A network overview display of the distribution system with substations, feeders color coded by voltage shall be provided. This display shall present the distribution system in a graphic format. Telemetered and calculated values like active and reactive power flows etc. shall be displayed with direction arrow. Lines, Loads, transformers etc. that have exceeded their loading limits shall be highlighted. Stations shall be depicted by suitable symbols which reflectthe presence of alarms. Cursor selection of a station symbol shall result in display of the associated Single line diagram for that station. "What if "analysis shall be included to visualize network & verify the impact before an action is taken by dispatcher. For all switchingactions which dispatcher have to execute manually/step by step shall have the option to simulate switching operations in order to visualize the effect on the distribution network using what if analysis.

All DMS result tabular displays shall have capability for sorting by name and calculated parameters. The solution prescribed by DMS application shall consider & identify & sort the following as minimum.

1. Remote controllable circuit breaker with capability to interrupt fault currents
2. Non-remote controllable circuit breaker with capability to interrupt fault currents
3. Remote controllable circuit breaker with no capability to interrupt fault currents
4. Non-remote controllable circuit breaker with no capability to interrupt fault currents.
5. Remote controllable disconnector
6. Non remote controllable disconnector.
7. Fuse
8. Ground/ Earth switch etc.
9. RMUs
10. Sectionlizer
11. Communicable FPIs

Network Model, GIS association

The DMS applications shall have a common model for the project area comprising of primary substation feeders, distribution network and devices with minimum 10 possible islands, which may be formed dynamically. All DMS applications shall be able to run successfully for the total distribution system with future expandability as envisaged under the specification. The following devices shall be represented in the model as a minimum:

a) Power Injection points
b) Transformers
c) Feeders
d) Load (balanced as well as unbalanced)
e) Circuit Breakers
f) RMUs &Sectionizers
g) Isolators
h) Fuses

i) Capacitor banks

j) Reactors

k) Generators

l) Bus bars

m) Temporary Jumper, Cut and Ground

n) Ring, Meshed & radial network configuration

o) Line segments, which can be single-phase, two-phase or three-phase and makeup a distribution circuit.

p) Conductors & Cables

q) Grounding devices

r) Fault detectors/FPI

s) IEDs

t) Operational limits for components such as lines, transformers, and switching devices

All DMS applications shall be accessed from graphic user interface through Operator consoles as defined in this specification. Reports, results and displays of all DMS application shall be available for printing at user request.

Population and maintenance of the distribution network model should be possible by using the database maintenance tools to build the database from scratch. In case the required data already exists within the Employer's corporate Geographic Information System (GIS) as a legacy, the DMS database functions should leverage this effort by providing an interface/adaptor to extract GIS data using the CIM international standard IEC 61970/61968 and automatically generate the complete Network Operations Model. The data extracted should include network device information, connectivity, topology, nominal status and non- electrical data such as cable, l a n d b a s e data etc. Further Land base data can be sourced from GIS in Shape files or DXF. The utility shall provide all necessary details of legacy system for interface and to use this data. The extraction process should comply with the international standard CIM data descriptions. The CIM standard is maintained by the IEC (Technical Committee 57, WorkingGroup 14) and is used for a wide range of purposes. The extraction process should be independent of the real-time network management system. Any GIS model should be extractable to build the network model regardless of the supplier or internal schema.

The extraction should also allow incremental updates & global transfer with no need to bring the system down or even fail over. The model should support extraction on a per-station basis and must be fully scalable from a single zone substation to the largest distribution networks.SCADA/ DMS should be able to present geospatial data even when the link to the source GIS at the data center/DR is not available. The user interface supporting the database will provide updated data directly to display geographic and/or schematic views of the network.

The model should support multiple geographic coordinate sets for each device so that, if available, the network can be displayed in custom geo- schematic formats. The network views may also include various levels of detail depending on the zoom level. Information such as land-based data (provided as a dxf file, shape file etc.) may also be displayed as required.

An interface with the already existing Geographical Information Systems shall be developed using interoperability features between the DMS and the installed GIS.

Each of the two systems shall keep its own specificity, and shall be used for what it has been designed: the SCADA for the real-time data acquisition, control and processing, the GIS for the maintenance of the network construction and geographic data.

The interface shall be developed in order to obtain a maximum benefit of the two systems use. It shall be implemented while maintaining the SCADA/DMS and GIS integrity as individual systems. It is of the utmost importance that the two systems remain able to operate separately.

The required functionalities for this interface shall cover the two following aspects:

The transfer of specific real-time data from the DMS into the GIS data-base the possibility to navigate easily from one system to the other through the user's interface

Data exchanges shall be made through the Control Center LAN/WAN.. Bidder shall demonstrate its incorporation capability to the main GIS Vendors through a dedicated reference list or provide and support standard interfaces to GIS.

In case of non-availability of the interface details of legacy system by utility. GIS adaptor shall tested to establish with sample database and the bidder shall run the same through, single line diagrams schema with network element parameters.

Utility shall specify availability of updated GIS based asset /network database and GIS application software In case of non-availability of the same , utility shall be provided through sanctioned scope of IT/AMISP etc or on their own funds. For SCADA/DMS , if existing database of electrical assets is not up to date or incorrect. Bidder may consider , the scope of survey , data entry , updation in their scope . Further , if license is not upto date. Then bidder shall in their as part of "any other items required to meet functional and performance requirement" in the BOQ . The details software ,available interface and state of data to be specified in the legacy section .i.e chapter 1 of RFP

As an option , utility may also include GIS software also in the RFP as per approved IT OR /SCADA projects . There shall not be duplication in IT (AMISP etc and SCADA). Key feature / specification is given in the table below:

Sr.No.	GIS Specifications
1	Geographic Information System solution consists of a system for capturing, storing, checking, integrating, modification , analyzing and displaying geo data related to positions on the Earth's surface and data related to attributes of the entities/Customers in an utility area. It pertains to both vector and raster GIS
2	The GIS product shall have an industry standard Data Model and shall be CIM compliant. Standard adaptors to export the data in CIM model should be available off the shelf.
3	Geographic Information System solution shall support modelling of High voltage, Medium voltage and Low voltage distribution network and associated assets including Generators, HV lines, HV Transformers, MV lines (OH & UG cables), Poles, Primary Substations, LV lines (OH, ABC & UG cables, 1Phase, 2Phase & 3Phase), Switchgears, Auto-Reclosers, Load Break Switches, DDLO's, Distribution Transformers, LV fuses, Retail & Bulk customers , RMU, IED , FPIs etc using appropriate GPS coordinate system .
4	Existing data if available with discom will be shared with the bidder which shall be migrated to the proposed GIS solution by the bidder.
5	Bidder will propose to follow the three-stage database modeling process involving Conceptual, Logical and Physical data models. The finalization of the data model would be performed as part of SRS jointly with discom. To design the Data model, Bidder will develop conceptual model to assemble a high-level abstract representation of the GIS

	layers and to identify basic relationship between data entities by grouping of simple features into categories or thematic groups. Standard five key elements of Geo database design
6	Logical model will be developed further to visualize clearly data relationships, shapes and business attributes and finally Physical model will be prepared which will constitute complete details, defined schema design and specifically defines attributes and their characteristics like Relationships, Subtypes, Domains, Topology Rules, data dictionary, primary keys for each feature class. Fine-tuning of these models will be performed until all the data requirements are fulfilled.
7	This shall enable creation of GIS base application geo-database, which shall provide interfaces to the business process applications presently operational in the utility and to future business applications planned to be implemented by the utility.
8	Shall support structured export of connected network in CIM/XML format for one-time initial load as well as incremental changes. Shall also support structured publishing of proposed network changes with SCADA/DMS/OMS system.
9	The GIS Enterprise software package with latest version, and spatial database engine with industry proven database specifically for maintaining spatial networks and long transaction spatial handling scaling up to very large numbers of users and terabytes of data with latest version supplied. The system shall have to be Open GIS consortium (OGC) registered compliant product time tested, widely deployed at multiple utilities worldwide
10	The system shall provide support in the form of a documented interface specification (API) to allow software - based functionality
11	The system should have functionality to Zoom; PAN the display across the screen.
12	. The system shall generate color graphic displays of the system network which can be zoomed in / out. This shall represent each of the elements in the electrical system with suitable differing colors for the elements. The color-coding will be based on the rated voltage, Percentage of voltage at each bus, Percentage of loading of section, Symbols or any other chosen parameters by user.
13	Dynamic selection of attributes: User should be able to dynamically select one or more of the attributes of an object, to be displayed as label of the object. This can be for viewing, plotting and printing purposes
14	System should be able to perform move, copy, rotate, mirror and offset.
15	System should specify the real time measurement / length while drawing the lines.
16	Ability to report the lengths of conductors and the associated cost of the conductor (if available from associated compatible units.
17	The graphic user interface shall have a modular structure with main menus and sub-menus that allow users to dynamically configure their own user interface to required level.
18	It shall be possible to view the system elements such as Customer location etc on, mapping and indexing work. It shall be dynamically possible to switch from one mode of view to the other by use of a pointing device. It shall be possible to view the physical system details in the background of the area maps created
19	The application should have facility of cluttering and decluttering. The process of showing more details as users zooms in is called cluttering and process of hiding details as user zooms out is called decluttering
20	The software shall be able to check the electrical network line continuity for the power flow through graphical and non- graphical data as listed below : The electrical line tracing till the end of the line by considering the switch positions on the line. The line will have to be highlighted after the tracing.
21	Should provide a collection of tools for managing, modelling, and editing facility and land base data in an enterprise system.

22	Should have configurable tools such as. • Support electric feeder/circuit creation and configuration • Support to industry standard utility data models • Support various types of electric feeder Traces (upstream, downstream, protective device etc.). • Network trace shall be configurable – By Voltage Class (HV,MV,LV), phase, circuit, upstream/downstream, etc.
23	Should support for Standard distribution operations such as Phase Change/Phase propagation, Replacement or Addition of Conductor, Rotation of phasing information, updating flow directions, updating voltages etc
24	Should have out of the box tracing tools for the Electric utility: • Find Downstream features • Find Upstream features • Protective device trace and options
25	It should have out of box tools to store stored items and can update attribute in a mass manner.
26	Database extraction tools for importing and exporting network data.
27	Audit trail of changes made with detals
28	System shall support effective management of asset lifecycle status. The current network shall include equipment that already exists in the field, and the future network shall include new network proposed in the design, together with the currently existing network.
29	To support the business processes that involve planning, design, maintenance and retirement of facilities, conducting and structure objects in the data model shall have a Lifecycle status attribute which determines whether the object is considered to belong in the current or future state of the network, or both
30	Report Generation Tools. A business user shall be able to connect to proposed GIS, other standard GIS databases as well as other enterprise system databases (Oracle, SQ Server) and flat file databases like excel, csv etc. without any data extraction or loading
31	Features should support file attachments, which should provide a flexible way to store additional information in any format related to your features. For example, if you have a feature representing a building, you could use attachments to add multiple photographs of the building taken from several angles, along with PDF files containing the building's deed and tax information
32	Multiple geometries per object to support multiple representations of same object, e.g. on geographic maps or schematic diagrams
33	System to support plotting functionalities including template creation for standard layouts and output the plot to PDF. Plot Series creation for creating map books and job sheets is also required
34	The system shall support to quickly generate plots for the Construction Pack provides tools to create construction plots and manage these and other related documents.
35	The system shall support users to add content to layout document pages. The content could be: • Text annotation: users can add free text or they can add predefined annotations to database objects shown in the viewport • Lines, arrows and symbols • Images • Additional Views • Stencils
36	Snap to vertex, endpoint, midpoint, or along the edge of features & layer wise snapping
37	On-the-fly dynamic joins between different databases

38	Create statistics & various statistical operations, viz. create charts and reports, and Sort tables by multiple attributes, populate values based on expression, Summarize data.
39	Should be able to plot data on the map directly from the tables.
40	Software should support Display graphs, charts and calculated values
41	Tool should have simplified view of the network for better operations management and faster decision making.
42	Tool should Check network connectivity
43	**GIS solution shall be a integrated GIS product to deliver value beyond just asset data tracking.** **GIS Software should be compatible to be integrated with enterprise systems such as AMI, Mobile work Force Management, SCADA, DMS,OMS ERP, Online billing System, or any other system to be used by utility in future with standard interface specificied.**
44	**Data analytical dashboards / reports**

3.1.1 Network Connectivity Analysis (NCA)

The network connectivity analysis function shall provide the connectivity between various network elements. The prevailing network topology shall be determined from the status of all the switching devices such as circuit breaker, isolators etc. that affect the topology of the network modeled.

NCA shall run in real time as well as in study mode. Real-time mode of operation shall use data acquired by SCADA. Study mode of operation will use either a snapshot of the real-time data or save cases.

NCA shall run in real time on event-driven basis. In study mode the NCA shall run on operator demand.

The topology shall be based on:

(a) Tele-metered switching device statuses

(b) Manually entered switching device statuses.

(c) Modelled element statuses from DMS applications.

It shall determine the network topology for the following as minimum.

(a) Bus connectivity (Live/ dead status)

(b) Feeder connectivity

(c) Network connectivity representing S/S bus as node

(e) Energized /de-energized state of network equipments

(f) Representation of Loops (Possible alternate routes)

(g) Representation of parallels

(h) Abnormal/off-normal state of CB/Isolators

The NCA shall assist operator to know operating state of the distribution network indicating radial mode, loops and parallels in the network. Distribution networks are normally operated in radial mode; loops and/or parallel may be intentionally or inadvertently formed.

A loop refers to a network connectivity situation in which there exist alternative power flow paths to a load from a single power source. A parallel refers to a topological structure in which a load is fed from more than one power source. Parallel paths often result in circulating currents and such operating conditions need to be avoided. All loops/parallels in an electrical network shall be shown by different colors in such a way that each is easily identifiable.

Abnormal state of CB/Isolators means these devices are not in their Normal OPEN or CLOSED position.

Alarms shall be generated when presence of abnormal switches, De- energized components of network and of Network loops / parallels is detected.

3.1.1.1 Tracing

NCA function shall also have the capabilities of network tracing when requested by the dispatcher. Dedicated colors shall be used for feeder and circuit tracing and also when information available is not complete or inconsistent. The trace shall persist through subsequent display call-ups, until the operator explicitly removes it or requests another trace. In addition, at the bottom of the geographic view the number of transformers and customers passed by the trace are shown.

(a) **Feeder tracing** - This feature shall aid dispatcher to identify the path from a source to all connected components by same color.

(b) **Circuit tracing**- This feature shall enable operator to select any device and identify the source and path by which it is connected through the same color.

(c) **Between Tracing-** This feature shall enable the operator to select any two components of the network and shall able to trace all components connected in between them.

(d) **Downstream Trace**- from a selected circuit element the trace identifies all devices that are downstream of the selected element. In the case where a downstream trace is performed on a de-energized section of the network, the trace highlights all devices electrically connected to the element.

3.1.1.2 Temporary Modifications:

The NCA will allow temporary modifications at any point in the distribution network to change the network configuration, to isolate faults, restore services or perform maintenance. A Summary shall list the jumpers, cuts and grounds that are currently applied. The function is performed by the NCA and is implemented locally within the client software and has no effect on the operations model or other clients viewing the network.

3.1.1.3 Cuts:

Cuts facilitated in any line segment in the network. The cut may be applied to one or more available phases of the conductor. The cut could also be applied as a temporary switch inserted in the line.

- The cut must be given a name or id number for identification, which is displayed as a label on the geographic network view.
- It should be possible to select the position of the label relative to the cut symbol.

- The position can be altered after the cut has been placed.

Once placed the cut symbol can be selected and switched on and off by the operator in the same way as a standard disconnect switch. Cuts can also be tagged.

3.1.1.4 Jumpers

Jumpers are a means of providing a temporary, switchable connection between two points on the network. The operator should be able to select two points and place the jumper with relevant details. The initial state of the jumper may be set to open or closed. The jumper popup automatically defaults to show the phases available for connection between the two points but other partial or cross-phase connections may be made if required. The popup shall warn the operator about abnormal connections such as not all phases being connected or the nominal voltage being different at the two connection points. Once the jumper has been placedthe switch symbol in the center can be selected and switched open or closed. The topology of the network model is updated accordingly. There is no restriction on the placement of jumpersbetween lines connected to different feeders or different substations.

Temporary connections between phases on the same line segment, known as a phase jumper shall be supported. This can be used in conditions where one phase is de-energized and it is desired to restore customers by energizing the dead conductor from one of the live phases.

3.1.1.5 Temporary Grounds

Temporary grounds should only be placed, for obvious reasons, on de- energized sections of a line. These grounds represent the mechanical grounding of lines for safety purposes during maintenance or construction.

A temporary ground may be placed on one or more of the available phases. It must be given a name and addition information can be included in the description field.. If a line segment is re-energized while a temporary ground is still applied, the ground will be automatically removed.

3.1.1.6 Reports and Displays

The reports and displays shall be generated indicating the followings as a minimum:

(a) Abnormal switches in tabular display

(b) De-energized components of network in tabular display

(c) Presence of loops & parallels on network displays

(d) Un-served/ disconnected loads (loads affected due to tripping of CBs) in tabular displays

(e) List of temporary jumpers/cuts /grounds

3.1.2 State Estimation

The primary function is to determine network state where SCADA system monitoring is directly envisaged. The State Estimation (SE) shall be used for assessing (estimating) the distribution network state. It shall assess loads of all network nodes, and, consequently, assessment of all other state variables (voltage and current phasors of all buses, sections and transformers, active and reactive power losses in all sections and transformers, etc.).

Firstly, the symmetrical (per phase) and asymmetrical (three-phase) load of all nodes in the radial or weakly meshed MV network, which are not remotely monitored, that is not directly covered by the SCADA System shall be using evaluated Load Calibration . **SE** represents the basic DMS function, because practically all other DMS Analytical Functions are based on its results.

This is the unique function dealing with the unobservable load of the actual network, which is not directly covered by the SCADA System. Function is used for balanced and unbalanced networks.

The function is based on an algorithm specially oriented towards distribution networks, with low redundancy of real time, remotely monitored data, The deficiency of real time data has to be compensated with historical data.

Beside the parameters of network elements, the real-time data consists of:

- Actual topology, transformers tap changer position, etc.
- Voltage magnitudes of supply point and other nodes in the network.
- Current magnitudes (active and reactive power) at feeder heads.
- Current magnitudes (active and reactive power) from the depth of the network.

The historical data of the network consists of:

- Daily load profiles – current magnitudes and power factors, or active and reactive powers for all load classes (types, for example: industrial, commercial, residential), for all seasons (for example: winter, spring, summer, autumn), for e.g. four types of days (for example: weekday, Saturday, Sunday and holiday).
- Peak-loads for all distribution transformers and/or consumers (peak-currents and/or peak powers) and/or monthly electric energy transfers across all distribution transformers (consumers).

SE function shall run in all cases from the range of networks where all historical data are known, but also in networks with no historical data available (based on parameters of the network elements).

Also according to users setting, the **SE** function shall be able to run:

- With or without verification of telemetered measurements.
- With manual or automatically processing unobservable parts of network.
- With or without fixed measurements.

This shall have real time & Simulation mode both. In the first one, the function shall be used for estimation of the current state. In the Simulation mode, the function is used for estimation of the desired state (e.g. any state selected from the saved cases).

The **SE** algorithm shall consider into account the non-availability of real-time data and compensates them with historical data, pseudo and virtual measurements, to achieve the minimal set of input data necessary for running a consistent Load Flow.

The **SE** algorithm shall consist of the next important steps:

- Pre-estimation – It shall be based on the historical data of the network: daily load profiles, peak-loads for all distribution transformers and/or consumers, etc. This step shall give pre-estimated states of considered MV networks.
- Verification of measurements– It shall be obtained from artificially redundancy of measurements (too small number of measurements and notable main number of pseudo measurements obtained from first approximation). This step shall consider

two sub-steps: (a) in sighting evidence bad measurements, (b) verification and/or correction all permanent measurements. In this step, incorrect measurements shall be corrected or discarded.

- Load calibration – The function shall distribute the load to the busbars of the MV network on the basis of the set of verified measurements and historical data.Also, Load calibration shall deal with consumers specified directly through their current/time diagrams i.e. load curves as well as with consumers with constant consumption. The function shall run even any of these data are not available. It shall be designed in such a way that the quality of results of the function running increases directly with the amount of given data.

- Load Flow calculation – This shall be the next function in the specification based on the loads assigned in the previous step.

3.1.2.1 Input/output

Beside the network element parameters, main inputs for the functions consist of above noted real time and historical data. In the case of the function running in the Simulation mode, the real time data must be replaced with the corresponding data from the saved cases or forecasted ones.

Main outputs of the function are estimation of:

- Voltage magnitudes in the entire network.
- Current magnitudes and power factors for all network elements.
- Loads of all MV and LV consumption buses.
- Losses of active and reactive powers in the entire network, by each supply transformer or feeder.

Beside those results, output of **SE** function is tabular report, also. In this report measurement verification results are presented those results are:

- Pre-estimated and estimated values of measurements. Minimal and maximal expected values of measurement. Quality of each measurement.
- Deviation measured values from estimated and pre-estimated values.

3.1.3 Load Flow Application (LFA)

The LFA shall utilize information including real-time measurements, manually entered data, and estimated data together with the network model supplied by the topology function, in order to determine the best estimate of the current network state.

The Load Flow Application (LFA) shall determine the operating status of the distribution system including buses and nodes

The LFA shall take the following into consideration:

a. Real time data
b. Manual entered data
c. Estimated data
d. Power source injections
e. Loops and parallels

f. Unbalanced & balanced loads

g. Manually replaced values

h. Temporary jumpers/ cut/ grounds

i. Electrical connectivity information from the real-time distribution network model

j. Transformer tap settings

k. Generator voltages, real and reactive generations

l. Capacitor/reactor bank ON/OFF status value.

m. Save case data

General Characteristics of LF application:

The following general characteristics/ capabilities shall be provided as minimum:

- The LF model shall support the different kind of lines such as cable feeders, overhead lines and different kind of transformers having various vector groups & winding configurations.
- Unbalanced & balanced three phase loads connected in radial and non-radial modes.
- Compute voltages and currents and power factor for each phase for every node, feeder and network devices.
- Compute each phase active and reactive loads and technical losses for the distribution system as a whole, for individual substations and feeder wise with in telemetered zone.
- Use previous save-case to make new save case or use new snapshots to set the base case for LF.
- The results of the LF application shall reasonably match with the operating condition in which the distribution system is stable.
- The LFA function shall be executed in real time & study mode.
- It shall be possible to model load either as a percentage of system load or profile base load modeling
- It shall be possible to model individual component of load i.e. Active and Reactive parts

3.1.3.1 Real Time Load Flow Execution:

The Real-Time LF function shall be executed:

- On event trigger
- On periodic basis
- On demand basis
- On initiation by other DMS applications functions
- On placement of temporary jumper, cuts and ground

The Event Triggered LF execution shall always have the highest priority. The study mode LF function shall be executed on a snapshot or save case with user defined changes made to these cases. The study mode execution of LF Function shall not affect the Real-time mode execution of LF function.

(a) Event Triggered Real Time LF Execution:

The LF function shall be executed by pre-defined events that affect the distribution system. Some of the events the dispatcher may choose for triggers shall include:

- Power system Topology Change i.e. Alteration in distribution system configuration.
- Transformer Tap Position Change / Capacitive/reactor MVAR Change
- Feeder Over loadings
- Sudden change in feeder load beyond a set deadband

(b) Periodic Real Time LF Execution:

The real-time distribution system load flow application shall be executed periodically as configured by the dispatcher. The function shall be executed periodically even if there are no significant changes in the operating conditions, as some of the power flow outputs shall be required to provide aggregate summaries (losses, etc.)

(c) On Demand Real Time LF Execution:

Dispatchers may initiate the real-time LF function at any time through dispatcher command.

(d) Real Time LF Execution initiated by other DMS Applications:

Other DMS functions may initiate the real-time LF function at any time as desired for the execution of the respective functions.

3.1.3.2 Study Mode Load Flow Execution:

It shall provide despatchers with estimates of kW, kVar, kV, Amps, power losses and the other information on the distribution system, but not necessarily reflecting its real-time state. In study mode the application should use the same data model and have direct access of the real time data as necessary. Study mode load flow shall be used to study contingency cases.

It shall be possible to prepare and store at least f i f ty cases along with the input parameters, network configuration and output results.

The dispatcher shall be able to select the saved Case to be used as a Base case for LF execution and modify the base case. Possible changes, which the dispatcher shall be permitted to make, shall include:

(a) States of individual power system elements

(b) Values of specific parameters including nodal loads, bus voltages, connected kVA, power factor etc.

The Study Mode shall calculate various values for each feeder and prepare summaries as LF output.

The Load Flow function shall provide real/active and reactive losses on:

- Station power transformers
- Feeders

- Sections
- Distribution circuits including feeder regulators and distribution transformers, as well as the total circuit loss

3.1.3.3 Load Flow Output:

The following output capability shall be provided:

(a) Phase voltage magnitudes and angles at each node.

(b) Phase and neutral currents for each feeder, transformers, section

(c) Total three phases and per phase KW and KVAR losses in each feeder, section, transformer, DT substation & for project area

(d) Active & reactive power flows in all sections, transformers List of overloaded feeder, lines, bus bars, transformers loads etc. including the actual current magnitudes, the overload limits and the feeder name, substation name

(e) List of limit violations of voltage magnitudes, overloading.

(f) Voltage drops

(g) Losses as specified above

3.1.3.4 Display and Reports

All input and output data shall be viewed through tabular displays and overlay on the one line network diagram. Tabular displays shall consist of voltages, currents (including phase angles), real and reactive powers, real and reactive losses as well as accumulated total and per phase losses for each substation, feeder and project area. All the overloaded lines, busbars, transformers, loads and line shall start flashing or highlighted.

The LF outputs shall be available in the form of reports. The report formats along with its contents shall be decided during detailed engineering.

3.1.3.5 Alarms

The LFA shall warn the Despatcher when the current operating limits are exceeded for any element or when lines are de-energized. It shall also warn the Despatcher when any abnormal operating condition exists.

Alarms generated during Study Mode shall not be treated as real-time alarms but shall be displayed only at Workstation at which the LF application is running in study mode.

3.1.4 Volt –VAR Control (VVC)

The high-quality coordination of voltages and reactive power flows control requires coordination of VOLT and the VAR function. This function shall provide high-quality voltage profiles, minimal losses, controlling reactive power flows, minimal reactive power demands from the supply network.

The following resources will be taken into account for voltage and reactive power flow control:

- TAP Changer for voltage control
- VAR control devices: switchable and fixed type capacitor banks.

The function shall propose the operator solution up on change in the topology of the network switching. The function shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The functions shall be based on user configurable objectives i.e. minimal loss, optimal reactive flow voltage limits, load balancing. These objectives shall be selectable on the basis of feeder, substation & group of substations or entire network. The despatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers. The solution shall identify /sort the different type of switches that are required for operation i.e. remote /manual etc.

3.1.4.1 Modes of operation

The VVC function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

The despatcher shall be able to select one of the above modes. These modes are described below:

Auto mode

In auto mode, the function shall determine switching plans automatically and perform switching operations upon despatcher validation automatically.

Manual mode

In manual mode, the function shall determine switching plans automatically and perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan.

3.1.4.2 Reports

Detailed reports of complete switching sequence for VVC operation, including voltage / VAR levels before switching & after switching shall be presented.

3.1.4.3 Displays

The User interface for VVC function shall have following summary displays as minimum:

(a) Network & tabular display to VVC switching

(b) Tabular display giving chronological sequence for VVC operation

3.1.5 Fault Management & System Restoration (FMSR) Application

The Fault Management & System Restoration application software shall provide assistance to the despatcher for detection, localization, isolation and restoration of distribution system after a fault in the system. The FMSR function shall be initiated by any change in the network connectivity due to any fault. It shall generate automatic report on switching sequence depicting analysis of fault, location of fault & recommendations for isolation of faulty sections & restoration of supply.

3.1.5.1 Functional Requirement

The FMSR function shall include the following characteristics:

1) FMSR shall be capable of handling phase-to-ground and phase-to-

phase faults and shall not be restricted by their time of occurrence on one or more feeders. Thus, the ability to handle multiple faults of different types, on multiple feeders, shall be provided. It shall be capable to carry out restoration of large area after a occurrence wide spread faults amounting to substantial outages in the town.

2) FMSR shall be capable of allowing the substitution of an auxiliary circuit breaker or line reclosers that may temporarily function in place of a circuit breaker or line reclosers that is undergoing maintenance.

3) The Operator shall be able to suspend FMSR restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Operator shall be able to resume FMSR's normal operation by deactivating the same point.

4) FMSR shall be capable of isolating faulty sections of network by opening any available line Circuit Breaker that may be necessary, however operating limitations on device such as control inhibit flag shall be respected.

5) FMSR application shall utilize the results of LF for recommendations of switching steps for restoration where in it should guide the operator for amount of overloading in lines ,bus voltage violations and amount of load that can be restored for various options of restorations ,the operator shall have the privilege of selecting the best restoration option suggested by FMSR before it starts restoration .The operator shall also be to simulate the LF for the recommended switching actions ,so that the necessary violations can be displayed on graphical display also. If an overload condition is expected as a result of the proposed switching, it shall be displayed to the operator on a graphical display and proposed alternative switching sequence to avoid or minimize the overload.

6) FMSR shall be capable of using data derived from substation RTUs/FRTUs /FPIs to recognize faults in substation transformer banks, any fault on the primary side of these banks that cause loss of outgoing feeder voltage and current or any fault occurred on 11KV network.

7) FMSR shall be capable to make Restoration plans with identification name and respective merit orders & its execution of Restoration plan using network Display and single line diagram of substation.

8) FMSR shall be capable to find delay in the restoration of network beyond specified time (Despatcher configurable) and shall be able to report separately in the form of pending restoration actions.

3.1.5.2 Detection of fault

FMSR function shall detect the faulty condition of the network causing CB tripping due to protection operation or FPI indication. The Circuit breakers having auto-reclose feature, the FMSR application shall wait for programmer specified (settable for individual feeders) duration before declaring the network as faulty. On detection of fault in the network, an alarm shall be generated to draw attention of the dispatcher.

Switching device tripping caused by SCADA/DMS applications shall not be considered as a faulty condition. FMSR application shall also not be initiated if the quality flags such as, manually replaced value , and Out of scan are set for a switching device.

To avoid potential difficulties during severe storm conditions, the Operator shall be able to suspend FMSR switching sequence of restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Operator shall be able to resume FMSR's normal operation by deactivating the storm-mode control point. When this occurs, FMSR shall be ready to restore power as well as detect and isolate faults following the next outage event. The same shall be recorded as an event.

3.1.5.3 Localization of Fault:

Wherever protection signal or FPI indication is not available, FMSR function shall determine the faulty section by logically analyzing the telemetered data (status of CBs, analog values etc.) as acquired through SCADA system. Besides this, for such cases an iterative method for determining fault shall be used e.g. In case of fault, upstream breaker is tripped & long stretch of multiple sections are having no intermediate fault indicators & intermediate switches are not capable to trip on fault upto the closest NO(Normal open) point, the dispatcher can open the last switch before NO point & try to close breaker , if trips again faultis on further upstream & the same method is to be repeated else fault is located in the downstream section only. For t h e sections where protection signal or FPI indication is available, the same shall be derived through these telemetered signals. Network diagram identifying the faulty sections/components shall be displayed identifying the relevant section. And various configurations of switch type etc.). Minimum of following switch types shall be considered by FMSR system:

1. Remote controllable circuit breaker with capability to interrupt fault currents
2. Non-remote controllable circuit breaker with capability to interrupt fault currents
3. Remote controllable circuit breaker with no capability to interrupt fault currents
4. Non-remote controllable circuit breaker with no capability to interrupt fault currents.
5. Remote controllable disconnector
6. Non remote controllable disconnector.
7. Fuse
8. Ground/ Earth switch etc.

3.1.5.4 System isolation & restoration

Once faulty section is identified, the FMSR function shall determine the switching plan to isolate healthy area from unhealthy area. FMSR function shall suggest switching plans for restoration of power to the de-energized healthy sections of the network. It may done be by closing NO switch to allow the power from alternate source. In case more than one feasible switching plan exist, the despatcher shall be guided for most optimum plan based on the merit order ie minimum switching operations, minimum loss path, and system operation within the safe limits of various network elements. The despatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number ofaffected customers. The FMSR function shall have feature to attain the pre-fault configuration on despatcher’s request after repair of faulty sections.

The FMSR function shall have following modes of restoration process:

(a) Auto mode of restoration

(b) Manual mode of restoration

The despatcher shall be able to select one of the above modes. These modes are described below:

(a) Auto mode of restoration

In auto mode, the FMSR shall determine switching plans automatically upon experiencing fault & proper isolation of unhealthy network from healthy part of the network and perform restoration actions upon despatcher validation automatically.

(b) Manual mode of restoration

In manual mode, the FMSR shall determine switching plans upon experiencing faulty state & proper isolation of unhealthy network from healthy part of the network. The switching plans shall be presented to despatcher for step by step restoration. Despatcher shallbe allowed to introduce new steps.

A filter for remote operable & manual switches shall be provided with switching plan,

3.1.5.5 Reports

Detailed reports of complete switching sequence from outage to restoration, feeder-wise outage duration with Date & Time stamp, and quantum of served & un-served load, number of consumers interrupted & restored and network parameters limits violations shall be generated by FMSR application

3.1.5.6 Displays

The User interface for FMSR function shall have following summary displays as minimum:

(a) Network & tabular display to identify faulty network

(b) Network & tabular display to identify remotely controllable devices

(c) Network Display to show plan for Isolation of faulty sections from the network using single line diagram of substation or network as selected by the despatcher.

(d) Tabular display for Restoration plans with identification name and respective merit orders & execution of Restoration plan using network Display, and single line diagram of substation

(e) Delay in the restoration of network beyond specified time (Despatcher configurable) shall be reported separately in the form of pending restoration actions in Tabular display.

(f) List of sections not restored with the reasons for non-restoration such as overloading and voltage limit violations etc. shall be shown in tabular display.

3.1.6 Loss Minimization via Feeder Reconfiguration (LMFR)

This function shall identify the opportunities to minimize technical losses in the distribution system by reconfiguration of feeders in the network for a given load scenario. The technical losses are the losses created by characteristic of equipments & cable such as efficiency, impedance etc.

The function shall calculate the current losses based on the loading of all elements of the network. The telemetered values, which are not updated due to telemetry failure, shall be

considered by LMFR application based on recommendations of LF Application.

Function shall advise the transfer of load to other elements of the network with an aim to minimize the loss. All such advises shall indicate the amount of loss reduction for present load condition. The LMFR application shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The despatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltageprofiles, load restored, system losses, number of affected customers.

LMFR application shall run periodically at every 15 minutes and on demand. Short duration Power Interruption to the consumers during suggested switching operations may be permitted.

3.1.6.1 Modes of operation

The LMFR function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

The despatcher shall be able to select one of the above modes. These modes are described below:

Auto mode

In auto mode, the function shall determine switching plans automatically for minimal loss condition in the network and perform switching operations upon despatcher validation automatically.

Manual mode

In manual mode, the function shall determine switching plans automatically for minimal loss condition in the network based on which despatcher can perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan,

3.1.6.2 Displays & Reports

At the defined periodicity or on demand, the despatcher shall be presented with the tabular & graphical displays indicating feeder-wise, substation-wise, project area wide technical losses in % before & after the feeder reconfiguration.

The summary report shall also be generated periodically to display technical losses and possible reduction in losses if despatcher follows the LMFR recommended switching operations. The report shall also highlight violations that are occurring in the network with display layers before and after reconfiguration.

3.1.7 Load Balancing via Feeder Reconfiguration (LBFR)

The Load Balancing via Feeder Reconfiguration function shall optimally balance the segments of the network that are over & under loaded. This function shall help in better utilization of the capacities of distribution facilities such as transformer and feeder ratings.

The Feeder Reconfiguration Function shall be activated either by an overload condition, unequal loadings of the parallel feeders and transformers, periodically or on demand by the despatcher. It shall generate the switching sequence to reconfigure the distribution network for transferring load from some sections to other sections. The LBFR application shall consider the planned & unplanned outages, equipment operating limits, tags placed in the

SCADA system while recommending the switching operations. The function shall distribute the total load of the system among the available transformers and the feeders in proportion to their operating capacities, considering the discreteness of the loads, available switching options between the feeder and permissible intermediate overloads during switching. The despatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers.

3.1.7.1 Modes of operation

The function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

The despatcher shall be able to select one of the above modes. These modes are described below:

Auto mode

In auto mode, the function shall determine switching plans automatically for load balancing in the network and perform switching operations upon despatcher validation automatically.

Manual mode

In manual mode, the function shall determine switching plans automatically for load balancing in the network based on which despatcher can perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan,

3.1.7.2 Displays & Reports

The summary report shall cover the followings:

(a) Loadings of feeders and transformers before and after reconfiguration.

(b) Voltage profile of the feeders before and after reconfiguration.

The report shall also highlight violations that are occurring in the network with display layers before and after reconfiguration.".

3.1.8 Operation Monitor

The Operations Monitoring function shall track the number of operations made by every breaker, capacitor switch, reclosers, OLTC, isolator and load break switch that is monitored by the System. Devices shall be identified by area of responsibility, substation, feeder, and device ID to provide the necessary information for condition-based maintenance of these devices.

Each monitored device shall be associated with a total operations counter. This counter shall be incremented whenever the associated device changes state. When a multiple change (such as a trip-close-trip sequence) is reported by an RTU/FRTU, each transition shall be counted separately. In addition, a fault operations counter is required. This counter shall be incremented only for uncommanded trip operations. The date and time of the last operation shall be saved for each device when one of the counters is incremented.

An Operator with proper authorization shall be able to enter total operations and fault operations limit for each counter. An alarm shall be generated when a counter exceeds its limits. No additional alarms shall be generated if the counter is incremented again before it is

reset. For each counter, the System shall calculate the present number of operations expressed as a percent (Which may exceed 100%) of the corresponding limit.

The ability to reset individual counters shall be provided. In addition, a user shall be able to inhibit operations counting for individual devices. Such devices shall be included in summaries based on areas of responsibility. Resetting and inhibiting counters shall be permitted only for devices that belong to the areas of responsibility and resetting shall require the console to be assigned to an appropriate mode of authority. The user info, date and time, when each counter was last reset shall be saved.

The countersand other related information shall be available for display and inclusion in reports. The user shall be able to view the date and time of a device's last operation together with its accumulated operations data by simply selecting the device on any display where it appear

3.2 Outage Management System

3.2.1 Outage Scheduling Management

Full-fledged OMS is envisaged in A/U towns and in B/C it is limited to Fault reporting from FPI to maintenance crew over mobile and information to customer care centre and considered in SCADA functions and servers under B/C towns

The system shall enable utility to partially or completely deenergize an electric circuit and notify utility concerned personnel and provide interface to customer care system. The system shall exhibit following features

- Advance notifications
- Priority Management of outage requests
- Work permits
- Generating switching plans to support the power outage requests
- Status updates
- Work order completion
- Notifies affected customers in advance so that they have adequate time to make appropriate decisions or alternate plans
- Allows for field crew to communicate delays in planned work and assists in providing a timely update to the expected time of restoration
- Allows for field crew to promptly provide notifications when their work is completed
- Crews can submit preliminary information about changes made to the energized system, and close the associated work orders or tasks

3.2.2 Trouble Call Management System

Customer outage related trouble call management system summarizes all of the ticket information and primarily used by the operator or dispatcher to analyze the location of any ticket (prediction or confirmed outage). The data of OMS regarding outages / tickets shall be shared with Customer Care Centre of DISCOM.

The system shall exhibit following features:

- Trouble call summary display provides an itemized summary of all trouble calls on the system in whole or by area.
- Switching devices operated by SCADA as a commanded change of state will

generate an outage ticket which does not have to be confirmed by a crew.

- Telemetered protective devices operate automatically on a fault condition when they are tripped by relay. In this condition, outage prediction will 'walk' downstream to predict incident downstream of tripped protective device.
- If a telemetered protective device closes automatically, or under SCADA control, the system will close the outage ticket and commence with the call back process to inform the affected customers.
- Trouble calls are organized into accounts and may be expandedby geographical, electrical or work areas:
  - Normal
  - Critical
  - Premium / VIP
  - Medical, etc.
- SCADA generated outages are logged as SCADA generated so as to differentiate them from trouble calls generated manually or by the prediction algorithm.
- Customer-centric information organized and displayed both graphically and in tabular form by area
- User friendly table organizes the calls into the following basic ticket groups which are filtered by type based on the user's area of responsibility:
  - Unassigned
  - Assigned
  - Incident
  - Trouble Calls
  - Outages
  - Completed Trouble Calls
  - Rejected
  - Closed

3.2.3 Crew Dispatch & Work Management Key Features

Crew & Work Order Management provides an organized and efficient way to manage the correlation of crews to Work Orders or Tickets. Crew Management user interface enhances the dispatcher and supervisor's situational awareness via an easy to use and visual progress of outage restoration or work resolution.

- Enables Operator / Dispatcher to monitor crews and assign crews to jobs
- Manage crews and activity related to daily work orders
- Schedule the work for independent creation, tracking and management of each job
- Work orders may be linked to Trouble Calls if the work order is related to the outage
- Dispatcher is able to monitor the crew workload and the crew's progress.

- Summary screens to monitor and manage Work Orders and Trouble Calls
- Crew workload can be balanced to handle changes in the personnel or resources

3.2.4 Outage Analytics & Reporting

Real-time dashboard summaries as well as detailed tabular and customizable graphic reports supporting drill-down and query capability shall be built up

- User-defined reports covering crew, trouble calls, outage, outage codes, call codes, failure codes, calculations, area reports, device operation, planned outages, etc.
- Create custom reports using drag and drop from the data model.
- Automatic calculation and reporting of several performance indices including IEEE 1366 continuity of service indices: SAIDI, CAIDI, SAIFI, MAIFI, etc.
- Quality of Service (QoS) reporting based on the logged events, times and degree of restoration for display and reporting.
- Reporting to crew through SMS about on configured feeder manager nos.

The following reports shall be minimum and shall be defined apart from utility specific reports :

- Outage History
- Cause analysis
- KPI indices (Reliability, efficiency in closure of tickets)
- Recurring trouble summary
- Worst performing feeders/ devices
- Crew assignments
- Closed cases

3.2.5 Web Clients & Mobile Views

The Web-Based Solution offers an extended thin-client web-based application that allows users to visualize, simulate, and manage their electrical systems remotely from the web.

This tool applies to Real-Time operations as well as analysis, and optimization. It provides the user with a remote platform for executing “what-if” scenarios on existing operating conditions and predicts system responses using analysis calculations. Users can monitor single or multiple systems from a single web page; No software installation is required at the client machines.

Applications

- Predictive “What-if” Simulation using exiting operating conditions
- Remote Scenario Execution
- Review Results on the One-Line Diagrams & Reports
- System Monitoring & KPI Views
- Geographical Power Distribution Views
- Alarms & Events

- Load Shedding System View
- Switching Sequence Management
- Customizable User Interface & Reporting

3.3 Disptacher Training Simulator (DTS)

A Dispatcher Training Simulator (DTS) shall be provided for SCADA/DMS system for training of operators/ dispatchers during power system normal, emergency/ disturbance and restoration activities. The DTS shall be installed at the at each SCADA/DMS control center for Group A towns and District Scada Control Centre for Group B towns, where it shall be used to train employer and other utilities dispatchers. The major DTS features shall include:

a. The DTS model shall simulate the distribution power system in a realistic manner, including its response to simulated events, Instructor actions, and Trainee actions. The response shall be identical to the response observed by the dispatcher in the actual computer system environment.

b. The consoles shall be assignable as trainee or instructor consoles. The DTS shall support at least one instructor & two trainees

c. Instructor control features shall include the ability to set up, control, participate in, and review the results of a training session.

d. Dispatcher control feature shall facilitate dispatchers to train dispatcher to use all SCADA, dispatcher & DMS functions under normal & disturbed conditions.

e. An ability to obtain data from the SCADA/DMS systems automatically for DTS initialization. The initialization data shall include save cases, predefined & instructor defined scenarios.

f. It shall prevent actions & keep insulated the actions performed by the Instructor and Trainee using the DTS from affecting the real-time system database or the actual power system.

g. An ability to simulate actual system disturbances from historical data "snapshots" stored by the real-Time database Snapshots.

h. DTS function shall have ability to establish the following training conditions as a minimum:

   (i) Normal steady state

   (ii) Disturbed network conditions for distribution network

   (iii) High & Poor Voltage conditions

   (iv) Poor VAR conditions

   (v) Indiscriminate tripping

   (vi) islanding

   (vii) System blackout

   (viii) System restoration

   (ix) Conditions/functions included for SCADA/DMS real time system

   (x) OMS related actions

i. Following features as minimum:

(i) All SCADA/DMS/OMS functions as envisaged in the specification

(ii) Cry wolf alarms

(iii) Record/ Playback /slow/real-time/fast forward

(iv) Record trainee actions

DTS Model features, functions & user interface shall be true replica of SCADA/DMS system model for that project area. The DTS can be used in the following modes as minimum:

1. Instructor Control
2. Trainee Control

3.3.1 Instructor Control:

The Instructor shall be able to perform pre-session, session, and post-session activities. Each training session shall consist of executing a scenario (tailored to the simulated SCADA/DMS system) starting from a base case. The base case shall consist of a solved network output case from the NCA or load/power flow and one or more load curves.

Pre-session activities consist of scenario building and development of events that occur during the training scenario. A load/power flow function shall be provided in the DTS tosupport this feature.

Session activities performed by the Instructor include initiation, control, and participation in the training session.

Post-session activities shall consist of session review and evaluation of Trainee performance. The DTS shall maintain records of the training session so that the base case, scenario, Trainee actions, and other session activities may be reviewed. Instructor shall have all rights of trainee mode also as mentioned below:

3.3.2 Trainee control :

All activities, features, functions, user interfaces, which dispatcher can perform or use in real time shall be available to trainee in trainee control mode.

3.3.3 Pre-Session Activities

The Instructor shall be able to create a base case and to execute a power flow if desired to initialize the base case. The Instructor shall be able to build groups of events scheduled to occur during the training session. A training session shall be built by combining one or more event groups with a base case.

3.3.4 Scenario Construction

The following features shall be provided for building a training session:

(a) Base Case Construction: shall allow Instructor to set conditions, parameters, and limitation for equipment in the network database. It shall be possible to initialize a base case from the following sources:

(1) A stored base case created in the DTS

(2) A power flow solution obtained in the DTS

(3) A power flow or NCA /SE solution obtained from real-time system.

(4) Output of real time DMS executed functions

(b) Base Case Store: shall allow instructor to save a base case for future use. It shall be possible to transfer saved base cases to auxiliary memory (e.g., magnetic tape) and to reload saved base cases from auxiliary memory.

(c) Base Case Select: shall allow instructor to select a specific base case for modification or further processing. Base case selection may be indexed by title or subject.

(d) Base Case Review: shall allow instructor to display the contents of the base case.

(e) Base Case Editing: shall allow instructor to modify a base case and to store the updated version.

(f) Event Group Construction: shall allow instructor to construct event groups containing one or multiple events. The Instructor shall be able to define the events within the event group to occur simultaneously or according to other parameters of time or system conditions. Checks shall be performed to assure that each event entered is one of the predefined set of events and that the equipment and parameters associated with the event are valid for the event specified.

The system shall provide an interactive means for specifying the device or point associated with each event.

(g) Event Group Store: shall allow the Instructor to save the event group constructed for future use.

(h) Event Group Select: shall allow the Instructor to select one or more event groups for incorporation into a training scenario.

(i) Event Group Review: shall allow the Instructor to display events within an event group.

(j) Event Group Editing: shall allow the Instructor to modify an existing event group and to store the updated version.

3.3.5 Event Types

The Instructor shall be provided with a set of permissible event types that can be scheduled as part of a scenario. As a minimum, the following event types shall be included:

i. Change of bus load
ii. Change of system load
iii. Fault application/FPI indication
iv. Circuit breaker trip/close
v. Circuit breaker trip with successful reclosers
vi. Circuit breaker trip with unsuccessful reclosers
vii. Isolators switching
viii. Supervisory control disable/enable for specific device
ix. Relay status enable/disable

x. Loss of RTU /FRTU/FPI due to telemetry failure for specified period of time

xi. Loss of single RTU /FRTU/FPI point

xii. Replace value of telemetered point

xiii. Messages to Instructor

xiv. Pause simulation

xv. Demand snapshot.

xvi. Cry wolf alarms

3.3.6 Event Initiation

Events shall be executed at an Instructor-specified time, when Instructor-specified conditions occur, upon Instructor demand, and when protective relays operate. Event initiation shall include:

(a) Time Dependent Events: These events shall be scheduled by the Instructor to occur at a specified simulated clock time or at time intervals relative to the start time of the scenario.

(b) Conditional Events: Conditional events shall be based on simulated power system conditions obtained from DTS model. The Instructor shall be able to specify a conditional event by specifying a permissible events and a Boolean equation for the power system condition that will trigger the event. The Boolean equation shall allow the following triggers to be incorporated separately or in combination:

(1) A status variable equal to a defined state

(2) An analog variable above or below a defined threshold

(3) Change in analog variable from one DTS cycle to the next by more than a defined amount (positive or negative).

(c) Demand Events: The Instructor shall be able to demand the immediate execution of an event without having to insert it in the events list.

(d) Relay Initiated: The operation of a relay shall result in the execution of one or more Instructor-specified events.

3.3.7 Session Activities

The Instructor shall be able to monitor the training scenario and guide it toward a specific objective by inserting new events omitting scheduled events, and performing other actions. The following commands shall be provided to control a Trainee scenario:

(a) Pause/Resume: Shall allow the Instructor to suspend or resume the training scenario without affecting the scenario. While in the Pause mode, the Trainee and Instructor shall be able to call all displays but perform no other functions. The Resume command shall resume the simulation from the point at which the pause occurred.

(b) Slow/Fast Forward: shall allow the Instructor to move a training scenario forward at a Instructor-specified speed slower/faster than real-time.

(c) Event Insertion: shall allow the Instructor to add new events when a training scenario is in progress without the need to interrupt the training scenario.

(d) Event Demand: shall allow the Instructor to demand the immediate execution of an event.

(e) Event Omission: shall allow the Instructor to omit a scheduled event from the training scenario in progress without interrupting the training scenario.

(f) Periodic Snapshot: shall allow the instructor to create a historical file that is periodically updated with session data necessary to resume simulation as it occurs during the simulation. The DTS shall not pause while the snapshots are being collected and saved. The snapshot save area shall be circular in nature where the oldest snapshot will be overwritten each time a new snapshot is saved when the save area is full.

(g) Demand Snapshot: shall allow the Instructor to create a historical file, identical to that created by a periodic snapshot, on demand during the simulation. The DTS shall not pause while the snapshots are being collected and saved.

3.3.8 Post-session Activities

The DTS shall provide the following capabilities to assist the Instructor in reviewing a training session with the Trainee:

(a) Snapshot Review: shall initialize the DTS with a snapshot saved during a training session. After a snapshot has been loaded, the Trainee and Instructor shall be able to call displays to examine any data available during a session.

(b) Snapshot Resume: shall resume the simulation from a snapshot in the same manner as it would resume from a Pause.

(c) Evaluation report: Based on the actions performed, timeliness & an evaluation report shall be created to review performance of trainee.

3.3.9 DTS Performance and Sizing

The DTS shall be sized the same in all respects as the SCADA/DMS control system. In addition, the capabilities of the DTS shall include the following items as minimum:

(a) 20 DTS base cases

(b) 20 scenarios

(c) 250 event groups

(d) 50 events per group

(e) 50 session snapshots

(f) 5-minute snapshot periodicity

(g) 100 conditional events

(h) 1000 variables in conditional events.

(i) 2 Trainee (according to no. of DTS consoles) & 1 instructor

3.3.10 DTS Database and Displays

The DTS SCADA and Network model database must have the same functionality & displays as the real-time system database & displays. It must be possible to initialize the DTS with a copy of the database of real-time system in addition creation of database locally.

End of Chapter 3

CHAPTER –4: USER INTERFACE REQUIREMENTS

4.0 General Requirements

This chapter describes the User Interface requirements for the SCADA/DMS system. All SCADA/DMS functions shall have common user interface as user interaction shall be performed from Operator Consoles envisaged in this specification. This chapter is applicable to Group A, B, C towns as per functional requirements. All user interactions shall be from full graphics display. The sizing requirements are given in **the appendices in chapter 19**

4.1 System Users

The term "user" is applied to the personnel interacting with the SCADA/DMS system. These users shall be required to login in one or more of following **user modes**, which include:

(a) **Supervisor**: Personnel responsible for SCADA/DMS system administration and management such as assigning the access area to users, creating users etc.

(b) **Dispatcher:** Personnel responsible for real-time Power system operations including real-time study as per assigned town /domain in AoR (Area of Responsibility)

(c) **Engineer:** Personnel having access to certain SCADA/DMS system functions and maintenance of database/ displays and responsible for support activities such as post fault analysis, report generation, regular backup of database

(d) **Programmer:** Personnel responsible for continuing development and maintenance of the SCADA/DMS system functions, databases, displays and report formats. Security system

(e) **Remote VDU user:** Personnel having only monitoring access of real-time power system from SCADA/DMS system, reports..

(f) **DTS (Instructor & Trainee modes):** The Consoles dedicated for DTS shall have instructor & trainee modes. The requirements are defined in chapter 2 & chapter 3

The role, accessibility for each mode is defined as above, However, the Utility with login as supervisor shall be able to assign the operation of certain functions, or features of functions, to specific user modes. Utility shall maintain the privileges as specified to each user mode .Each individual user shall be assignable to anyone or more user modes. User access to all SCADA/DMS functions shall follow a consistent set of common user access guidelines. A mechanism for defining and controlling user access to the SCADA/DMS system shall be provided.

Password security shall be provided for access to the SCADA/DMS system, its operating system, layered products, and other applications. Each password shall be validated against the corresponding user information in the database. Users shall have the ability to change their own passwords.

4.2 Function and Data Access Security

After a user has successfully logged on, access to the SCADA/DMS functions, displays, reports, and databases shall be restricted by pre-assigned operating jurisdictions. These operating area assignments shall be made when the function, display, report, or database element is defined.

The access security function shall compare the user's assigned operating jurisdiction against the operating jurisdictions assigned to the function, display, report, or database element each time a user attempts a console action, such as:

(a) Calling a display

(b) Entering or changing display data

(c) Viewing, editing, or printing a report

(d) Executing a supervisory control action

There shall be no restrictions on the assignment of multiple jurisdictions to a console & user or the assignment of a jurisdiction to multiple consoles & users. The access security function shall ensure that each jurisdiction is at all times assigned to a least one console. If a console failure or manual reassignment of jurisdiction results in one or more jurisdictions not being assigned to at least one console, the unassigned jurisdictions shall be automatically assigned to a pre- assigned default console and suitable alarms shall be generated.

SCADA/DMS users shall not require additional login (user name and password) to the other facility allowed as per operating jurisdictions such as ISR. “Single Sign-On” (SSO) technology be employed (i.e., a user logs on once to the SCADA/DMS using individually defined user name and password which permits appropriate level of access to all SCADA/DMS facilities, including IS&R. Further, the facility should be compatible with enterprise-wide SSO capabilities.

Each log-on and log-off shall be reported as an event. Unsuccessful attempts to log-on shall also be reported as events.

4.3 Windows Environment

The user interface for SCADA/DMS system shall be web enabled. The SCADA/DMS system displays shall operate within a windows environment and shall conform to the standards contained in the X Consortium's Inter-Client Communications Conventions Manual (ICCCM). The window system shall work with the graphical user interface provided and shall allow windows created on the workstations to communicate with processors equipped with X Windows- compatible software on their respective local area networks (LANs) and with future remote applications over the wide area network (WAN).

Alternatively, the SCADA/DMS system can have the user Interface based on Microsoft Windows. The functionality in technical specification related to the GUI features of X-windows, shall be met by available features of Microsoft Windows.

It shall be possible to save window configuration in Rooms. Rooms shall allow each user to configure and save a preferred layout, size, and location of windows and displays. The World Display Features shall provide two-dimensional graphic world displays that a user shall be capable of panning, zooming and rubber banding.. The world display features such as Layers, Declutter levels, Overlays shall be supported. Displays & navigation on VPS shall be same as on the operator workstations.

The user interface software shall be based on state-of-the-art web-based technology to present interactive, full-graphics views of system data via LAN, corporate intranet or the internet. The same displays shall be used.

It is essential that the same web-based user interface (same navigator, same tools) be available to the operator either for local use in the dispatching center or remotely.

Real-Time Dynamic Graphics and HMI Solutions for C/C++, C# / NET, Java and Web / Mobile is envisaged.

The web technology shall be natively supported by the SCADA & DMS product, which means that having the displays shown in the web browser shall not bring additional work to the maintenance engineer at display building time. Nor shall it require additional third-party software products like specific plug-ins.

C/C++, Java and C# .NET libraries for a variety of Windows, Linux/Unix and embedded platforms, with MFC, Qt and Gtk support. z Cross-platform support for a run-time choice of a graphics driver: hardware-accelerated OpenGL or a native GDI. z Web deployment via a client-side HTML5 and JavaScript, or server-side (ASP.NET or JSP. Supported platforms: Windows, Linux, Solaris, AIX, HPUX etc

A vast collection of pre-built widgets - real-time charts, graphs, dials, meters, process control symbols and others – to be provided with the Toolkit. The Graphics Builder may be used to modify widget drawings, create dashboards containing multiple widgets, as well as design custom widgets and add them to the Builder's palettes.

The web user interface shall support and enforce all security features including cyber security compliances.

4.4 Display interactions

Rapid, convenient, and reliable display requests shall be provided using the following methods:

4.4.1 Display Requests

a) Selection of a display from a menu display

b) Cursor target selection on any menu, graphic, or tabular display

c) Selection of an alarm : in this case, it shall call up the one-line display containing the alarm's location,

d) Selection of an alarm or event message on a summary display followed by a display request command

e) Selection of display by Entering a display name or number

f) Forward and reverse paging in a page-based display.

g) Selecting a previous display by re-call command.

h) Selecting a point of interest from an Overview display for viewing on full screen (such as viewing a SLD of a substation by selecting the Substation node from a Network diagram).

i) Selecting function keys or cursor targets dedicated to displays.

4.4.2 Display navigation

Display navigation methods shall provide a consistent approach for moving within a display. The following methods shall be provided:

a) Panning with cursor positioning device or scroll bars

b) Zooming with cursor positioning device

c) Navigation window for rapid movement between portions of a world display

d) Rubber-band zooming.

e) Tool tip

f) Find & locate

g) Drag & drop

Zooming shall affect the magnification level of the data displayed. Panning shall move the viewed portion of a world map space. The size of the viewed portion of the map relative to the whole display shall be indicated by the width of the sliders in the scroll bars of the window displaying the sector. When a display is first called up in a window, it shall be automatically scaled as per default zoom level.

Both continuous and discrete panning and zooming control shall be provided. Continuous panning and zooming shall be done in a convenient and intuitive way using the mouse; and the resulting changes in the screen contents shall be "smooth" and instantaneous without any noticeable delay. Discrete panning and zooming in larger steps shall be possible by dragging the mouse, using the keyboard, and clicking on pushbuttons on toolbars.

When only a part of the display is shown in the active window, the user shall be able to request a "navigation" window for orientation. This window shall show a small replica of the complete display, with the displayed sector of the display highlighted. The user shall be able to move the navigation window anywhere on the screen, and shall be able to close it.

A decluttering mechanism that defines the visibility of a graphic construct as a function of its magnification shall be provided. As zooming changes the magnification of data displayed, the declutter mechanism shall cause levels of detail to be shown or suppressed.

The magnification range corresponding to each declutter level shall be defined as system configuration parameter. Static and dynamic element within a display shall have associated with it a visibility designation as yes or no for each

In addition to reaching the various decluttering levels through zooming, users shall also be allowed to request a specific level from a dialog menu.

The user shall be able to scale (zoom) the image of a world co-ordinate space or display in a smooth fashion to any convenient scale factor. The scale factors shall allow the presentation of an entire world co-ordinate space or display on the full screen or a window.

Static and dynamic data shall be displayed and updated during a scaling operation, and display text shall be scalable to be consistent with the scaled image. At defined scale factors, levels of de-clutter shall be invoked.

The user shall be able to select an area of a world co-ordinate display by cursor manipulation ("rubber-banding") and cause the display to be redrawn with the selected area centered in the display and with the selected area magnified to best fit the full window. The window dimensions shall not be changed by such an action.

A tool tip or equivalent method shall be provided for displaying information in English text & numeral upon moving cursor on the device etc.

Find & locate feature to take the user to the online/ network display where the particular component exists.

4.4.3 Permanent Indicators

Several indicators, including those listed below, shall be permanently shown on each SCADA/DMS Display screen as minimum:

- Date and Time: Date shall be presented in the format DD/MM/YY.

- Time shall be presented in the format HH:MM:SS with a resolution of one second, and shall be updated once per second.
- Username: Name of the user logged in the SCADA/DMS Name of the active server
- Name of the SCADA/DMS display accessed
- Name of the display window

4.4.4 Default Screen Layout

It shall be possible for each user to define a personal layout (Rooms) for the screens displayed on the screen(s) of the workstation, i.e. to define a personal default setup of the position, size, and contents of the screens.

The user's default layout shall appear when the user logs on to a workstation. When a dispatcher takes over a new shift by logging on without the previous dispatcher logging off first, the current screen layout shall be preserved. It shall be possible to go to another room layout of the logged on user at any time.

4.4.5 Display Note pad

User shall be able to place and edit a note on bays, devices etc. on any display. A symbol shall appear on the display indicating the presence of Note on that display. The content of the note shall be callable using a cursor target.

4.4.6 Quality Code and Tag Indication

All displays and reports containing telemetered analog values, device status and calculated values shall have a data quality code associated with each data field. The quality code shall reflect the condition of the data on the display or report. When more than one condition applies to the data, the symbol for the highest priority condition shall be displayed.

A separate indicator shall identify the devices that have supervisory control inhibit tags. When more than one tag is present on a device, the highest priority tag shall be displayed.

4.5 User Interaction Techniques

The user's interaction with the SCADA/DMS system for power system operations shall primarily be accomplished using a menu item selection technique. The first step in the interaction will be selection of the item to be operated upon. The user shall then be provided a menu of operations applicable to the selected item. The required operation alternatives include:

(a) Supervisory control

(b) Data entry

(c) Device status entry

(d) Scan inhibit/enable

(e) Tag placement/removal

(f) Trend.

A set of parameters shall be presented appropriate to the item type and operation to be performed. For example, selecting a device for control shall cause a menu of control actions to be presented. Selecting an analog value for trending shall cause a menu of parameters, such as range and trend rate etc., to be presented.

As appropriate for the data and function requested, a menu containing output destinations such as screen, printer, or file shall be presented. When the destination is selected by the user, the requested action shall begin. It shall not be necessary to select an execute command to complete the interaction except for supervisory control actions.

The user shall be able to end the interaction sequence at any time by selecting a cancel command. The progress of all user operations shall be monitored. If the user does not complete to a step within a multi-step operation within a pre-defined time, the process shall reset, and the user shall be informed of the reset. A partially completed action shall be reset if the user begins another non-related sequence.

A programmer-adjustable time-out cancel shall also be provided.

4.5.1 User Guidance

The SCADA/DMS system shall respond to all user input actions indicating whether the action was accepted, was not accepted, or is pending. For multi-step procedures, the systems shall provide feedback at each step. User guidance messages shall be English text and shall not require the use of a reference document for interpretation. User shall be guided for multiple options. The use of mnemonics is prohibited, unless the mnemonics are industry-accepted or approved by employer. Provisions are required for administrators to edit the toolbars and menus, user guidance messages and to construct new ones through an interactive procedure and without programming.

4.5.2 User Help

In addition to the user guidance, general and specific context-sensitive on-line help shall be available to the SCADA/DMS user. Context sensitive means that the help informationprovided shall be applicable to the next step or steps in the sequence being performed. The Help menu shall present a list of topics available for reference. The topics shall refer to the SCADA/DMS user documents. The ability to scroll through the topic's explanatory text shallbe supported.

The Help button in a dialog box and help key shall present the text of the user documents where use of the dialog box is explained. The user shall be able to scroll through this text. Exit from the help facility shall return the user to the same point in the sequence for which help was requested.

Context sensitive help facilities shall be provided for each application software package and operator display. The capability to easily edit or add additional help facilities in the future shall be provided.

The provided help facility shall also support:

- Search mechanism
- Navigation links between related topics within the help documents
- select/copy mechanism
- Print facilities

4.5.3 Overlapping user access

The ability to queue multiple commands from different consoles shall be provided. In this regard, however, interlocks shall be provided to avoid overlapping user access to certain functions such as data entry and supervisory control as follows:

(a) Data Entry: Although the same data entry field, device status entry or fields (in the case of full-page data entry) may appear concurrently in multiple windows at multiple consoles, data entry for the field or fields shall be restricted to one window at one console at a time. An attempt to initiate data entry for the field or fields from another window shall result in a user guidance message. Concurrent data entryon different areas of a world display, however, shall be allowed.

b) Supervisory Control: Although the same power system device, such asa circuit breaker, may appear concurrently in multiple windows at multiple consoles, control of the power system device shall be restricted to one window at a console at a time. An attempt to initiate control of the power system device from another window shall result in a user guidance message.

4.5.4 Function Key Usage

Special functions shall be assigned to the 12 function keys on a standard keyboard. With extensions (e.g., Shift, Alt, Esc) this shall result in a minimum of 48 function key actions.

4.6 Trend

Trend shall be a display of series of values of parameters on a time axis. Both graphical trend and tabular trends shall be supported. The attributes of the trend display shall be user configurable. The trend application shall be able to show trends for any measurement type from more than one source, at least from real- time, historical and forecast sources. It shall be possible to combine this data showing data for comparison using a shared timeline simultaneously comparing for example yesterday (historic) and today (historic, actual and forecast) as two curves on the same time axis. It should be possible to trend different types of parameters (P, Q, V, I, F etc.) with associated Scales on the same display. The user shall be able to select a trend rate different than the sampling rate.

4.6.1 Graphical Trend

The user shall be able to select and configure trending on Graphical displays enabling user for entry of the following parameters:

(a) Data value name

(b) Trend header

(c) Trend direction (horizontal or vertical)

(d) Scale (unidirectional and bi-directional)

(e) Zero offset

(f) Trace number, color & texture

(g) Trend data rate

(h) Trend start time and date (historical data only)

(i) Total trend duration (historical data only)

(j) Reference lines or shading axes (With default to restrictive alarm limits)

(k) Windows/chart to be used

(l) Simultaneous trending of different parameters with associated scales.

Trending of at least four values simultaneously, on a common axis or separate axes shall be supported. All scales corresponding to the values selected shall be visible on the Trend Display simultaneously. There shall be automatic movement of data down or across the screen as new values are generated. When the number of real-time trend samples reaches the limit that can be displayed, the oldest value shall automatically be removed as the display is updated.

The magnitude & time of all the trended quantities at a particular time instant shall be displayed when the cursor is placed on the timescale on the trend display.

When historical data is selected for trending, the user shall be able to page forward and backward, or scroll by the use of a scroll bar, through a non-updating snapshot of the data within the constraints of the data stored in the historical files.

Shading between each trend value and user-definable axes shall be provided. Trend colour shall be changeable based on a comparison of the trend value against associated alarm limits.

It shall be possible to have at least data samples corresponding to 2 months on line storage for each of the trended variable. The user shall be able to print the trend without interfering with the continuing trending process.

4.6.2 Tabular Trending

Tabular trending shall be a listing of the time-sequential values of a variable/ variables. The tabular trend shall present the data in a tabular form with one column for Date/time and additional columns for each of the trended variable. The tabular trend shall contain at least rows for samples corresponding to 2 months on line storage. Each row shall contain the values of the trended variables. It shall be possible to scroll up and down to see the rows. The sampling rate shall be individually definable for each tabular trend.

The historical tabular trends, which shall be produced from the previously stored values in trend files, it shall be possible to choose the start time, the end time, and the sampling rate independently of the sampled rate of historical data.

It shall also be possible to save trend output to an Excel, .csv ,ASCII file., with date and time information and the engineering unit value of the trended variables for each collection interval. The user shall be able to print the trend on a user-selected printer without interfering with the continuing trending process.

4.7 Alarms

Alarms are conditions that require user attention. All alarms shall be presented to the user in a consistent manner. Alarm conditions shall include, but not be limited to, the following:

(a) Telemetered or calculated value limit violations

(b) Values returning to normal from a limit violation state

(c) Uncommanded changes of a power system device state

(d) SCADA/DMS application program results

(e) Data source communication errors resulting in loss of data

(f) SCADA/DMS system hardware or software failures.

Each alarm shall be subjected to a series of alarm processing functions. A device or value's alarmable conditions shall be assigned to an alarm category and alarm priority levels. Alarms

shall also be subjected to advanced alarm processing. The results of the alarm processing shall determine the console(s) that will receive and be authorized to respond to the alarm and the associated actions with the alarm.

All alarm messages shall be recorded on auxiliary memory of SCADA/DMS system and archived in chronological order & reverse chronological order. It shall be possible to sort, display and print user selected alarm messages from any console by the user.

4.7.1 Alarm Categories

An alarm category provides the logical interface that connects an alarm condition to a specific Area of Responsibility (AOR) or operational jurisdiction as defined and accordingly alarm shall be reported to user. Every alarm shall be assignable to a category. Each category shall, in turn, be assignable to one or more users. A means shall be provided for changing operating shifts without reassignment of alarm categories at a console. Each log-on and log-off shall be reported as an event.

4.7.2 Alarm Priority levels

Each alarm shall be assigned to an alarm priority level. Up to 8 alarms priority levels shall be supported. Each alarm priority level shall be presented in separate display. For each alarm, it shall be possible for the programmer to independently configure the following actions:

(a) Audible alarm tone type selection and its enabling/disabling

(b) Alarm messages to be displayed on an alarm summary

(c) Alarm message deleted from alarm summary when acknowledged

(d) Alarm message deleted from alarm summary when return-to-normal alarm occurs

(e) Alarm message deleted from alarm summary when return-to-normal alarm is acknowledged

(f) Alarm message deleted by user action.

This assignment shall determine how the alarm will be presented, acknowledged, deleted, and recorded.

4.7.3 User Interaction for Alarms

The User shall be able to perform the alarm interactions described below.

4.7.4 Alarm Inhibit/Enable

Inhibiting alarms for a value or device, including a complete RTU /FRTU/FPI or other data source, shall cause all alarm processing of that value or device to be suspended. The action shall be recorded in the event log. However, Scanning of the value or device shall continue and the database shall be updated.

4.7.5 Alarm Acknowledgment

An alarm shall be acknowledged by selecting an alarm acknowledge command when the item in alarm is selected on:

(a) Any display showing the item in alarm

(b) Any display showing the alarm message.

User shall be able to acknowledge alarm individually, by page, user selected manner. It shall be possible for the user to distinguish persistent & reset alarms under acknowledged &

unacknowledged conditions. All alarms shall be stored by the system

4.7.5.1 Audible alarm silencing

User shall be able to silence alarm without acknowledgement and shall remain until the user enable the audible alarm. The silencing & enabling shall be recorded as event. The tones shall be definable on the console basis. For each console, multiple tones shall be available. Tones shall be of continuous & short duration type both. The former shall be of high priority condition & require operator intervention to stop. In case of short duration tone, it shall go offat its own.

4.7.5.2 Change Alarm Limits

The user shall be able to change the alarm limits.. When the user selects an item to change its alarm limits, a menu showing the alarm limits currently in use and a data entry field for the revised limits shall appear. All changes to alarm limits shall be subjected to data entry error checking and recorded as events. The alarms shall be annunciated according to the changed alarm limits. The user shall be able to reset alarm limits to the limits set in the SCADA database. However, these shall be treated as temporary changes & if the system is re-initialized, the original limits defined in the SCADA database shall be operationalized.

4.7.5.3 Alarm Presentation

Alarm presentation shall be determined by the alarm's category and priority. Displays shall highlight every alarm condition using a combination of color, intensity, inverse video,blinking and audible sound. The alarm condition highlighting shall show whether the alarm has been acknowledged. The highlighted alarm condition shall appear on all displays containing that device or value at all consoles regardless of the alarm's category.

Alarm messages shall be a single line of text describing the alarm that has occurred and the time of occurrence. The alarm message shall be English text and shall not require the use of a reference document for interpretation.

4.8 Events

Events are conditions or actions that shall be recorded by the SCADA/DMS system but do not require user action. Events shall be generated under the following conditions

(a) User initiated actions

(b) Conditions detected by application functions that do not require immediate user notification, but should be recorded.

Events shall be recorded in the form of an event message. The event message format shall be similar to the alarm message format. The same message format shall be used for displaying and printing events. Event messages shall be displayed on an events summary.

Event messages shall be stored on auxiliary memory of SCADA/DMS system and archived in chronological order and reverse chronological order.. It shall be possible to sort, display, and print event messages from any console.

4.9 Hardcopy Printout

The SCADA/DMS system shall have features to produce a print out of a display, reports, Alarms, Events etc. from a menu. Any of the available printers shall be selectable by the SCADA/DMS users from menus for taking printout.

It shall be possible to print a complete display or a selected portion of a display. The options for printing shall include at least choice for orientation, background color, page size, color/

black & white and print preview. Also any of the available printers shall be selectable from the print Menu.

4.10 Report Generation

The contractor shall be required to generate the Daily, Weekly, Monthly reports formats for SCADA/DMS system. The report formats shall be finalized during detailed engineering stage. The user shall be able to schedule periodic generation of reports, direct report to display, print report, and archive report using report-scheduling display. The report scheduling display shall enable entry of the following parameters, with default valuesprovided where appropriate:

(a) Report name

(b) Report destination (printer or archiving device)

(c) Time of the system should produce the report.

The user shall be able to examine and modify the contents of reports for the current period and for previous report periods using displays. Any calculation associated with the revision of data in a report shall be performed automatically after data entry has been completed.

The report review displays shall accommodate formatted report pages up to132 characters in width and 66 lines in length and shall contain headings that correspond to the printed report headings. For reports containing more columns or rows than the display, the system shall include a means to view the entire report in a graphic format. The report view and editing displays shall function with the initially supplied reports and all future reports added by employer.

4.11 System Configuration Monitoring and Control

The user shall be provided with the capability to review SCADA/DMS computer system configuration and to control the state of the configuration equipment using displays. The following operations shall be possible:

(a) Failover of each server

(b) Monitoring of servers, device, including workstations, RTUs, FRTUs,FPIs, status & loading of WAN LANs etc.

(c) Monitoring of the processor resource, hard disk & LAN/WAN Utilization

(d) Control & monitor of SCADA/DMS functions

4.12 Dynamic Data Presentation

It shall be possible to present any item in the database on any display. All supervisory control and data control capabilities shall be supported from any window of a world display. Device status or data values shall be displayable anywhere on the screen, excluding dedicated screen areas such as the display heading.

Only standard X Window system or Microsoft windows standard fonts shall be provided with the SCADA/DMS. All fonts supplied shall be supported on the user interface devices and all printers supplied with the system. The types of fonts to be used in a particular display shall be selected at display definition time.

Status and data values shall be presented in the following formats as appropriate:

(a) Numerical text that presents analogue values shall have the provision forthe format definition of the text shall include the number of characters, number of decimal places, and the use of positive /negative sign or flow direction arrows, etc.

(b) Normally the telemetered MW/Mvar values along with the sign/direction shall be displayed on the Single line diagram and Network diagram. However the user shall also be able to display all other telemetered and calculated/ estimated analog values (I, V, pf etc. for each phase) on the Single line diagram (SLD) and Network diagram.

(c) Symbols, including alphanumeric text strings for an item, based upon state changes e.g., circuit breaker (OPEN/CLOSE/ INVALID).

(d) Symbols, including alphanumeric text strings for indicating the data quality flags.

(e) Colors, textures and blink conditions based upon state or value changes or a change of data quality, e.g., alarm limits.

4.13 Element Highlighting

Element highlighting techniques shall be provided to draw the attention of Dispatcher to critical state of the system. The highlighting technique shall include change of color, color intensity, blinking, Character inversion, Line texture, appended symbols etc. This feature shall be used to highlight alarms, power system device and measurement status, data quality, data entry locations on a display and error conditions.

4.14 Display Types

The following indicative list describes the types of displays that are to be included in the SCADA/DMS system. The user interface shall support the capabilities of all displays as specified. The User mode, Current Time and date shall be displayed on a screen-basis, not on a display basis, and shall be always visible.

4.14.1 Dashboard

A suitable dashboard for utility to view vital parameters at a glance shall be created.

4.14.2 SCADA/DMS System Display

A display shall be provided that lists all SCADA/DMS system directory displays. The displays shall be listed in alphabetical order with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for display selection.

4.14.3 Distribution System Network Display

A graphic overview network display of the distribution system with substations, feeders. Distribution network color coded by voltage shall be provided. This display shall present the distribution system in a graphic format provided by employer. Telemetered and calculated data like Real and reactive power flows shall be displayed as a value with a direction. Lines that have exceeded their loading limits shall be highlighted. Substationsand power stations shall be depicted by symbols that reflect the presence of alarms at that substation or power station. Cursor selection of a substation/ power station symbol shall result in the associated Single line diagram display for that substation/ power station.

4.14.4 Interchange Display

The interchange display shall be provided as a schematic diagram showing power transfers among various utilities. This diagram shall show each power system as a block with actual and scheduled net interchange values outside the block. Symbolic arrows shall indicate power flow directions. The diagram shall also show schedule deviations. This display shall show the frequency values collected from all substations having tie-lines.

4.14.5 Substation SLD displays Menu

A display shall be provided that lists all substations that can be viewed via a SLD display. The name of the SLD displays shall be listed in alphabetical order, according to substation name, with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for graphic display selection.

4.14.6 Substation SLD Displays

SLD displays shall be provided for each substation, including those for which telemetry may not be available but are required for running the DMS applications. Each display shall present telemetered, manually entered, and calculated power system data on a Single line diagram that shows substation layout in terms of its buses, switches, lines, and transformers. The feeder names in the SLD shall have linkage with remote substation end SLD, distribution network associated with that feeder. It shall be possible to move to remote-end substations SLD by selecting this feeder. The user shall be able to perform any user interaction defined by the Specification on these displays.

4.14.7 Control panel displays

As utilities are presently using conventional panels at S/S for supervision & monitoring, The control panel displays giving look -alike feeling shall be provided for operator supervise & operate

4.14.8 Tabular Displays

Tabular displays shall be provided for each substation. These displays shall list the real-time values of telemetered, manually entered, and calculated data associated with the substation as well as related information such as alarm limits. The user shall be able to perform any user interaction defined by the Specification on these displays.

4.14.9 Alarm Summary Displays

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. The summary shall separate acknowledged and unacknowledged alarms. Capacity shall be provided for at least 200 alarm messages for each alarm summary type. If an alarm summary display becomes full, the oldest messages shall be automatically deleted and the newest messages shall be added. It shall be possible to perform any alarm interaction from this display. The user shall be able to select between viewing events in chronological or reverse chronological order.

4.14.10 Event Summary Displays

Event summary displays shall list the most recent events and shall be organized by category for those categories assigned to a given console, as one summary display for all categories assigned to a console, or by all conditions system-wide without reference to the categories assigned to a console, as selected by the user. The user shall be able to select between viewing events in chronological or reverse chronological order.

4.14.11 Operating Information Summaries

The operating information summaries defined below shall be provided. Summary items shall be listed in reverse chronological order with the most recent item shown on the first page. All summary displays, except for Tag Summary shall be information-only displays; no user interaction, other than display call up, shall be associated with them. The Tag Summary shall be interactive, i.e., the user shall be able to place or remove tags on this summary.

4.14.12 Manual Override Summary

The manual override summary shall list all telemetered and calculated device status and data values for which a user has substituted a value

4.14.13 Off-Normal Summary

The off-normal summary display shall list devices and values that are found to be abnormal, i.e., are not in their normal state. Telemetered, calculated, and manually entered status and data values shall be included.

4.14.14 Out-of-Scan Summary

The out-of-scan summary display shall list device status and data values that are not currently being processed by the system. If an entire telemetry source such as an RTU /FRTU /FPI is out-of-scan, the out-of-scan summary shall display the source without any of the individual device status or data values associated with the source

4.14.15 Alarm Inhibit Summary

This display shall list devices and data values for which the user has suspended alarm processing.

4.14.16 Tag Summary

This display shall list and describe all active device tags.

4.14.17 Graphical Trending Summary Displays

The summary display shall list all items being trended. The list shall include the item name, trace number or color, trend orientation, and trend range.

4.14.18 Tabular Trending Summary Displays

The summary display shall list all items being recorded for tabular trends. The list shall include the item name and the file name.

4.14.19 Notes Display

This display shall include a minimum of 5 pages on which a user at any console may enter and edit messages. The contents of these pages shall be accessible by any console. The user shall have the ability to clear any page of this display and to type over previous messages.

4.14.20 Computer system Configuration and Monitoring Displays

Graphic and tabular displays shall be provided that allow the user to:

(a) Monitor and revise the configuration of the computer system

(b) Monitor the system's resource utilization statistics

4.14.21 RTU/ FRTU/FPI Communication Channel Monitoring and Control Display

This display shall show information on the status of the system's communication interface devices (including communication channels), the accessibility of each RTU/FRTU/FPI in a

graphical form. The user shall be able to Enable/Disable any communication channel from this display. Such actions shall be recorded with User ID details

4.14.22 SCADA/DMS Application Program Displays

Application program displays shall be provided to satisfy the user interface requirements of the system functions stated throughout this Specification. Application program displays shall be based on a standard user interface design across all applications to provide a common look and feel. The application's information shall be presented in such a way as to facilitate user operations.

The required displays for all DMS Applications, as defined in Chapter 2 shall also be made available to the user.

4.14.23 SAIDI/SAIFI displays

There shall be suitable displays to visualize SAIDI /SAIFI (Planned, unplanned & total) feeder wise, Substation wise , Town wise, Distt. wise or any another logical boundary mentioned by utility on daily, weekly, month, quarterly, FY , Yearly basis with comparison with past years through suitable navigation

4.14.24 SLA monitoring displays

The display shall capture and maintain record and display historical and current values as per requirement of monitoring of SLA as per chapter 17

4.14.25 Help Displays

Help displays shall be provided to aid the user in interpreting displayed information and to guide the user through a data entry or control procedure. Help displays shall be provided for each display that is provided with the system. Each display shall have a prominent cursor target that the user can select to request the associated help display. For standard displays, software aids (such as context sensitivity) shall be used to present pertinent help information in an expeditious manner. A programmer shall be allowed to modify and create help displays.

Further,e SCADA/DMS dynamic distribution network with GIS land base at the back ground shall be available for navigation. Operator shall be able to perform all functions & have features as envisaged in the specification. Suitable GIS adaptor shall be provided to import the distribution network model & GIS information from GIS system. Refer other GIS details as mentioned in chapter 1 &2 of this section.

End of Chapter 4

CHAPTER -5: SYSTEM SOFTWARE REQUIREMENTS

5.0 General

This chapter describes the characteristics of system software such as Operating system, RDBMS and support software (programming language compilers, database development and maintenance, display development, network services, report generation, diagnostics and backup utilities) to be provided by Contractor and the original software manufacturer as necessary to support the SCADA/DMS/OMS/RT-DAS applications. This chapter also describes the standards to be followed for all supplied software. It is necessary that functional, availability & performance aspects are met. Bidder shall assess the adequacy of software specified & if any additional software is required to meet all the requirements of the technical specifications, the same shall also be included in the offer. This chapter is applicable to Group A,B,C towns as per functional requirements

5.1 Software Standards

All SCADA/DMS software provided by the Contractor, including the Operating system, RDBMS and support software, shall comply with the industry-accepted software standards produced by national and international organizations, such as ANSI, ISO, IEC, IEEE, ECMA in order to facilitate maintenance and enhancement of the SCADA/DMS systems being supplied. In areas where these organizations have not yet set standards, the software shall comply with those widely accepted de- facto standards put forth by industry consortiums,such as OSF and X/Open or equivalent. The Contractor shall commit to meet the "open systems" objective promoted by industry standards groups by using software products that arebased on open standards.

5.1.1 Design and Coding Standards for SCADA/DMS applications

All SCADA/DMS applications shall be maintainable by employer using the supplied software utilities and documentation. The SCADA/DMS software design and coding standards shall also address the following:

(a) Expansion/ scalability: software shall be dimensioned to accommodate the ultimate size of SCADA/DMS system envisaged.

(b) Modularity: software shall be modular to minimize the time and complexity involved in making a change to a program.

(c) User-Directed Termination: Functions taking long execution times shall recognize and process user requests to abort the processing.

(d) Programming languages: The software shall be written using ISO or ANSI or ECMA standard programming languages like FORTRAN, C, C++ and SQL and for Unix based systems the APIs shall be POSIX- conforming.

(e) SOA architecture: Software shall conform to SOA.

(f) Enterprise service bus (ESB): ESB based architecture is essential toenable interaction of applications from different product manufacturer, platforms etc.

(g) Portability & Interoperability: The software shall be designed for hardware independence and operation in a network environment that includes dissimilar hardware platforms to the extent possible. The use of system

services software shall be built on Open standards

5.2 Operating System

The contractor shall use Unix /Linux / Microsoft Windows™ operating system servers. The servers based on of Unix O/s, shall generally comply with the evolving set of POSIX standards defined by IEEE.

5.3 Time and Calendar Maintenance

The SCADA/DMS system shall maintain Time and date for use by various software applications. The GPS based time receiver shall be used for synchronizing the SCADA/DMS system time. All Servers and O p e r a t o r workstation clocks shall be synchronized within the accuracy of +/-100 milliseconds. The SCADA/DMS system shall not be dependent on a particular server for time /calendar maintenance. . The SCADA/DMS shall include two redundant time and frequency standards. Failure of the online unit shall result in automatic switching to the redundant unit. The SCADA/DMS shall periodically check if the backup unit is operational and failure of either unit shall be alarmed.

The frequency reading shall be accessible by SCADA/DMS applications with three post-decimal digits resolution .The system shall support communication protocols such as NTP and SNTP. The time and frequency standard unit shall support a common time code output format such as IRIG-B.

A surge protection system shall be included to prevent the time and frequency standard equipment from lightning.

5.4 Network Software

The network software for SCADA/DMS system shall include software for network communication, security and services.

5.4.1 Network Communication

Users and various applications shall be able to communicate within the SCADA/DMS local area network and operate as described in this Specification. The network communications software shall use a standard network protocol such as TCP/IP. The software shall link dissimilar hardware nodes, including local and remote workstations, application servers, communication servers, and various peripherals (such as printers) into a common data communication network allowing communications among these devices.

5.4.2 Network Security

A user authentication scheme consisting at least of a user identification and password shall be required for the user to request a connection to any network node.

The design & configuration , parameterization, placement of DMZ shall be such that SCADA /DMS /RTDAS system shall be protected from intrusion /vulnerabilities from outside world as per IEC62443, IEC 62351-3, ISO/IEC27001. The cyber security same shall certified on SAT by CERT.IN empanelled agency/ NCIIPC or any GoI agency before Operational acceptance by SIA. The same shall be required to be verified at least once annually or Major upgrade or change on the system or data of validity of certification which ever earlier during the FMS period also and maintain required performance and functional requirements/SLA

5.4.3 Network services

The following network services shall be provided for the users of SCADA/DMS system:

(a) Network file management and transfer, for files containing text, data, and/or graphics information

(b) Network printing management

(c) Network time synchronization

(d) Network backup over LAN

(e) Task-to-task communications to external computers

(f) LAN global naming facilities.

(g) Remote procedure call

(h) Remote terminal session

5.4.4 Security Services

The security solution shall comprise of comprehensive solution for secured zone Firewalls i..e LAN Firewall & Gateway Firewall, intrusion Prevention system IPS (Network based & Host based) & Strong Authentication (multi layered), LDAP , Encryption mechanism. The contractor shall provide a tightly integrated intrusion detection system to detect and prevent intrusion

Followings are the functional requirement from the security system:

- System shall have Multilayer (at least network, application layer) firewall which shall protect the complete system network from unwanted users. Further the separate firewall of different OEMs shall be provided to take care the security of all the servers & shall have High Availability architecture with No Single Point of Failure (NSPOF).
- Gateway Firewall should be capable of load balancing multiple links from different service providers.
- LAN Firewall shall provide isolation/security services between the subsystems installed under SCADA system
- Firewalls deployed should not become a bottleneck. It shall be Robust, Secure, Scalable and future-proof with Centralized Management.
- Two type of IPS Host based & Network based shall be deployed with minimum hardware & they should not go blind in peak traffics.
- IPS should have hybrid technology to detect attacks. It should detectthrough a combination of Protocol Anomaly and Signature matching.
- Shall have Gateway antivirus which will protect from inflow of virus from the Internet and other WAN locations at the gateway itself with content filtering without any lag in data transmission.
- Shall have strong authentication containing user name and passwords which shall be very difficult to compromise.
- SSL over VPN to provide secured link over public network such as with RTU/FRTU/FPI

5.4.5 Features

Followings are the features specific to each component of security system

5.4.5.1 Firewall

The Firewall shall be hardware box Firewall system with following features.

- Firewall speed >250 Mbps
- Data encryption supported DES (56 bits) 3 DES (168 bits) and hashing algorithm like MD5 and SHA-1
- Encryption to offload the main CPU
- It shall have minimum 8 Ethernet 10/100 /1000 ports (4ports for connectivity to two web servers & 4 Ports for connectivity to LAN
- Support NAT and PAT
- Capability of working in Load sharing and hot standby mode
- Denial of service prevention.
- DNS guard features
- JAVA and ActiveX blocking
- Radius integration
- Web based management interface
- Stateful inspection for web, mail, SQL application etc.
- Detailed system logging and accounting feature
- No. of concurrent TCP Sessions supported shall be more than 5000.

5.4.5.1.1 Intrusion Prevention System (IPS)

The contractor shall provide a tightly integrated intrusion detection & prevention system Capable for detecting the intrusion attempt that may take place and intrusion in progress and any that has taken place.

Both Network based and Host based IPS should have centralized Management Console system which will be either the application server with NMS or any of the workstation. The Centralized management console shall have integrated event database & reporting system & it must be able to create and deploy new policies, collect and archive audit log for post event analysis. The system shall have Integrated Event Database & Reporting System.

Automated Update of the signature for two years shall be provided and there should be provision for creating customized signature

(A) Intrusion Prevention System (Network Based)

After detecting any intrusion attempt there should be provision to configure to perform the following functions:

- Capability for Detecting the intrusion attempt that may take place, intrusion in progress and the intrusion that has taken place
- Reconfigure the firewall provided in this package.
- Send an SNMP Trap datagram to the management console.
- The NMS server envisaged under the specification shall be used as management console also.
- Send an event to the event log.

- Send E-mail to an administrator to notify of the attack.
- Save the attack information (Timestamp, intruder IP address, victim IP address/port, protocol information).
- Save a trace file of the raw packets for later analysis
- Launch a separate program to handle the event
- Forge a TCP FIN packet to force a connection to terminate.
- Detect multiple forms of illicit network activity: -Attempted
- Vulnerability Exploits -Worms -Trojans -Network Scans -Malformed
- Traffic -Login Activity
- The System shall support monitoring of multiple networks. The system shall also support the monitoring of additions or changes to addresses of devices on the network.

The system shall have detection rules for monitoring faults, dangerous and malicious activity related to IP based protocols. The Contractor shall also apply its power control and security experience to enhance these detection rules for specific issues within the system.

(B) Intrusion Prevention System (Host Based)

Host based IPS shall run on the servers. After detecting any intrusion attempt there shall be provision to configure the IPS to perform following actions

- Send an SNMP Trap datagram to the management console. The NMS server envisaged under the specification shall be used as management console also.
- Send an event to the event log. Send e-mail to an administrator to notify of the attack.
- It should be capable of creating audit trail for user and file access activity, including file accesses, changes to file permissions, attempts to install new executable and/or attempts to access privileged services,
- In an event where user accounts are added, deleted, or modified changes to key system files and executable is done in by unauthorized account or there is unauthorized attempt to overwrite vital system files, to install Trojan horses or backdoors, suitable action shall be taken such as :
  - Terminate user Login (intruder)
  - Disable user Account (intruder)
  - Administrator can define the action to be taken
  - Forge a TCP FIN Packet to force a intruder connection to terminate.
- Should provide events check for suspicious file transfers, denied login attempts, physical messages (like an Ethernet interface set to promiscuous mode) and system reboots.

5.4.5.1.2 Gateway Antivirus

This shall be used for Gateway scanning of viruses. Gateway antivirus shall have Centralized-user Administration which will Communicate directly with centralized userdirectories such as LDAP. It shall have the all the essential/standard features of Latest version of Gateway antivirus, some of the features are as following:

- It shall have Policy-based URL filtering and Dynamic Document Review.
- It shall protect web traffic with high-performance, integrated virus scanning and web content filtering at the gateway
- It shall ensure protection by combining list-based prevention with heuristic content analysis for both virus protection and web content filtering
- It shall eliminate unwanted content and malicious code & Scan all incoming and outgoing HTTP and FTP traffic etc.

The Security System shall use the best practices to prevent the System itself being a source of security compromise. The System shall be hardened, patched, tested, and designed with security as a primary objective. Communication with (GUI and notifications) and within (agent reporting and updates) the System shall use encryption and authentication.

5.4.6 Other Aspects of Security

5.4.6.1 Application Security Monitoring

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

- Application Software Error Conditions
- Application Software Performance Issues
- Application Configuration Changes
- Application Logins, etc.

The system shall be capable of annunciation, to include audible and visual alarms and remote paging whenever a security event takes place and shall support the following:

- Instant notification through email or pager
- Logical grouping of security events by time, location, and device, etc
- Interactive dashboard window for viewing and acknowledgement

5.4.6.2 Analysis and Reports

- The system with the stored information shall be able to produce analyses and reports to meet security compliance requirements. The system shall be equipped with best practices ad-hoc reports widely used in the industry.
- The employer's personnel shall be trained to be capable of creating new custom analysis and reports, and revising existing, without requiring external consultation.

5.4.6.3 Log Archiving

The security system shall archive, record, and store all security related events in raw form for at least one year. As a minimum, the event logger shall record all security related events from the perimeter security devices and the host IPS. Graphical trend displays of each event shall be available along with specific information on the type of intrusion, the area affected and the source via IP address.

5.4.6.4 Data Access through intranet

The Web server at Control Center is to function as source of information on the distribution network. It will be accessed by utility intranet user. Any additional client software, if required, at external clients/users ends, the same shall be made dynamically available from Web server for its downloading by these external clients. There shall not be any restriction to the number of clients downloading this software (i.e. Unlimited number of client downloads shall be provided).

The external users shall be licensed users of the employer. The following features are required:

a) The Web servers shall be sized to support atleast 50 concurrent external intranet clients/users for providing access to real-time data.

b) External intranet clients/users shall be connected to the web servers through secure authentication such as VPN access. These users shall be denied direct access to the SCADA/DMS protected LAN.

c) Internal SCADA/DMS users shall not have any dependency on the availability of the Web servers.

d) For the purpose of transfer of data/displays/ from the SCADA/DMS system to the Web server system, the SCADA/DMS system shall initiate a session with the Web server and any attempt to initiate a session by the Web server shall be terminated by the Firewall in SCADA/DMS system LAN. Interface between Web server and SCADA/DMS zone shall preclude the possibility of external clients defining new data/Report/Displays.

For any sessions initiating from the DMZ LAN into the protected

LAN, the servers shall be located in a separate DMZ LAN that will be isolated from common applications connected directly to ISP such as email. The Access to these servers from the external web will be through authorization of Virtual Private Network.

e) The web server shall provide access to allowable real time data and displays, at defined periodicity, for viewing by external clients/users. The access to each display shall be definable on per user type basis. It shall be possible to define up to 100 users. Further the SCADA/DMS system administrator shall exercise control over the real-time displays which can be accessed through the Web server.

f) The Web server at Control Center shall also facilitate exchange of email messages from ISP (Internet Service Provider) and other mail servers supporting SMTP..

g) Suitable load balancing shall be provided among the web servers where each shall serve proportionate number of clients.

However in case of failure of one of the servers, all the clients shall automatically switch to the other web server(s).

Typical displays/pages for Intranet access shall be same as that on the SCADA/DMS**.** Real time SCADA data on web server shall be refreshed every minute. The access to Web server/site shall be controlled through User ID and password to be maintained /granted by a system administrator. Further, different pages/data access shall be limited by user type (i.e. CMD, Mgmt. user, in-charge etc.). The access mechanism shall identify and allow configuration of priority access to selected users.

Further, tools shall be provided for maintaining the website, web server configuration, E-mail configuration, FTP configuration, Mailing lists setup and customer support. Latest protections against viruses shall be provided.

5.4.6.5 Signature Updating Requirements

The system shall be able to accept timely updates. The updates shall keep the threat signatures current, providing the latest detection and protection. The updates shall also incorporate the latest security enhancements into the Security Management System. These enhancements shall increase security and functionality, without requiring redesign or reengineering efforts.

5.4.6.6 Network Management system (NMS)

A network monitoring and administration tool shall be provided. The interface of this tool shall show the DMS hardware configuration in form of a map. The network-monitoring tool shall automatically discover the equipment to construct the map. It shall support management of multi-Vendor network hardware, printers, servers and workstations.

It shall support remote administration of network devices, management of thresholds for monitoring performance and generation of alarm and event notifications. It shall be possible to send these notifications to maintenance personnel through e-mail

The Network management system shall manage the interfaces to the SCADA/DMS servers, workstations, devices, communication interface equipment, and all SCADA/DMS gateways and routers ,switches etc

The network management software shall be based on the Simple Network Management Protocol (SNMP-Internet latest RFC) over TCP/IP (CMOT), with additional proxy software extensions as needed to manage SCADA/DMS resources.

The NMS software shall provide the following network management capabilities:

(a) Configuration management

(b) Fault management

(c) Performance monitoring.

The network management software shall:

(a) Maintain performance, resource usage, and error statistics for all of the above interfaces (i.e. servers, workstation consoles, devices, telephone circuit interface equipment, and all SCADA/DMS gateways , routers etc.) andpresent this information via displays, periodic reports, and on-demand reports.

The above information shall be collected and stored at user configurable periodicities i.e. upto 60 minutes. The Network Management System (NMS) shall be capable of storing the above data for a period of one year at

periodicity of 5 minutes.

(b) Maintain a graphical display of network connectivity to the remote end routers

(c) Maintain a graphical display for connectivity and status of servers and peripheral devices for local area network.

(d) Issue alarms when error conditions or resource usage problems occur.

(e) Provide facilities to add and delete addresses and links, control data blocks, and set data transmission and reception parameters.

(f) Provide facilities for path and routing control and queue space control.

(g.) SLA monitoring - Availability of all devices shall be monitored and SLA shall be calculated as per SLA requirement specified in FMS chapter

5.4.6.7 Central Cyber security Monitoring & Detection

The Contractor shall implement a unified cyber security Application platform purpose built to monitor, manage & maintain the security posture of the overall control system network. The system shall establish mechanisms & processes for detection of cyber security threats, to ensure cyber security threats or incidents can be responded promptly to. These shall include key security technologies like central security policy management for host machines, capturing and & analyzing security event logs from all security/networking assets and continuous threat detection systems adopted for an operational technology environment.

The proposed deployment shall be based on a **vendor agnostic** platform, natively supporting the said cyber security services, while offering **flexibility and scalability** to provide additional functionalities needed in the context of security improvement plan.

The software platform shall be designed in conformance to key global standards like IEC 62443 and IEC 62351 while supporting compliance to the country specific guidelines/frameworks.

The central security management server shall be deployed in the De-Militarized zone inside the control room segregated by suitable firewalls and shall act as an IT/OT interface

All hosts machines shall implement advanced end point protections including antimalware, application whitelisting, data loss prevention, HIPS etc. The whitelisting and application control shall allow only list of permitted applications, services and processes to run on each host; no other processes shall be permitted to be executed on the host. It shall not be possible for users to circumvent the malicious code protection on a host device.

The Host based IPS shall monitor the characteristics of a host and the events occurring within that host for suspicious activity. The characteristics which need to be monitored include network traffic, system logs, running processes, file access & modification, and system & application configuration changes.

The central policy Orchestrator shall be deployed to enable operators/security administrators to centrally monitor and manage the security policy for all host workstations. The application shall allow creation of automated workflows, support creation of reports, customized dashboards to analyze the performance of each security setting while tracking the deploymentof signature (DAT files) updates date from a single location.

Continuous (24/7) anomaly & threat detection shall be implemented to detect and alert for all known & unknown threats including Zero days, MITM attacks, DDoS attacks, unauthorized behavior or malicious activities on the network. The system shall support a wide range of IT & OT communication protocols including the proprietary protocols, and able to discover information from the network passively using Deep Packet Inspection by connecting to the

Mirror Port / SPAN port on a backbone switch(s).

The proposed system shall support the following capabilities:

- **Real time network visualization** of the entire ICS network, including asset inventory information, communication patterns, connections, protocols and topology.
- Discover detailed **asset inventory information** (like Manufacturer, Model, Firmware, serial no etc.) from network devices including nested devices to enable enhanced visibility, segmentation, and vulnerability management. Additionally, it should be capable of automatic asset grouping to help visualize a micro-segmentation view of the network primarily based on asset behavior.
- Automated **identification of vulnerabilities** in the environment, correlated with operational context to provide detailed insights and rapid remediation.
- The system shall learn typical behavior through **Dynamic learning via artificial intelligence** to automatically learn nodes, devices, connections, etc. to accurately profile normal process behavior and engage a "protection mode" where variants and risks from the learned process behavior are alerted.
- Create detailed behavioral profiles for every device according to the process state thereby identifying/alerting users for anomalies on the network such as new or unusual assets, communication patterns, configuration changes, malfunctions etc. based on extensive learned baselines using **Deep Packet Inspection (DPI) into the OT protocols.**
- System should be able to calculate a **granular Risk score** for each identified threat based on the context it has about the network, the assets and the events that occurred.
- Automatically capture network traffic associated with the alert to **analyze and identify** what happened before and after the Incident.
- **Integrates with firewalls** to inject rules associated with an alert or policy

The security monitoring application shall encompass collecting security logs from various devices in the system (Hosts, IED's, Firewalls, routers, IDS, AV Servers etc) over standard protocol formats i.e. syslog/SNMP/WMI etc. and provide dashboards for real-time situational security awareness and alerts. The application must be compliant to international standards IEC 62443-3-3 (for providing syslog server and audit trail capabilities) and IEC 62351-14 (for central management functionalities).

The system shall have a capability to archive, record and store all security related events. The logs of the system shall be analyzed for exceptions and the possible incident of intrusion/trespass shall be presented to the employer in the form of alerts/notifications. The audit log function must be enabled and protected against tampering. The Bidders shall put in place audit trail and logging mechanism to ensure security logs are available for upto 12months.

The entire system shall use a uniform system time which can be synchronized with an external time source (GPS).

The tool must be open and customizable with dashboards as per the local infrastructure requirements and business KPI's. Typically it should support basic used cases like:

Application Security Monitoring

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

- Application Software Error Conditions
- Application Software Performance Issues
- Application Configuration Changes
- Authentication activities - login, logout, failure access

Host Security Monitoring:

- Security policy changes.
- Anti-malware activities - alerts provided by antivirus or whitelist solutions
- Mobile drive activities - USB connection in the system
- Windows event logs from Windows Machine System - Windows patches and activities,

Network monitoring alerts and events:

- Configuration update activities - settings and parameters changes in systems
- Unauthorized access attempts events from Security appliances

Application must be simple and intuitive to support OT operators with limited IT skills to quickly identity the security issues or any unauthorized access to the system and respond to it before it becomes a major threat to the system. Employer's personnel shall be trained to be capable of creating new custom analysis and reports.

The contractor shall propose a centralized patch management solution to securely execute and manage all necessary systems, security mitigation and signature-related patching in timely manner. All host machines shall be configured via domain policy to contact patch servers and check for missing updates. These updates shall be installed manually to avoid cause unscheduled disruptions.

All the security appliances (Firewalls, Antivirus, central cyber security monitoring & detection appliances etc) being supplied under this project shall have definition updates for virus/signatures and updates for software patches for the warranty and complete FMS period. The signature and patches shall then be deployed to all the respective devices. These enhancements shall increase security and functionality, without requiring redesigning or reengineering efforts.

5.5 Database structure

The SCADA/DMS RTDB (Real Time Data Base) shall be an active process model. i.e. It shall initiate actions or events based on the input it receives. The RTDB shall describe the state of the power system at a given point in time and the events that move the system to a new state at the next point in time. This database is required to support the data access to real time information and to allow efficient integration and update.

A library of event routines may encapsulate or interface the RTDB with other components of the system. These event routines shall be the preferred means for application programs to

interact with RTDB. This way, application programs (and programmers) only need to concern themselves with callable interface (API) of these routines. Each application shall interact with the RTDB through the event library. These event routines shall serve as generic APIs for database access thereby eliminating proprietary database function calls at the application level.

The SCADA/DMS shall include a single logical repository for all data needed to model the historical, current, and future state of the power system and SCADA/DMS – the Source Database (SDB). All information needed to describe the models on which the SCADA/DMS operates, shall be defined once in the SDB and made available to all SCADA/DMS applications, real-time database, and user interface maintenance tools that need the information.

Any database update, whether due to local changes or imported network model changes, shall be able to be placed online in a controlled manner without causing undue interruption to network operations, including without losing any manually entered data. For example, a network model update to introduce a new substation shall not interrupt the ability to perform supervisory control actions or receive telemetry to view the network state. It shall be possible the changes, local or imported, to be placed online either automatically or under manual control with proper validation. It shall be possible to easily revert to an earlier databaseVersion, again without undue interruption to network operations.

The capability to import & export the CIM compliant network model data including the corresponding telemetry and ICCP data reference in XML format to send it to other parties shall be provided. The capability to import the CIM compliant network model data from other parties in XML format shall also be provided.

The SCADA/DMS shall provide a consistent interface to accept XML format data for updates from other database applications; and provide a consistent interface to import & export data in XML format.

5.5.1 Software Maintenance and Development Tools

5.5.1.1 General requirements

A set of software shall be provided to enable maintenance of application software and development of new software in software development mode.

All hardware and software facilities shall be provided to allow creation, modification and debugging of programs in all languages that are supplied.

The following shall thus be possible:

- Program and data editing
- Program compiling and assembling
- Linking
- Loading, executing and debugging program. Version management
- Concurrent development

The following features shall be provided:

- Library management
- Programs allowing to copy and print any data or program file
- Backup and restore File comparison Sort and merge

- Programs that allow to partially save and recover volumes
- Core and memory dump.

In addition tools shall have the following:

5.5.1.2 Command language

A complete command language shall be provided that allows interactive use of any console to interactively create, modify and debug programs in all languages provided. It should also be possible to create and save command procedure file and to execute it sequentially.

5.5.1.3 Linkage Editor and Loader

Compilers and assemblers, linkage editor and loader shall be provided to link object modules from an assembly or compilation to produce an executable module and load it in system. As far as possible, the loader shall accept object modules issued from various language compilers.

5.5.1.4 Symbolic Debugger

A language-independent, interactive symbolic debugger shall be provided to enable the user to test new software and inspect the characteristics of existing software. The execution of a program shall be under the control of the debugger according to parameters entered by the user. The following features shall be supported:

(a) Program execution breakpoint control

(b) Program execution sequence tracing

(c) Display and modification of program variables

(d) Attachment of specifically written debug code to the program under test.

The debugger shall allow halting execution of a program at predefined points, reading and modifying the registers and memory locations and executing step by step a program. Tender shall describe the features of debuggers for each type of equipment.

5.5.1.5 System Integration

System integration services shall be provided for adding new programs to the set of active software after the programs have been tested. These services shall include commands to substitute one program for another, to set up or modify operating system tables, and to schedule and activate a new program with a minimum of interference with the normal running of the SCADA/DMS functions. The capability to restore the system to its status prior to the new program integration shall be provided.

5.5.1.6 System Generation

System generation software and procedures shall be provided to generate an executable object code of all software, databases, displays, and reports. Employer personnel shall be ableto perform a system generation on site, using only equipment, software, procedures, and documentation supplied with the SCADA/DMS. It shall not be necessary to return to the Contractor's facility or rely on the assistance of Contractor personnel.

The procedures necessary to perform a complete system generation shall be provided as interactive or batch commands maintained on auxiliary memory and on archive storage, source listings, and detailed manuals. System generation shall be accomplished without programming; only directives or control commands described in the procedures shall be required.

5.5.1.7 Code Management

A code management utility shall be provided for documenting and controlling revisionsto all SCADA/DMS application programs. The utility shall maintain a library of source, object, and executable image code and provide a controlled means for changing library files containing this code.

The code management utility shall include inventory, version, and change control and reporting features. Program dependencies shall be included in the library for user reference. The code management facility shall retain a complete history of additions, deletions, and modifications of library files.

An integrated source code development subsystem supporting C, Fortran, Java, and C++, other programming languages used in the SCADA/DMS shall provide a software configuration management system to define the elements and the associated attributes of the applications provided in the SCADA/DMS. Source definitions for all elements of an application shall be maintained in disk files under a code management system. As a minimum, the code management system shall:

1) Manage source code and binary images
2) Allow tracking of code changes by date, author, and purpose
3) Manage documentation modules and associate them with source code, binary images, and other documentation
4) Support multiple teams of programmers working concurrently on the same modules
5) Provide an efficient link between modules

5.6 Database Development software

The databases organization shall be designed to meet the following major functional requirements:

- Data consistency,
- Compliance with the system performance requirements including both response times and expansion capabilities,

A Database development software shall be provided which shall contain database structure definitions and all initialisation data to support the generation of all relational , real time database (RTDB) non-relational run-time databases required to implement the functions of SCADA/DMS system. All the facilities required for generating, integrating and testing of the database shall be provided with the SCADA/DMS system. The delivered SCADA/DMS database shall be sized for the ultimate system as described in this Specification. The database development facility shall be available on development system comprising of server & workstation. Once the database creation/ modification activity is over, the compiled runtime executable shall be downloaded to all respective machines. Executing the database generating functions shall not interfere with the on-line SCADA/DMS functions.

The database development function shall locate, order, retrieve, update, insert, and delete data; ensure database integrity; and provide for backup and recovery of database files. The database development function shall generate and modify all SCADA/DMS data by interfacing with all database structures. The location of database items shall be transparent to the user

performing database maintenance.

Extensive reasonability, integrity, and referential integrity checks shall be made on user entries to detect errors at the time of entry. Invalid entries, such as entering an invalid data type or attempting to define contradictory characteristics for a database item, shall be detectedand reported to the user in an error message. All error messages shall be in plain English. Theuser shall not be required to repeat steps that were correctly executed prior to the erroneous action. Help displays shall be available to provide additional, detailed information to the user on request.

All newly defined points shall be initially presented to the user with default values for all parameters and characteristics where defaults are meaningful. It shall also be possible to initialise a new database point description to an existing database point description. The user shall be guided to enter new data, confirm existing data, and change default values as desired.

All required entries for any database item selected for changes shall be presented to the user. When parameters are entered that require other parameters to be specified, the additional queries, prompts, and display areas required to define the additional parameters shall be presented automatically.

(a) Add, modify, and delete telemetered, non-telemetered, or calculated database items and data sources such as RTUs/ FRTUs / FPI, data links, and local I/O.

(b) Add, modify, and delete application program data

(c) Create a new database attribute or new database type

(d) Resize the entire database or a subset of the database

(e) Redefine the structure of any portion of the database.

The database tool for creation, editing, generation, export, import of ICCP database including complete definition, association, bilateral tables, objects etc. shall be provided.

5.6.1 Run-Time Database Generation and Maintenance

The database development software shall generate incremental database changes as well as run-time (loadable) databases from the global source database (user entered database) Incremental structure changes in the source database such as addition of a bay or a substation shall not require regeneration of the entire run-time database. Based on the nature of the change, the database development software shall determine which portion of the database must be regenerated and which displays, reports, and software functions must be re- linked.

All errors that were not detected during data entry time but are encountered during run- time database generation shall be flagged. The database generation routines shall continue processing the database in an effort to detect all errors present in the database before terminating the generation task.

5.6.1.1 Data Retention

The database generation process shall retain and utilize data from the current SCADA/DMS database in the newly generated database, even when a newly generated database contains structure changes. Data to be retained across database generation cycles shall include, but not be limited to, quality codes, manual entries, tags, historical data, and tuning parameters.

5.6.1.2 Making Database Online

After an error-free database generation, the user shall be able to test the data- base in an off-line server prior to its use in an on-line server. The previous run- time database of the server shall be archived such that it is available to replace the new database upon demand. The archived database shall be deleted only when directed by the user.

Newly generated run-time databases shall only be placed on-line by user command. Following the assignment of a new database to a server and on user demand, the database management software shall access each SCADA/DMS server to ensure that all databases are consistent. Inconsistencies shall be annunciated to the user.

5.6.1.3 On-Line Database Editing

Selected database management functions and changes to a run-time database shall be possible without requiring a database generation. These shall be limited to viewing functions and changes to the contents, but not the structure of the database. On-line changes shall be implemented in all applicable SCADA/DMS run-time databases without system downtime. Changes shall also be implemented in the global database to ensure that the changes are not lost if a database regeneration is performed. On-line database editing shall not affect the SCADA/DMS system's reaction to hardware and software failures nor shall it require suspension of exchange of data among servers for backup purposes.

5.6.1.4 Tracking Database Changes

The database manager utility shall maintain Audit trail files for all changes made by all users. The audit trails shall identify each change including date and time stamp for each change, and identify the user making the change. An audit trail of at least last 2 months shall be maintained and another audit trail maintaining records of who/when performed the edit operation shall be maintained for a period atleast 2 months.

5.6.1.5 Initial Database Generation

The initial database shall contain all data required by the SCADA/DMS systems. Default values shall be used in consultation with the employer for data that is not provided by employer. Population and maintenance of the distribution network model should be possible by using the database maintenance tools to build the database from scratch.

5.7 Display Generation and Management

SCADA/DMS displays shall be generated and edited using interactive display generation software delivered with the system. The display generator shall be available on development system & once the display/ displays creation/ modification activity is complete, the compiled runtime executable shall be downloaded on all workstations/servers.

The display editor shall support the important construction options like:

- Copy/move/delete/modify,
- Building at different zoom level,
- Linking of any defined graphics symbol to any database point, Pop-up menus,
- Protection of any data field on any display against user entry based on log- on
- identifiers
- Activation of new or modified displays for any application or across all applications of the system by a simple command that

causes no noticeable interruption of on-line DMS system activity.

All displays, symbols, segments, and user interaction fields shall be maintained in libraries. The size of any library and the number of libraries shall not be constrained by software. The display generator shall support the creation, editing, and deletion of libraries, including copying of elements within a library and copying of similar elements across libraries. A standard set of libraries and libraries of all display elements used in the delivered SCADA/DMS system shall be provided.

Displays shall be generated in an interactive mode. The user shall be able to interactively:

(a) Develop display elements

(b) Link display elements to the database via symbolic point names

(c) Establish display element dynamics via database linkages

(d) Define linkages to other displays and programs

(e) Combine elements and linkages into display layers

(f) Combine display layers into displays.

The display generation, compilation & loading shall not interfere with the on line SCADA/DMS functions. All user interface features defined in this Specification shall be supported by the display generator.

5.7.1 Display Elements

The elements available to create a display shall consist of graphic primitives symbols, segments, User Interaction Field and layers. These elements shall be available to be linked to the SCADA/DMS functions and dynamically transformed on the display as governed by linkages to the database.

5.7.1.1 Segments

The display generator shall support the construction of display segments consisting of symbols, primitives, and dynamic linkages to the database and user interface. Typical uses of display segments are pull-down menus, bar charts, and common circuit breaker representations. The display generator shall be able to save display segments in segment libraries for later use. The SCADA/DMS system shall include a base library of segments commonly used by display builders.

The display generator shall support the addition, deletion, and modification of segments, including the merging of one segment with another to create a new segment. Segment size shall not be limited. Segments shall be defined at an arbitrary scale factor selected by the user.

5.7.1.2 Dynamic Transformation Linkages

Dynamic transformations shall be performed on symbols and display segments based upon dynamic linkages to database variables. All linkages to the database shall be defined via symbolic point names. Each symbol or segment stored in a library shall include its dynamic transformation linkages, although the specific point names shall be excluded. Dynamic transformation linkages shall support the dynamic data presentation

5.7.2 Display Generation and Integration

The displays shall be constructed from the display elements described above. The display definition shall allow displays to be sized to meet the requirements of the SCADA/DMS application for which they are used; displays shall not be limited by the size of the viewable area of the screen. The display generation software shall allow unbroken viewing of the display image being built as the user extends the size of the display beyond the screen size limits. Each display shall include the display coordinates definition that will permit a userto navigate successfully to the portion of the display that is of interest.

It shall be possible for a user to build a new display starting with a blank screen or an existing display. The definition of each layer shall include a range of scale factors over which the layer shall be visible. The display generator shall also support manual control of layer visibility, where the user of the display shall determine the layers on view. Each display may incorporate manually and automatically (by scale factor) displayed layers. The user shall also define the periodic update rate of the dynamic information on the display and any programs called before or after presentation of the display.

The display generator shall support the integration of new and edited displays into the active display library. During an edit session, the display generation software shall allow the user to store and recall any display. To protect against loss of display work when computer fails, the current work shall be automatically saved every 5 minutes (user adjustable) to an auxiliary memory file.

The display generator shall verify that the display is complete and error-free before integrating the display into the active display library. A copy of previous display library shall be saved & protected and it shall be brought back on line or can be deleted upon user request.. It shall not be necessary to regenerate any display following a complete or partial system or database generation unless the database points linked to the display have been modified or deleted.

5.8 Report Generation Software

The SCADA/DMS /OMS system shall include report generation software to generate new report formats for SCADA/DMS/OMS and edit existing report formats. The user shall be guided in defining the basic parameters of the report, such as the report database linkages as symbolic point names, the report format, the report activation criteria, the report destination (workstation, printer, or text file), and the retention period for the report data.

The user shall be able to construct periodic reports and ad-hoc queries via interactive procedures. The capability to format reports for workstations and printers shall be provided. The user shall be able to specify the presentation format for periodic reports and ad-hoc query reports as alphanumeric display format, graphical display format, or alphanumeric printer format. The user shall be able to specify that processing functions, such as summations and other arithmetic functions, be applied to portions of the report data when the report is processed for display, printing, or file storage. The software shall provide for generation of reports that are the full character width of the printers and that use all of the printer's capabilities, such as font sizes and styles and print orientation. For report data editing, the usershall be able to obtain the data from a retained report, modify the data, repeat the inherent datacalculations, reprint the report, and save it in a report retention file on auxiliary memory without destroying the original report.

The user shall also be able to access a retained report, modify its point linkages to the database, modify its format, and save it in a report retention file on auxiliary memory as a newreport without destroying the original report.