CIS/CRM	Notification	Management			Restoration Date and Time, Power On Off count
Power outage management - remote disconnection and reconnection	Head-end	Power Outage / restoration events to Outage management if OMS subscribed from HES for these events.	Power Outage and Restoration Notification (if OMS subscribed for events)	Head-end	OMS	IEC 61968	Meter number, Outage/ Restoration Date and Time, Power On Off count
	Meter Data Management	Power outage information to CIS/CRM	Power Outage and Restoration Notification	Meter Data Management	CIS/CRM	IEC 61968	Meter number, Outage/ Restoration Date and Time, Power On Off count
Visibility of gross and net generation/demand to prosumer	CIS/CRM	Customer providing the meter particulars	Instantaneous Meter Read (status and data) of gross and net meter	CIS/CRM	Meter Data Management	IEC 61968	Meter Number, Readings details, Read Date and time

## Integration Interfaces for Power Quality

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
Measuring Voltage variations at Distribution Transformer LT side for DTs supplying Domestic /Small Commercial Consumers	Meter Data Management	Meters (for measuring voltage variations) sending data	Voltage variations to be monitored for compliance with standards set by the regulatory authorities. This information could be utilized by OMS for predictive maintenance or installation of fast power factor correction equipment by the utility	Meter Data Management	OMS / DMS		Meter Number, Voltage variations below the standard values / as specified, % time slots in which violations occurred, maximum and minimum instantaneous voltages and duration
Measuring Voltage variations at Distribution Transformer LT side for Large Industrial / Commercial Consumers	Meter Data Management	Meters (for measuring voltage variations) sending data	Voltage variations to be monitored for compliance with standards set by the regulatory authorities. This information could be utilized by OMS for predictive maintenance, by metering systems for penalization if the voltage variations have happened due to specific identified customers.	Meter Data Management	OMS / DMS		Meter Number, Voltage variations below the standard values / as specified, % time slots in which violations occurred, maximum and minimum instantaneous voltages and duration
Measuring Flicker at consumer premises and at Distribution Transformers	Meter Data Management (Flicker meters)	Meters for measuring flicker	Flickermeter measures the degree the annoyance flicker causes. P <sub>st</sub> , is the measure of annoyance. It may be noted that the annoyance	Meter Data Management (Flicker meters)	OMS / DMS	IEC 61000-4-15	Meter Number, Values of P <sub>st</sub> , the measure of annoyance. The duration and time during the day, this exceeded standard/regulated

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
			<p>threshold corresponds to <math>Pst=1</math>. When <math>Pst&gt;1</math>, the observer is understood to suffer annoyance% when <math>Pst&lt;1</math>, the light fluctuations may be perceivable but not annoying</p> <p>The outputs of these meters could be transferred to the OMG / work force responsible for monitoring power quality, for both corrective and regulatory measures.</p>				values.
Measuring and transferring Voltage Sag/ Surge at consumer premises and Distribution Transformers	Meter Data Management (Meters for capturing voltage sags and surges, along with voltage angles)	Voltage Sag/ Surge Measurement	<p>Events when voltage sags / Surges that have been observed can be transferred to MDMS and/or OMS as may be required.</p> <p>This could again be utilized for both corrective and regulatory purposes.</p>	Instrumentation for capturing voltage surges/sags	OMS / DMS		Voltage (sinusoids) curves, angles, rms values with angles
Measuring Harmonics	Meters with a capability to compute Total Harmonic Distortion	Harmonic Distortion Measurement	<p>The impact of harmonics is measured in terms of Total Demand Distortion (TDD).</p> <p>These meters can be placed at various load centers</p>	Instrumentation for capturing Harmonic Distortions	OMS		Total Demand Distortion, Total Harmonic Distortion

Use case	Primary Actor	Name of the Process/ Activity	Description of Process/Activity	Source Application	Destination Application	Relevant Industry Standards	Information Exchanged
	(THD) and Total Demand Distortion (TDD)		where the nature of load is non-linear. The communication devices could be utilized to transfer this information to both OMS and for regulatory purposes. Harmonics can cause transformer burn outs even in instances when the load at fundamental frequency voltage and current may not be high.				

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