Implementing a Production Line for Mapping of very large Areas

Abstract

GAF AG has developed and implemented a powerful production line for the mapping of very large areas with highly complex interpretation keys containing over 100 object classes. For the system design, a detailed customer requirements analysis was executed. This yielded a selection of functionalities from ArcGIS extensions JTX and PLTS to be used, including adaptations to account for particular requirements of the project. The development of the production line was done in a close international cooperation with ESRI Germany and ESRI USA. Their extensive technical support whenever needed, accompanied by the readiness to assist the particular requirements on licensing were important to succeed. The presentation will outline which steps where undertaken to establish the entire production system with its numerous clients and the logistical challenges to be met. Finally the experiences from the operational project phase will be illustrated.

Background

Since its formation in 1985, GAF AG has gained extensive experience in large mapping based upon remotely sensed data from various sources, including high resolution (HR), very high resolution (VHR), digital orthophotos (DOP) and radar. For each application project a decision has to be undertaken as to whether the working environment should be based on an "off the shelf" software product or whether it would be advisable to adapt OTS solutions or to consider proprietary developments. Depending on project and customer requirements, some proprietary solutions have been utilized e.g for monitoring agricultural subsidy controls, for the development of land use cadastre, assistance of farmers and administrations or in the field of urban area mapping.

With increasing complexity, detail, scale and territory, the demand driven flexibility in software selection yielded the necessity for evaluation of ESRI's Production Line Tool Set (PLTS). PLTS was found to be able for efficient handling of eg. complex object keys with a demanding number of classes . Consequently a decision was made to undertake projects of this nature, in particular topographic mapping projects, in collaboration with ESRI Germany. GAF contributed its expertise with mapping, project organisation and

quality control, and ESRI supplied the software and any support needed in the setup of the software.

During the last years, considerable expertise was gained with the ArcGIS PLTS extension, utilising a mapping workflow developed by GAF AG. Through customization and careful selection of the necessary tools, a very efficient production system could be implemented.

Project Requirements

Successively the topographic mapping projects were continued with new specifications. Thereupon detailed analysis of the extended project requirements was undertaken. All requirements were especially cross-checked for changes of the present specifications.

The client-side main requirements regarding the mapping results were as follows:

1. Over 150 different object classes
2. Object classes are to be emphatically dependent on the region mapped, so that only some classes will be relevant to the mapped area
3. Emphasis on occurrence probability of different objects. Types which occur say 4 or 5 times in the world are equal to objects occurring ubiquitously
4. Very complex topological relationships between object classes. Depending on object type, certain objects may not overlap respectively have to overlie others
5. Single Object classes can be points, lines or polygons
6. Mapping guidelines define all details about the objects as coded domains
7. Wide range of attributes with complex relationships defined between them.
8. Data delivery in platform independent format such as PDF or XML.

The client requirements concerned only the results and highlighted the platform independecy. We extended the requirements to the technical specifications of the production system to give us the flexibility to meet any future requirements of the production environment and to allow us to extend the scale of the project further:

1. Using all object classes must be easily possible to allow mapping in all areas of the world.
2. Ability within the production environment for up to 100 users to simultaneously access and edit the data

Analysis and Decisions

A cursory analysis quickly indicated that a project with the above mentioned requirements is still safely manageable in a software environment including ARCGIS and the PLTS extension on the client side and ARCGIS Server on the server side. JTX (Job Tracking Extension) was chosen for production planning and control including data handling in a versioned environment.

The analysis to which extent of the data management the existing tools PLTS and JTX could be used and respectively, on which parts adaptations would be needed, was considerably more complex.

Here some of the considerations are listed:

Problem	**Analysis**	**Decision**
Performance/capability of the PLTS tools	Aggregation of Edit Tools in Edit and Editing Advanced Toolbar is practically based „Auto Complete“ as an important tool for adjacent polygons but works only in one feature class	In use Tool „auto complete“ needs replacement or adjusted data structure
Performance/capability of the PLTS QC-Tools	PLTS Data Reviewer is very powerful since PLTS 9.2 Batch capability enables to aggregate all QC checks relevant to each step of the QC process into one single batch check.	In use Reviewer table is not used to trace the status of certain Reviewer results
Performance/capability of the PLTS Display and Data Tools	PLTS TOC toolbar and PLTS Target Tab support editing when many feature classes and many attributes are present	In use Adaption of the attribute display in the Target Tab is necessary (via PLTS fields filter table). Adaption is made according to the efficiency

Problem	Analysis	Decision
Usability of the PLTS templates for the data structure	PLTS provides many useful templates for GDB structures. However tests indicated weaknesses in performance and interoperability of tools such as “Auto Complete”.	Data structure will be completely reconstructed Objective: Precise fulfilment of user requirements using Coded Domains, performance enhancement and support of the “Auto Complete” function through customized aggregation of object classes as subtypes of a feature class.
Usability of JTX for version management	Good. Enables working in a versioned environment without contact to versioning techniques. Fundamental functions in assigning working units (jobs) to single users. Application of ArcCatalog becomes unnecessary.	In use Only basic use of the Workflow: Creates the correct version and only so the corresponding ArcMap document can be opened (Smartstarting ArcMap)
Usability of JTX for tracing the workflow	Relatively large effort if the production group is not spatially separated. Direct communications are easier. JTX-Log is sensible for tracing of post actions JTX-Job-Numbering is not practical for the workflow	Workflow tracking is realized through external systems Fixed IDs are assigned to Working units by external systems to trace their status.
Performance of Editing with PLTS	Tests showed that performance is best using less feature classes and more subtypes	Improvement of performance through completely redesigned data structure

Problem	Analysis	Decision
Influence of JTX on the performance	JTX places heavy loads upon the server through a high quantity of connections. The requested number of users enforces an appropriate server upgrade	Server must have 16 GB RAM and 64 bit OS

It has been found that JTX- and PLTS-Tools meet the requirements to a large extent. The most important issue in the decision on the composition of the production environment was the fact that no new tools needed to be developed. Alternatively we decided to change the data structure in the production environment. This data structure was a variation of the PLTS templates with a substantial aggregation of the existing objects into a smaller number of feature classes. This modification enabled a more widely use of the important “Auto complete” tool as well as a higher performance. Through a certain design of the data structure, all worldwide existing objects could be captured without making the environment unclear and unmanageable.

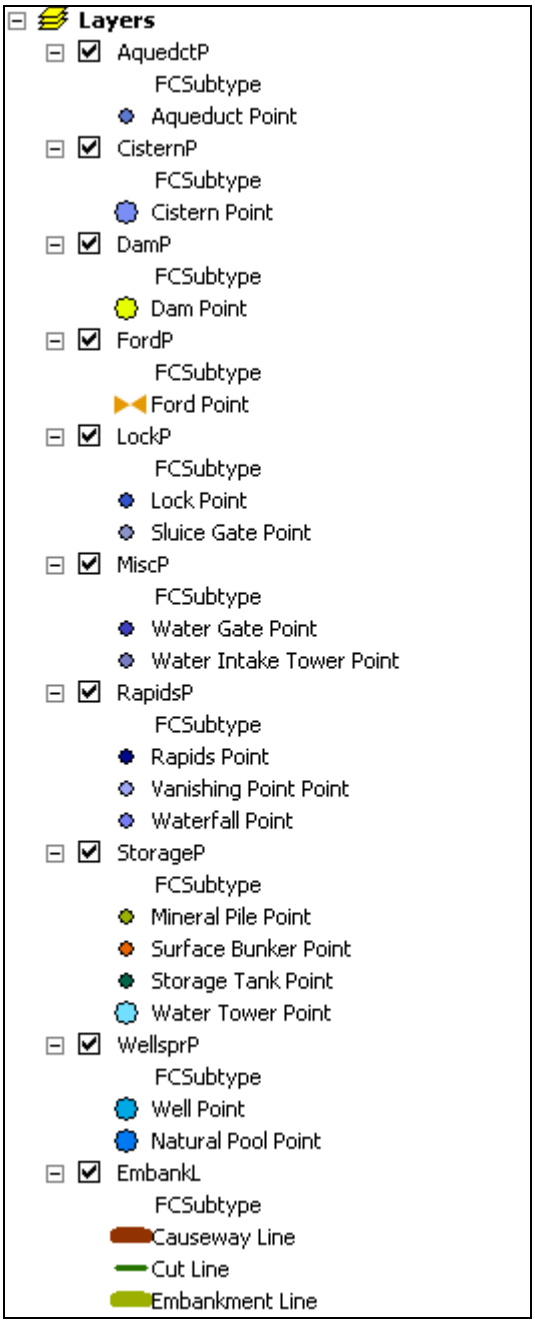
Customisation of the Production environment

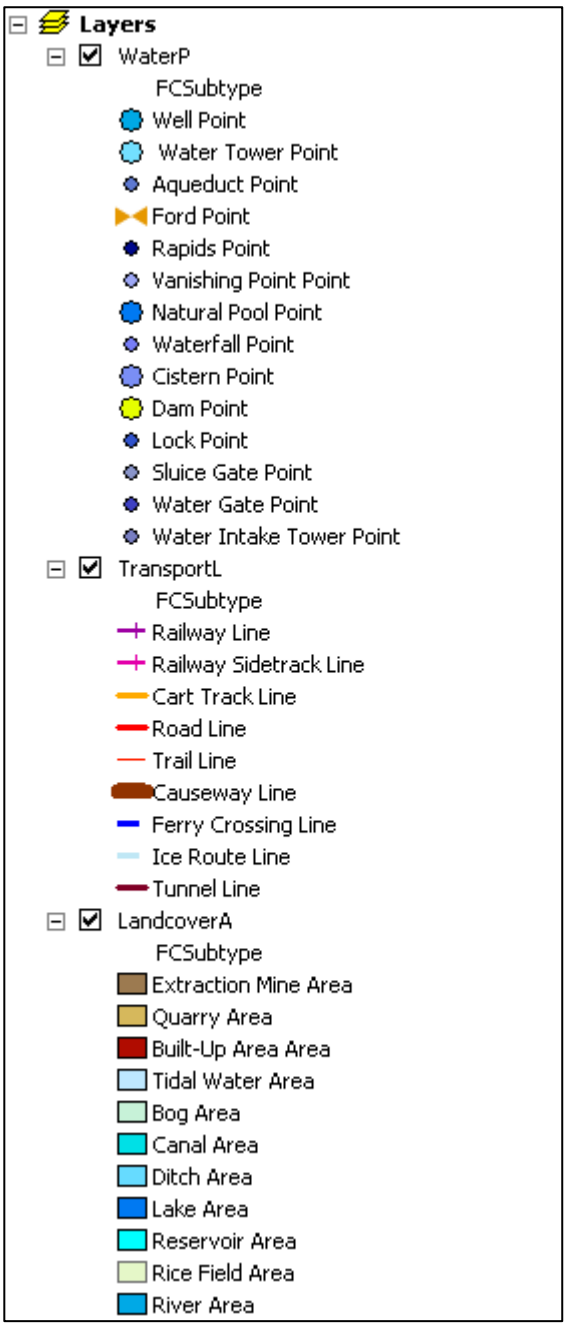
Besides the above mentioned customisation of the data structure an appropriate versioning concept and a simple implementation of the workflow in JTX needed to be developed.

Data structure

In order to create the data structure, PLTS contains a tool enabling creation of a GDB directly from an Excel spreadsheet (“xls2gdb”). This complex Excel spreadsheet contains all information regarding feature data sets, feature classes, subtypes and coded domains. In order to create the sheet on the client side, a VFP program was developed, which uses the specifications given by the client in table form for attributes and coded domains to create the Excel template for the GDB. The aggregation of object types to feature classes was thus so parameterized that it enabled the easy and quick creation of several versions, which were then tested by experienced interpreters for their suitability for daily use.

For the final version of the data structure involving aggregation into feature classes, special principles were deployed according to each object type. e.g, all object types in a transport network, technical principles (feature classes with only one subtype expected by PLTS Tools), or performance principles (all with “Auto complete” to processed objects in one feature class).



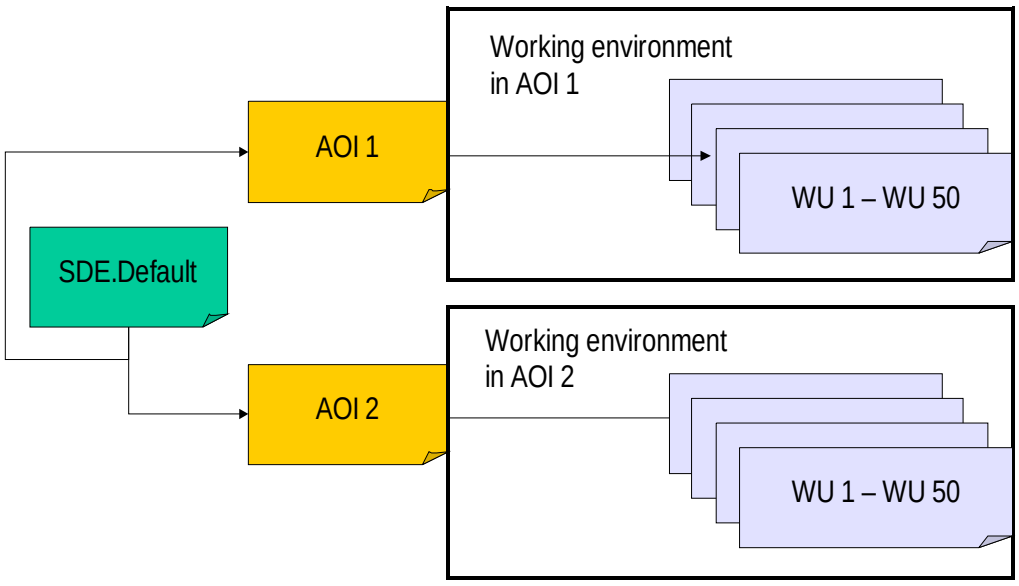


Original data structure with many feature classes

New datastructure with limited number of feature classes and many subtypes

Versioning concept

Following a very simple two level versioning concept during the first pahse of the mapping projects and a more complex four level concept in the second phase it was decided to use now a concept with two levels under SDE default, because the practical experience indicated that more levels for a system used exclusively by experts were not necessary.

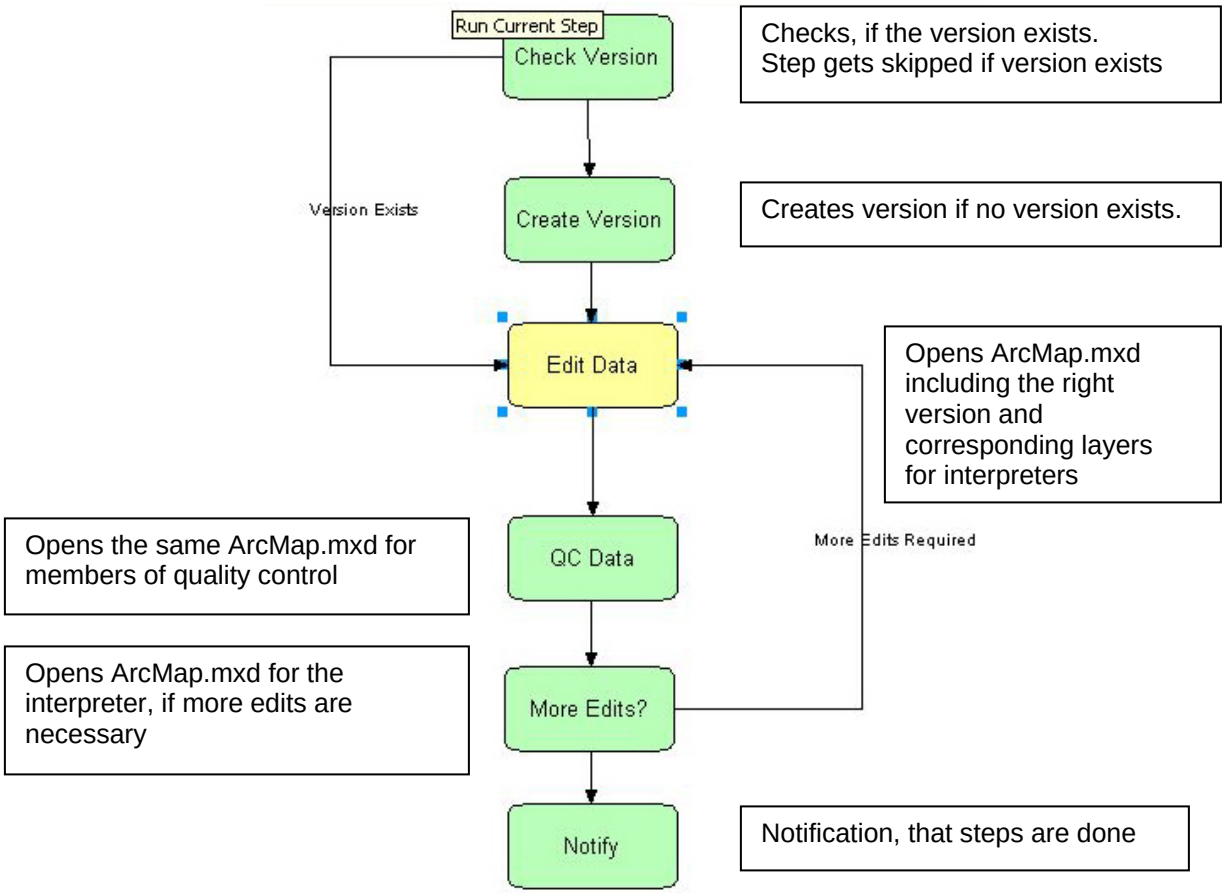


Versioning concept 2007

The versioning concept is conducive to the production line system, to allow very large areas to be processed. It is critical to develop an efficient system where large areas are divided into smaller priority areas and then further subdivided into single "working units". Our versioning concept aims to devolve responsibility for small areas respectively to each interpreter. The production environment does not determine though, which tasks the user undertakes.

Workflow implementation

The setup discussed here is implemented for one production group concentrated in one office. Thus communication between workers is easy and directly possible. Direct communication is even desired to foster team coherence and exchange of ideas. Therefore the workflow can be implemented in a straightforward manner.



Workflow as implemented in JTX

Tracking of workflow steps is implemented in external systems, which define processing sequences and show which status each working unit has obtained. This system is administered by team leaders. Requests for new Jobs by the interpreters or notifications about reaching intermediate states in the production workflow are exchanged by direct communication. Thus a constant and regular communication between team leaders and interpreters is ensured. The implementation of the workflow in the production environment is done only as appropriate and necessary in a "no-frills" manner.

Licensing Model

Processing of large areas within the particular framework of topographic mapping requires a sufficient quantity of available workstations to permit fulfilment of tasks. This quantity is affected by further factors besides technical and methodological project requirements. Hereby several influences upon the work efficiency have to be considered as well as accurate production planning and control. Last but not least in

a competitive environment the resultant cost-effectiveness enables an optimized design based upon economies of scale.

In partnership with ESRI suitable license models were tested, with the result that an innovative and flexible solution could be developed, which fulfilled the project-specific requirements as well as reconciling the interests of both licenser and licensee.

Practical Experience

The hardware for the production system was purchased and installed several months before the project start. This long pre-operational period permitted precise configuration of all client workstations and initial tests with conditions similar to the production line.

JTX

High server-side memory requirements following the deployment of JTX results in a server configuration with a memory of 16 GB RAM. Due to delivery difficulties of the server components we were forced to undertake the initial training and work with a server possessing only 4 GB RAM. This approach was only possible without the use of JTX. In order to enable a simple handling of server connections and versions, the necessary versions and MXD's were pre-configured by a small team for the users. This clearly indicated the advantages JTX offers for version management and work preparation.
Presently JTX is used to prepare all necessary working steps for each particular user, e.g., JTX creates automatically a version for each working unit and the corresponding ArcMap document. The MXD includes all relevant data layers of the corresponding version and zooms automatically to the respective working unit. In order to enable the same working environment for each user the GUI (Graphical User Interface) and the symbols of all data layers are predefined in the MXD, thus it is almost impossible for the user to work accidentally in the wrong version or in a wrong working unit.

Raster data

It was decided not to set up an Image server. Rather raster data, as an information source for topographic mapping, is stored on the client workstations. For this purpose hard disks with up to 1 TB are used. When an AOI or priority area is completed the relevant imagery is deleted and replaced with the necessary data of a new AOI. Thus the workload on the network is minimized and evenly distributed over time. A file server with 4 TB of disk space is used as a repository for the whole image set.

Expansion

Presently it is planned to further expand the number of workstations. Experience has shown that the available server technology with a main memory expansion is sufficient to meet this new demand. Further changes are unnecessary because the project was set up to be scalable in this scope from the very beginning.

Performance

Regarding data editing, the performance of the whole system was from the start better than expected. To maintain this performance level regular database maintenance over short time intervals is necessary. To maintain the performance level in the face of an increasing vector data load changes to the versioning concept and data management were undertaken. Initially all AOI's were stored in one data schema. Following the change every AOI is stored in a separate data schema. A positive extra aspect is that completed AOI's can be protected against accidental editing through restricted privilege assignment, yet this data may be accessed when adjacent areas are edited.

The newly created data structure which was based upon performance and production principles confirmed the test results, with an emphasis on the performance side. This became particularly apparent when a partner company adopted exactly this data structure without any further changes to their production environment. Thus all pre-existing performance problems were solved in one complete step.

General assessment

Our overall appraisal of the production line was very positive. In particular the system design has effectively proven itself with regard to high robustness and simplicity. For all components of a production line (editing environment, workflow control, work preparation, quality control, production monitoring) adequate solutions could be found without "over-engineering" the whole system. Project requirement customization could be achieved through a sophisticated data structure and easily configurable PLTS elements. Easy adaptability for future projects is a built-in feature as these elements of the setup must be customized anyway.

To summarize the above, together with the flexible licence solution an extremely powerful and adaptable production line could be developed for this project.

Author Information:

Dr. Axel Relin
Program Manager

GAF AG
Arnulfstrasse 197
80634 Munich – Germany
info@gaf.de
+49 89 121528-0

Andreas Lippert
Project Manager

GAF AG
Arnulfstrasse 197
80634 Munich – Germany
info@gaf.de
+49 89 121528-0

Isabella Bodechtel
Technical Project Manager

GAF AG
Arnulfstrasse 197
80634 Munich – Germany
info@gaf.de
+49 89 121528-0