"DC NOVA GORICA"

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1. PREFACE

This document provides an overview of system architecture and its configuration/usage in DC Nova Gorica.

2. SYSTEM ARCHITECTURE

The Network Manager system has a complete set of graphical and forms oriented interactive tools for configuration of the system in an open and distributed environment and for modeling the power system. Some of the most important engineering tools are:

- DE400 - The Data Engineering tool for modeling network topology, process objects and other utility data
- PED500 - The Picture Editor for creation and maintenance of picture displays
- SpiConf- The Configuration Tool for configuration of the application servers and the telecontrol equipment
- ADF - The Avanti real-time database configuration tool for definition and sizing of the real-time database

The Network Manager system also includes an extensive set of APIs and support of standard interfaces like ODBC for easy integration of utility specific business rules and applications in a distributed database environment supporting network transparency and interconnectivity over operating system boundaries without any modification of the programs

2.1 DATABASES AND MIDDLEWARE

Network Manager uses a distributed, 3-tier, middleware architecture specifically designed for real-time performance with very large system databases and user communities, using low bandwidth wide area communication networks.

Two database management systems are used. Avanti DBMS for very-high performance real-time SCADA and DMS tasks and the Oracle DBMS for the OMS applications.

The Operator Stations are directly linked to the two middleware buses so as to obtain data from and execute the various applications in an integrated, seamless manner.

Two memory network model databases are used, one based on the Avanti disk files and another based on Oracle disk resident files. The Avanti based memory is used by the SCADA, DMS and Operator Workstation (for dynamic network coloring, etc.) applications. T

The DE application is configured for off-line use, uses the Oracle DBMS, and communicates directly to the two on-line DBMSes and middleware, as required.

2.2 SYSTEM CONFIGURATION

Implemented system distributes the system functions to various computer servers. Redundant server configurations are offered for the SCADA/DMS ad Utility data Warehouse (UDW) server based applications, as well for worksations Single server configurations are offered for the Web and DE functions. A single GPS/Time base is offered.

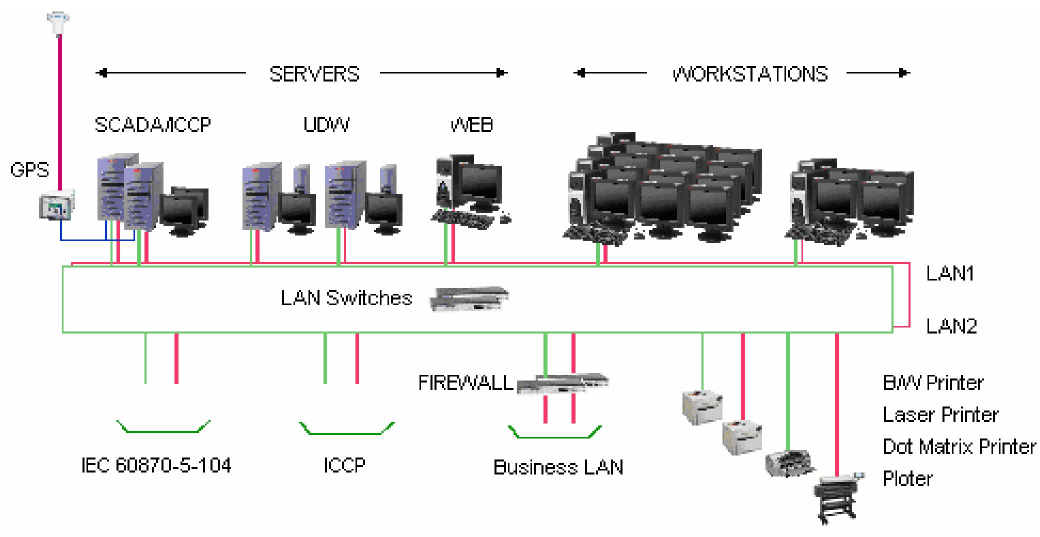

Figure 1. System overview

2.3 OPERATING SYSTEMS

UNIX is used as the operating system to execute the server based applications and databases while MS Windows are used for executing the Operator Station client software and the RTU Front-Ends.

2.4 OPERATOR STATIONS

The Operator Station is equipped with SCADA/DMS application specific client software. All application client applications are linked to the WS500 Operator Station application.

The SCADA and DMS applications require the WS500 Operator Station software.

2.5 WEB SUPPORT

Two levels of Web support are provided.

The WS500 based displays such as one-line diagrams and event lists can be accessed using the IS500 application over web browsers for display purposes. Although possible form a technology point of view, device operations are not supported on security concerns. The displays shown on the Web Browser are the same as those used in the PC Windows environment, there is no need to create special display pictures for Web usage.

In the case of the IS500 application, the server application uses a copy of the real-time Avanti data that is kept up-dated with on-line database via a data replication mechanism used in a cyclic mode

2.6 REMOTE SYSTEM ACCESS

The proposed system architecture therefore supports the access of the SCADA/DMS system from WMC/NMC remotely located personnel at the various district or zonal offices. Such locations can be equipped with full Operator Station capabilities thus allowing complete remote access to SCADA/DMS system or only with OMS client software.

3. S/COM SYSTEM (FEP- FRONT END PROCESSOR)

Purpose of the S/COM System is to secure functionality of dual communication interface between up node SCADA center and remote stations using the following protocols:

- IEC 60870-5-104 protocol towards up node SCADA center
- ADLP-80 and/or IEC 60870-5-101 protocol towards remote stations

For each and every user it is allowed to view activities in system, no matter the authorization that they have. System possesses the user authentication service through user names and passwords. For different users is possible to allocate the specialized access authorization.

Unlimited access to System is allowed for user with administrative authorization. Administrator is responsible for allocating other users and their passwords. Authorizations allow users to work with deactivation and activation of devices from/in communication tool and work with tools for the System configuration.

It is recommended though, for security reasons, that users which access to system functions and parameters of device, has only so called privileged system operator (administrator) with unlimited access. Administrator logs in on system through administrative password.

FEP uses direct addressing and predefined transfer operation modes – it is set up through minimal set of parameters. If users have requests regarding predefined set up, it is possible to edit parameterization files for preaddressing process.

Interactive tools that are used for device parameterization are: Text editor, Database editor, Object picture editor, Dynamic picture editor and FTAB editor.

After basic training course, operator is able to independently set up and maintain the system.

4. COMMON OPERATOR SERVICES

Advanced operator services are provided through the use of the WS500 Operator Station that supports the various system applications in a common and integrated fashion that facilitate the effective sharing of information across various utility organizations and locations in a secure environment.

4.1 OPERATOR AUTHORITY

Advanced Operator Station authority handling features allow for the independent definition of responsibilities at the physical workstation and at the operator ID levels. Operator responsibilities can be defined in terms of power system areas of responsibility, general system access rights (e.g., review/read, control/modify, etc.), access to the various system applications (e.g., SCADA, etc.), and access to the various operator displays.

Operator authority definitions can be changed dynamically and on-line. Special purpose features are available to support the transfer of authority across operators in support of normal operations (e.g., transfer at the end of the regular shift) and emergency operations, to re-assign or split a given area of responsibility to more operators.

4.2 WORLD MAP AND DIAGRAM DISPLAYS

Various types of operator displays are supported; all linked to the same process data, network model and customer data thus ensuring consistency across all views of the distribution system. For geographic based world map displays SCADA operators use schematic based feeder maps and substation diagrams, for example.

The very same displays are used to display DMS data (e.g., the results of the Load Flow calculation) and SCADA data (e.g., actual switching states, location of special grounding equipment, etc.).

4.3 ADVANCED NAVIGATIONAL FEATURES

System events and alarms, irrespective of the application responsible for generating them, can be displayed on all operator workstations in accordance to defined operator areas of responsibility.

Advanced navigation features based on a common Locate function are available that allow the quick identification on the map or diagram displays of specific equipment such as a particular switch or MV/LV substation, operating condition such as a low voltage or equipment overload, and work related information such as the location of Planned and Unplanned Outage work, and operating equipment such as grounding rods.

Direct access to detailed information managed by the various applications is achieved through simple command operations from the one-line diagrams.

Detailed information produced by the various system applications, under the responsibility of various system operators and possibly at various utility locations, can thus easily be made available to the various system operators.

5. TEMPORARY NETWORK CHANGES

Line Cut and Jumper line operations are supported. Jumper lines are used to denote the presence of temporary new lines to connect equipment while Line Cuts denote the physical cutting or disconnection of a line without the use of switching equipment. Both operations are performed directly on the map displays.

5.1 DYNAMIC FEEDER MAP COLORING

Advanced network coloring features based on network topology, voltage level, and operating service areas are provided. Both Global and Local coloring modes are supported that result in a quick identification of feeder connectivity and operating state information. Global, system default network coloring can be used to denote the existence of special operating conditions such as parallel feeder connections, de-energized feeders, and the existence of special operating tags such as Ground connections. Local, user-defined coloring is used to perform in a fast manner upstream and downstream feeder-tracing operations that show the current network connectivity state in an efficient manner thus further minimizing dispatch error.

5.2 TOPOLOGY BASED SAFETY CHECKS AND INTERLOCKS

Comprehensive Process Control features are provided that address specific control room management procedures needed for the safe and effective control of distribution networks with very low levels of automation, in addition to the traditional manually defined operational SCADA Interlocks, Sequential Control and Tagging features.

The standard special purpose distribution interlock check features prevent or warn the operator about the consequences of switching in a real-time environment thus greatly reducing erroneous system dispatch and control. Supported automatic interlock conditions include the checking for paralleled feeder sources, disconnection of MV/LV load points and the existence of grounding rods downstream in the feeder network.

These advanced safety interlock checks are available for use with any given network topology without special purpose end-user programming.

6. SCADA APPLICATIONS

The SCADA module is used for executing all network operations irrespective if they are conducted automatically and remotely, using RTU equipment, or manually using Crews.

Advanced features are available on several areas including:

- System operation and event logging;
- Event and alarm handling;
- Trending;
- RTU communications and device operations;
- ICCP;
- Historical data processing including the ability to “play-back” historical data on operator one-line diagram displays; and
- Tabular displays and reports using the MS Excel tool or others using the supported APIs (COM, ODBC, etc.).

6.1 DMS APPLICATIONS

Network calculations are specifically developed and optimized to handle highly unobservable and very large distribution networks, operated radial or meshed.

6.1.1 LOAD CALIBRATION AND LOAD FLOW

The key differentiator of the proposed solution when compared with traditional EMS network analysis is the use of special-purpose Load Allocation and Load Models that result in fast and accurate State Estimation, given low availability of real-time data.

The Load Allocation function takes advantage of existing load related data at the various network connection points (e.g., distribution MV/LV transformer stations) to estimate the local load given a set of real-time distribution network measurement data acquired by SCADA and Higher Voltage injection measurement data (e.g., voltage and power injections) measured by SCADA or calculated by external traditional State Estimators. Three Load Allocation methods can be used concurrently, depending on data availability: connected KVA (e.g., the size of the MV/LV transformer or a typical load figure); connected billed energy and number of customers; and customer class data. The resulting allocated loads can then be modeled as part of the Load

Flow calculation using either one of three models to better reflect actual load behaviors found in distribution networks: Constant Power, Constant Impedance, and Constant Current models.

Many features are available that make the application easy to use by the operator including: different execution modes (cyclic, event driven as a result of switching, and manually upon operator request); presentation of results on the same Operator Station one-line diagram displays; summary tabular displays; multiple user defined Limit conditions (e.g., Summer and Winter loading limits); extensive summary tabular displays including Limit Violations; Study Data Base usage; and Save Cases.

6.1.2 SHORT-CIRCUIT CALCULATIONS

The Short Circuit Analysis (SCA) function is used to provide the system operators with information on simulated balanced faults in the electrical power system. Both symmetrical and asymmetrical faults can be simulated. The following asymmetrical fault models are supported:

- line-to-line short circuit without earth connection
- line-to-line short circuit with earth connection
- line-to-earth short circuit

The results of the SCA indicate whether circuit breakers will operate properly under fault conditions. The results can also be used to design protective relays for system planning or to study critical states of the electrical power network.

6.2 SYSTEM SERVICES

6.2.1 DATA ENGINEERING TOOLS AND PROCEDURES

All SCADA/DMS components are engineered using a common graphical environment, DE400 tool, which supports all modeling requirements. There is no need to enter the same data twice nor for complex data synchronization procedures. A common network model manager is used to distribute the required source data to the various on-line applications and databases thus ensuring data consistency across the integrated system.

Features are provided that allow for the integrated maintenance of the distribution network model data and associated displays without requiring a switchover operation of the on-line SCADA/DMS server applications. This feature is now widely accepted as essential for SCADA/DMS systems due to the high frequency of network model changes needed to reflect new construction of MV lines and MV/LV substations.

DE400 tool is Oracle based and is designed to support the efficient modeling, data entry, and subsequent maintenance of very large distribution networks. Key features include the automatic generation of object relationships including network topology from the user entered World Map graphical one-line diagram displays and extensive copy/paste facilities. These features ensure a high-level of data consistency between the graphical displays and the underlying network model and allow for the fast modeling of large MV distribution feeders, for example, through the replication of user-defined MV/LV substations.

6.2.2 DATA ENGINEERING

Import of the electrical model data is done by using Data Import facilities based on ASCII, common separated value (csv) files. The proposed data models, tools and procedures provide a well-defined, well-documented procedure for integrated model and data management with external systems. The supplied procedures support incremental and bulk load data transfers using a common/integrated model for attribute data, namely graphical attributed required for the World Map displays (both schematic and geographic are supported), network connectivity, network model/asset data, and customer data needed by the integrated SCADA/DMS system.

The idea is that any object type and attribute data related to the electrical network model not available on the external GIS and CIS systems but required by the SCADA/DMS system should be added to the external systems before export to SCADA/DMS. Optionally the additional data can be added and maintained by entering directly into the supplied DE tools.

The import of RTU and SCADA I/O point data is also supported and is proposed for the initial population of the SCADA database from data available in the current SCADA systems. Standard Data Engineering (DE) tools are used for the subsequent maintenance of the SCADA RTU and I/O point database after the initial database population.

The proposed system supports the combined use of imported and locally DE created data thus providing flexibility on the final data engineering solution to be adopted by customer. As an example, the SCADA/DMS' own DE tools can be used to create detailed SCADA schematic one-line substation diagrams and orthogonal based feeder world maps linked to the network connectivity and model data imported from the GIS/AM systems and to the customer data imported from the CIS. Data ownership can also be distributed whereby the external systems, e.g. the GIS systems, can be made responsible for the MV networks while the SCADA/DMS own DE tool is the owner and source for the HV network.

KONCAR proposed to build the network model data including world map graphical displays from the existing GIS. The required detailed SCADA station schematic displays are manually built and linked to the network model data using the supplied DE tools

6.2.3 DEVICE SUPERVISION AND SWITCH-OVER

All SCADA/DMS computer nodes and applications, including external system interfaces are monitored and controlled from a single application.

6.2.4 HISTORICAL DATA PROCESSING

For historical data processing UDW (Utility Data Warehouse) application is used. It is based on Oracle database.

The fundamental feature of UDW is the ability to store the continuous inflow of measurements from the power process, along with information from any other Utility Information System, and make it all available for Data Mining. The UDW does this, while providing high user performance, high availability and redundancy.

Instead of SCADA application for historical data processing; Time Tagged Data (TTD) where historical data is stored in the Avanti database; the Utility Data Warehouse (UDW) is used.
TTD is primarily aimed towards storage of real-time data from the system in an historical archive, and should be considered when the historical data is to be accessed primarily from the Network Manager or the MS Windows environment.

The UDW is designed to meet the requirements of control room operation, such as short response times and high availability, as well as the requirements of a Data Warehouse user on the office network, such as openness and possibility to do extensive data analysis.

SCADA/DMS data is sampled from the Network Manager real-time database Avanti and stored in the UDW Oracle database together with results from calculations applied to the sampled information.

Data can be sampled from the Network Manager system at a very high frequency.

Data originating from any utility information system can be stored in the UDW using any of the available open interfaces or APIs.

Hence, UDW is as a general data warehouse suitable for all types of information. The data mining and calculation capabilities support analysis and further elaboration on the collected information.