# A CASE STUDY FOR AN AIRPORT INFORMATION SYSTEM

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**Abstract**
Starting with the active use of information systems that provide easy and faster access to data, they help to provide better and more quality services to their users in many fields. In this study, the role of information systems is investigated for professional management and service quality improvement of airports, which to some extent shows the levels of the development of a country and the integration with the rest of the world. Considering its size and air traffic capacity, Ataturk airport in Turkey is chosen for this research. For the design and creation of Ataturk airport information system, required spatial data were collected and digitized, and then combined with the attribute data. When the system becomes fully functional, it will provide considerable benefits to users and management by improving operational efficiency and productivity.

**Keywords:** Airport Information System, Geographical Information Systems, Web Based Information Systems, Management, Operational GIS.

## SISTEMA DE INFORMACIÓN AEROPORTUARIO. UN ESTUDIO DE CASO

**RESUMEN**
El uso activo de los sistemas de información proporciona acceso fácil y más rápido a los datos. Ayuda, además, a proporcionar servicios de mejor calidad a los usuarios en muchos campos. En este estudio, el papel de los sistemas de información se investiga para la mejora de la calidad profesional de la gerencia y del servicio de los aeropuertos, lo cual redunda en demostraciones de los niveles del desarrollo de un país y de su integración con el resto del mundo. En vista de su tamaño y capacidad del tráfico aéreo, el aeropuerto de Ataturk en Turquía se elige para esta investigación. Para el diseño y la creación del sistema de información del aeropuerto de Ataturk, los datos espaciales requeridos fueron recogidos y digitalizados, y después combinados con los atributos de dichos datos. Cuando el sistema llegue a ser completamente funcional, proporcionará ventajas considerables a los usuarios y a la gerencia aeroportuaria mejorando la eficiencia operacional y productividad.

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**Palabras claves:** Sistemas de Información Aeroportuario, Sistemas de Información Geográfica, Sistemas de Información WEB, Gerencia, SIG Operacional

## 1. Introduction

Since the beginning of life, human beings have always aimed to find more comfortable and better solutions to their problems in any field. This has resulted in many innovations, discoveries and inventions. Today technological development and scientific research have reached their peaks and resulted in many important developments in communication, satellite, space and information technologies.

Information technologies are now used in almost all fields ranging from small companies to the largest. Main reasons for their popularity rest on their effectiveness for handling large and complex structured data, easy management of geographical data, advantages in the analysis and presentation of the outputs produced, and powerful decision-making support required for unexpected situations.

In this study, an airport information system is designed for Ataturk airport, which is the largest airport in Turkey. This airport gives services to more than 350.000 airplanes and 22 million passengers every year. It is obvious that such a large size airport has many problems or issues to be considered in improving the quality of the services considerably for both passengers and personnel working at the airport. In addition to the operation and security of the airport, its effective management is of considerable importance. With the information system to be constructed in a web environment, visitors having little knowledge about the airport will be enlightened with detailed information and given directions. Moreover, necessary precautions can be taken with high confidence when a problem or an unexpected case takes place.

Some international airports are reviewed during this study and an attempt has been made to build an optimum structure for the information system for Ataturk airport. Investigations have shown that most airports have been still run by small and independent information systems designed for different parts of the airport system, such as passenger services, air traffic services and airport management system. In this study, the question of how all management sections can be put into a generic information system in an effective way that can provide maximum efficiency is tried to be answered.

## 2. Information Technologies

Information systems can play a major role in solving organizational problems in many fields and in providing critical information for decision making. Information technologies currently show themselves in all new technological developments. From mobile phones to Internet technologies many services benefit from information technologies and provide improved services to their users. Advances in this area intend to meet the expectations and varying needs in time at the earliest time. Parallel to the recent developments in information technologies, advances are needed in hardware components of these technologies. Information technologies not only require advanced hardware but also need more robust, flexible and user-friendly software solutions. These technologies have been the major motivation of researches for new developments and enhancements that are expected to meet the current and future expectations. Research carried out in this arena can not only

meet the expectations of the user but also provide an infrastructure to other information technology based services.

Advances in information technology field are now in revolutionary stage and they are regarded as an important factor for socio-economical development in all over the world. These technologies have significant contributions in planning of future products and services, improving education and job possibilities, improving the speed and quality of the services provided by public and private sectors. However, the effects of the conversion to information technology services should be carefully analyzed in terms of social, ethical and personal privacy perspectives.

### 3. Geographical Information Systems

Geographical information system (GIS), which is a type of information system for creating, analyzing and managing spatial data and associated attributes, is regarded as one of the keystones in the formation and development stages of information technologies. GIS systems are systems constructing relations between geographically referenced data and their attributes in a software environment that has the capability of storing, capturing, analyzing and presenting results in various ways and giving high level query capabilities. With the advances in computer based technological systems enabling better storage, analysis and updating facilities, the idea of combining or relating geographic and attribute data in a layer or a coverage is put into practice in GIS systems (Yomralioglu, 2000). GIS systems differ from other computer based information systems from two main perspectives. Firstly and more importantly, data used in these systems are geographically referenced. Geographical reference is usually given by geographic coordinates of objects or features. Geographic reference can be, for example, coordinates of the corners of a parcel, or a border of a village or a town. Alternatively, coordinates of an interested point can be estimated from neighboring points using the GIS system. Secondly, GIS systems have important capacities and open-to-development structure for data analysis and modeling, and thus they are not restricted solely to standard data entry, storage, update and output facilities as the other information systems.

It can be stated that GIS is formed by three main components: hardware, software and data. Some researches also add user and conceptual model as other components of GIS. The use of GIS software considerably increased in 1980s with their employment in important business areas and personal computers. Through the end of 1990s, server-based and Internet-based software were become widely used. The ideas of representing data in layers and relating these layers with each other have been the main starting point of many GIS software. Detailed analysis can be only conducted by establishing relations between geographical features and attribute data, which include descriptive information about the features. Two data models are used in GIS systems, namely raster and vector models. Whilst vector models use point, line and polygon features to store geometric objects, raster models use layers formed by cells or as widely known pixels for this purpose. Both models have advantages and disadvantages as highlighted by Aronoff (1989) and Burrough (1986). It can be stated that the best model is totally problem-dependent and, therefore, needs careful considerations.

Applications in GIS field have been categorized in various ways in the literature. They are usually classified in terms of their specific application area (e.g. Cadastral Information System, Urban Information System, Property Information System, Land Information System), but classification considering their level of contribution to the decision support process seems to be a more robust consideration. One of the objectives of an established GIS system is to minimize the uncertainty rate presented to the management level. According to the classification made by Grimshaw (1994), GIS applications can be grouped into operational, tactical and strategic categories, as shown in Figure 1. Operational GIS applications are those supporting the operational activities and decisions of the business. For example, operational activities in a public utility company would involve maintaining a gas pipeline. Such GIS systems are usually used to carry out daily operations of a company or organization. The decision making activities of middle management tend to be described as tactical or semi-structured decisions (Scott-Morton, 1967). More external data are usually required to provide information for decision making. GIS applications requiring the highest level of management and information for decision making are named as strategic GIS applications. This type of applications requires vast amount of and timely collected data for decision making (Grimshaw, 1994).
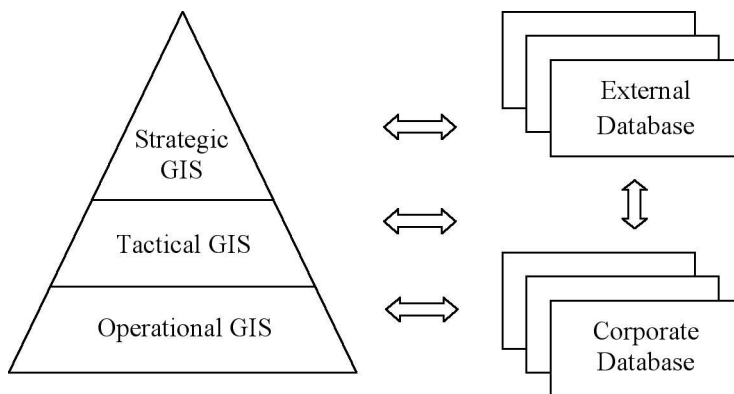


**Figure 1.** GIS applications framework (Grimshaw, 1994)

GIS application can also be divided into three categories as business, engineering and military information systems. GIS systems have found wide range of applications especially in business and engineering areas. Applications of GIS to business can be categorized into a number of different areas. They can be classified according to subject, for example route planning, mine planning, facilities management or catchment area analysis, or according to industry such as retail, manufacturing, real estate, utilities and transportation (Grimshaw, 1994). In engineering arena, GIS has been used in almost all engineering fields ranging from meteorology to environmental engineering. It is also known that some important information systems have been developed for military and security services.

**4. Airport Information Systems**
Considering the above categorization of GIS applications, airport information systems can

be easily identified as an operational GIS application. The main objective of these systems is to improve the effectiveness and efficiency of the airport services. In addition, it should be noted that external data are not needed for these systems. The key objective is to improve the system such that all components of the airport are included. Realizing the benefits of the use of GIS, airports especially the large airports have utilized these systems to improve their services and maintain airport operations. The Airport GIS Committee formed by the American Association of Airport Executives (AAAE) in the USA aims to educate airport personnel on the technical and beneficial aspects of airport GIS, to provide a forum to promote GIS use at airports and to provide increased communications among airports for the application of GIS. The committee also sponsors an annual airport GIS conference and workshop.

Airports in Turkey, as throughout the world, are struggling to meet the increasing demand for air travel. Therefore, construction of new infrastructure and improvement of existing facilities are needed. In order to meet this expectation, the necessity of using new information processing technologies has come to a place. A technology that can provide great benefits due to the availability of large amount of spatial data is geographical information systems.

An ideal airport information system should be produced from the combination of several sub-systems. Some of these systems include an airport security system, a system for terminal services, a flight information system, a system for emergency departments and a passenger information system. Depending on the capacity of an airport, baggage, radar control, air defense and apron management systems can be also added to the system. It should be emphasized that airport information systems should be open systems for addition of new sections.

Technological developments should be followed to manage an airport with minimum error and also to give optimum services to airplanes and passengers. In order to build a successful system, data must be structured and managed in a way that helps personnel perform their daily activities much more easily and effectively. Many countries including USA have taken some precautions for the security of the airports after the 11th September tragedy. It is obvious that the construction of a comprehensive airport information system will be a requirement for all airports in the near future, especially the international ones. GIS is employed in many airports in the world for variety of reasons. Whilst the importance of geographical information systems for airport safety is discussed with the examples from real cases in Croft (2005), a detailed survey conducted through the AAAE GIS Committee for GIS applications at airports is given by McNerney (2000). The survey indicated that over 60 percent of the airports in the USA use GIS or plan to use GIS with the next 3 years. Main applications of GIS in these airports are mainly for infrastructure management, environmental analysis and airport operations.

## 5. The Design of Ataturk Airport Information System
Ataturk international airport of Istanbul, opened in 1912 to civilian flights, is selected for the construction of an airport information system for the reason that it is the largest and most active airport of Turkey. It should be noted that for security reasons limited data were provided by the authorities. Several international airports are surveyed in terms of their

passenger and air traffic services. It is observed that management systems of these airports are constructed upon a total-quality based strategy.

In the first stage of preparing necessary maps of the airport, same general maps given by the airport construction department were digitized and edited in AutoCAD environment. These maps played an important role as a starting point of the project. Roads, airplane runways, aprons, terminal buildings and lighting points were all digitized as separate coverages. Some other maps showing other parts of the airport were also digitized. All coverages were later converted to the same projection and coordinate system and then transferred to the ArcView 3.3 format. Attribute data were collected for the details existing in coverages, and relationships were established with the corresponding details, which were in point, line and polygon format. In order to meet one of the main objectives of the study, providing visual details of the airport to its users, detailed maps, photographs and camera records were collected for domestic and international terminals. These data were also integrated into the system.

The system was constructed with 14 coverages, general view of which is shown in Figure 2. In the creation of these coverages numbering and labeling of details were carefully performed. Short descriptions of the main coverages are given below.

Road coverages: These coverages were prepared for general transportation route of the airport, which is important for passenger's arrival to the airport, runway roads and their links to terminals.

Building Coverage: All buildings including hangars, storage depots, terminals, air traffic control center, fire station and other type of buildings are available in this coverage. Attribute data containing explanatory information (e.g. total area of the building, owner of the building, details of the firm or organization that use the building) are also attached to the features.

Park Coverage: In this coverage parking zones for the airplanes are shown and detailed information, such as the type of airplanes that can use that particular zone and the facilities available in that zone is provided.
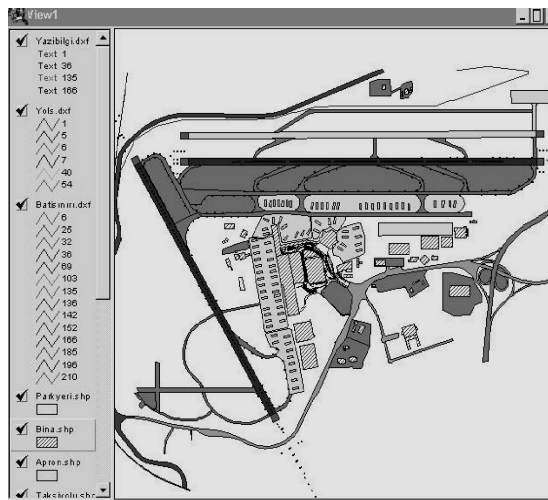


**Figure 2.**  A general view from Ataturk airport information system

Apron Coverage: Aprons are the places where cargos are loaded/unloaded and passengers are serviced. Aprons give services to different types of airplanes depending on their distance to the terminals and their existing facilities. Borders of the aprons were digitized and transferred to the system. Detailed information for each apron was also added to the system.

Lighting Coverage: Lighting facilities are extremely important for the safe landing of airplanes. For the formation of this coverage locations of the lights (i.e. side and center lights of the flight runways, runway approaching lights) were determined and integrated into the system after digitization.

Runway Coverage: There exist three runways in Ataturk airport. Although two of them (2300x60m and 3000x45m) are actively used, the other one (3000x45m) is under construction. These runways were digitized and then loaded into the system with their details.

A sample query window is shown in Figure 3 giving the detailed information of the air traffic control building. By using the hotlink button in ArcView software attribute data can be easily retrieved from the database. The information system is designed as a pilot study that is ready to be accessible in Internet. The system, as shown in Figure 4, is fully tested once it is loaded into a server. It provides directions, information, photographs for different part of the airport. As an important detail, locations of the duty free shops were also integrated into the system through and up-to-date map. In this way, passengers can obtain necessary information and directions about the airport, and look at the photos of the terminal section that they are interested.

Flight timetables and online arrival information are planned to be added to the system in the future. At the moment, the photos of some sections, not undermining the security of the airport, are available in the system, but the addition of short descriptive camera records into the system is intended.

## 6. Results and Discussion

Developed countries have long realized the importance of fast response to the problems encountered and the necessity of management of the geographic data. They all reorganized their structures according to these considerations. Geographical information systems greatly help to produce solutions to the problems and provide information for decision making. It is clear that GIS is a robust and strategic tool. When it is used effectively, it can make enormous contribution to the decision making processes. GIS systems are now popular in many fields and are considered as new type of data analysis and presentation technique. Being one of the signs for the development of a country, airports should always be well managed to minimize the problems faced during daily routines. In this study, how a GIS system can be designed and used successfully in an airport is discussed and a pilot study is presented for Ataturk airport in Istanbul, Turkey. For the constructed airport information system, roadways, runways, buildings, storage depots, parking areas, terminals and all other details were coordinated and then transferred to the GIS system. One of the major benefits of the system is that the airport   can be directed from a single point unlike the previous method of utilizing several independent systems for management. With the

established GIS application designated airport staff will have access to spatial data with corresponding attributes that can be used for planning, security and service improvement purposes. Several types of queries and analyses can be performed through the added buttons and menu items of the software. The system can store, retrieve and analyze the graphical data and can produce summary reports. When the system is put into practice and published on Internet environment, many passengers and their relatives will be able to benefit from the system. Plans are made to include some extra information to the system, such as online flight arrival and departure times.

## 7. Final remarking

Design stages of an airport information system are discussed in this study on a pilot project. The system can make significant contributions in improving the quality of the services and management. Therefore, reorganization of the airport and main facilities are needed. In order to establish an effective system, information from all sections should be combined in a complete information system that definitely requires high-level approaches and solutions.

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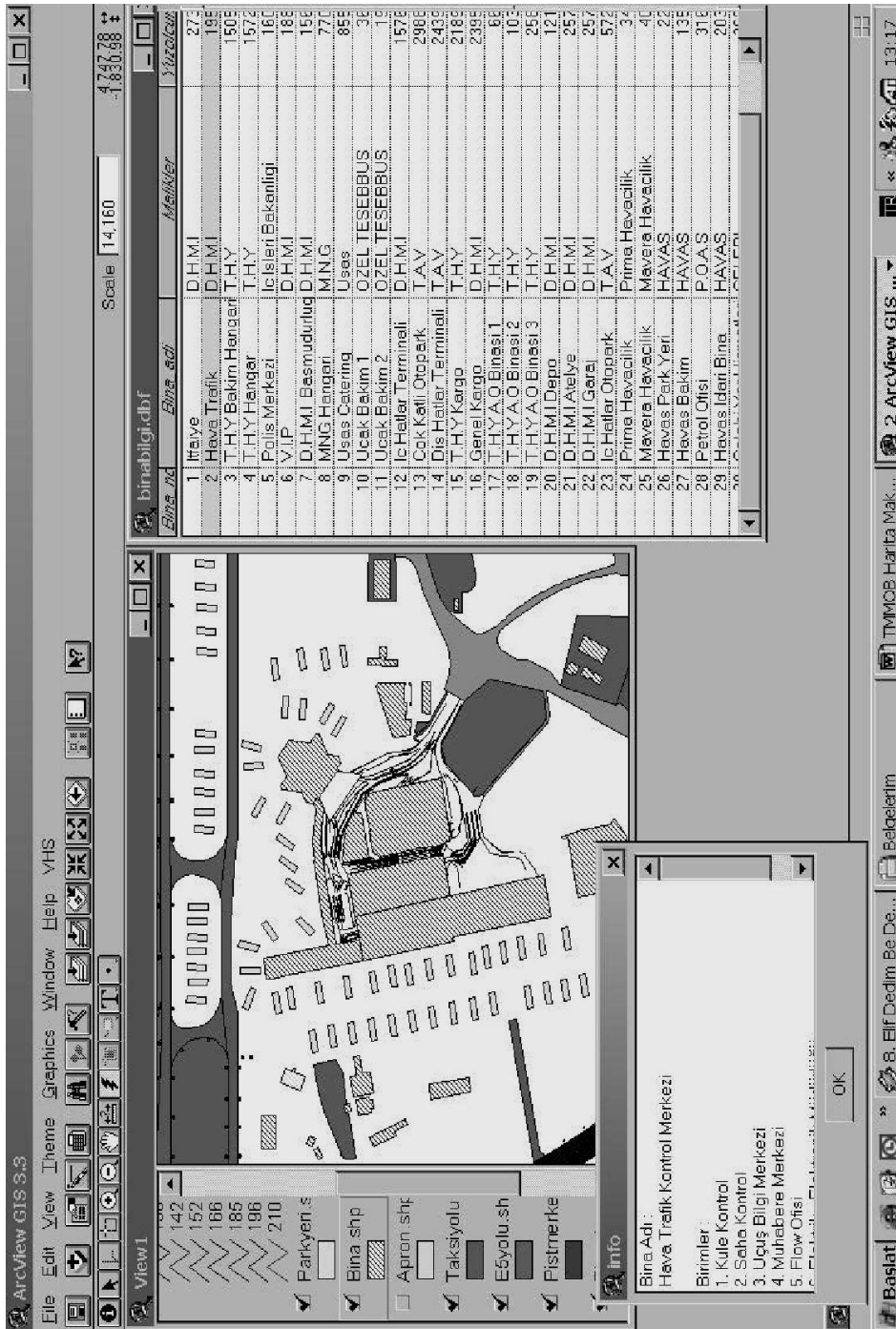
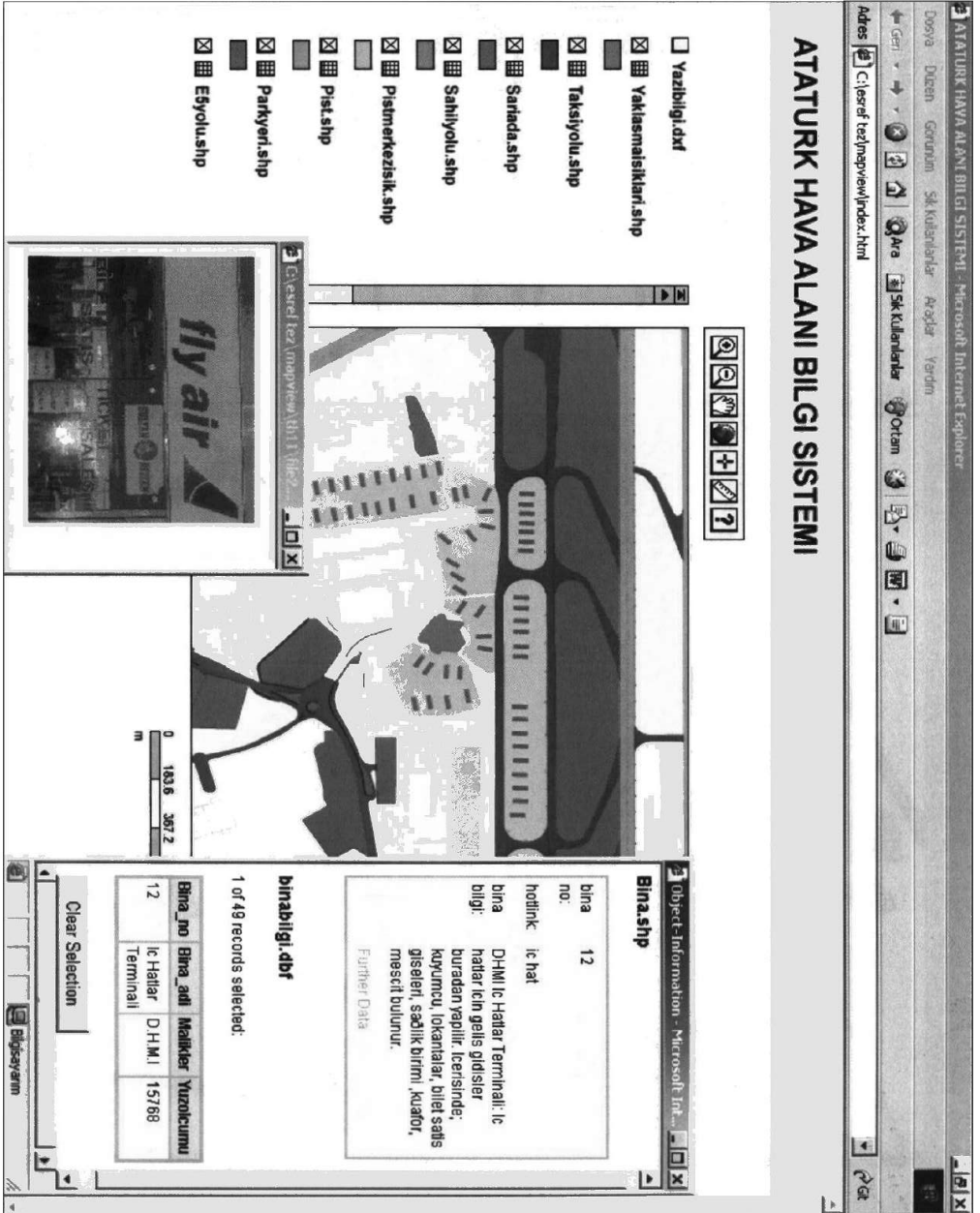**Figure 3**. A query performed for the air traffic control building

**Figure 4.** A query performed on the system loaded into an Internet server