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DEVELOPMENT OF TECHNICAL INFORMATION DATABASE AND APPLICATIONS IN J.P. ELEKTRODISTRIBUCIJA NIŠ

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INTRODUCTION

Public power distribution company "Elektrodistribucija" Niš is in an early stage of implementation of modern information system. Important business operations, such as billing and ERP, are still performed on obsolete, host based system (Honeywell Bull DPS-7). This system is due to be replaced at the end of year 2004. New system will enable integration across different departments in company. Key component of the new information system is technical information system (Tehnički Informacioni Sistem - TIS).

The role of TIS is to help managing corporate technical resources, and therefore it needs to integrate information that comes from various sources. TIS must have four major parts:

- Technical Information Database (Baza Tehničkih Podataka - BTP) with accompanying applications for entering, manipulating and presenting data,
- Geographical Information System (GIS),
- Distributed Management System (DMS),
- Supervisory Control and Data Acquisition (SCADA).

In absence of "fully integrated solution" in the market, this four components must be separately developed or obtained. To ensure integration, all TIS applications must support one of standard data exchange protocols (1). The most important part is BTP, as other three parts of TIS rely on its knowledge of all electrical facilities.

TECHNICAL INFORMATION DATABASE

BTP is a foundation for TIS, and one must carefully plan entire database development process. BTP also has to reflect specific needs of each power distribution company (PDC). Each PDC has different facilities depending on consumer needs, therefore employee structure and managing procedures are inherently unique. This uniqueness can only be fully understood and exactly copied to database structure by an in-house development team.

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Initial information about 10/0.4 kV facilities has already been acquired with existing software solution (2). This data is being integrated to the BTP. Also, initial data is prepared for DMS software (3), and it is expected to enter evaluation phase soon. GIS software evaluation is under preparation (4).

Technical database data structure

BTP holds information about electrical facilities. But it needs to incorporate data about all important elements that influence the functioning of electrical facilities. It is important to choose the scope of data, and make correct relationships between them, in order to have a functional database that can be efficiently used. We propose the scope of the data, as on picture 1. Detailed explanation of each part follows:

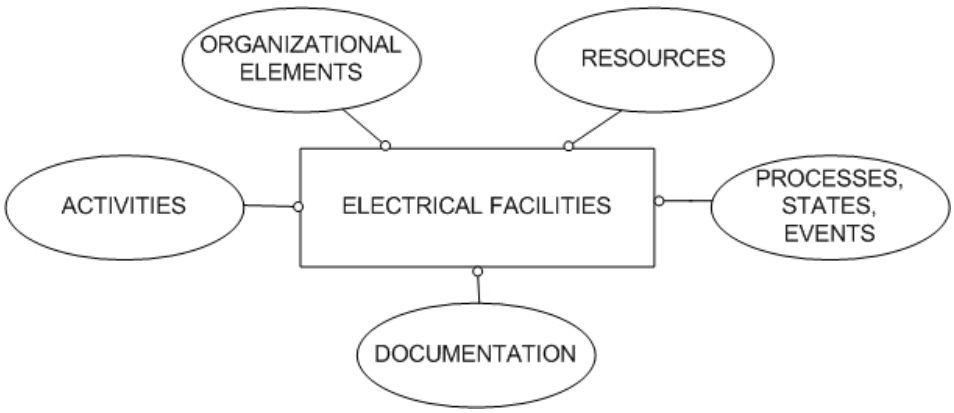
Electrical Facilities. The central part in BTP is data representing electrical facilities, and all components inside them. All voltage levels are represented here, ending with consumer connection point. It begins with small power plants, with its equipment. Separate tables are provided for information about transformer substations, each transformer with its elements (switches, feeders, cells, relay protection equipment...). All relevant information about cables, poles, conductors, and accompanying equipment are stored here. Also, information regarding consumer connection points and on-site instruments is stored, and related with existing billing information.

Organizational elements. To maximize the efficiency of data presentation, and make relevant day-to-day reports on various company levels, the organizational structure of the company must be defined. Each database element can then be associated with certain organizational level or structure. This part of BTP defines following entities: administrative organization (regions, counties, communities and streets), company organization (company, daughter companies, business units, and branch offices), and technology organization (departments, units, sectors, positions and employees).

Resources. One important benefit of BTP is capacity planning (including maintenance and service). All information about important resources is in this area. Resources like vehicles (cars, trucks, special purpose vehicles), radio equipment (radios, relays, repeaters, licenses), assorted equipment (such as measuring equipment) are tracked.

Processes, status and events. In order to support facility analysis in terms of maintenance, and make correct action recommendations, one needs to store information about relevant processes, status and events. Facility events like malfunctions, supply interruptions, relay protection performance are logged. Extended information, such as measured parameters of voltage, current, supply level, demand level etc, will be associated with each event. Other resources will have its events (vehicles - registration data, service info; radios - service info, logged conversations; protection equipment - expiration dates...)

Activities. Database will hold information about activities performed by employees. Specifically, ones that relate to maintenance of electrical facilities (repairs, revisions, failure point localization, etc). Also, activities related to managing of the grid will be stored (area shutdowns, area state information). Finally, information about customer related actions will be stored (control, cut-offs, metering equipment readings and calibration).



Picture 1 - Elements of technical database data structure

Documentation. Proper document flow is ensured with this information. Each process requires certain documents to be properly filled and in correct order. This area of BTP stores such information. From everyday documents like work orders, and reports, to process documentation like technical approvals and project document approvals. Dispatching documents are also stored (shutdown requests, work approvals, telegrams).

Miscellaneous information. Normalization process requires serialized and unambiguous data. This part of BTP holds such data, common to all other parts. Information like codes, measuring units, catalogues etc is stored here.

System support data

System support data is part of BTP that is not in function of technical data. It stores information about database usage, thus increasing security. Although most of database vendors have implemented security related functions, like journaling or role matching, this additional security feature has its benefits. Above all, administrative procedures related to usage journaling and privilege elevation. Since users can enter sensitive data, that could potentially give wrong overall picture of the system, application usage tracking is implemented. Picture 2 shows these tables in detail, and relationships between them as well. More detailed explanation follows:

logUsers. This table holds general user data.

logAdmins. Users referenced in this table will perform administrative procedures, like privilege elevation and maintenance.

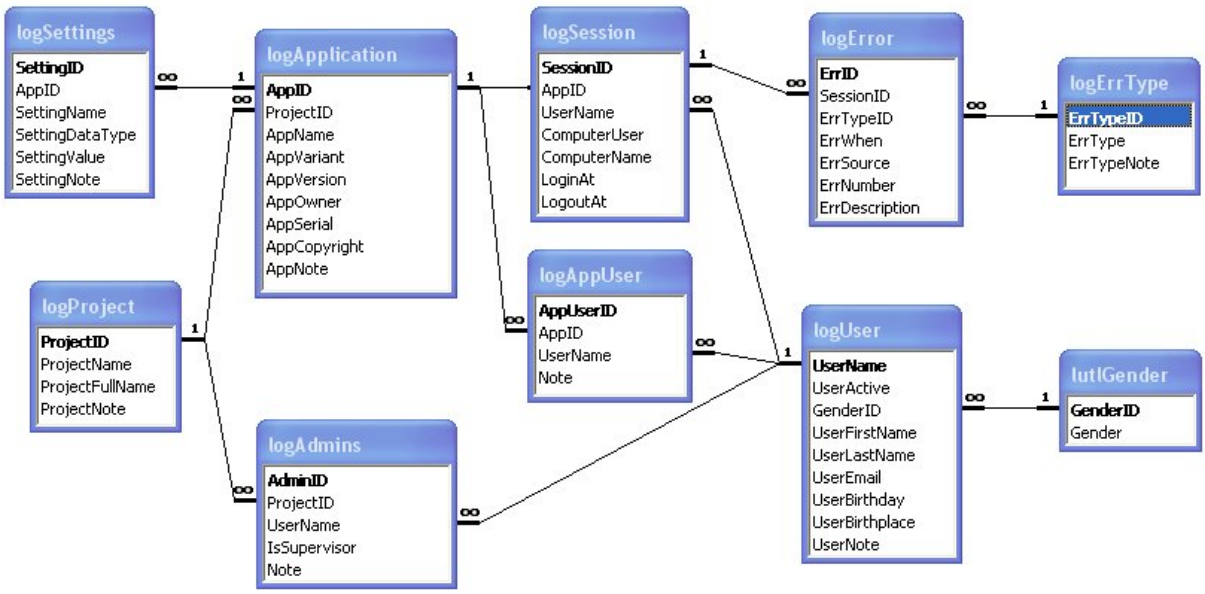
logApplication. Available applications.

logAppUser. This table makes possible to assign applications to users.

logSession. All sessions are logged here, with extended information about users. Such organization of tables enables tracking user access to data.

logError. Should an error arise during application usage, this table holds valuable information.

logAuditing (not shown here)**.** All potentially harmful atomic actions like updates and deletes are logged.



Picture 2 - System support tables

Technical characteristics of the database

BTP is developed according to all design rules to ensure proper data modeling and efficient retrieval. Some important issues are:

Database design. Data are stored in database tables, created and bound using entity relationship model. Data model is then normalized up to third normal form (4). Compatibility is guaranteed with usage of ANSI SQL for defining queries.

Data integrity. Database is designed to rely on "clean" data. Therefore steps are taken to ensure data integrity. The best way is to use RDBMS features that enforce relationship (referential) integrity and transaction processing wherever possible.

Security. Being an important feature of TIS, security is taken further of usual database security mechanisms. Since full exploitation of built in security of a RDBMS requires advanced DBA skills, additional applications are developed to enable producing of extended journaling and working with fine grained privileges to less skilled user. This ease of use guarantees actual security enforcing.

Backup and recovery. During development phase, users are able to make backup copies of their scope of data, to prevent accidental data loss. After commissioning of TIS, and migration to server RDBMS, backup and recovery procedures will be removed from applications, as enterprise backup will cover TIS fully.

Performance. Proper data modeling guarantees highest performance. However, in complex database model, one can not foresee all performance issues until database is fully populated. Current index field choices are best estimates of what will be performance bottlenecks. After database population is done, thorough performance review will be conducted, and steps taken to maintain highest performance.

Availability. After movement to server hardware, redundant systems will guarantee availability. Operators will be alarmed in case of service unavailability, by the means of network management and monitoring software. Maintenance procedures will be formed to make outages or performance slowdowns in off-peak usage hours.

Data migration. BTP supports importing and exporting data through XML files. In this way compatibility with different applications and database vendors is ensured.

APPLICATIONS

User applications are used to manipulate BTP data. These can be standalone second tier, Oracle Forms second tier, or web based third tier applications.

Planned applications

There should be many small specialized applications instead of one application. Their usage and scope will be limited to specific area of BTP, and user interface tuned to minimize impact on everyday use. As database grows, more applications that require broad range of data will be added.

System. Application for database administration. It is used to assign privileges for users and applications, and to report database usage.

Integral. Business executive oriented application. It can give detailed reports of important data across different areas of BTP. This application can't edit any data.

Organization. Application is used to edit organizational elements of database. Since all electrical facilities are bound to some organizational level, this application is used to accurately copy all organizational structures (administrative, territorial and technological) to database.

EEO. Main application for editing information about electrical facilities. Information like facility capacity, resources, activities are entered using this application. It uses organizational information to filter data available to user.

Management. This program deals with events in electrical grid. All events including failures, and relay protection state and performance are entered here. Application then combines that data with facility information from EEO to analyze grid performance

Services. Application for automation of common power distribution customer services. Services like technical terms for connection to grid, approvals to customer technical documentation, metering equipment calibration etc, are performed with this application.

Investment and planning. Monitors activities related to investment into electrical facilities.

Vehicles. As vehicles are major resource, this application automates managing all related information about service and usage.

Radio links. Information about telecommunication equipment. This application enables managing of radios, repeaters, antennae, licenses, and other related information.

Technical documentation. Easy access to technical documentation to all employees is accomplished with this application. It stores all available information about electrical facilities like situation plans, object schematics, plans, cable runs etc.

Technologies used in development

Great care has been taken to ensure ease of use for end users. User interfaces are modeled according to OS vendor recommendations (6). Applications are developed to meet OS quality assurance standards, which guarantees ease of usage and administration (7).

Data access is developed in a way that minimizes impact to computer networks, which in turn increases speed, and user experience. Industry standard libraries are used to implement data access (ADO, ADO.NET).

Data compatibility between different database vendors is accomplished by using ANSI SQL queries and UNICODE encoding. XML files are used for data import and export, which ensures compatibility with future applications.

PROJECT REALIZATION

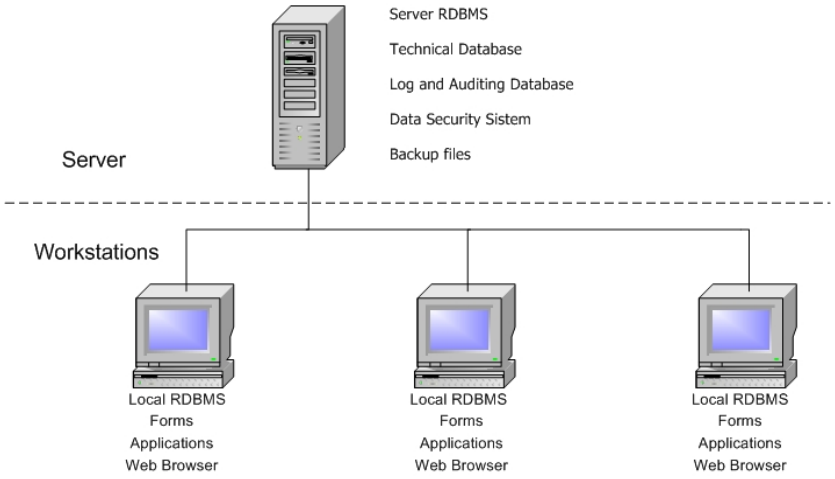
BTP project realization is bound to other parts of PDC informational system (IS). Modern and standard technologies are used in all parts of PDC IS.

Environment

Foundation for PDC IS is Microsoft Windows 2003 Server managed network, with Microsoft Windows XP Professional computers localized to Serbian language as clients. Each workstation that will use TIS comes with Microsoft Office System 2003 localized to Serbian language.

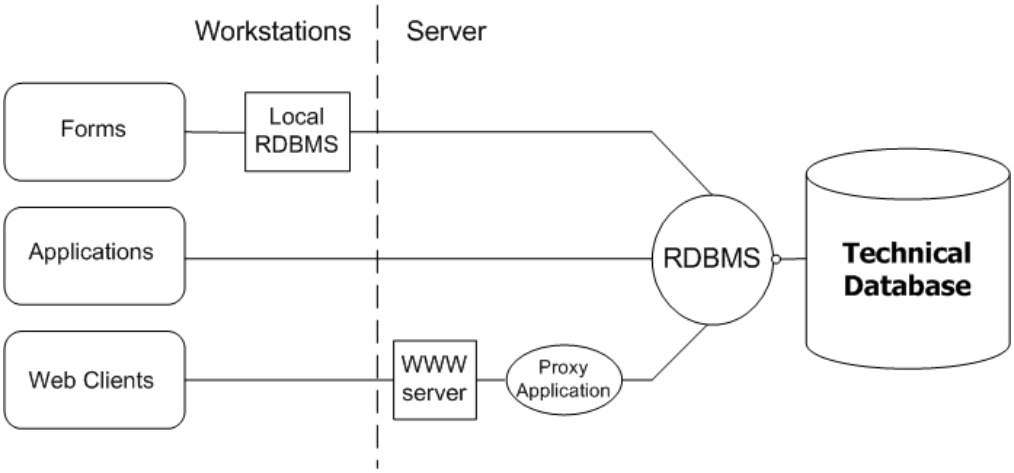
System design. PDC IS is designed to support centralized management, authentication and database. This concept ensures high security and robustness, as qualified manpower is always near sensitive server equipment in controlled conditions. BTP backup is part of enterprise backup procedure.

Workstations have client access software installed. Not only standalone executables are used, but front-end RDBMS with forms (such as MS Access), are used as well.



Picture 3 - BTP components across workstations and server

Data access. RDBMS data is retrieved using client server model. Database is located on server hardware, as a part of RDBMS software (Oracle or MS SQL Server). Workstations can use one of following three ways to access data. One way is to use local RDBMS (MS Access, Oracle Forms) software as front-end to server RDBMS. Other way is by standalone applications, specially written for TIS. Another way is browser based access, which can use Internet to access data.



Picture 4 - Ways to TIS access data

Network infrastructure overview. Technical database is relying on existing corporate network infrastructure. The only transport protocol in PDC is TCP/IP. Upper ISO levels provide application services and security, which relies on Microsoft Active Directory infrastructure. Users and computers are authenticated and authorized using Kerberos protocol. All network traffic is IPSec encrypted, eliminating all unauthorized communications over corporate network. Servers providing this functionality are physically secured in a NOC room, with controlled environmental conditions.

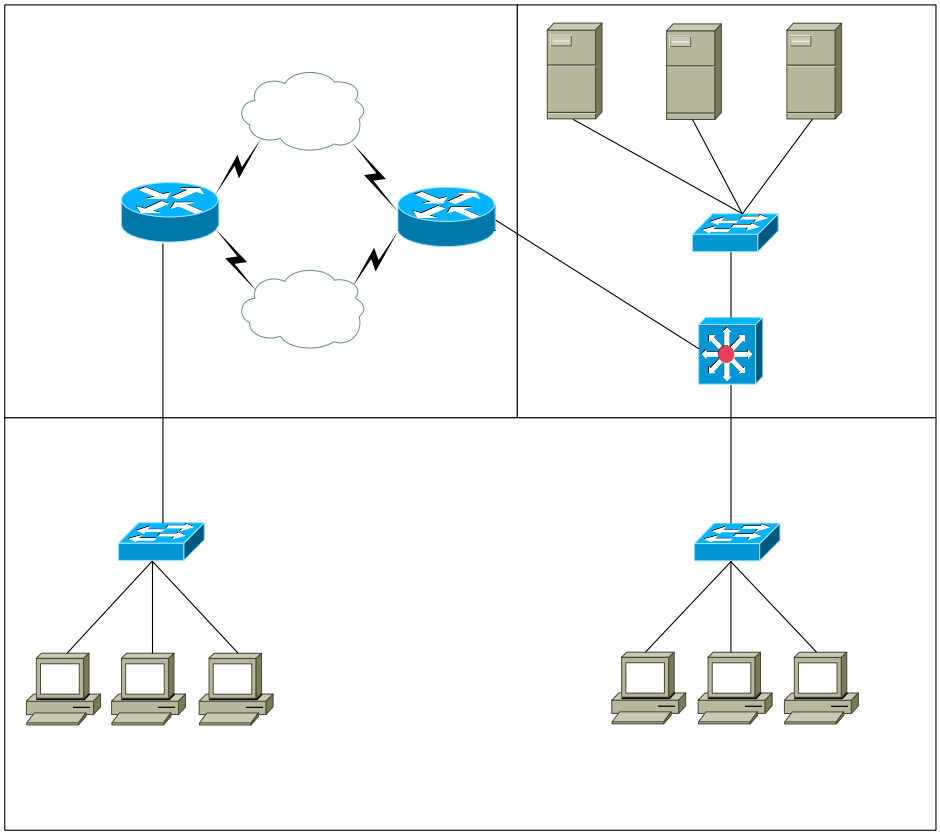


Figure 5 - Network infrastructure overview

Development tools. Following development tools are used for this project:

SOHO router

Microsoft Office Access 2003 – desktop RDBMS, supports file sharing network access, or client side access to client-server RDBMS. It is used for data modeling and concept validation through its rapid application development features

Microsoft Visual Studio 2003 Enterprise Architect – Standalone applications are developed using VS 2003, which is an industry standard development tool.

Microsoft SQL Server 2000 Desktop Engine - While BTP awaits full commission status, this "lightweight" RDBMS is used. After BTP is commissioned, MS SQL Server will be its primary database.

Project milestones

Given the complexity of BTP project, one can not expect the solution at once. Three milestones are set to mark phase completion. At the end of each phase, certain project validation and redesign is to be undertaken.

Phase one. During this phase all data modeling is completed (table structure, relationships, important queries). Important applications are completed (System, Organization, EEO, and Integral). These applications are means to initially populate database with important data. Advanced users and early adopters of the applications are trained and educated to use this version of software.

Phase two. All other applications are completed, with accent on event and status management of electrical facilities and resources. Phase one applications are modified according to user input and arisen issues with data model. Additional features are added to enable advanced use of available data. Additional users are trained to work with applications.

Phase three. Data is migrated to server RDBMS (Oracle or MS SQL Server). All users are trained and TIS is commissioned for use. Applications migrate over time to browser based data access to support usage of multiple platforms (cellular phones, PDA)

CONCLUSION

Given the broad scope, TIS is a kind of pioneer project with a lot of unforeseeable issues. To name one, company restructuring in future may render organizational data obsolete. The real challenge is to model the data in such way to accommodate future grows or shrinks of the company, without significant impact on already available data, and procedures. On the other side, without such system, normal functioning of a medium size PDC becomes increasingly difficult. Such situation presses for an immediate short-term solution. As a result, phases are modified to quickly produce some important applications, thus buying time for development of more complex management applications.

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