**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/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 |
|---|---|---|---|---|---|---|---|
| **AMI System detects alerts, events or tampering 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 | 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 |
|---|---|---|---|---|---|---|---|
| **Customers having access to consumption details** | 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<br>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<br>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<br>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<br>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 ICCP | 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 ICCP | |
| Calculation of Performance indices | OMS | SAIDI, SAIFI Calculation | Performance indices SAIDI, SAIFI are calculated | OMS | SCADA | CIM/XML or ICCP | |
| 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 ICCP | |
| Manual Switching operations | DMS | Network Status update | Manual Switching operations for non telemetered points | DMS | OMS | CIM/XML or ICCP | |
| 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 ICCP | |

| 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 majure | Management of incoming outage requests during EHV outage / force majure | 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/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 | 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.<br>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. Pst, 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 $P_{st,}$ 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 |
|---|---|---|---|---|---|---|---|
| | | | threshold corresponds to Pst=1. When Pst>1, the observer is understood to suffer annoyance‰ when Pst<1, the light fluctuations may be perceivable but not annoying<br>The outputs of these meters could be transferred to the OMG / work force responsible for monitoring power quality, for both corrective and regulatory measures. | | | | 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 | Events when voltage sags / Surges that have been observed can be transferred to MDMS and/or OMS as may be required.<br>This could again be utilized for both corrective and regulatory purposes. | 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 | The impact of harmonics is measured in terms of Total Demand Distortion (TDD).<br><br>These meters can be placed at various load centers | 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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