BIOGRAPHICAL INFORMATION

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Product Manager
ESRI Inc.

Specific Responsibilities

Joined ESRI in 2002. Responsible for product management of the ArcGIS Schematics product line. Responsible for the development of the ArcGIS Schematics products.

Past Experience

President & CEO of NetGraph Information Technology. A software company specialized in the development of automatic schematic solutions.
Director of the Infrastructure Business Unit at Intergraph France. Worked 18 years with Intergraph Corporation.
Survey Engineer at the Institut Géographique National in France.

Educational Information

Graduate in Topography/Geodesy/Photogrammetry/Cartography, Ecole Nationale des Sciences Géographiques, France

SCHEMATIC VISUALIZATION OF OPERATIONAL DATA WITH GIS

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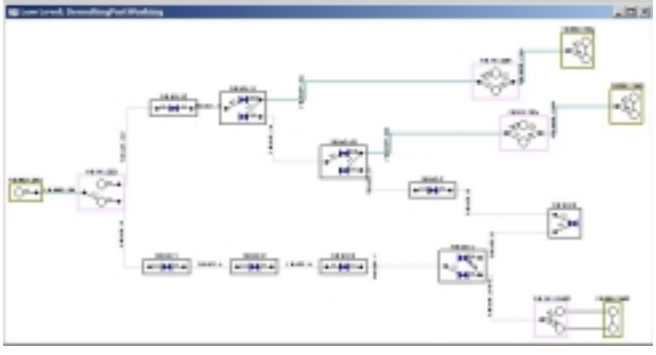
ABSTRACT

Real-time operational systems such as Supervisory Control and Data Acquisition (SCADA) and Network Management systems, by their nature, have different graphics requirements than Geographic Information Systems (GIS). In order for a user of such a system to visualize the network in an efficient manner, the graphic display needs to be in schematic form. Until recently, this precluded the use of GIS for visualization because a GIS, by its nature uses geographically positioned data.
This presentation will describe how a software extension can be utilized to automatically reposition elements within a GIS into schematic form and how a similar set of tools can be used independently to extract the connectivity logic from operational systems and display their elements schematically. Various display optimization mechanisms and feature manipulation options will be discussed. Examples of case studies will be presented where these tools have been implemented for visualizing networks from external systems and where users have extended their core GIS with schematic generation.

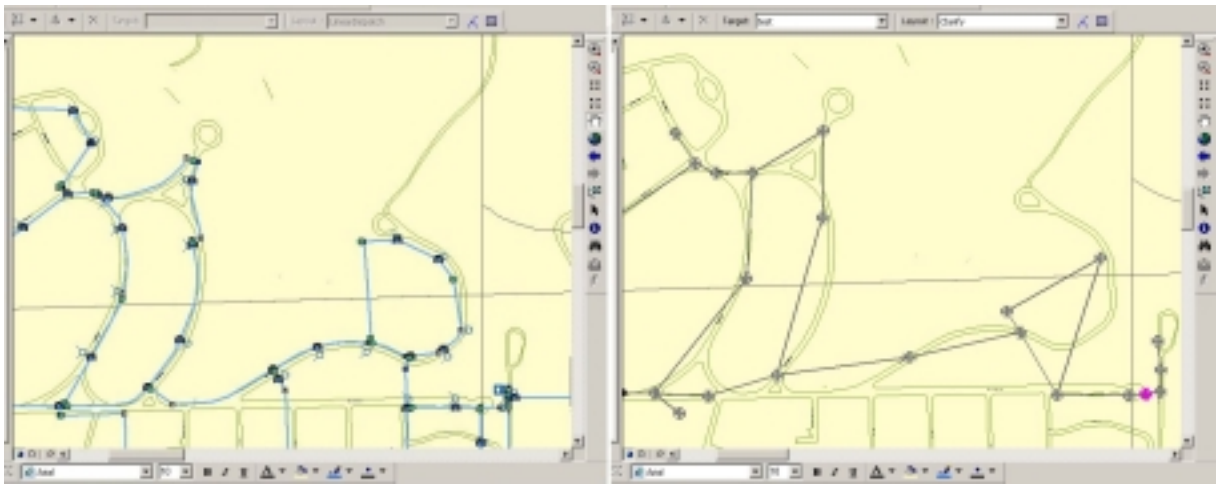
SCADA AND NMS

SCADA and Network Management systems are used by utilities to monitor and control network status. Equipment and network conditions data are processed and presented as schematic diagrams, offering a simplified and manageable visualization of the network situation. Schematics facilitate the network representation as they bring out the network architecture and allow for the logical display of the network components. These types of applications must only display equipment that has an impact in the control of the network despite the network being full of nodes and connections not directly impacting control. A Schematic must provide a way to access all of the network information in order to filter the active equipment and generate super spans between them. This principle is called Node Reduction.

By courtesy of MESA Solutions



Geographic Information Systems offer a complementary view of networks as they allow the positioning of features in their geographic environment. While control room and field technicians require diagrams of the network, planning and construction engineers need access to geographic maps as they provide additional and specific information on sites. GIS representations can also become a subset of a schematic called Geoschematic. It is often useful to have a relative positioning of network equipment, a simplification of the connectivity, and a filtering of the equipments.



Geographic *Geoschematic*

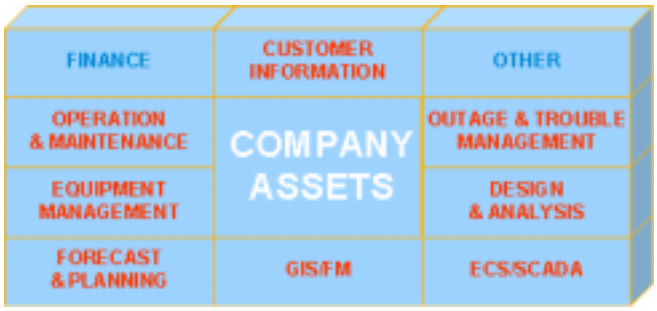
By courtesy of City of Montgomery, AL

DEFINING SCHEMATIC

One way of defining a schematic is to state that it is a simplified representation of an object or a set of objects, intended to explain its structure and to make the way it operates understandable.
Another definition of a schematic is a drawing or diagram representing a set of relationships. Relationships are the features connecting nodes in the model. This is called connectivity.
A final definition of a schematic is a way to represent any type of network and the ability to diagram within a symbolic system, in a defined space, and without scaling constraints. A defined space could be compare to a piece of paper where we want to display a lot of network information by optimizing the placement of the features. Within a schematic, there are no scale constraints (cable length, distances, etc).

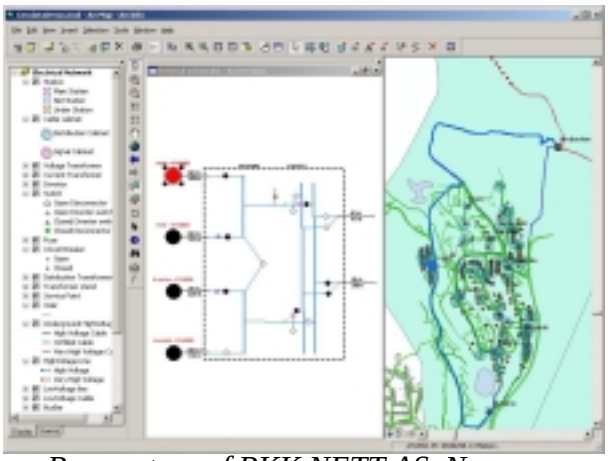
USING SCHEMATIC

Schematic representations are used by several industries such as Telecommunications, Energy, Water & Wastewater, Transportation and Oil & Gas. Other sectors like Logistic, Local Government and Defense are potential schematic users.



A typical Electrical Company Organization
In red, the Departments producing and using schematics

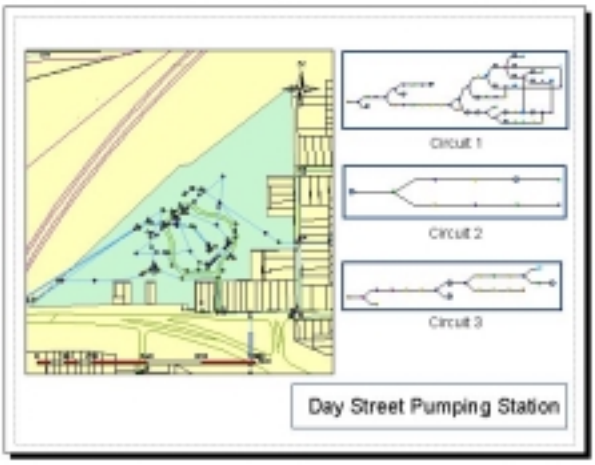
When looking at such a chart, the challenge becomes merging the use of GIS and schematics. Most of the time each department above has a need for both. This implies GIS and schematic must work together, share the same database and be dynamically linked. By working together, a user is able to display a diagram from which he can interact to open or close equipment and at the same time display a map, locate equipment and check the result of its interaction.



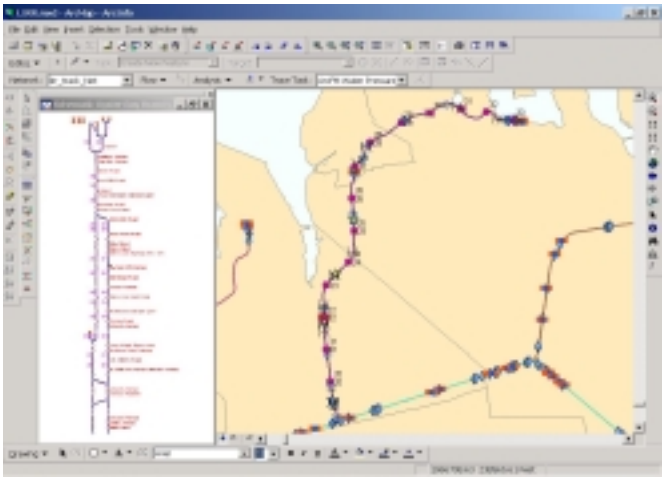
Managing substation switches from schematic

By courtesy of BKK NETT AS, Norway

Managing water circuit within a pump station



By courtesy of City of Montgomery, AL



Managing switching within a rail branch

By courtesy of Long Island RailRoad

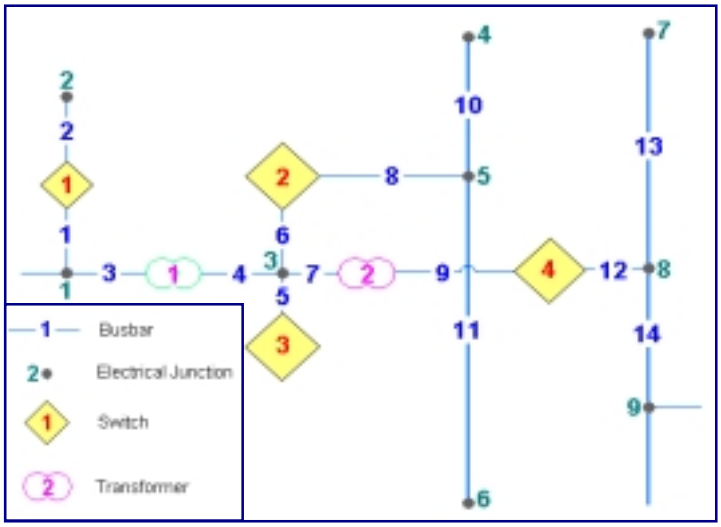
AUTOMATIC SCHEMATIC GENERATION TECHNICAL COMPONENTS

The user must be provided with tools to automatically generate, visualize and manipulate schemas and diagrams from network data.

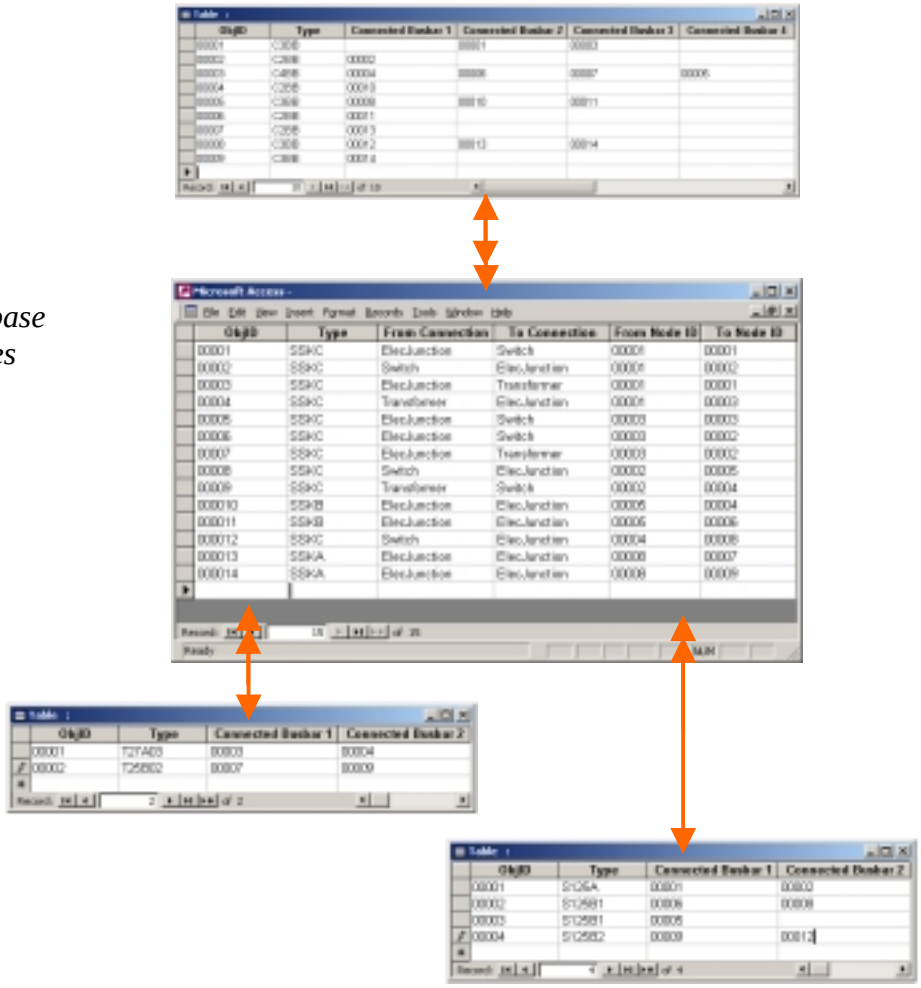
Connectivity

Typically users store and manage connectivity information in many different ways. There are two main categories for storing this type of information. The first is called simple as the value of an attribute gives direct access to another table. The second is designated as complex because attributes must be processed to retrieve connectivity.

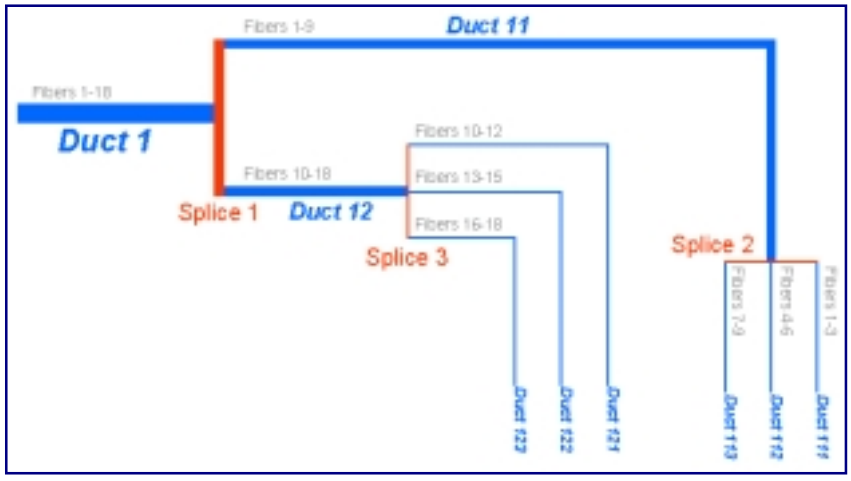
The following figure and tables show an example of simple connectivity.



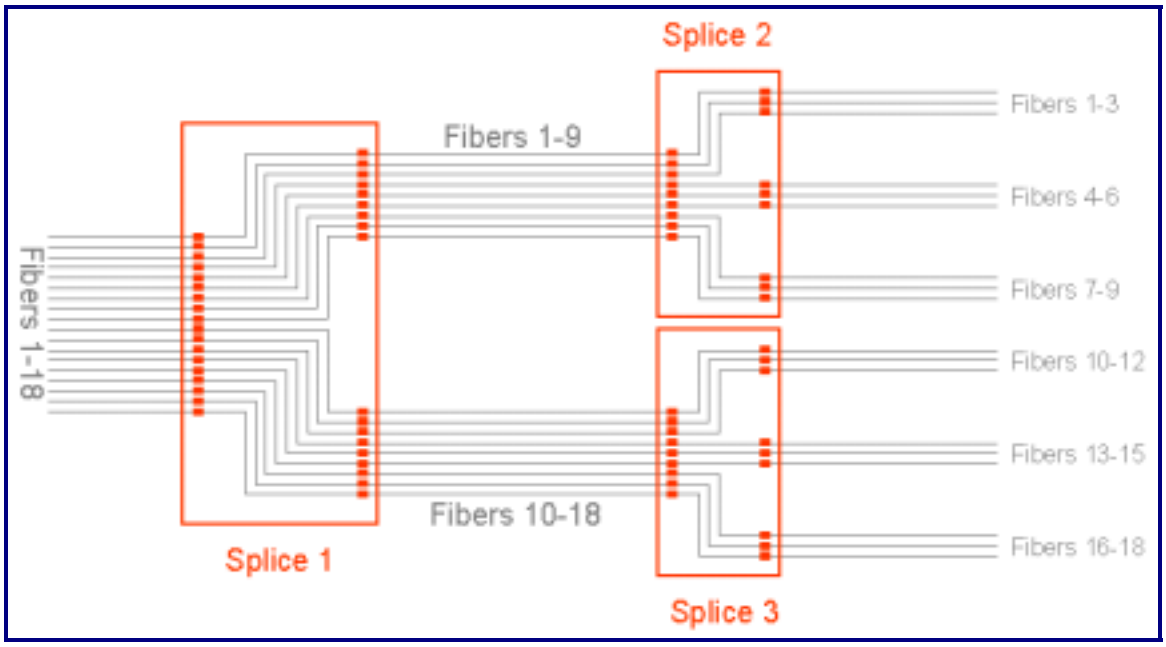
Database Tables

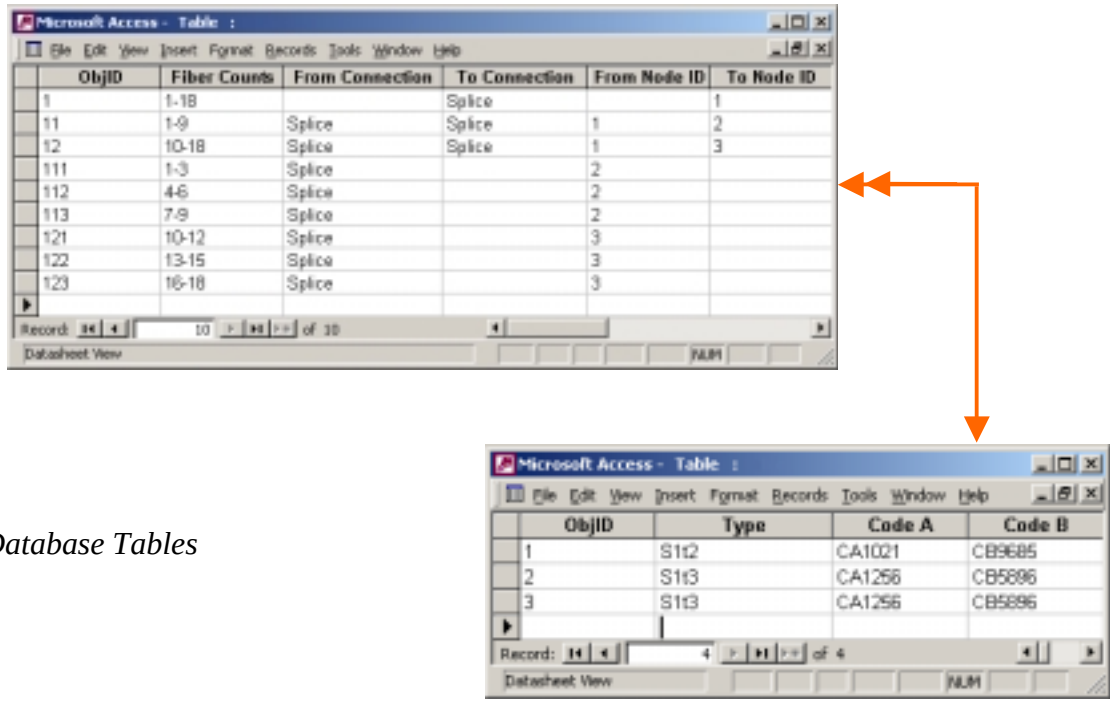


The following figures and tables show an example of complex connectivity descriptions.



The above duct schema is using simple connectivity while the below cabling diagram uses the fibers counting to get the connections within the splices.





Database Tables

Layouts

Two types of layouts are useful when generating diagrams: geoschematic and schematic. In a geoschematic layout, the relative spatial positions of features are maintained though the reference system is dropped. The overall effect of a geoschematic layout, is to normalize the spacing of the node features, while still maintaining some of the original spatial relationships between the facilities.

In a schematic layout, network connectivity is maintained and the nodes are positioned according to a set of rules that dictates their relative positions in order to create a patterned layout where the distances between nodes is normalized. The relative position of the nodes is not maintained and the reference system is dropped. Spatial coordinate values are replaced by those generated from the layout algorithms.

Layout algorithms

Several different algorithms are available. Those algorithms can be used to display the schematic in a specific way, giving a more readable layout of the network and its features (hierarchical-smart tree layout, orthogonal layout, backbone layout, grid layout).
It is important that each algorithm can be applied on a part or the full diagram. Users can change algorithm parameters. It is also important to provide an API for the development and integration of custom layout algorithms so a user can replicate the way he was representing his schematic.

Refinement tools

Schematic documents can be refined by using a set of refinement tools. Among those tools are rotation, alignment, scaling, path, reduction and connected tools. The rotation tool allows to rotate schematic objects according to an angle defined by the user. The alignment tool allows a user to align selected nodes horizontally or vertically. The scaling tool allows a user to change the size of symbols and texts. The path tool is used to find the shortest path between two nodes. The reduction tool allows a user to collapse a set of objects into a single compaction node. The find connected tool allows a user to find the connected schematic objects from a selected root node.

Dynamic interaction between GIS and Schematic

An integrated solution allows the user to retrieve information through selection from schematic to geography and vice versa so that schematic complements GIS for the design, construction, and management of networks. It emphasizes the location in the geographical space.