Conceptual Integration of Raster Techniques Into Atkis

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ABSTRACT

Recently digital photogrammetric, remote sensing and image processing techniques are discussed to support the up-dating of the ATKIS-DLM. This leads to the question how to integrate image structures into the ATKIS concept. Besides of already embedded ratser elements it is proposed to add a "Digital Image Model (DIM)" to the existing DLM and DKM. The DIM could serve a pixel based description of the real world situation and could be used to analyze changed parts of the landscape by digital methods. DIM data could be given to the users as a standardized official product of the Surveying and Mapping Administration.

INTRODUCTION

In 1989 the Working Committee of the State Surveying and Mapping Administrations of the Federal Republic of Germany (AdV) published the description of the Authoritative Topographic- Kartographic Information System (ATKIS) worked out by AdV working groups as an AdV standard. In the following, several successful implementations of this standard on different hardware and software platforms as ALK-GIAP, Siemens-SICAD and Intergraph- TIGRIS underlined the usefulness of this approach.

Northrhine-Westfalia started the ATKIS data production in 1989 and has now nearly 40% of its Digital Land Model to be collected during the firstdata capturing phase available.

Meanwhile ATKIS plays an important role in the development of regional and national application oriented Geo Information Systems with respect to its role as the kernel database providing basic geometric and attributive data to all of them.

Last but not least the ATKIS standard is one of the major concepts as a basis for the development of international spatial data standards.

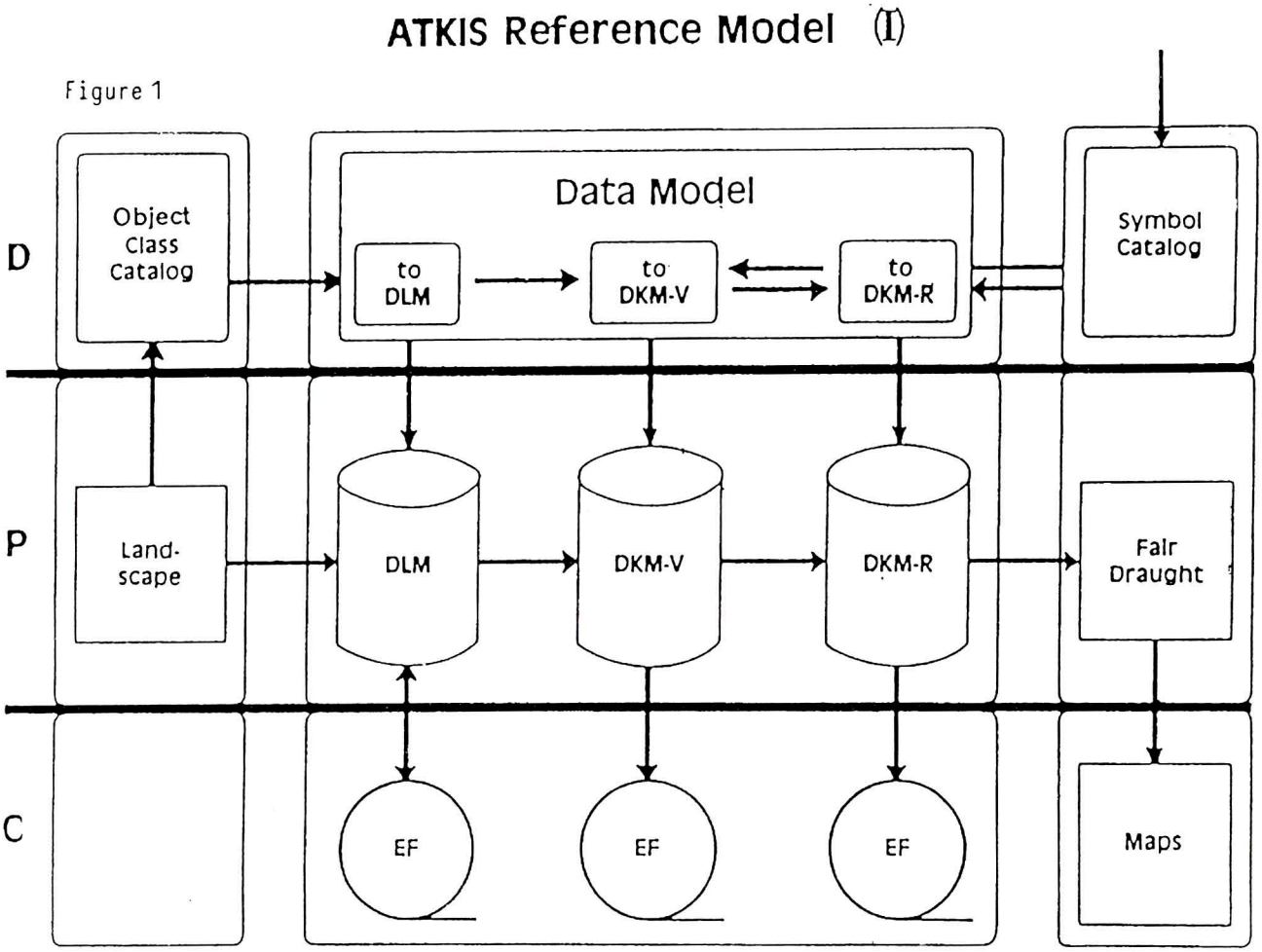
After more than two years of practical experience in capturing data according to the ATKIS standard with respect to the first filling of the database, it becomes necessary to prepare the next steps, the updating process and the mapping process, which includes also the cartographic generalization process. This analysis leads to considerations how to complete the ATKIS concept to fulfill new requirements.

1. CURRENT ATKIS PRODUCTION PROCESS

When the AdV in 1985 asked an experts group to make a study on the building of an official topographic cartographic information system for the Federal Republic of Germany, the concepts of the Digital Cadastral Map (ALK) and implementations of the ALK standard were already available. It seemed to be evident to orientate the new concept towards this already exisitng standard and to try to use ALK data as much as possible for ATKIS.

But soon it became clear, that large scale topographic data according to the ALK accuracy and based on the ALK concept would not be available in time, and that a standard for large scale cadastre information based on old hierarchical data modelling concepts could not be very well applied to cartographic medium and small scale applications. Whereas the cadastral map allows, because of its scales between 1:500 and 1:2000, to show the content of the cadastre together with addition topographic information on a map sheet without problems, the presentation of the land features in scales 1:25000 and smaller makes necessary partly extensive generalization efforts.

But, generalization needs the complete knowledge of cartographic specialists, and it is not to be seen, that this working step can be replaced by a computer the next time.



Therefore, it was obvious to describe the modelling of the landscape and the modelling of the map in different data models and to store them in different databases. So the Digital Land Models (DLM) contain the features on the earth's surface on their real place even though simplified according to a defined accuracy. The AdV decided to build DLMs according to the map scales 1:25 000, 1:200 000 and 1:1 000 000 called DLM 25, DLM 200 and DLM 1000.

On the other hand Digital Kartographic Models (DKM) derived from the DLMs only contain those features represented in the map to be realized. The limited space on the map makes necessary to displace objects partly with the result, that position and shape of the feature can be different from the real situation.

Independent of the separation into ALK and basic topography of high accuracy on the one hand and topographic DLMs on the other hand, which in addition are related to different administrative levels in Germany (ALK: municipalities and counties; DLM 25: states; DLM 200 and DLM 1000: federal level), the vertical integration of the different models will play an important role in the future and lead to a conceptual integration of the different data models in the feature.

The basic separation of DLM and DKM leads to the ATKIS Reference Model (I) shown in figure 1 containing the main data structures and process as well. Aspects of data definition (D), of data production (P) and of data communication (C) are brought together. Figure 1 shows not only parts already working but also conceptually prepared components, which are being developed by the Surveying and Mapping Agency of Northrhine-Westfalia based on the ALK-GIAP platform.

The definition phase has been ended with the decision on the ATKIS standard by the AdV in 1989. Now we have:

- the ATKIS Feature Class Catalogue for the DLM 25 and DLM 200
- the specification of the DLM Data Model and the DKM Data Model,
- the ATKIS Symbol Catalogue for the DKM 25 and the map serie 1:25 000 to be derived from the DKM 25.

Feature Class Catalogue, Data Model, and Symbol Catalogue are the basic components for the realization of ATKIS production system by the different AdV administrations. Based on suitable paltforms like the ALK-GIAP, the Siemens SICAD System, and the Intergraph TIGRIS solution, the DLM data model has been mapped on the system specific databases, and data collection has been successfully started.

The goal is to have a first complete coverage of Germany by basic features themes like road and railway networks, water, and land use until 1995, and to add the remaining feature classes within a second data collection phase. There is an agreement of the German Surveying and Mapping Agencies on those feature classes and attributes as the minimum informative content of the DLM to be captured during the first data collection phase.

In Northrhine-Westfalia data collection is based on Germany Basic Map 1:5000 and the Orthophoto Map 1:5000 to fulfill the accuracy requirements of +/- 3m for the DLM 25. The map sheets are prepared according to the needs of the DLM 25; missing information is added during a preparation phase using all available sources.

Until now, digital data sources are not being used, but a close cooperation with other administrations, where application oriented databases are available, is being prepared. Especially close connections with the Road Database of the German Road Administrations are just being discussed.

The German data exchange standard for both ALK and ATKIS is the Uniform Database Interface (EDBS). First users already got ATKIS data base on this standard.

Figure 1 describes also the ATKIS mapping process form a conceptual point of view. Map features and their sumbolization are specified in the Symbol Catalogue. This catalogue contains also rules how to derive map objects from DLM objects and how to generalize DLM objects.

The idea is to do the derivations process step by step: First there will be derived a vector based DKM (DKM-V) with a nearly identical data structure as the DLM, with partly selected, simplified and shifted objects because of the space available on the map sheet. The second step will be to assign symbols to the DKM objects and to calculate a symbolized raster based DKM structure (DKM-R). The last step will be the derivation of fair draughts as a preparation of the map printing process.

Both DKM structures the DKM-V and the DKM-R will be offered to the users, the DKM-V as a basis for user-oriented thematic mapping, the DKM-R as simple and completely symbolized digital map. This assumption is supported by the fact, that a lot of users are asking for scanned map data as background information for different applications.

The ALK-GIAP already supports cartographic symbolization based on DLM data. This capability is used to present the content of the DLM to the user and can be immediately used for the mapping process based on the DKM because of the identical structures of DLM and DKM-V. A special graphical programming language has been developed, which will later become a "generalization language" supporting the derivation process from DLM to DKM.

2. EXISITNG RASTER SUPPORT IN ATKIS

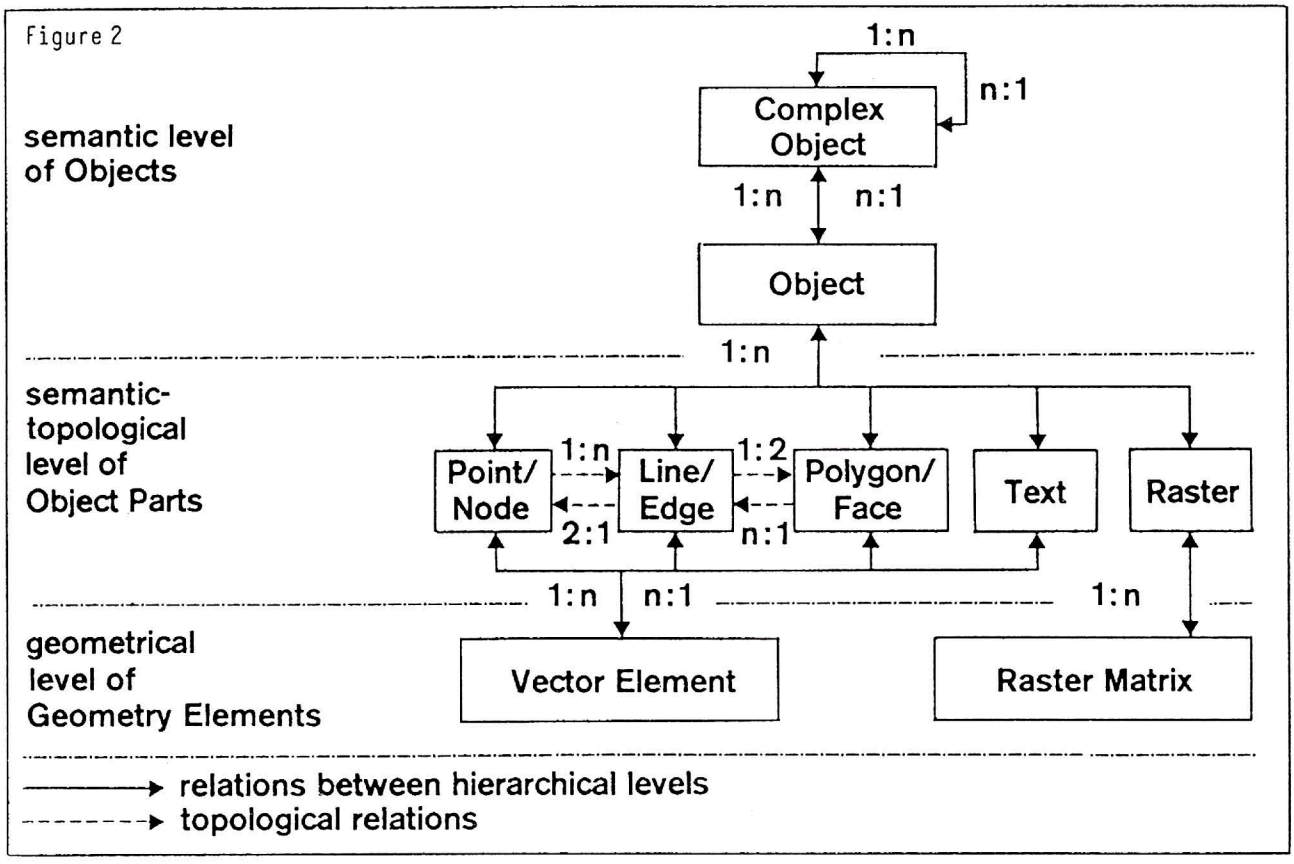
Until now only the Institute for Applied Geodesy (IfAG) in Frankfurt uses scanning techniques followed by vectorization processes to set up their vector based databases. All other ATKIS producers use manual digitization techniques to set up their DLM's, which directly produce vector data.

All existing systems follow the concept, that vector to raster conversion should be used to produce analogue products out of DLM and DKM by raster plotters. The result of the rasterizing process can be given to interested users as a simple digital graphic structure of the map.
The ATKIS standard offers some possibilities of integrating raster elements, which are outlined in the following paragraphs.

2.1 DLM and Feature Class Catalogue

The structure of the ATKIS Data Model is shown in figure 2. The main term is the Object. Features of the real world described and specified in the Feature Class catalogue (ATKIS-OK) are stored in the DLM as DLM Objects. They consist of Object Parts of the types Point/Node, Line/Edge, Polygon/Face, Raster and may be aggregated as Complex Objects. Attributes can be assigned to Compex Objects, Objects and Objects part. The relation between an Object and its Object parts is 1:n, between Objects and Complex Objects are m:n relations allowed. Object Parts can be used to describe topological relations, too. They then become nodes, edges and faces of a graph. Overpassing relations are used to reference Object Parts on top or below an Object Part.

ATKIS Data Model



The geometrical structure of an object is described by Geometrical Elements. m:n relationship between Object Parts and Geometrical Elements allow the modelling of line geometry without redundancy (planarity of the graph).

Object Parts of Raster type allow, together with their Geometrical Elements of type raster Matrix, the description of regularly ordered geometrical structures like point rasters of a digital terrain model.

The elements of Objects, Object Parts, and Raster Matrix are shown in more detail in figures 3-5.

Until now, ATKIS data producers do not use these specific elements, because a DTM is not an integrated part of the first data capturing phase. Existing DTMs are stored without relation to the ATKIS Data Model. The ATKIS-OK does not use raster based elements being offered by the Data Model. All spatial objects are specified only by vetor elements.

2.2 DKM and Symbol Catalogue

The DKM data Model contains in an analogue manner map features, which have been built from real world features by cartographic generalization. They are collected and classified in the Symbol catalogue (ATKIS-SK). The current ATKIS concept does not allow the assignement of attributes to the DKM Complex Objects, DKM Objects or DKM Object Parts.

The DKM Data Model offers specific raster structured elements verx similar to the DLM. On the Object Parts level they are called Pixel Field, which can consist of Cell Arrays on the geometrical level. These constructs are built to allow the storage of pixel structures derived from the DKM-V. Until now, the existing solutions do not use these possibilities.

As the ATKIS-OK, the ATKIS-SK does not use raster based elements of the DKM Data Model.

Figure 3

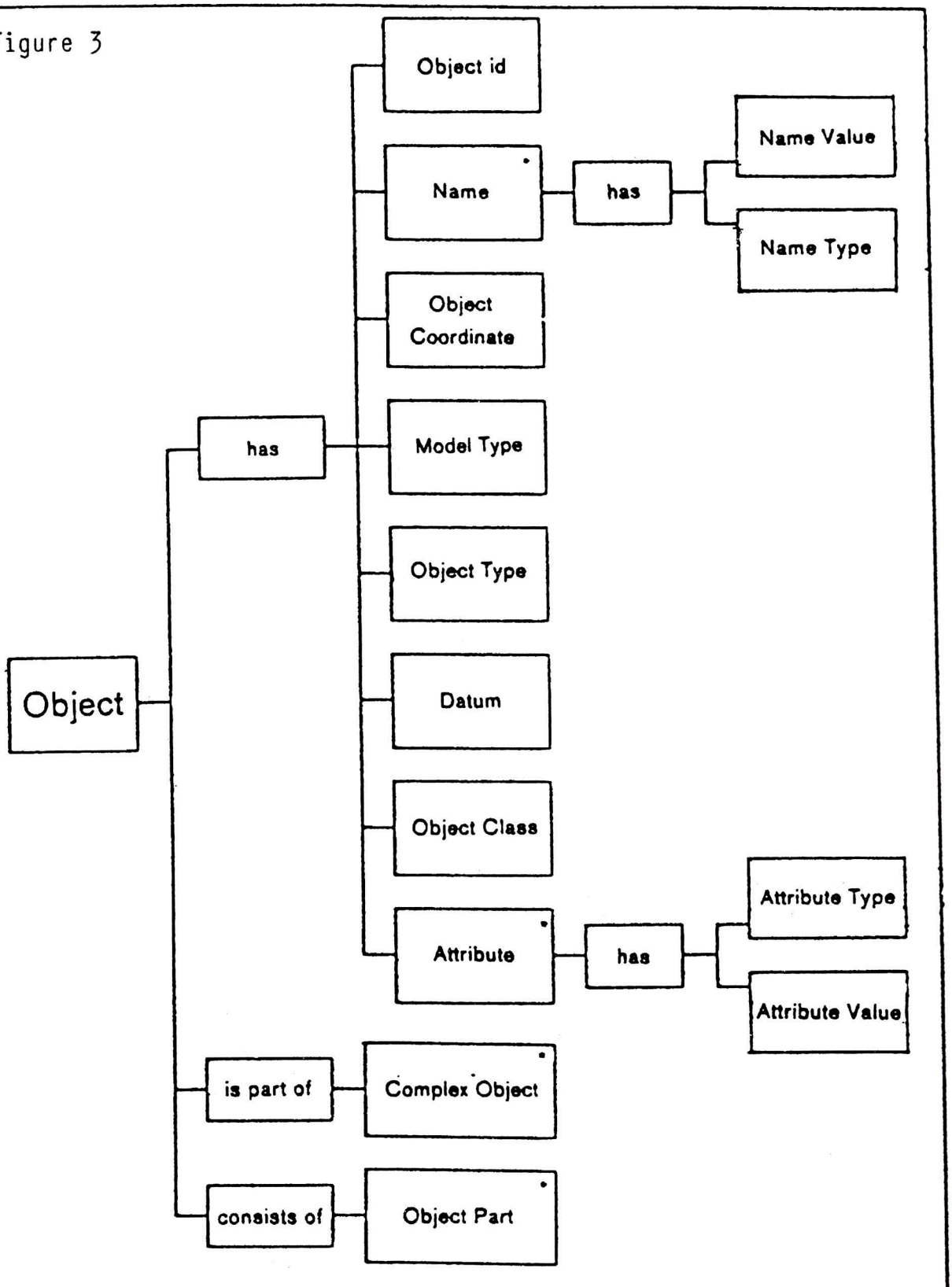
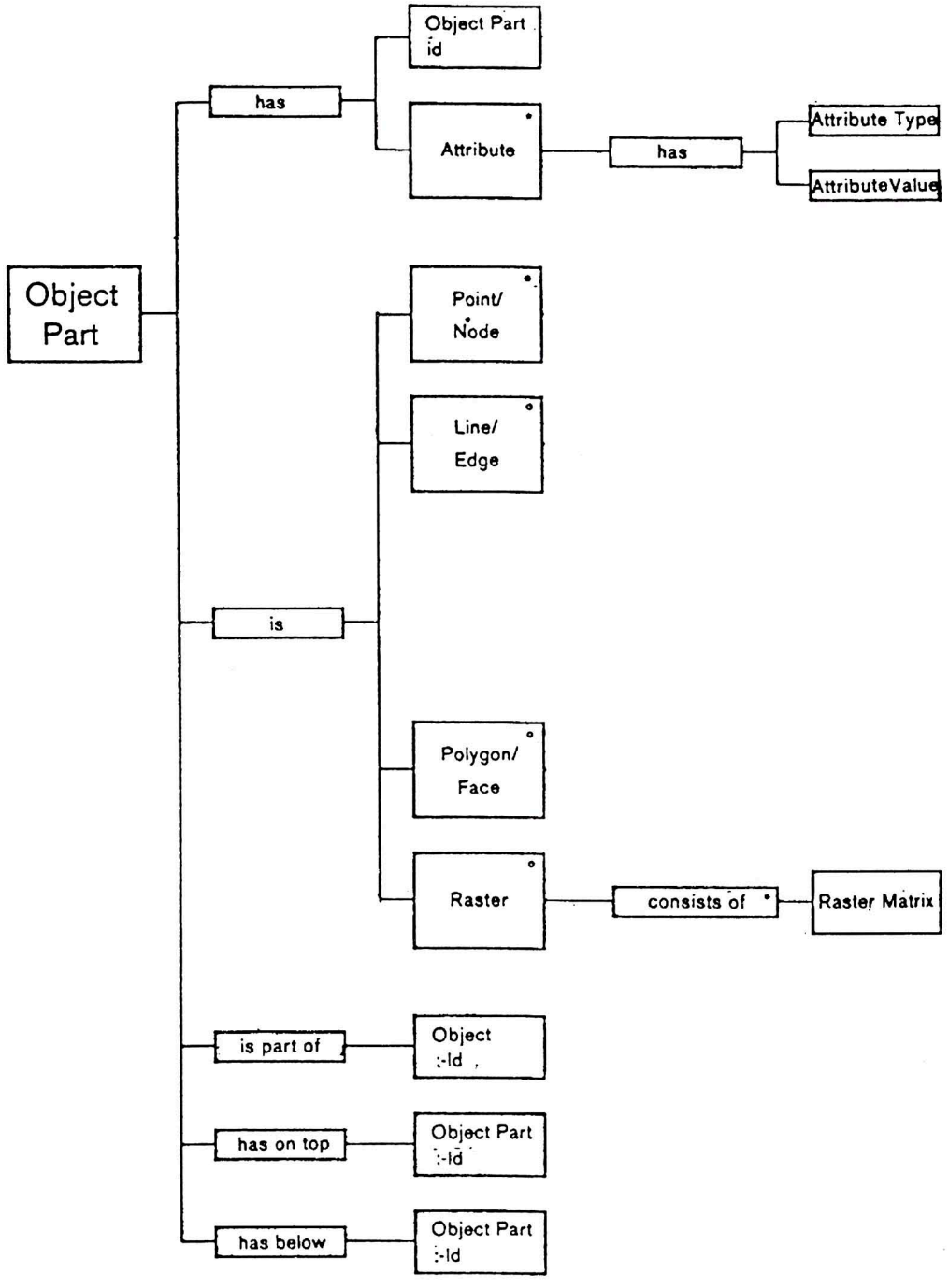

Object
has
Object id
Name
has
Name Value
Name Type
Object Coordinate
Model Type
Object Type
Datum
Object Class
Attribute
has
Attribute Type
Attribute Value
is part of
Complex Object
consists of
Object Part
Explanations:
*:-Iteration

Figure 4

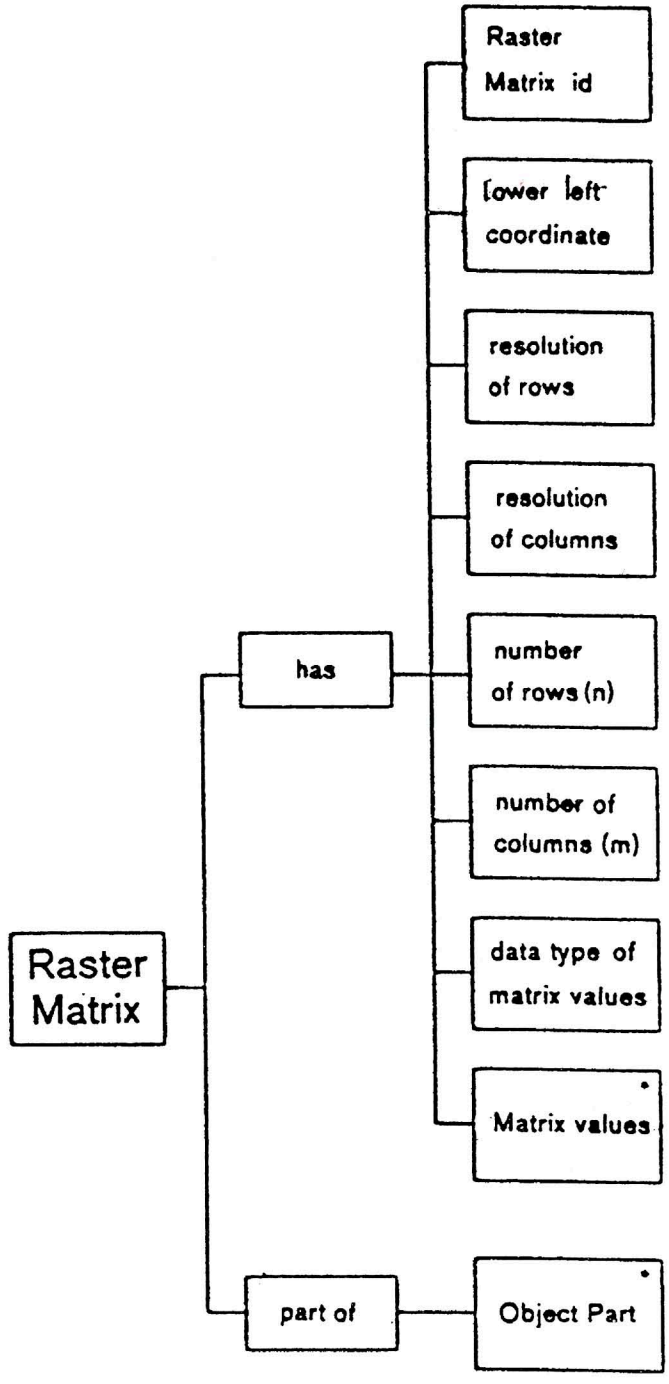


Explanations:

*:-Iteration

°:- selection

Figure 5



Explanations:

*:-Iteration

2.3 Established ATKIS Processes

As already mentioned, the manual digitization process, the DLM mapping process and the derivation of EDBS datasets have been installed and are in daily use by the Surveying and mapping Agency of Northrhine-Westfalia. Other systems support similar processes, too.

Until now, raster based structures and processes are mainly used as part of the mapping process. All exisitng systems follow the concept, that vector to raster conversion should be used to produce analogue products out of the DLM by raster plotters. The result of the rasterizing process can be given to interested users as a simple digital graphic structure of the map.

Recently discussion arised, where vector to raster conversion in the mapping pipeline should take place. Until now, the Surveying and Mapping Agency of Northrhine-Westfalia uses the possibilities of a well equipped turnkey system with special support of intelligent raster processes to generate "clean" map symbolization. But, problems arised in trying to integrate the system in the ATKIS production process using large datasets and producing complicated map symbols.

On the other hand, the ALK-GIAP offers excellent syboli-zation support by its graphical programming language. Therefore, there are running developments to use these ALK-GIAP facilities and to use the raster system only as a "stupid" plotter.

3. FUTURE NEEDS

As shown, the existing ATKIS solutions are concentrated on the first DLM data capturing phase, on the questions how to provide data and how to show the DLM data content to interested users. Important open questions are how to up-date an exisitng DLM and how to derive DKM's from a DLM.

The Surveying and Mapping Agency of Northrhine-Westfalia tries to find answers to these questions and installed projects and working groups to analyze possible solutions and to introduce results of these discussions into the AdV working groups.

After having collected about 40% of the DLM data to be captured during the first data collection phase, solutions for the up- dating process have to be developed fast. Recent developments and surveys on remote sensing image processing and digital photogrammetry allow the conclusion, that these methods and techniques will be available for practical use during the next few years. Products like the Intergraph Image Staion will allow to concentrate all processes on spatial data on one interactive graphic workstation using both 2D and 3D techniques.

DLM up-dating needs the comparison of existing DLM data with up- to-date data sources. This procedures can be done in the same way as the data collection procedure described earlier. A very similar way would be to use system like Zeiss PHOCUS which allows the direct comparison of the stereo model with the DLM data in an analogue manner and the production of ATKIS data using the PHOCUS database.

But only a digital image station would be allow the later integration of digital comparison methods and automated up-dating techniques.

Another reason why photogrammetric methods will play an important rule during future ATKIS data collection phases is the need of integrating height informatiom. This has to be done for specific objects according to the definition of the feature class catalogue and for the development of an integrated DTM with an accuracy fitting to the requirements of the ATKIS Digital Situation Model.

Digital photogrammetric methods, remote sensing and image processing techniques need conceptual support by the ATKIS Data Model.

Of minor importance for raster concept integration into ATKIS seems to be the integration of the cartographic generalization process. Recent papers and surveys on this subject show, that there are ideas of using raster structures to support this process by digital methods. But, both the DLM and the DKM structures have to be vector based because of users needs. So, rasterizing for generalization purposes remains an internal problem of this process and must not be regulated by the ATKIS standard.

4. A DIGITAL IMAGE FOR ATKIS

As shown above, the ATKIS concept should be opened according to the updating requirements derived from digital photogrammetric methods, remote sensing and image processing. The system should be prepared to be able to compare scanned images with existing DLM data. That means that a Digital Image Model (DIM) should be part of the ATKIS data Model concept.

ATKIS Reference Model (II)

Figure 6

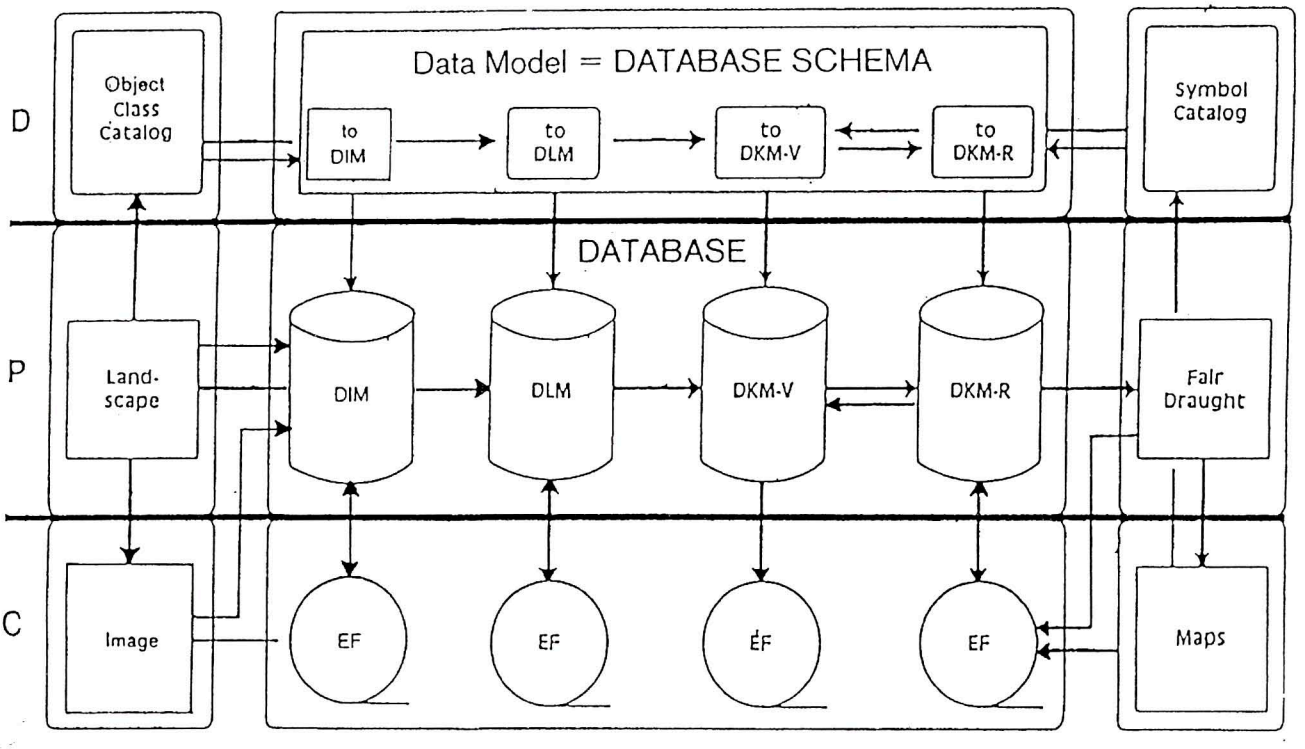


Figure 6 shows the ATKIS reference Model (II), which has been enlarged by the DIM.

As DLM and DKM the DIM needs a specific description in the definition part of the Reference Model. The DIM coordinate system, its resolution, its pixel depth, the used colour system and other data are to be fixed based on the DIM Data Model.

The additional processes begin now part of the ATKIS production environment are:

- Deriving the DIM from aerial photos by scanning and rectification
- Deriving the DLM from the DIM by image analysis techniques and by DIM - DLM comparison
- Providing DIM data by a standardized exchange format as official product of the Surveying and Mapping Agencies

It seems not to be necessary to change the existing ATKIS data Model approach to integrate the DIM. Existing elements like Ratser on the Object Part level and raster matrix on the geometrical level could be slightly suited to the new requirements. On the other hand, it has to be slightly suited to the new requirements. On the other hand, it has to be analyzed, how the integration of new processes like image analysis and DIM - DLM comparison could affect the DLM concept. It seems to be necessary to open the ATKIS Data Model to a complete object oriented approach includig topographic and cartographic knowledge by constraints and rules supporting high sophisticated processes like image analysis and generalization and preparing future artificial intelligence techniques.

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