IMPLEMENTATION OF DYNAMIC SYNOPTIC SCREEN IN DISTRIBUTIVE CONTROL CENTER „ED SOMBOR“

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Abstract
In this paper, through a brief description of supervision and control functions in a distributive center, an explanation for projection wall implementation, containing Dynamic Synoptic Screen presentation (DSS), is given. DSS is a substitution for the existing static board (mosaic board). Paper explains basic concepts of Distribution Network (DN) real time presentation by use of SCADA system. Construction of DSS in dispatcher rooms takes into consideration topics which are discussed in the paper. Respecting available technical solutions for DSS construction, paper evaluates a number of variants regarding wall projection.

Key words: Distribution Management System (DMS), Dynamic Synoptic Screen (DSS), Distribution Network (DN), projector, Acrylic Glass Projection Screen (AGPS).

1. INTRODUCTION

Wall projection of plants and systems is an efficient substitution for static synoptic boards in production and transmission system control centers where on the other hand Distributive Dispatcher Control Centers (DDCC) still have DN presentation done on Static Synoptic Boards (SSB). Implementation of Distribution Management System (DMS) and remount control of high/middle voltage transformer stations, middle voltage DN plants imposes the need for wall presentation of DSS. Present static synoptic boards are competitive to computer based DSS only in dispatcher habits domain but far to the efficient way of DN supervision and control.

On SSB the present topology of DN is represented by use of tampons, buttons or led signal lights of different color connected to a device. The same effect is achieved by a mouse click or by an automatic display of switchgear status change collected from SCADA system. Manipulation of details on SSB is done on a specific way where on the other hand entering of name or code of a transformer station it’s position is immediately presented. The basic advantage of DSS is presentation of huge number of information, flexibility and real time presentation of changes in DN. DSS strongly improves the Man-Machine-Interaction as well as the communication between all participants in control process.

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Important operational decisions depending on the availability of and amount of information are made faster and more accurate by use of DSS.

By the end of 20th century wall projection technology had a huge progress. In general, there are two basic concepts of development:

- Compact display devices,
- Projection technology.

Compact display devices, either with LCD or plasma screens, have an important progress offering better technical characteristics with the only limit on display size which is at the moment limited to 50 " diagonal.

Projection technology includes projection systems comprising of a video projector device and an Acrylic Glass Projection Screen (AGPS). In projection technology there are compact devices (cubes) as well as projector-AGPS solutions. Cubes are compact devices comprising of video projector device and an AGPS with rear projection. Both devices are placed in a box, a cube, so that AGPS is opposite to the dispatcher and actually the only surface that is visible. Inside the cube there is a mirror which reflects the picture from the projector on AGPS in order to obtain a small projection distance. Cubes could be organized in a projection wall. Solution with cubes is rather expensive one and is not taken into consideration for DDCC. Projector-AGPS solution has a projection screen of much larger dimensions and uses a larger projection distance. In this case both, rear and front, projections could be used what will have impact on the type of AGPS. Video projectors are capable for performing both types of projections.

2. EXISTING STATIC SYNOPTIC BOARD

The existing SSB has been made 40 years ago and comprises of a punched metal sheet with 175x235 cm in dimensions. It is used for presenting the entire 20kV bus bar single line diagram of 100/20kV transformer stations (TS) and 20kV switch yards. The presentation comprises of 1027 20kV TS, around 400 20kV breakers and isolators as well as around 2000 20kV sections. The diagram is realized with following concepts:

- Lines and sections are represented with insulation tape stuck to the board. All sections of a line are the same color in order to easier distinguish sections of another line.
- Distributive 20kV TS are presented with label stuck on the line. The label has the name of TS as well as the nominal power of transformers in TS.
- Disjunction points in DN, breakers and isolators, are represented with plastic tampons placed over lines in holes of the punched metal sheet. The color of a tampon represents the status of disjunction point, breaker and isolator, and is used according to following internal rules:
  - yellow tampon over the line - isolator switched on,
  - red tampon over the line, yellow tampon aside - isolator switched off,
  - yellow tampon over the line, red tampon aside - isolator switched on and out off order
  - red tampon over the line, yellow tampon aside, red tampon aside - isolator switched off and out off order

Modification of DN presentation on SSB is done according to following events:

- sticking of new labels and tapes represents construction of new DN objects; tearing down of existing objects is done in case if an object is collapsed.
- replacement and placement of tampons is done according to events in DN control.

SSB positive features are:

- Entire 20kV DN is represented,
- No maintenance expenses (there are no replaceable parts, labels and tapes are of minor importance)
- In case of SCADA system failure SSB has the presentation of the last established topology of DN.

SSB negative features are:

- an unclear presentation of DN regarding number of DN objects. SSB size was defined according the present number of DN objects 40 years ago. The present number of DN objects is far over all estimations done.

- unsuitable modification of switchgear status presentation. The person has to be very familiar with all presentation rules.
- SSB appearance is pretty poor at the moment.

Despite of all negative features of SSB, the main reason for SSB replacement with DSS is the necessity for real time presentation of DN elements. Distribution Company (DC) "Sombor" has implemented several systems to support this demand and they are:

- SCADA system, implemented in 1985, controlling all five 100/20kV TS and three 20kV switchyards,
- DMS system, implemented in 2001,
- Middle voltage SCADA system, implemented in 2006, controlling six line isolators and five 20/0,4kV distributive TS.

3. DISTRIBUTION MENAGEMENT SISTEM

After establishing all demands towards Distribution Network, Distribution Company uses DMS as a decision support system for solving all electricity supply problems in real and extended real time. Further decomposition of DMS, fig. 1, done by use of Structured System Analyses, introduces two management subsystems or submodules:

- real time system, SCADA,
- extended real time system, DMS Software with Analytical Function System (AFS),

and necessary databases for their implementation:

- General database, GDB,
- SCADA archive,
- Parametric database, PDB,
- Application database, ADB, [L2].

There are two additional subsystems which are integrating all subsystems in a unique distributed system:

- TC system (telecommunication system) with computer communications,
- DMS server

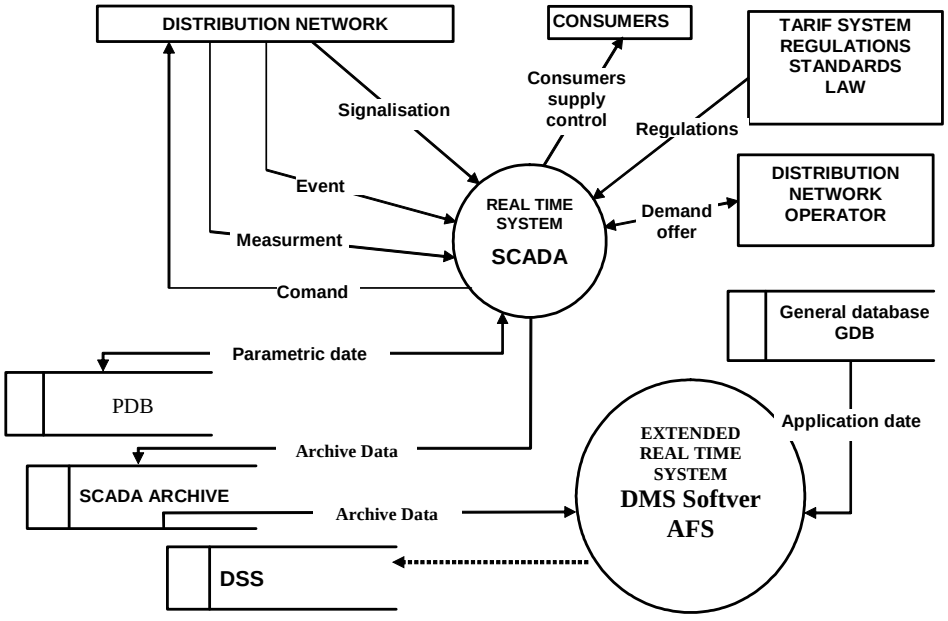

Fig 1 – DMS subsystems

All DMS submodules are integrated by DMS server as well as by use of computer communications. Computers are running in LAN (Local Area Networks) environment, where upon they are integrated in a unique system. With this type of solution, communication between client stations and servers is enabled. All OF-LINE development tools are installed on a separate computer so that all dynamic presentations, additional calculations, tables and reports could be completed and later on sent to

sever and MMI stations. In order to maintain all functions in real time, integration of all modules is done on the company level as shown on Fig 1.

3.1 DMS software with AFS

DMS Software comprises of following submodules:

- **Network Editor** – (NE) real time data delivered from SCADA system for DN regime and topology are automatically archived in GDB. Network Editor is a graphic software module used for DN element data managing as well as managing of topology data (switchgear statuses). NE manages data in Technical Data Base (TDB) as well.
- **Dynamic Synoptic Screen** – (DSS) is a software module for graphical presentation of DN regime and topology, TDB data presentation and overview as well as AFS start up and result presentation.
- **Analytical Functions System** – (AFS) are the set of software and algorithms that enable the most efficient decision making, i.e., the most efficient utilization of a DMS and all the equipment installed in the distribution network. AFS is integrated in the DMS as a unified software package used in four main modes: ***operation management, operation planning, development planning and analysis,*** as well as ***simulation and training***. DMS analytical functions significantly increase the profit from investments into distribution networks, with relatively small cost compared to other investments, [L2].

The proposed integrated system of AFS consists of 25 functions that are shown in Fig 2 [L2].

The functions are divided into four groups according to the complexity and to the application purposes: A) Preparatory functions, B) Functions for analysis, C) Basic functions, D) Composite functions.
DMS analytical functions, within an integrated DMS, provide the following utility **benefits**: 1) monitoring the state of the entire distribution network, 2) minimum power and energy losses, 3) the best voltage profiles; 4) minimum damages caused by incorrect switching operations, 5) minimum of non-delivered electric energy, 6) increase of customer satisfaction, 7) high quality education of dispatching staff, 8) the most efficient utilization of existing facilities, 9) postponement of new investments, 10) simulation and limpid presentation of the functionality of a DMS even before its purchase and installation, etc.

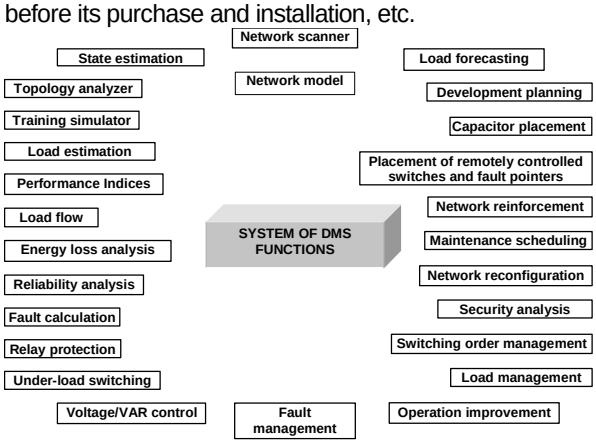

Figure 2 – System of DMS functions

3.2. SCADA system

Implementation of real time system by use of information technology is done through SCADA system. Basic functions of SCADA system in integrated DMS are:

- Acquisition and overview of real time and archive measurements from distribution network,
- Acquisition and overview of switching gear status,
- Acquisition and overview of alarms from distribution network. In advanced solutions they can be used as triggers for operation of adequate analytic functions of AFS.
- Acquisition and overview of events from distribution network.

Performing the above mentioned functions SCADA system is a tool for realization of two important functions as components of DBM:

- Supervision,
- Control, [L5].

Supervisory function of SCADA system is used for permanent overview of electrical energy flows and regime of distribution network operation (overview of voltage, current, power and frequency).

Basic components of SCADA system are:

- **Remote Terminal Units** – (RTU) are components placed in remotely controlled distributive objects in order to collect analog and digital signals, send all collected signals to remote control centers and process controls form a remote control center to switchgear,
- **Servers** – are components which perform processing of all signals collected from RTUs. Because of the importance of their role in SCADA system and reliability of the entire system, two servers are implemented working in parallel. Both of them are connected to telecommunication lines in order to receive exactly the same signals from objects. One of them has the role of leading server and performs calls to RTUs, receives signals from RTUs, issues control telegrams to RTUs and communicates with dispatcher working stations. The other one, passive server, receives signals from RTUs and saves data to archives as the leading server if there is no separate computer with the role of an archive server.
- **Man Machine Interface** (MMI) working stations – have the role to present data collected form remotely controlled objects, previously processed on servers. MMI stations offer to dispatcher presentation of real time data (metering values, switchgear statuses) and logs of event data organized through a graphical interface. Dispatcher uses MMI to issue commands to switchgear placed in DN objects.

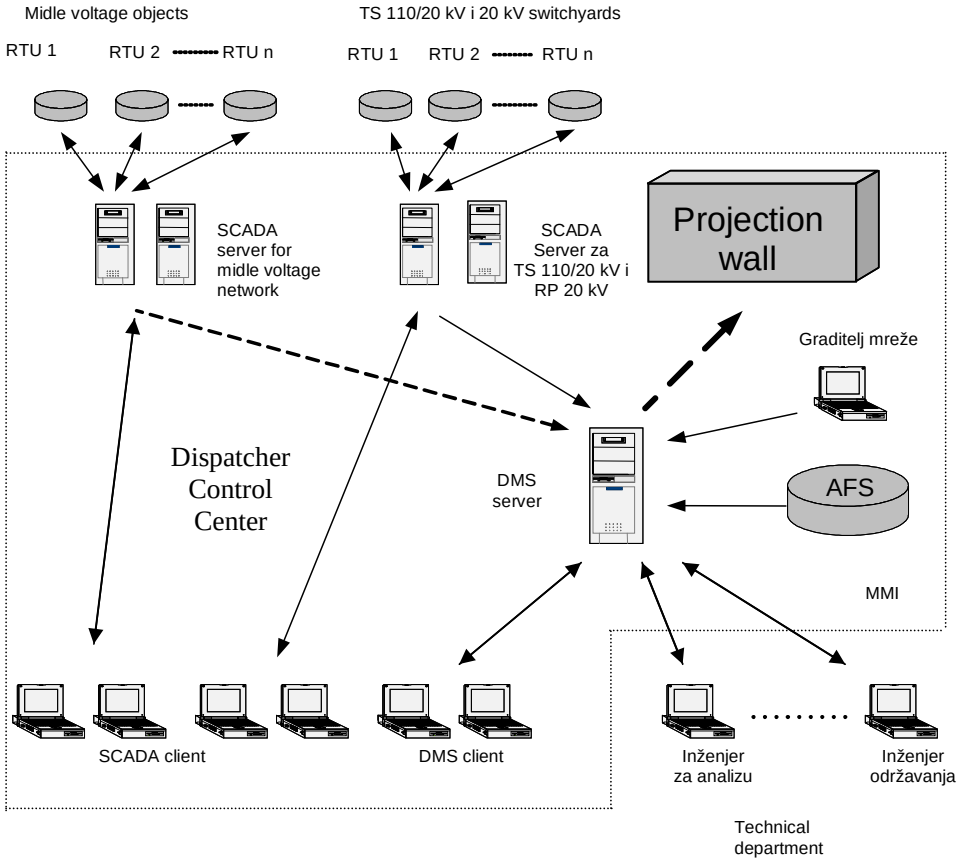

Figure 3 – DMS u ″ED Sombor″.

Figure 3 shows the hardware implementation of all DMS components in DC “Sombor”. With broken lines are marked links to be realized in future. With the implemented solution, DMS software is used by a variety of specialists like dispatchers, engineers for operation and optimization of DN, research and development engineers, engineers in charge for DN maintenance.

4. DYNAMIC SYNOPTIC SCREEN

Any DSS solution comprises of:

- DSS graphic server,
- Acrylic Glass Projection Screen (AGPS).

Beside these two components, DSS system includes other components like DSS software, network equipment, AGPS placement construction. DSS graphic server is computer with similar characteristics as MMI stations. AGPS is the most expensive part of DSS system and therefore we will pay attention on possible variants of it. AGPS has two possible solution types:

- monitors,
- projectors with AGPS

4.1 Monitors

Monitors of high resolution and of large size are produced in plasma and LCD technology. On our market there is a variety of manufacturers and types of monitors but with average technical characteristics shown in Table 1 [L3]. Visual characteristics of this type of solutions is shown in Table 2.

Table 1 – Technical characteristics of monitors

N^o	Type	Max. diagonal length	Resolution in pixels	Size of the screen in cm	Thickness of the frame	Working hours
1	Plasma	50 "	1366x768	111 x 62	53 + 53	30.000
2	LCD	42 "	1366x768	83 x 46	65 + 65	60.000

Table 2 – Visual characteristics of projection wall made with 6 monitors

N^o	Type	Ratio pixel/mm	Symbol size in mm	Screen resolution	Screen size in cm	Frame size
1	Plasma	1p=0,8мм	8 x 8	4098x1536	330 x 124	11 cm
2	LCD	1p=0,65мм	6,5 x 6,5	4098x1536	276 x 104	13 cm

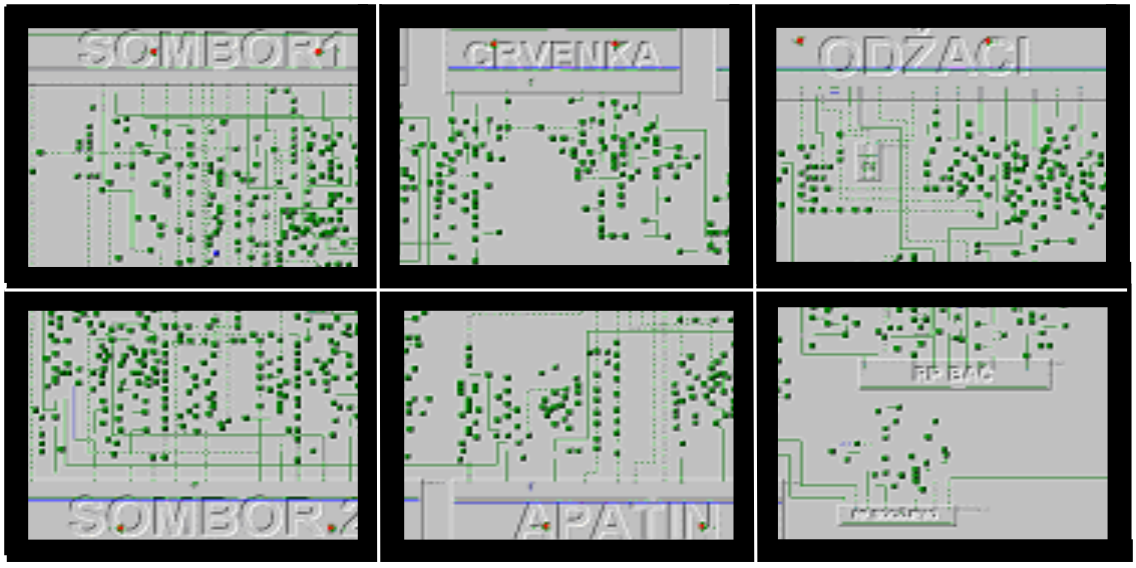

Figure 4 – Presentation of DN done with 6 monitors

Advantages of the solution with 6 monitors:

- additional possibility for adjusting – remount control device,
- soundless operation,
- easy maintenance

Disadvantages of this solution:

- visual grid because of monitor frames ,
- small projection screen,
- Small symbol size, [L3]

4.2 Projectors and AGPS

High resolution and large monitor diagonal size is still expensive to achieve in production. Thus, for the purpose of DN presentation in control rooms, there are no products of acceptable many/performance ratio in monitor technology. In this case, as an acceptable solution, which offers large projection screens, could be with projectors and AGPS. Presentation of DN is done by projecting the picture on AGPS whose role is, by means of prism system, to achieve high contrast ratio on a big screen surface. With a good selection of projector lens and AGPS a quality presentation of DN on large screen surface could be achieved. It has to be noticed that projector manufacturing technology has a significant development announcing high resolutions. With price drop of AGPS on the market, DSS solution done with projector-AGPS technology represents a quality solution for a longer period of time.

In selecting components for projector-AGPS solution, attention has to be paid on DSS graphic server video display adapter and projector resolution in order to get best of solution performance. Professional projectors should be of the resolution not less than 1280x1024 pixels. Projector resolution of 1400x1050 pixels should be suitable for a quality solution; it keeps the 4:3 ratio.

Designing a quality projector-AGPS solution [L3], regarding AGPS size and dimensions, there are no limits on AGPS size. We recommend AGPS with 200x150cm in dimensions because it keeps the 4:3 ratio and has an adequate surface size for presentation of huge number of DN elements.

Table 3 – Technical characteristics of projector-AGPS solution

N^o	Type	Max. diagonal length	Resolution in pixels	Size of the screen in cm	Thickness of the frame	Working hours
1	Projector	No limits	1400x1050	200 x 150	0	3.000

Visual characteristics for projector-AGPS solution with two projectors is shown in Table 4.

Table 4 – Visual characteristics of projector-AGPS solution with 2 projectors

N^o	Type	Ratio pixel/mm	Symbol size in mm	Screen resolution	Screen size in cm	Frame size
1	Projector	1p=1,5мм	15 x 15	2800x1050	400 x 150	0

Advantages of projector-AGPS solution are:

- large projection screen surface,
- better symbol appearance and larger notation,
- unlimited exploitation AGPS life,
- through exploitation life projectors could be replaced with of better characteristics.

Disadvantages of projector-AGPS solution are:

- projector lam short exploitation life,
- required maintenance,
- air conditioning is necessary, [L3].

Regarding the importance of visual appearance on DSS DN presentation, Table 5 shows most important characteristics of discussed variants [L4].

Table 5 – Presentation of important visual characteristics

N^o	**Feature**	**Plasma**	**LCD**	**Projector**
1	Projection screen size in cm	330 x 124	276 x 104	400 x 150
2	Symbol size in mm	8 x 8	6,5 x 6,5	15 x 15
3	Frame size in mm	53 + 53	65 + 65	0

4.3. Financial aspects of variants

DSS construction comprises of connecting DSS graphic server and projection screen to DMS server. The choice of projection screen type has the greatest impact on overall DSS system cost. Rest of equipment (DSS graphic server&software) is the same for all variants. Costs in case of monitor solution for DSS projection screen is calculated for 6 monitors, plasma and LCD. DSS projection solution in projector-AGPS solution is calculated for 2 projectors and 2 AGPS surfaces. Inical costs as well as the exploitation costs are shown in Table 6.

Table 6 – Initial and exploitation costs for discussed variants

N°	Criteria	Plasma	LCD	Projector
1	Initial costs in €	16.800	14.000	10.500
2	Exploitation costs for 3 year period in €	0	0	7.200
3	Exploitation costs for 6 year period in €	16.800	0	14.400
4	Exploitation costs for 7 year period in €	33.600	14.000	16.800
5	Exploitation costs for 7 year period brought down to yearly level in €	4.800	2.000	2.400

Projector maintenance costs are related to projector lam change after 3.000 hours of exploitation. Yearly 3 laps should be used for a 7/24 hours exploitation time with approximately 400 € per lamp. Although there is no maintenance for monitors, for a 7 year DSS exploitation period customer has to by 2 sets of plasma monitor, in set of LCD monitors and approximately 42 lamps for projectors.

In order to get a clear impression of all discussed criteria, in Table 6 is shown ranking for important criteria's. Ranking is done so that the best positioned variant gets 1 point and the worst gets 3 points. The best positioned variant and the one that should be chosen as the DSS solution proposal should be the variant with less points.

Table 7 – Ranking according to important criteria

N°	Criteria	Plasma	LCD	Projector
1	Initial costs in €	3	2	1
2	Exploitation costs brought down to yearly level in €	3	1	2
3	Visual impression and presentation quality	2	3	1

It is recommended that, beside of variant evaluation done so far, dispatcher opinion should be seriously taken into consideration before drawing the final decision upon the DSS solution.

5. CONCLUSION

- DSS is a submodule of DMS,
- Implementation of DSS into DSM provides an efficient solution for DN supervision and control,
- Evaluation of DSS solution variants has to take into consideration a certain number of criteria as well as the opinion of dispatchers in control centers.

6. LITERATURE

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