Geo-Information Management in utilities: A posteriori Integration of Digital Cadastral Maps

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Key words: Digital Cadastral Map, Utility Base Map, Data Migration, harmonisation, adjustment.

SUMMARY

In the early eighties numerous utility companies in Germany set up CAD-Systems for purposes of planning and documentation. As Digital Cadastral Maps (DCM) were not available at that time the companies had to compile their own Base Maps. These Base Maps provide base information showing location, shape and size of each street, parcel and building. Up to now this base map layer is used as main spatial reference for most of utility specific infrastructure data (instead of absolute coordinates).

Since 1995 the Digital Cadastral Map (DCM) became available in several states of Germany. In order to reduce maintenance costs more and more utility comapanies discarded their own maps and began to use the “official” Cadastral Map as base map.

As simple as this approach appeared to be in the beginning as complex was it’s implementation. Reason for this were the different spatial reference (as well as the positional accuracy) of the Digital Cadastral Map and the companies Utility Base Map. As all assets had to be transferred without losing their spatial associations, differences between the to maps required correction of the utility map.

This paper describes how an a posteriori implementation of Digital Cadastral Maps can be done. The necessary steps and methods are discussed. As an example of “best practice” it describes how the Bavarian utility company E.ON Bayern AG in Bamberg (EBY-RB) successfully manages this transition process.

ZUSAMMENFASSUNG

Vor über 20 Jahren begannen Unternehmen der Versorgungswirtschaft in Deutschland mit dem Einsatz von CAD-Systemen und gehören so zu den Pionieren der graphischen Datenverarbeitung. Aufgrund der mangelnden Verfügbarkeit von Geobasisdaten entstand die vermessungstechnische Grundkarte der Geo-Informationssysteme vielfach durch Eigendigitalisierung.

In den letzten Jahren haben die Vermessungsverwaltungen große Anstrengungen unternommen, um eine flächendeckende Verfügbarkeit der digitalen Liegenschaftskarte zu gewährleisten.

Versorgungsunternehmen lösen heute vielfach die eigendigitalisierte Grundkarte ab, um die Kosten für die Fortführung nachhaltig zu senken. Dieser Übergang bedarf einer belastbaren Planung, da sich die digitale Liegenschaftskarte sowohl inhaltlich als auch geometrisch von der eigendigitalisierten Grundkarte unterscheidet.

Dieser Beitrag schildert am Beispiel der E.ON Bayern AG, Regionalleitung Oberfranken (EBY-RB), wie eine solche Datenmigration durchgeführt werden kann. Für die geometrische Anpassung der bestehenden Netzgeometrie setzt das Unternehmen die Software HOMAGE NETZ des Anbieters grit GmbH ein. Es werden Hinweise zum praktischen Einsatz gegeben, die die Anzahl der Eingriffe in den Verfahrensablauf und den Aufwand der manuellen Nachbearbeitung minimieren. Bisherige Tests haben ergeben, daß etwa 85% aller Betriebsmittel vollautomatisch angepaßt werden. Nur unter dieser Voraussetzung ist es möglich, das Versorgungsgebiet in der Größe von 8.587 km² mit einem Leitungsnetz von rund 28.000 Km Länge innerhalb eines festen Arbeits- und Zeitplans umzustellen.

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1. INTRODUCTION

The Utility Industry (UI) represents a group of highly experienced users of GIS-Technology with specific requirements for their digital mapping. As Digital Cadastral Maps (DCM) were not available in the early eighties utility companies in Germany had to compile their own Utility Base Maps (UBM). These UBM provide base information showing location, shape and size of each street, parcel and building. Up to now UBM layer is used as main spatial reference for most of utility features.

Since 1995 the Digital Cadastral Map (DCM) became available in several states of Germany. In order to reduce maintenance costs more and more UI's rely on the *"official"* DCM as reference layers in their GIS.

2. E.ON BAYERN AG - GERMANY'S LARGEST REGIONAL UTILITY

Since 2001 E.ON Energie Group's Bavarian regional utilities form E.ON Bayern AG with headquarter in Regensburg. The company was selling 34.3 TWh of power with a turnover of 2.68 billion EURO in 2001. The company is responsible for all customer segments, running the gamut from private and municipal clients to key accounts and keeping local networks up and running with loads up to and including 20 kV [E.ON 2001]. Regionalleitung Oberfranken (EBY-RB) is one of five regional utility companies with its headquarter in Bamberg. Table 1 figures out some facts about EBY-RB.

Criteria	Fact
Number of customers	about 314.000
Area of EBY-RB	8.587 km²
Cable length high voltage	6.664 km
Cable length low voltage	15.405 km
Cable length street lighting	6.304 km

Table 1: Some facts about EBY-RB

3. THE CHALLENGE

EBY-RB has to integrate Bavarian Digital Cadastral Map (DFK) a posteriori. As simple as this approach appeared to be in the beginning as complex was it's implementation. Reason for this were the different spatial reference (as well as the positional accuracy) of the Digital Cadastral Map and the companies Utility Base Map. As all assets had to be transferred without losing their spatial associations, differences between the to maps required correction of the utility map.

4. APPROACH

EBY-RB currently starts to migrate all utility features from the UBM to the DFK by means of grit GmbH's software product HOMAGE NETZ. EBY-RB data are corrected with a step by step method:

4.1 Define the Extension of the Migration Area

HOMAGE NETZ is able to work within polygonal subsections of a map. In order to reduce manual effort EBY-RB uses the borders of an analoguous map sheet as subsection. In fact every single sheet (scale 1:1.000) is a migration dataset. Over all appr. 12.500 sheets cover the area of EBY-RB.

4.2 Extract the Utility Features from the Utility Base Map

EBY-RB holds utility features and utility base map in different layers. Without doubt As the data snooping for the following adjustment process works on the original data, the operator has to extract the utility features from the utility base map.

4.3. Detect control points in the base map datasets

The map correction is done by means of control points. A control point is a point which is contained in both the UBM and the DFK. The different coordinates of the control points yield a field of vectors (residuals), whose size and direction serve as input for the harmonisation of the utility features and the DFK. EBY-RB is able to determine these control points without manual work because HOMAGE NETZ provides a highly sophisticated algorithm called *"correlated point exchange"* which identifies control points in the different maps with a very high reliability.

4.4. Detect geometrical constraints

In addition HOMAGE NETZ provides algorithmic detection of straight lines, orthogonal lines and parallel lines. These are regarded as constraints related to utility features. The detection process is done before the final proximity fitting (harmonisation) starts. So it is sure, that the shape and size of utility features (Cables, Symbols, Text) can be preserved as far as possible. Finally all features will appear in correct position related to each other.

4.5. Proximity fitting (harmonisation)

Finally HOMAGE NETZ recalculates the position of all utility features towards their true relative or associated location. This recalculation is done automatically by a least squares adjustment which is driven by the vector information calculated in Step 4.3. The geometric conditions like straightness and parallels are maintained strictly.

5. DATA MIGRATION IN FIGURES

The following four figures show four different spotlights on the stages of the data migration. The screenshots may clarify the five steps pointed out in chapter 4.

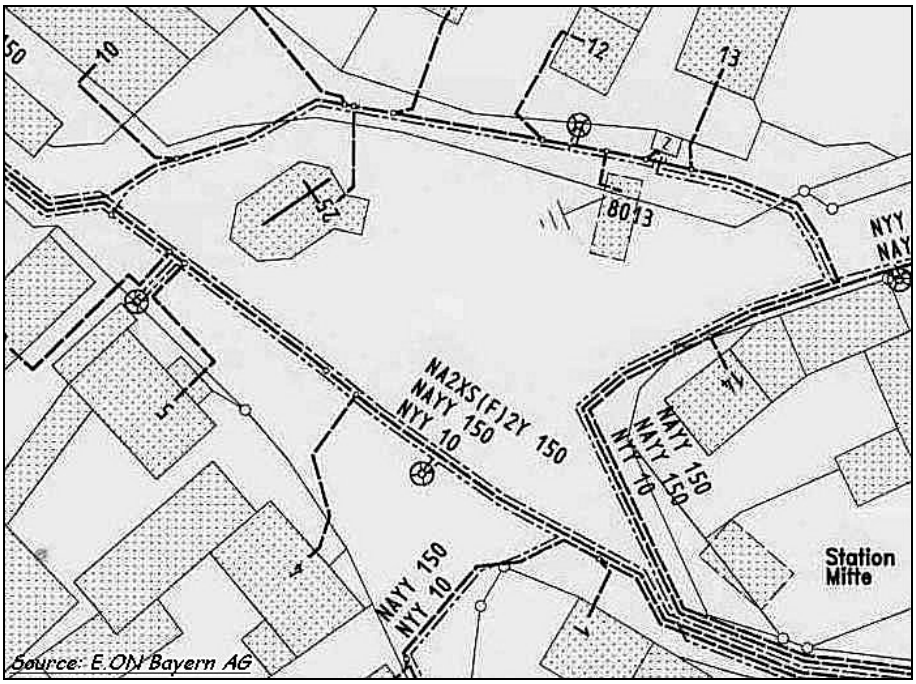

Figure 1: Utility base map and utility features before migration begins

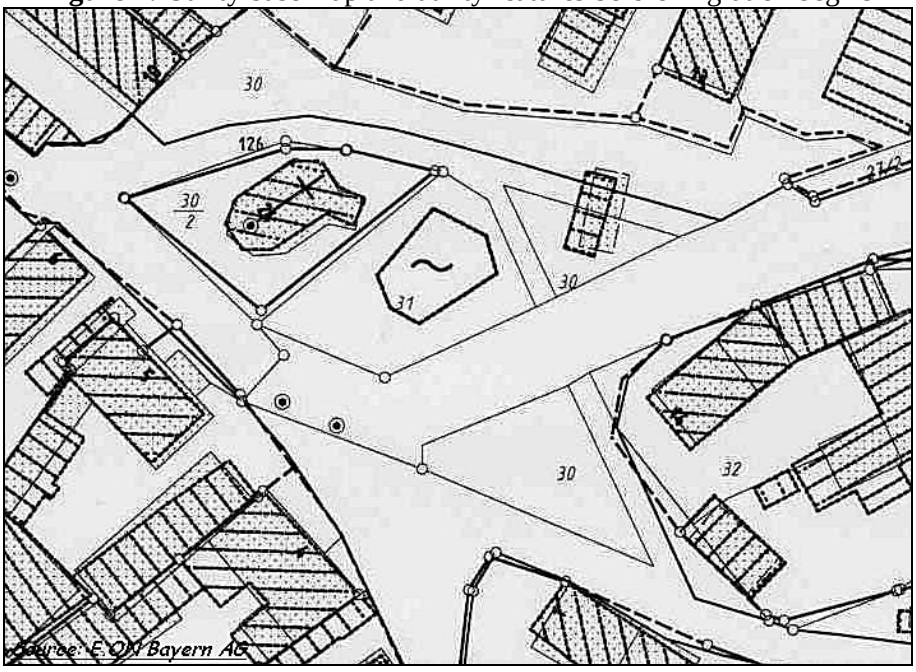

Figure 2: Utility Base Map and Digital Cadastral Map overlay

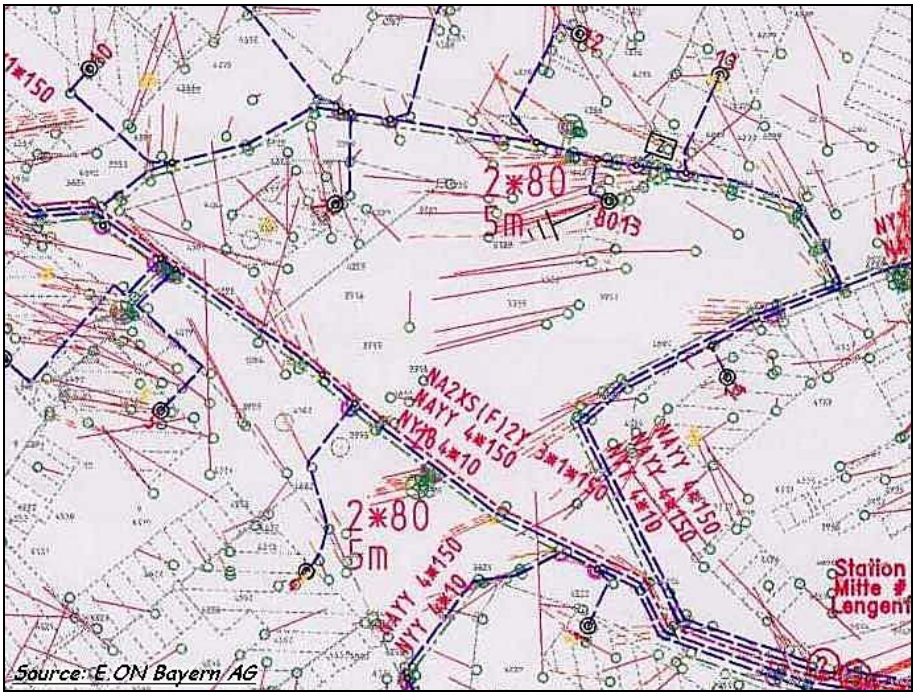

Figure 3: Results of proximity fitting (harmonisation)

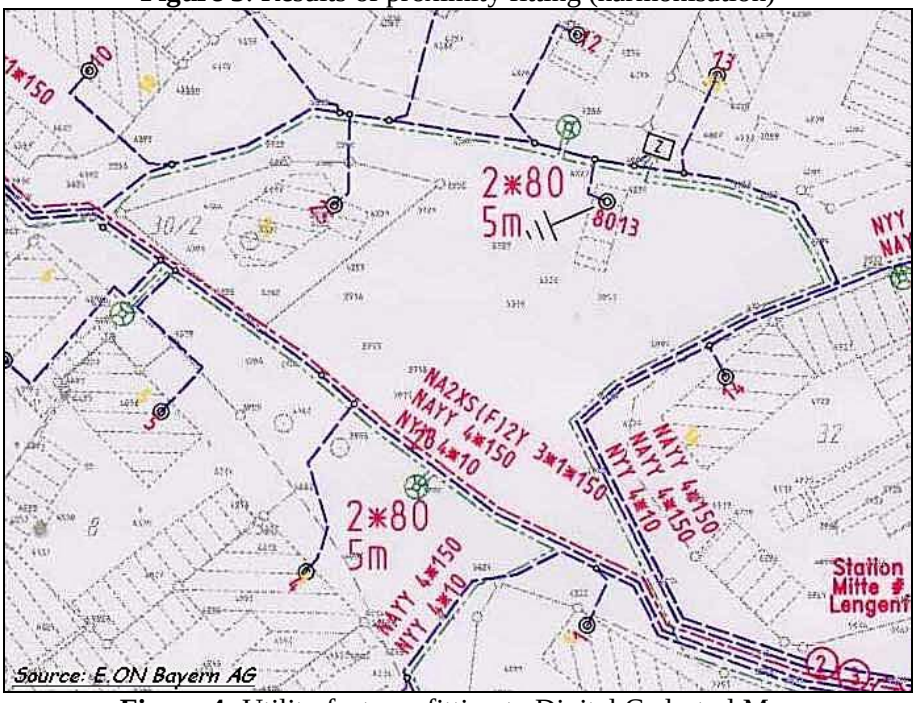

Figure 4: Utility features fitting to Digital Cadastral Map

6. CONCLUSION

EBY-RB is not the only one who has to solve the above described problems. All over the world Cadastral Data is shifting due to various reasons.

For example British Ordnance Survey's *"Positional Accuracy Improvement Programme"* [PAI 2003] causes the harmonisation of asset data all over Great Britain. The Ordnance Survey offers *"link files"* that can be used with harmonisation software as an aid to assist in moving asset data in accordance with any data shifts in the map areas covered by these files.

Features in German DCMs are shifting, too. A differentiation in the incremental update information between update and upgrade information is required. Scheu, Effenberg & Williamson [2000] recommend to supply information about the precis amount cadastral objects are moved. Preferably the recalculation is done automatically by an adjustment software package which is supplied the information representing the shift of the DCM and geometrical constraints concerning objects in the cadastral layer and the UI asset data.

EBY-RB will start the migration process in spring of 2003. Currently the working plans are set up. As shown in Scheu & Rose [2002] each migration process needs reliable organisational methods for the migration of IT systems. Basically computer-aided harmonisation via HOMAGE NETZ is only one cogwheel in the gear needed to transform utility features.

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BIOGRAPHICAL NOTES

Dr. Martin Scheu received his Dipl-Ing. in surveying in 1990 and a Ph.D. in GIS in 1995 from the Technical University Berlin. After finishing his postdoctoral thesis in 2000 he was appointed as head of the grit branch office in Berlin. His special area of work involves the capture and maintenance of spatial data in GIS. He is a core member of the FIG Task Force On Standards and member of the national DVW-Working Group II (GIS).

Dipl.-Ing. Stefan Philipp holds the diploma of Surveying and Geomatics from the Technische Fachhochschule Würzburg. He started his career in utility industry in 2002 and is responsible for GIS and data migration process.

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