Title

Facility Management in ZCE (Czech Electric Energy Distributor) centralized into ArcFM

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Abstract

A Czech regional energy distribution and transmission company, ZCE, implemented ArcFM in one year. Replacing of an old ArcInfo7 application followed Miner and Miner project methodology. All user requirements were met with relatively small extent of programming, because customisation extended ArcFM generic functions. ArcIMS server and GIS-SAP integration spread electric network data through whole organisation.

1 About ZČE

Západočeská energetika, Co. (ZČE) was founded by the National Property Fund of the Czech Republic of the later year 1993. The founding of the company was preceded by the privatisation of Západočeské energetické závody.

ZČE is concerned especially with the trade of electricity and its distribution and sale in the west region of the Czech Republic. Territory of the ZČE activity is Plzeňský and Karlovarský region an area of almost 11 000 km^2 with a population of 860 thousand. The seat of the company is in Pilsen.

Západočeská energetika, Co has been a member of ČEZ Group in conjunction with four other regional distribution companies since 2003. The base of ČEZ Group is formed by energy corporation ČEZ, Co., its core businesses are the sale of electricity, which is generated primarily at its own power-stations.

The ČEZ Group is one of the ten largest energy holdings in Europe and the largest energy group in Central and Eastern Europe. It is the most powerful player on the Czech electricity market.

ZČE owns and operates in its region the distribution system, which can be divided into these main categories:

- very high voltage line (110 kV)
  1428 km overhead line and 4,5 km cable line
- high voltage line (6 to 22 kV)
  7260 km overhead line and 843 km cable line
- low voltage line (0,4 kV)
  7332 km overhead line and 4310 km cable line
- 32 transformer substations 110 kV
- 14 high voltage transformer substations
- 5893 distribution substations

2 Old GIS in ZČE

Geographic information system was implementing in ZČE for first time in years 1997–98. This system was built up as AML application supplied by the Swedish company Ellips Data on the basis ArcInfo 7. We started filling data promptly on successful finalization of the system implementation. There was started transformation project for data collection in the terrain and for data filling in the GIS. This project was successful ending on the end of year 2002 and our GIS has been completed by the needed data on "one hundred percent".

The data was started getting via ArcIMS to all competent subdivision of the ZČE since the year 2000.

In the last year started rise up need for upgrade of the GIS by reason of growth data volume, increases in requirements for functionality and system integration and growing old of the system and HW too.

The most convenient way of the offered possibility was proved upgrade of ArcInfo platform on the version 8 and implementation and customisation ArcFM Energy with using own data model.

3 Implementation Team

Implementation team consists of representatives of all 3 companies taking part of this project:

- Západočeská energetika, a.s. (ZČE) – customer, West Bohemian distributor company
- EN-DATA a.s. (EN-DATA) – ArcFM implementer in ZČE
- ARCDATA PRAHA, s.r.o. (ARCDATA) – official ESRI distributor for Czech Republic.

There were 6 key roles in implementation team:

- **Project Manager –** the person for getting direction from management and giving direction to the rest of the team
- **Conversion Leader** *(EN-DATA)* **–** the person who coordinates all data conversion activities
- **Configuration/Customization Leader** *(ARCDATA)* **–** the person who works with the ArcFM implementer to configure and customize the software to meet customer needs
- **Database Administrator** *(EN-DATA)*- the person who owns and tunes the geodatabase
- **Testing/QA Leader** *(ZČE)* – the person charged with testing both the data (conversion) and application (configuration and customization) to ensure that the specifications are being met
- **Training/Help Desk Coordinator** *(ARCDATA)* – the person who receives all problem reporting, bugs and other issues.

4 Methodology and Schedule

ArcFM implementation was based on 3D methodology described in **Building Your ArcFM** book written by Jeff Meyers, the president of Miner&Miner. 3D means 3 implementation phases:

- Design
- Develop
- Deploy

The methodology presumes the implementation of the system ArcFM in 12 months. Owing to the organization problems (new server availability, occupied training room, higher requirements for documentation workplace before the end of the year) the main part of the deploy phase was postponed from the end of the year to the beginning of the next year and therefore the implementation was prolonged to 14 months.

- **Design**

Design phase consist of several sub-processes which are described below.

- **Project Kickoff Meeting** – implementation team meeting managed by project manager
- **Core Team Training** – it is important that each member understand the ArcFM functionality
- **Functional Review** – offers the opportunity to overlay the models and tools on top of customer business requirements
- **Data Model (version 1)** – initial data model selection
- **Conversion Requirements Analysis** – is about determining whether and how that data model can be built with available data sources
- **Functional Gap Analysis** – analyzing the gap between that ArcFM can do out of the box, and what the customer really needs it to do
- **Data Model (version 2)** – changing data model based on conversion requirements and functional gap analysis results

- **Develop**

In this phase of the implementation the data model, which was the result of the proposal phase, was used. One part of the team carried out the conversion of data for the pilot project, while the others accomplished the configuration and creating of user tools for meeting needs of the end users. Even this phase is possible to divide into individual tasks.

- **Pilot Data Conversion** – preparation of the data sample for the needs of testing in the pilot program.
- **Component Reference Specification and Use Cases** – exact overlay specification of the requirements by individual components of the system.
- **Preliminary Configuration** – preliminary configuration ArcFM based on data model and detailed specification of the requirements.
- **Preliminary Configuration Check** – check of configuration of the system by means of pilot data.
- **Preliminary Customization** – creating of user interfaces and ArcFM extensions.
- **Preliminary Customization Check** - check of custom user interfaces and ArcFM extensions.
- **Data Model (version 3)** – final modification of data model based on practice from conversion of pilot data, preliminary configuration and preliminary customization.
- **Final Configuration** – based on check of the preliminary configuration and data model (version 3).
- **Final Customization** – final programming, user tools and interfaces testing.
- **Develop Phase Presentation** – short simple demo of pilot data after the check of preliminary configuration of the system.

- **Deploy**

The phase deploy includes the steps leading to the putting the system to the production, which means not only to prepare the production environment and carry out the final conversion, but also to prepare new workflow processes, to train the users and ensue the reliable support particularly when new system is being deployed. For the final tuning of the workflow processes and system functionality the phase deploy was prolonged by 1 month, within which the system was tested under higher supervision and all errors of the system were evaluated according to the importance and recorded into the central document. The condition for undertaking the system into the production was eliminating all the errors hindering from the operation of the system.

- **Production Conversion** – conversion of the resource data in accordance with the actual conversion process and putting these data into the data model (version 3).
- **Prepare Production Environment** - installation and configuration of the production server according to the needs of Data Administrator in the format of geodatabase.
- **Conduct Acceptance Test** – testing of the configuration and user tools before the handling of the system into the production.
- **Training** – preparation of training material and data for training for user adjustment.
- **Roll Out** – system ArcFM will be handed in the users and used in the production.
- **Support ArcFM Users**

5 Data model

To meet the clients' requirements it was necessary to adjust the ArcFM 8 object data fundamentally. First of all, the requirements for data model of distribution information system in ZČE were compared with the available data models. This comparison has shown that the most suitable system is ArcFM Energy 8 International Electric Object Model. This model served as the basis for the modeling of the final data model for the ArcFM system in ZČE.

To use fully all the possibilities to create the ArcGIS 8.3 data model with Case tools it was necessary to upgrade the model created for the version of ArcGIS 8.1. It made possible to model data sets, geometrical networks and rules of connection. The migration of the model from the original format Visio 5 into the

format MS Visio 2000 should, in particular, bring the possibility to use the format XML for generating of the database scheme instead of the slow process through the export model into Microsoft Repository.

Data model was completely localized into the Czech language and gradually spread in such a way, so as to meet the focused needs. New object and feature classes were added and the redundant classes were omitted. The required classes of detention were added and their specification at the level of subtypes was carried out. The model of distribution electric network as geometric network complemented by the rules of connection of individual elements of the network was created. Furthermore, the required domains (dials) were added and connected to the appropriate qualities of the individual subtypes of the object and feature classes.

In accordance with the requirements collected in the phase design 1st version of the data model was created and the version was gradually adjusted according to the requirements appearing when testing the data conversion, configuration and the system function. The result of the gradual changes was the final shape of the data model, from which the structure of geodatabase in the operation server was generated. Minor urgent changes of the model are carried out directly in geodatabase by means of the application ArcCatalog; they are simultaneously recorded into the change document and according to it they are put into the data model in Visio 2000. This guarantees the model is up-to-date regarding the needs of its presentation or further use.

6 Extra System Functionality

ArcFM users in ZČE make use of standard and extra-developed functionality. There are several of the most interesting:

Catalog handling
The energetic equipments are typing. There exist on the electric distribution network to each sort of equipment certain number of used types. It is possible to solve in ArcGIS via domains. We were however the demand for evidence more attributes including electric parameters to each type of equipment. Among these additional attributes are e.g. manufacturer equipment, detailed description of type, information if the type is standardized etc. We make use of the spatial data, system configuration and electric parameters of network for system Load flow calculation working directly with exported data from ArcGIS.
We weren't able to realize these our demands unlike creation catalogs in the data model. There is to each feature class (representative specific sort of equipment) joined separate table – catalog with records of the types and other specific data. Each record of feature class table involves a unique key to catalog table.

Electrical schemes of transformer substations, distribution substations and cable pillars
The drawing of the electrical single pole schemes of transformer substations, distribution substations and cable pillars was the most work-intensive operation in old GIS. In ArcFM the drawing has got fast and easy operation because we take use ArcFM composite favorites functionality. Most of the electrical make of substations are also typing. This fact can be use at the construction schemes just via composite favorites. There are stored both parts of schemes (e.g. bay of a substation, bus bars, switchgear etc.) and schemes of whole substations. We create the scheme by means of a few or even the only one click on the map.

Creation requests for statement on new electrical connections
If a customer asks for a new supply point, he must to support at least by these vouchers: filled in the request for statement form and a paper map with marked location a new supply point. Engineers of network provision in the ZČE register data from the form at the system SAP module PS and fix spatial information from a paper map via ArcIMS at GIS database.
When a new supply point is really set in, No. of requests for statement is entered at CIS system and sequentially also at GIS. This information facilitates users searching location for placing the new supply point in GIS map. It moreover gives engineers of network provision spatial survey of all allowed but not yet realized requests for statement on new supply points.

Connecting new supply points to the electrical network
ArcGIS users in ZČE assign new customers' supply points from Customer IS to fuse boxes on the end of connection lines in ArcGIS. Customers' supply points from CIS are periodically replicated to the external database placed outside of CIS and GIS. GIS users search unconnected supply points and connect them according to their address via a new ArcFM function developed by ARCDATA. In this way is filled a relation table (customer – supply point in network) based at the external database.
The total number of customers' supply points, which ZČE supply electric energy, count in hundreds thousands. Today we have connected 98% of all supply points to network in GIS.
We make use of these information among others for searching supply points in map, for information to customers about planned disconnecting for scheduled maintenance and repairs of the distribution network, as well as one of input attributes for system load flow calculation and so on.

7 System Architecture

The GIS architecture was designed to match the overall IT architecture in ZČE. ArcSDE stores versioned geodatabase data into Oracle 9.2 on HP-UX server. Update-users from 5 locations connect to ArcSDE. These users have 24 PCs with Win2000 or WinXP, ArcGIS, ArcFM and developed functions. Their role is to update the geodatabase, print maps, trace distribution network and to do complex searches and reports. One of these workplaces is located in company customer service centre to support "call before you dig" and "electric network extension request" services. We have experienced no performance problems in using ArcGIS in ZČE wide area network.

Specific requests on network structure analysis and presentation solves ArcGIS Schematics. This extension is rich in functionality, but needs knowledge of data model and some experience different from that of ArcMap. Two users are determined to work with this.

All the other authorised company users access GIS via ArcIMS server. There are about 300 such users, generating about 3000 requests per hour in average, 7000 in peak. ArcIMS functionality was extended using ArcMap Server and customisation to enhance map presentation quality and to enable redlining.

8 System Integration

GIS owns technical data on most important assets of the company. For GIS, it is not sufficient just to own and show the data, but GIS must provide the data to other technical and economical systems in company – Maintenance System, SCADA and Outage Management system, Asset Management, Project Planning and Construction, Network Analysis, CRM and Customer IS, to name the most important. Technologically, this integration should not be solved as a net of M:N links, but via an integration platform, an Enterprise Application Integration (EAI) product. The problem here is not in technology, ArcGIS provides tools for COM, http and XML methods to cooperate with any EAI. The issue is to design the logic.

The integrated systems have their own data models of technical objects. These models are often conceptually different from these of GIS. Maintenance people are interested in location and product types of devices, Network Computing System wants the topology and electrical parameters, the accounting units for the Asset Management are different from construction units for Project Planning. Simply, there are many views on data that GIS contains.

It is possible, yet complex and computing intensive, to present data such many ways. In ArcGIS, to extract coordinates or connectivity of Geometric Network of objects from some selected region takes time. For another type of integration we must extract many feature classes and resolve their relations. Note in each utility company GIS data updates are intensive, running on versioned geodatabase. Plus hundreds users simultaneously access the geodatabase via ArcIMS.

There are two ways to minimize load on production GIS when delivering expected data out of GIS:

First, the GIS data model can copy the most important or the most communication-intensive integrated system. Features can be designed as construction compatible units, or maintenance planning units. If eg. SAP ERP Technical sites and Equipments will be just extended by GIS attributes, the integration to SAP will be much easier. Still we must compromise the data model between many external systems.

Second, we can learn from how financial systems solved the same problem few years ago. Instead of letting external applications to overload the production system, they periodically export data to a data warehouse. These databases contain a well structured and indexed copy of production data and the integrator is free to tune his own views and selects without influencing performance of GIS.

In case of ZČE (and it may be similar in other companies too) the integrated systems are in progress of change so we could not build on their data models and we started to follow the second way. GIS periodically exports data to a database, which serves to Outage Management, SCADA and CRM applications. Data on customers and their feeders are extracted from GIS. Customer Call Center and SCADA operators share these data when resolving outages. This data warehouse runs 7 days x 24 hours and is independent on GIS backup and maintenance times.

The other integrated applications, which are not so computing intensive, are connected directly to GIS. ZČE selected SAP as ERP and Customer IS, so SAP Exchange Infrastructure (SAP XI) and SAP GIS Business Connector (GBC) are the integration technologies we use. GBC translates ArcObjects methods (COM technology) to SAP functions (RFC). Latest version of SAP XI enables enhanced integration scenarios, such as one-to-many replication and complex logic.

Besides of the integrations on database level we have implemented integrations on presentation level too. From ArcIMS one can call the ERP system to look at maintenance plan of selected electric equipment. The other way round, it is possible to find an ERP object in a map, by calling ArcIMS web service.

We expect that future applications will be designed as web services and the front-end applications will be assembled from these services. The three-tier system architecture becomes standard for robust enterprise applications. We are looking forward to implementing this new architecture using ESRI ArcGIS Server.