Politicians, planners and researchers are usually interested in geographically differentiating a local situation or development. Regional and urban planning is based on spatial analyses and this is based on geographical units, basically points, lines or areas. The main problem in performing spatial (and periodical) analyses is to collect and to store the content data for these purposes. If data have not been collected for the particular purpose of such an analysis, the analyst is usually confronted with the problem that the territorial references of the content data differ from the territorial structure he is aiming at.

This paper focuses primarily on geographical areas (less on points or lines) and discusses concepts and solutions found in urban research and statistics for areas below the municipal level. Here, the data are very often localised by postal addresses, but quite frequently they refer also to geographical areas, like the number of students in a school district or the total number of voters in an election district. Planners’ and researchers’ needs differ greatly: Election districts differ from school districts, planning zones from catchment areas of bus stops. Municipal statistical offices very often manage 20 or more different subdivisions of their city.

One strategy for flexibility in geographically grouping the data according to user needs is to store them with their references on the lowest possible territorial level. This strategy has been followed – as in most other statistical offices - also in the Bureau for Statistics and Urban Research of the City of Nuremberg. The data refer to different points in time or periods.

It is the aim of the geographical reference system to make any kind of geographical analysis possible with any kind of geographically referenced content data taking into account their date of validity and the validity of the geographical references requested.

As long as the available content data are referenced by postal addresses (like data about inhabitants, dwellings or other “content” of buildings), it is no great problem to group them according to any of the different area types, like building blocks, zip code areas or school districts, if for each of these areas there is a complete list of the postal addresses located within its boundaries at a given point in time. This is the basic alphanumerical solution by reference tables = GIS without geometry!

Alternatively, if the coordinates of each postal address are available and the boundaries of each area are also described by their coordinates, the postal addresses can be translated into the codes of the areas by geometric algorithms, and
vice versa, all addresses lying within their boundaries can be listed. This is the geometrical solution (e.g. by point in polygon) = GIS with geometry.

This translation of the available reference into the references of the target areas is an everyday task in geographical analyses. To facilitate this task, municipal statisticians have defined so-called building blocks delineated by the surrounding streets or “natural” boundaries, like waterways or railway tracks. The lowest territorial level of this system is the “side” of a building block from one street corner to the next. These units are arranged in a standard hierarchy so that most types of planning or administrative districts can be composed and defined by the largest possible territorial units in the hierarchy completely lying within the area of the target unit. These references to the target areas have to be updated only if the target areas themselves change their boundaries or if the units describing the target areas change. These functions are available in GI-Systems with or without geometry.

In translating territorial references available in the content data into what is requested by the user, three types of “problems” can be distinguished:

The first type of “problem” is to combine alphanumerical and geometrical systems. Here, a simple interface is required that translates numerical codes into coordinates, e.g. into the central points of the target areas or linking numerical codes with the coordinates of the boundaries of the target areas.

But translating addresses into area codes is not as straightforward, if the dates of validity of the territorial references of the content data and the target areas differ. This second type of “problem” is met frequently when comparisons in time are requested to reveal changes and developments, like population growth, changes in the housing situation, in the number of available jobs etc.

The third type of problem is the “translation” of one area type into another, if e.g. content data for school districts are to be combined with data for administrative welfare districts.

The paper will explain the concept and the standardised interfaces developed so far and the perspectives for further development in this field.

The Bureau for Statistics and Urban Research of the City of Nuremberg is managing the spatial Information at present for about 3.100 streets, 80.000 postal addresses, 17.000 sides of building blocks (10.900 with addresses) and 3.700 building blocks. In the hierarchy above the building blocks (= fourth level) there are 316 districts (third level), 87 quarters (second level) and 10 wards (first level), each level covering the whole municipal territory. Based on these units, about 50 types of administrative or planning areas like zip code areas, school or election districts, can be composed, always using the largest possible units as their mosaic pieces.

The problem with spatial data is their instability in time: Every day buildings are demolished or erected, streets are constructed or renamed, building blocks can change their shape, new housing areas or a new school require new school districts and so on. As long as such a change occurs within an existing territorial unit in the hierarchy, only the lowest possible unit affected has to be adjusted, thus adjusting automatically all units above it. If, however, each of the possible target areas had been described by the individual postal addresses belonging to it, the amount of time for updating the references would be enormous. The system of building blocks in a territorial hierarchy makes the territorial references quite stable, because all hierarchical and compounded elements must not be changed if e.g. just a new address or a new street is added.
The alphanumerical elements are stored without geometry in a database management system (DBMS) but including their “history”, where each element knows its relationship to the other elements and also its former or next state at every point in time. This system can be used by people without specific skills.

For each element there is also a geometry in a geo-database (GDB), a pair of x/y-coordinates for each address and more than 25,000 lines for the sides of the building blocks, from which all planar elements like building blocks and any compounded area can be composed. A number of functionalities check and maintain the consistency and coherence of the alphanumerical and geometrical databases as well as the relationships between them. The system is managed by people with specific skills in GIS.

Grid cells can also be used as reference areas for addresses. But grid cells are not suitable to define administrative or planning areas. So they don’t play a very important role in the municipal practice.

Already available are

a) a built-in flexibility for translating postal addresses to the building-blocks as basic units of the general structure into given or user-specific structures by alphanumerical codes (spatial localisation without geometry),

b) a built-in derivation of the target structure from the geometry of the basic territorial units (spatial localisation with geometry)

c) a built-in compatibility and flexibility for an automated translation of alphanumerical codes into the corresponding geometry as interface between the alphanumerical system and the geometry

Combining the geographical system with the statistical information system can create the desired flexibility and avoid the redundancy of data and the risks of incoherent updating of the territorial references in both systems, thus making the most of available data.

The statistical information system, or at least the part of it to be linked with the geographical system, must satisfy the conditions of territorial plausibility and precise definition of its validity in time. That is to say, the territorial reference of the content data must be coherent, also with respect to its validity, with the territorial references in the geographical system. This way, the territorial codes of the target areas can be retrieved in the geographical system and linked to the content data.

The open perspective is to facilitate translations of structures with different boundaries and dates of validity by incorporating factors for recalculation, within the general reference system. This interface can possibly also be adapted to allow transitions between user-specific territorial structures.

It should be possible to transpose the urban examples presented and the solutions proposed into similar tasks and solutions on the regional level.

It is a common goal of all urban and regional researchers to increase flexibility and reliability in this field. However, according to their educational background or institutional position, they either try to integrate the interfaces for this task in their statistical information system of the content data (usually relying on numerical references) or they try to integrate the content data together with the management of the geographical references in their geographical information system (usually relying primarily on coordinates and geometric algorithms). The state of affairs and the perspectives presented try to avoid overloading either of the systems with tasks for which they have not been designed, combining the strengths of both systems by
linking (instead of integrating) the geographical reference and information system (managing the geographical data and tools) to the statistical information system managing the content data and statistical tools.

The concept and technical tools for this geographical management system have been developed over the last decades and are now coordinated and further developed in a kind of co-operative of nearly 50 municipalities lead by the Nuremberg Statistical Office.