1 Modeling with ArcGIS Gas Distribution

ArcGIS™ Gas Distribution is an adaptable and robust solution for managing the large volume of data necessary for utility companies to successfully distribute natural gas to a wide range of customers. The object model and extensible tools in ArcGIS Gas help to accurately represent utility facilities, structures, devices, and pipes.

Topics discussed in this chapter:

- *Implementing ArcGIS Gas Distribution*
- *Gas utility data model*

Implementing ArcGIS Gas

The principal goal of ArcGIS Gas is to be the best product for displaying, maintaining, querying, and analyzing information related to gas utility outside the plant. The object model and extensible tools in ArcGIS Gas make it feasible to accurately represent utility facilities, structures, devices, and pipes. Because each utility is managed differently, the object population must also be ultimately flexible. ArcGIS Gas is a robust solution for managing the mountain of data necessary to distribute a reliable, consistent source of natural gas to a wide range of gas customers.

ESRI® ArcGIS replaces the traditional Arc–Node topology model with a more sophisticated network model and geodatabase derived from core ArcInfo™ 8 object classes. It further categorizes the ArcInfo foundation classes into a set of electric and gas objects. While there are many distinct, real-world objects in electric and gas utility transmission and distribution systems, the common aspects of these objects become even more apparent when you begin the process of grouping the common properties and names of the objects in an Analysis Model, which we describe below. The utility object model uses a subset of Unified Modeling Language (UML) that the ArcInfo computer-aided software engineering (CASE) tool solution supports. The object models include a complete specification of electric and gas custom features, object class extensions, relationships, validation rules, domain specifications, default values, and subtypes.

Building an Analysis Model

You can create an Analysis Model by starting with the core ArcInfo object classes: object, feature, simple and complex edge, and simple junction. Features that have a spatial reference and are part of the network have a role as either a junction or an edge. All network features inherit characteristics and behavior from JunctionFeature (point) or EdgeFeature (line) classes, whose relationship to each other and the rest of the network is maintained within the geodatabase.

Objects contain nonspatial data that is not displayed on the map such as inspection and customer information.

Features contain spatial, nonnetwork data that is displayed on a map but not connected to the geometric network. Examples include vaults and gas pipe casing. A feature may be a point, polyline, or polygon.

Simple junction features include spatial, network connected data; a simple junction is a point feature.

Simple edge features are linear features that have some type of junction on each end; you cannot place a junction along a simple edge (other than at either end) without splitting it.

Complex edge features are linear features that can support many junctions along their length and are still maintained as a single feature. Adding a junction to a complex edge does not necessarily require it to be split. Examples include cathodic protection rectifier cable and gas distribution pipe.

Gas Utilities

The gas distribution system is composed of the connected features that convey natural gas from a source such as a regulator or town border station to the customer. Principle components of the gas system are pipes (mains and services), devices which control and regulate flow in those pipes, fittings that join pipes, and metering equipment that measures the flow of gas within pipes.

Mains are pipes that carry gas from a source, such as a regulator or town border station, to a point adjacent to a customer premise. Service pipes transport gas from mains to meter locations. At the town border station (also called a city gate), gas transmission is converted to a distribution system. These features may have associated regulators, regulating meters, overpressure devices, and odorizers. Regulating stations define the location of one or more pressure regulators.

Several types of devices control the flow of gas through a set of pipes as well as the pressure at which gas is delivered. A regulator is a mechanical device used for the controlled reduction of pressure in a gas distribution system. Monitor and backup regulators are included in this feature type. A valve operates in a pipe to permit flow in only one direction or regulate the flow by means of a flat, lid, plug, or other mechanism to open or block the pipe. Valves designated as 'key' are critical to modeling and analysis. Flow control devices include any fitting that is not a regulator or a valve that can control the flow of gas and is machine operated.

Cathodic Protection

Steel pipes buried in corrosive soils will corrode. Coatings of epoxy, polyethylene, or other materials are common methods for inhibiting corrosion. Cathodic protection is another method of protecting underground metallic structures, such as steel pipes, fittings, and valves, from corrosion.

Metal structures deteriorate as stray electric current normally present in the ground flows from the relatively 'anodic' structure into the relatively 'cathodic' soil. By inducing a small electric current on metal structures to make them 'cathodic,' stray current flows from the soil to the structure and, as a result, the structure is protected.

Protected portions of the distribution system must be electrically separated from nonprotected portions. This is often accomplished by insulated fittings such as insulated flanges or insulated compression couplings.

Gas Utility Data Model

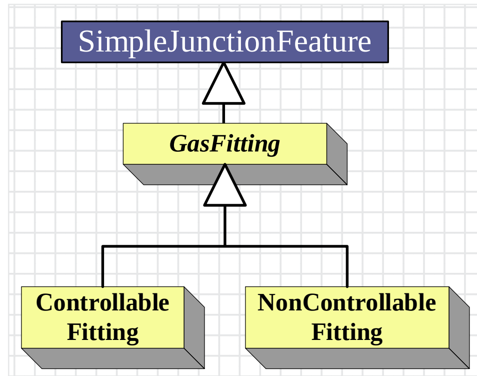
The components of the gas distribution system are grouped into three general, logical categories: (1) Devices and Facilities, (2) Pipes and Maintenance, and (3) Cathodic Protection.

These categories contain features classes that share common properties and/or behavior. For example, devices can be grouped together because they detect and/or control the flow of gas through pipes. Some devices measure the flow (e.g., meters), and some regulate the flow of gas (e.g., regulators). After establishing a basic grouping of objects, you can identify more specific similarities between objects. During this grouping process, you can define new classes (called subclassing) and merge some classes (subtyping). The final result is a set of root abstract classes, intermediate abstract classes, leaf classes, and relationships.

When you begin to define the properties of each leaf class, common properties emerge. For instance, both meters and regulators have manufacturers and model numbers. Rather than duplicate each property in both objects, you create a higher-order class (Gas Device), which is an abstract class, to contain these properties. This class contains properties common to all objects subclassed from it and will never be a standalone object. This process of generalizing properties results in a set of intermediate classes that represent, or model, the gas utility system. Gas distribution features fall into three general categories devices and facilities, pipes and maintenance, and cathodic protection.

Subtypes

Decisions about whether to subclass or subtype are important for your implementation. For instance, *GasFitting* control devices control the flow of gas through the system. While noncontrollable fittings permit the flow of gas, controllable fittings can be set.



They are split into subtypes of *GasFitting* because they "behave" differently. In general, you should try to group or "lump" your objects into fewer classes wherever possible to realize performance advantages.

Domain Values

Domain values are similar to valid values in previous versions of ArcGIS. By defining certain domain values, we limit the universe of values that an attribute can have. For example, a Flow Control Device is a subtype of Controllable Device and has a SizeCD attribute field. Throughout this reference, these "coded domain values" are described in the following format: "Code indicating size of device; domain values include ½, 1, 1½, etc." The "etc." at the end of the list indicates that there are additional valid values for this attribute. Restricting the possible values ensures that the entry in each attribute field is valid and thus ensures data integrity.

Relationships

Defining relationships among appropriate objects is another way to make the model more robust. For example, a gas pipe may have Inspection or Leak Report objects associated with it. In UML language, this would constitute a one-to-many relationship. Other possible cardinalities are one-to-one and many-to-many.

Building the Geodatabase

The model is represented within a Visio® Enterprise/Professional (Visio) diagram that you can immediately export from Visio to a Microsoft® Repository (either Access or SQL Server™) using the Visio UML Export wizard. Use ArcInfo 8 CASE tool wizard to build an instance of the model within a geodatabase. The following chapters describe the gas utility model components.