Teppo Kuuppelomäki

INTEGRATED SCADA AND DISTRIBUTION MANAGEMENT SYSTEM PROJECT

Engineering Process Principles

VAASAN AMMATTIKORKEAKOULU
Sähkötekniikka

TIIVISTELMÄ

Tekijä	Teppo Kuuppelomäki
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Tämä opinnäytetyö tehtiin ABB Oy Grid Automation-yksikköön.

Nykyään MicroSCADA Pro SYS600:n projekti, joka on integroitu MicroSCADA Pro DMS600 kanssa, tehdään kahdessa eri toimipisteessä

Opinnäytetyön selkeyttää projektin kulkua ja vähentää projekti-insinöörien työmatkailua ja työkuormaa.

Opinnäytetyö esittelee DMS600-ohjelman rakennetta ja kuinka kommunikaatio tapahtuu sisäisesti DMS600:n ja MicroSCADA:n tai muiden SCADA-järjestelmien välillä.

Opinnäytetyön tulokset selkeyttävät projektin kulkua ja mitä informaatiota tarvitaan asiakkaalta projektia varten.

Avainsanat   MicroSCADA Pro SYS600, DMS600, projektin selkeytys

VAASAN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES
Sähkötekniikka

ABSTRACT

Author	Teppo Kuuppelomäki
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This thesis is made for ABB Oy, Grid Automation Systems.

At the moment integrated a DMS600 project with MicroSCADA SYS600 is done by dedicated engineers and in two separate ABB locations. This thesis was made to clarify the main steps of an integrated project of DMS600 and decrease work travel and to ease work load by project engineers.

This thesis introduces architecture of DMS600 and how the communication happens internally and between DMS600 and MicroSCADA or other SCADA system.

The thesis result clarifies how integrated DMS600 project is done and what information is needed for the basic DMS600 project.

Keywords   MicroSCADA Pro SYS600, DMS600, clarify project

CONTENTS

ABBREVIATIONS

ABB	Multinational company which produces electrical devices and systems
AMR	Automatic meter reading
API	Application Programming Interface
DMS	Distribution Management System
DMS600	MicroSCADA Pro Distribution Management System
DMS600 NE	MicroSCADA DMS600 Network Editor
DMS600 SA	MicroSCADA DMS600 Server Application
DMS600 WS	MicroSCADA DMS600 Workstation
GSM	Global System for Mobile communications
OPC	OLE for Process Control (OLE = Object Linking and Embedding)
HSB	Hot Stand By is a redundant system
SCADA	Supervisory, control and data acquisition
SCIL	Supervisory Control Implementation Language
SQL	Structured Query Language
SYS600	MicroSCADA Pro SYS600
WMS	Web Map Service
XML	Extensible Mark-up Language

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1 INTRODUCTION

1.1 Objective of Thesis

This thesis was made for ABB Grid Automation Systems. The objective of the thesis was to clarify the integrated project of MicroSCADA Pro SYS600 and MicroSCADA Pro DMS600 systems. Typically, each engineering part has been done by dedicated engineers. Currently these engineers are in separate ABB offices and locations.

The first part of the thesis introduces the basic knowledge about MicroSCADA and DMS600. After that the functionality of DMS600 is discussed. The last part of this thesis clarifies engineering process principles on DMS600.
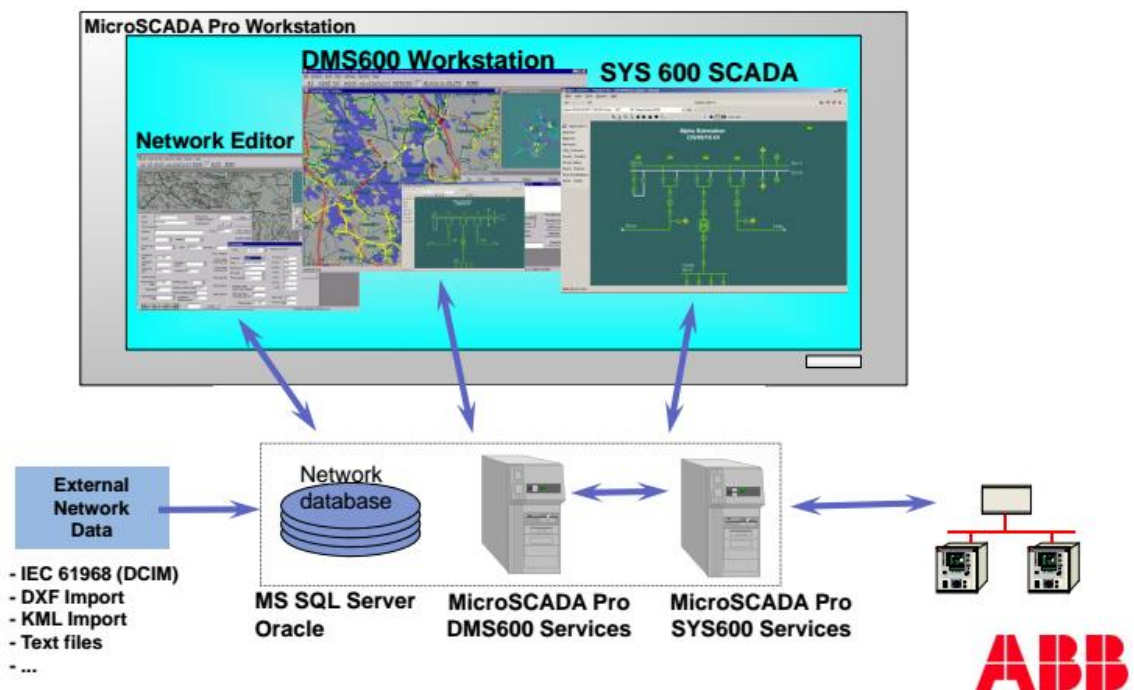

Figure 1. Architecture of DMS600 project

2 ABB

ABB is the world`s leading pioneer of power and automation technology company. The headquarters are located in Zurich, Switzerland. The company employs worldwide approximately 135 000 people in over 100 different countries. ABB`s business activities are divided in four global divisions units. These units are Electrification Products, Discrete Automation and Motion, Process Automation and Power Grids. /1/

2.1 ABB in Finland

In Finland ABB has business activities in 20 different locations. The factories of ABB are in Hamina, Helsinki, Vaasa and Porvoo. ABB in Finland employs approximately 5000 people. Because of that ABB is one of Finland`s largest industrial employers. /1/

2.2 ABB Grid Automation

The Grid Automation is part of the ABB Power Grid division. The Grid Automation business unit designs, markets and delivers Supervision Control and Data Acquisition systems (SCADA). The Grid Automation unit offers these SCADA project solutions to electricity companies, industrial and infrastructural project, such as railways, airports and tunnels. The Grid Automation business unit also offers technical support, maintenance, training service and spare part service. /2/

3 MICROSCADA

3.1 MicroSCADA Pro SYS600

MicroSCADA Pro is SCADA (Supervisory, control and data acquisition) software designed by ABB. ABB originally designed this supervision software for controlling and monitoring substation automation and network supervision but nowadays it can be also used to control and monitor different kind of non-electrical applications. These applications can be railroads, district heating/cooling, gas-, oil and water distribution. /3/ The MicroSCADA system has been up and running for over 30 years and delivered worldwide. /4/

3.2 MicroSCADA Pro DMS600

MicroSCADA Pro DMS600 is a distribution network management system designed by ABB where distribution networks can be viewed on detailed geographical maps in raster or vector formats as well as in a schematic diagram.
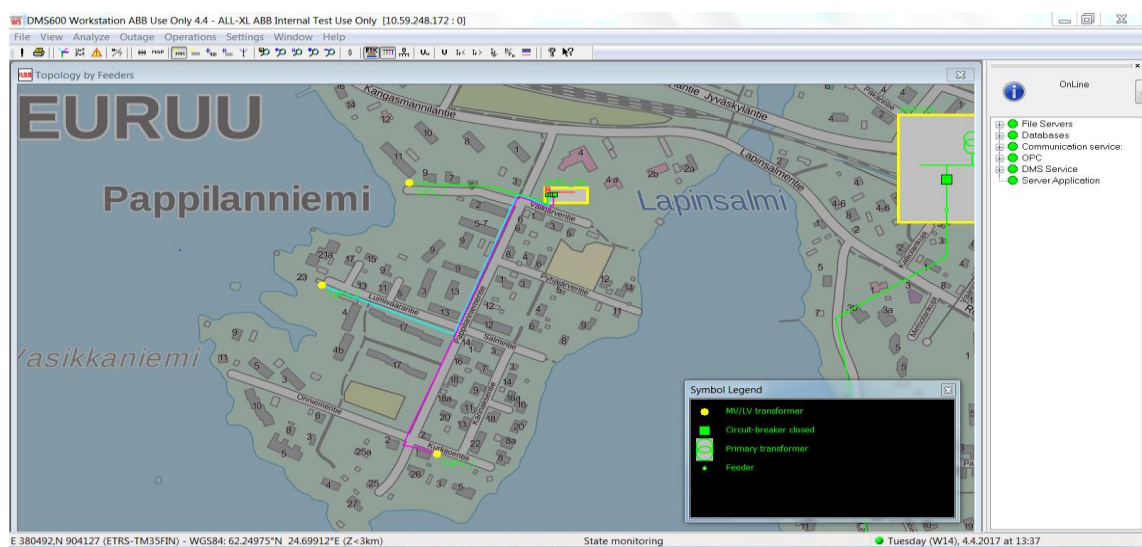

Figure 2. The geographical user interface of DMS600 WS

MicroSCADA DMS600 is used for network control and distribution management task.

The software can be used with MicroSCADA or without MicroSCADA or with other SCADA systems. DMS600 contains a high-level interface to MicroSCADA, which provides real time and static transfer. /5/

4   ARCHITECTURE OF MICROSCADA DMS600

4.1   General

Integrated DMS600 systems usually include several computers and servers. These can be physical or virtual. A typical integrated DMS600 project has two DMS600-servers and a separate SYS600 computer which has the OPC client installed. Also, a separate SQL server or cluster is possible. The system hardware varies between different projects. /6/
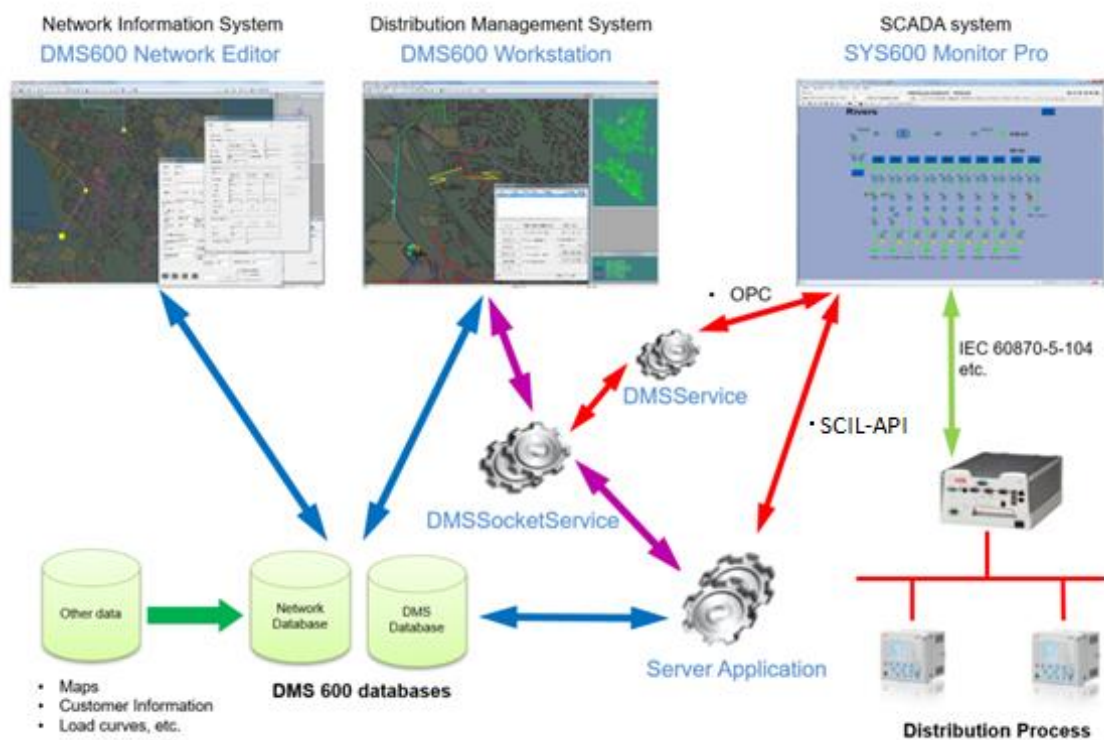

Figure 3. Architecture of DMS600 project integrated with MicroSCADA

4.2   Network Editor

DMS600 Network Editor is the administrator`s tool for managing only the network data and SCADA interface with restrictions.

The important tasks of DMS600 NE program are:

- Creating binary database to DMS600 WS
- Commissioning of background maps
- Digitizing the network
- Defining of components
- Management of the integration between DMS600 and SCADA systems and other administrative tasks.

In NE Administrator, it is possible to edit or add components to the network at the same time when the system is running. For linking OPC object between SYS600 and DMS600 there is an External OPC DA Client Configuration Tool. /7/

4.3 Workstation

DMS600 Workstation is the operator`s tool for monitoring and operating medium and low voltage distribution networks.

The main operational features provided by DMS600 WS are:

- Network topology management
- Network analysis
- Alarming
- Fault management
- Field crew management
- Outage management
- AMR meter data management
- Data analysis
- Customer service
- Document archive
- Map printing /7/

The integration of DMS600 and MicroSCADA makes a base for network topology management. Every change in the state of the switches or line sections causes an update on network topology. Both DMS600 and MicroSCADA can send information about the changes to the network topology. The coloring of the network topology is a way of clarifying the network management. The color can represent different kind of information. For example, adjacent feeders can be different colors or an unsupplied line section.

The network analysis function offers fault current and power flow calculations, protection analysis and operational simulations. These calculations can use measurement data which have been provided by SYS600.

 For these calculations, needed information from the customer is annual energy consumption, load curves, type of conductor used and length of the cable. The protection analysis needs information about protection relay parameters and medium voltage fuses./8/

The main function of the outage management is to create a complete outage report when a fault or maintenance outage takes place. Most important information that the report includes is how many unsupplied customers there are and when the maintenance outage or fault ends.

When a fault takes place, the fault management starts calculating the fault location. At the same time the Distribution Management System sends information about the fault to a web service. This web service launches an external application that sends GSM messages automatically or manually to all customers in the unsupplied area. After the fault is located, fault isolation and power restoration planning starts. This is an automatic function if there is all needed information available. In the DMS600 WS it is possible to execute the planned switching sequence. When the fault is fixed, the report about the fault is saved into the fault archive. /8/

4.4 Server Application

DMS600 SA is a Windows based service. Server Application provides information from MicroSCADA for the DMS600 Workstation instances.

The main operational features provided by Server Application are:

- Write coming fault from SCADA
- Write feeder color state
- Write changes of the switch position

Server Application writes the faults and reclosing operations in the DMS database. Server Application receives this data from SYS600 via the OPC client or fault service. /6/

4.5 DMS Socket Service

Serving communication routines for the DMS600 program is the main function of the DMS Socket Service. The DMS Socket Service is a communication server between workstations. The socket service is crucial part of DMS600 messaging because all messages is routed through it. This service can deliver all MicroSCADA information data to DMS WS and commands from DMS WS to MicroSCADA via the DMS600 Service Framework OPC client service. /7/, /9/

4.6   DMS600 Database

The essential part of the DMS600 software is a database. The database contains information about the components, lines and customer data of the distribution network. MS SQL Server and Oracle can be used as a relational database server to store the data.

DMS600 usually needs one or two databases. In a domestic project, there are usually two databases. The first database contains static information and the other contains dynamic information about the distribution network. One database which contains all network information is popular at new foreign projects. /7/

4.7 DMS Service Framework

DMS Service Framework is a support process. The process ensures that needed modules will communicate with each other and all modules are running without failure. Service Framework does not have a user interface but a separate software DMS600 Service Monitor can be used to connect for all the Service Framework instances in the system. The service monitor can view the status and their logs e and modify settings and restart modules.

The main services that Service Framework includes:

- OPC Client
- Interfaces to other systems
- Fault Service
- Outage XML Exporter
- Topology Updater
- Localizing the workgroup
- GSM service to customer/7/

DMS Service Framework provides interfaces for other systems. These systems can be Automatic Meter Reading System, Outage XML Exporter and WMS, for instance. WMS provides a simple interface for requesting map images from distributed geospatial databases.

The fault service sends information to the DMS600 which will determine if it is a fast reclosing operation, a delayed reclosing operation or a fault. The topology updater checks changes from the state of the switches. /9/

4.8   Communication between DMS600 and SCADA Systems

There are three internal communication interfaces in the DMS600 and countless external interfaces. The SCIL API- and OPC interface are used for communication between DMS600 and MicroSCADA. DMS600 uses mainly the OPC interface to communicate because the SCIL-API communication interface is obsolete. For internal the communication interface DMS600 uses the DMS socket service as a message routing component. /9/
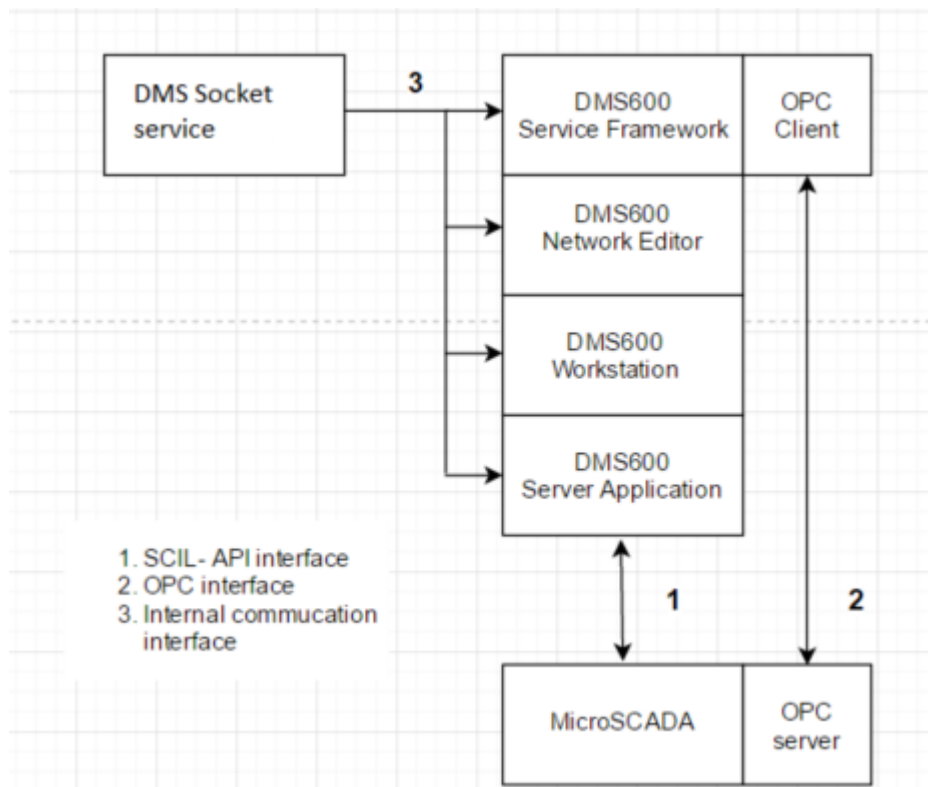

Figure 4. Communication interfaces between DMS600 and MicroSCADA

5 ENGINEERING PROCESS PRINCIPLES ON DMS

5.1 Main Steps for Creating of the DMS600 Project

The integrated DMS600 project with MicroSCADA needs an existing Mi-
croSCADA application, network data and background map material. If the project
has service, such as network analysis, fault management or AMR meter data man-
agement, then the project needs data from the customer information and load
curves. The DMS600 project can be created with or without MicroSCADA or other
SCADA systems. Before starting the project, it is essential to know which services
have been sold; if it is an existing system and what kind of systems it is and how to
integrate with it. /6/

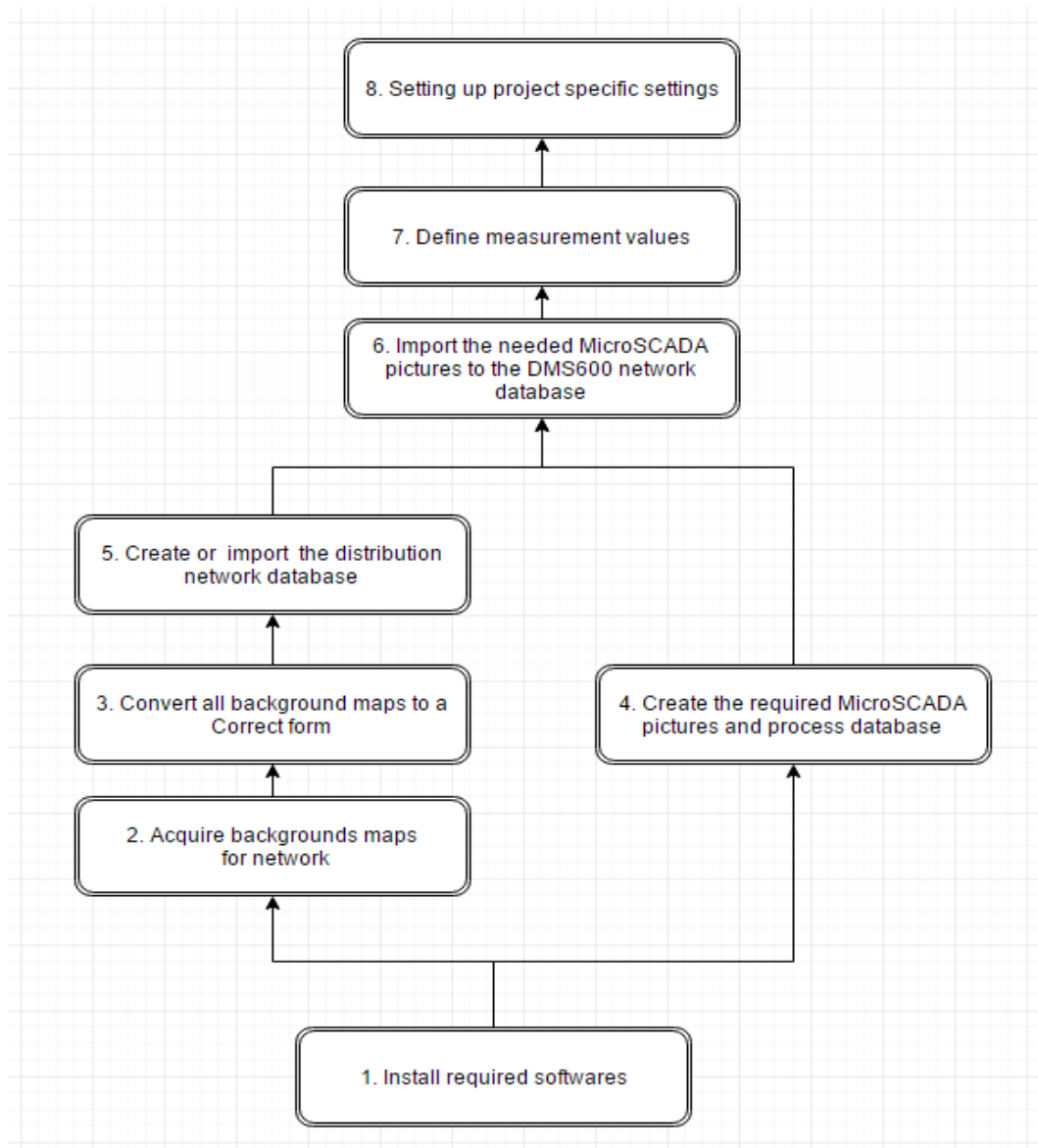Main steps for creating of the DMS600 project is explained in next chapter. (Figure
5.)

Figure 5. Process chart of the integrated DMS600 project

1. To start a new DMS600 project install these following programs: DMS600, SYS600 and SQL server. Install the needed project specific support software for DMS600. It depends on the project which support software is

needed. One example of this support software is Windows Office for customer listings and switching plans, for example for example lists of switching device operations for field crews. /6/

2. Background maps for the domestic DMS600 projects can be acquired from the National Land Survey of Finland (Maanmittauslaitos) and for the export projects there are different ways to acquire background maps. Acquiring backgrounds maps to exports project can be challenging.

   For export projects Openstreetmap and WMS server are services where needed background maps can be acquired. Also, the customer can be asked to acquire needed background maps.

3. Convert all background maps to a correct format, raster maps into BMP (Windows bitmap format) and vector maps into the AutoCAD DXF format. Adjust these maps to a single orthogonal orientation. The Coordinate System must be defined for each map layer before installing and adjusting background maps. A different map scale is needed for zooming between the overview map and more the detailed map.
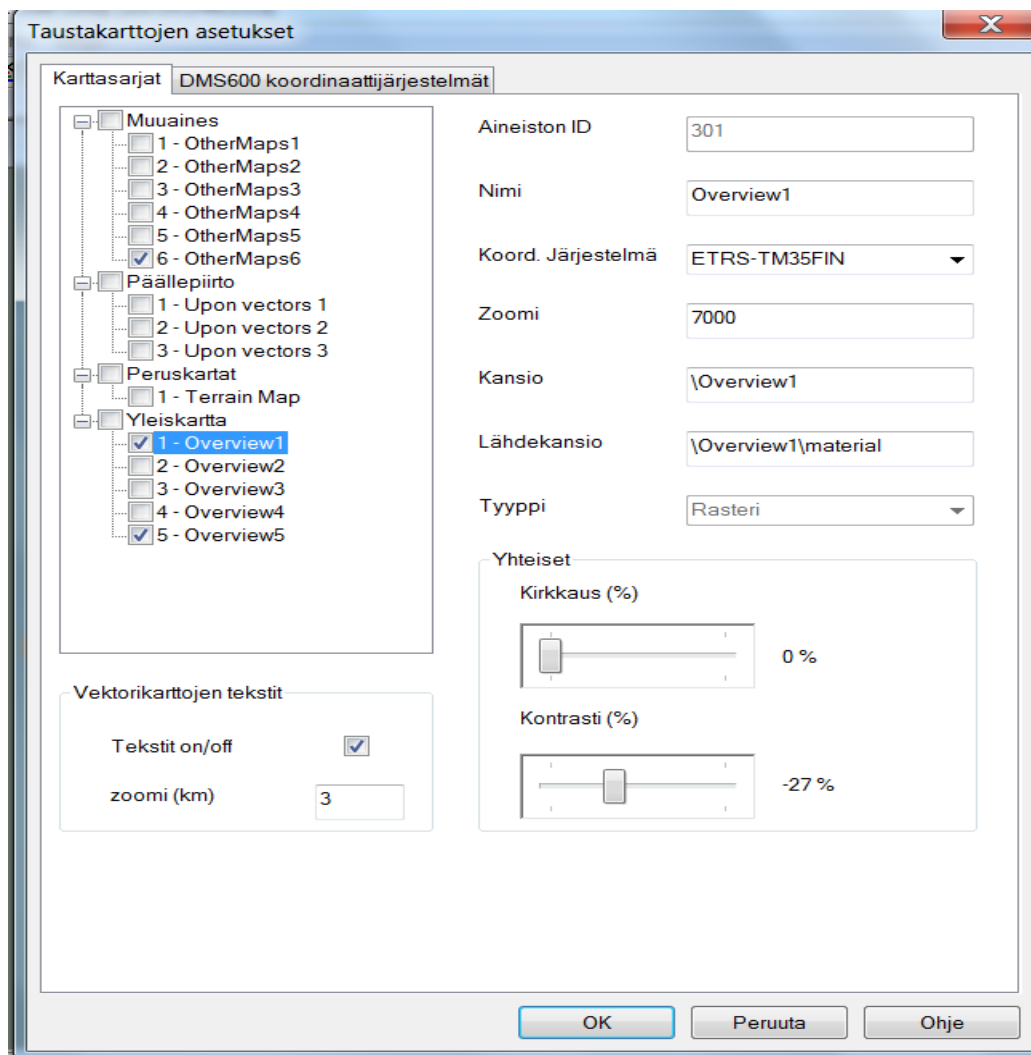
Figure 6. Adjusting map scale and zooming level.

The DMS map loader and QGIS program are tools for reading and adjusting background maps. A tool has been developed in the Python code for reading the WMS server. This tool converts map pieces into the right coordination, saves into the files and writes them at DMS600 root. /6/

4. Create the required MicroSCADA station pictures and process database. This can be done at the same time as converting maps to DMS600.

5. Create the distribution network database with DMS600 NE. The database contains data about the substation, lines and components. The most effective way create a network database is with importer tools.

Common import software tool to import network data are:
- DXF Importer
- Becos import
- PG import file

The most common import tools are DXF- and Becos import tools but these software tools can only import all network data once into DMS600. After importing, DMS600 NE keeps the network data. The PG import file imports the network data from a text file. The PG import file can import repeatedly all network data into the DMS600 without other engineering after the first installation. Under development is ESRI Shape File Import and KML Import tools, which can also do that.

DMS600 NE can edit and add network database manually, if necessary. The creating and updating of network database is only allowed in the data edit mode DMS600 Network Editor. /6/
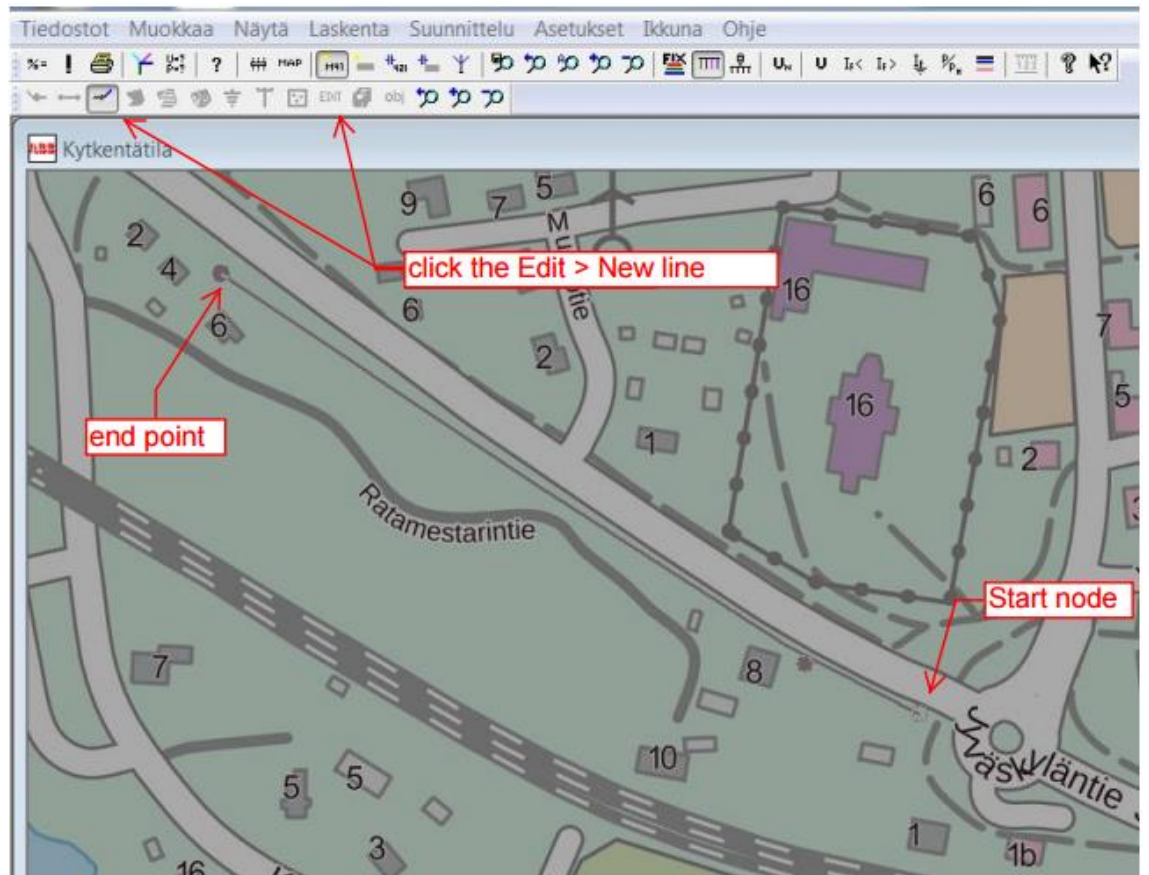
Figure 7. Adding the line in to DMS600

To add the new network line into the DMS600

- Click **Edit> New line**
- Insert the new line start node where you want to start drawing the line and define the node.
- Select the Voltage level for the line
- Draw the line by clicking the assumed route of the line. Right-click at the ending point of the line
- Insert the data of the start component
- Insert the data of line
- Insert the data of the ending component

The DMS Network Editor automatically fills in the length of the line, presumed voltage level and conductor type. The voltage level and presumed conductor type depends on the last connection of the line. /7/

6. Import the needed MicroSCADA pictures to the DMS600 network data-base. Normally internal control and station diagrams are converted from MicroSCADA. When importing some process object names are updated au-tomatically, for example circuit breaker. These pictures can also be created in the DMS600 Network Editor.
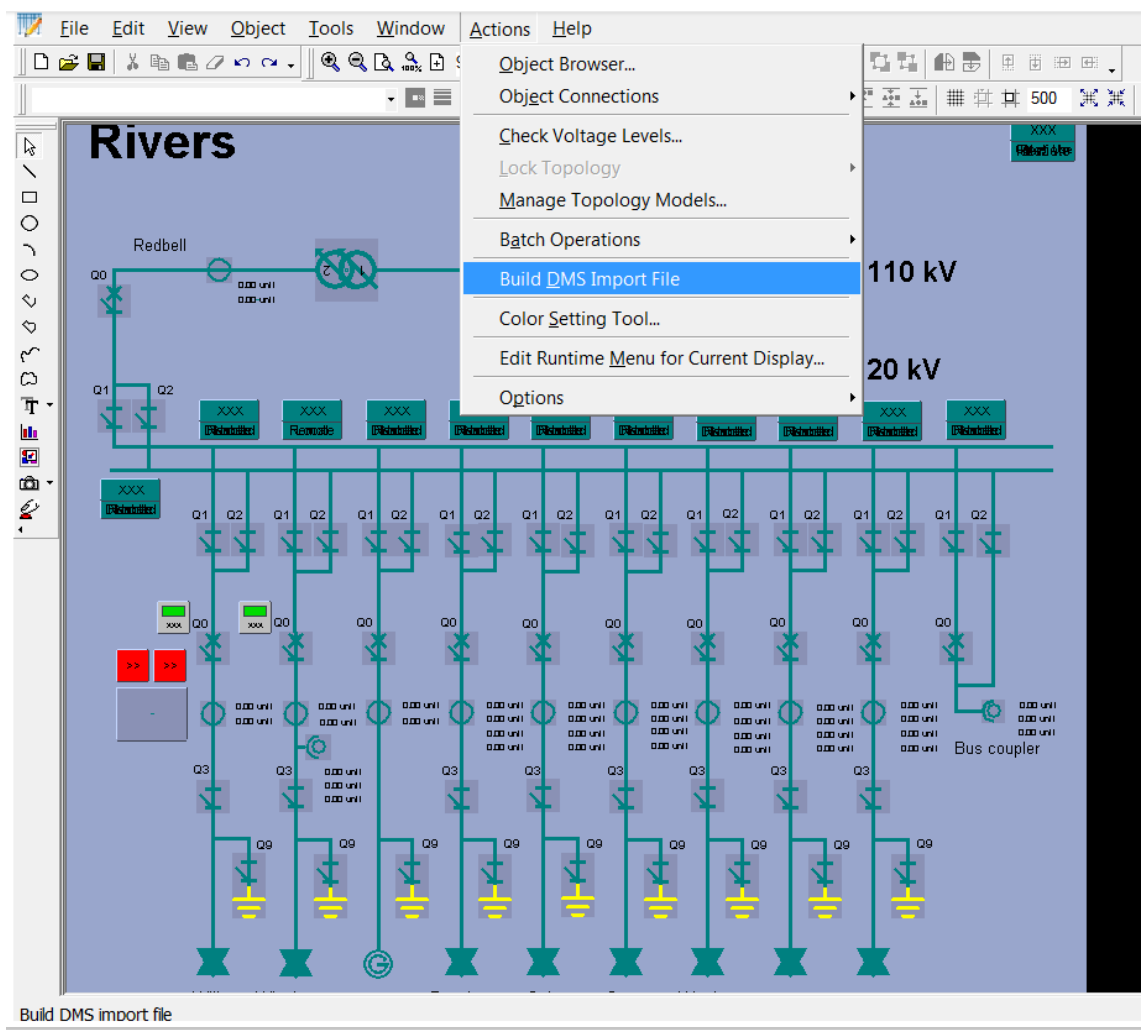

Figure 8. Import station picture in SYS600 for DMS600

To import MicroSCADA station picture to DMS600

- Open MicroSCADA and select picture to import
- Go to **Tools > Engineering Tools > Display Builder**
- Edit the picture desired form
- Then click **Action > Build DMS Import File**
- Go to the DMS600 NE
- Click import and select the needed picture. The type of the picture file is IS6G.
- Adjust the station picture into the background map

After importing, connect the network into the feeders of the station manually and check that they are correct. There is an automatic station feeder connection being planned. After the connection to MicroSCADA the pictures do not change the logical name or OPC address of the switching devices or line indicators. /7/

7. Defining measurement values

The measurement values from MicroSCADA can be linked at DMS WS and monitor in real time. DMS600 WS uses measurement values to make the network analysis more accurate.

Figure 9. Measurement data form where to define specific measurement settings.

To add manually a measurement to DMS600

- Open the DMS NE and Click **Edit > Add Measurement**
- Click the network window where you want to measurement box to be. After that the measurement data forms open
- Add the real power measurement manually into the type of measurement box
- To define the measurement object more accurately, use the Prefix, Unit, Factor, Decimal place and Default value for defining the object.
- Click **Connect** and then click the measurement node to make a connection between the selected node and the measurement node
- Update the binary database
- Open DMS600 External OPC DA Configuration Tool
- File > Fetch DB Data
- Click **Connect** at OPC Servers MicroSCADA – Measurements
- Open the Measurement tree
- Select the needed measurement and drag this measurement into OPC address
- Right click OPC Server **Set Value** MicroSCADA - Measurement
- Go to the measurement data forms and add the OPC name for the measurement
- Restart the OPC client

To add several MicroSCADA measurements to DMS600

- Open External OPC DA Client Configuration tool
- Click Fetch names recursively at the measurement section
- Connect the measurement section
- Write `filter` at the item filter for filtering needed measurement. example \\API\1\P\RIVH
- Check that the measurements are correct then click **Store Available Items**
- Restart DMS600 NE
- Open the DMS Ne and Click **Edit > Add Measurement**
- Click the network window where you want to measurement box to be. After that the measurement data forms open
- Select the OPC name for the measurement
- The type of the Measurement can be defined in the type box. Defining the measurement type is important if the measurement is needed in the network calculations of DMS600 WS.
- To define the measurement object more accurately, Use the Prefix, Unit, Factor, Decimal place and Default value for defining the object.
- Click **Connect** and then click the measurement node to make a connection between the selected node and the measurement node measurement must connect feeder node if not a bus bar. /7/

8. Setting up project specific settings

DMS600 project specific settings vary between different projects and according to the licenses and equipment sold in the project.

The project specific settings are

- zoom level of background maps
- symbol setting
- network color
- settings of outage planning
- settings of fault location
- regions and user level settings
- configuration of interfaces for external software for example for GSM- message system

These settings need project specific engineering. /6/

6   CONCLUSION

The aim of this thesis was to clarify integrated DMS600 project principles. This thesis helps to understand how the project structure works and what information is needed for basic integrated DMS600 project.

The workflow of this thesis was first to get to know how to MicroSCADA pro DMS600 works, then to clarify integrated project principles. Thanks to ABB's Tampere office group for providing information for MicroSCADA Pro DMS600 and project structure.

When I was working on thesis I received a good view on how MicroSCADA DMS600 works and what main project principles are. I hope that in the future I can improve my skills in integrated project and assist the DMS600 project engineers in Tampere.

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