GIS by ESRI ™

PC ARC/INFO®

Powerful GIS Functionality for
DOS and Windows

PC ARC/INFO— Powerful GIS Functionality for DOS and Windows

An ESRI White Paper

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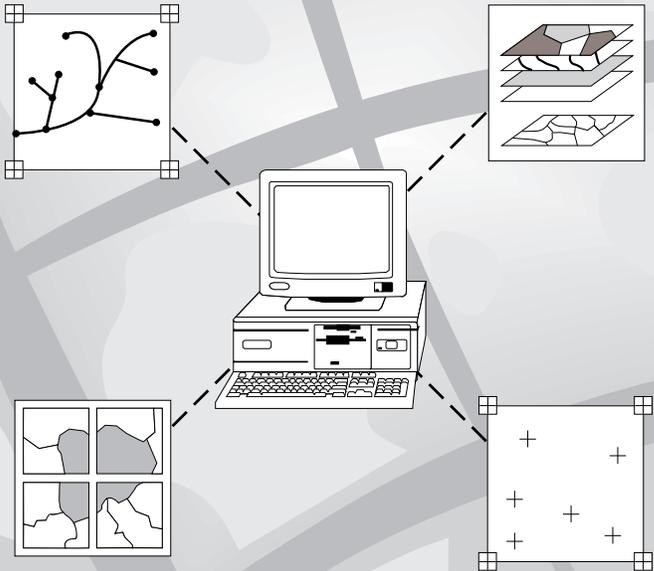
Environmental Systems Research Institute, Inc. (ESRI), has developed PC ARC/INFO®, the 386/486-based version of the world-renowned ARC/INFO® software package, to bring sophisticated geographic information management, analysis, and mapping to the DOS and Windows environment. The software is easy to learn and easy to use, and runs independently as a stand-alone product, networked with other PC compatibles, or in conjunction with a host computer.

PC ARC/INFO software's integrated series of products provide you with techniques for data entry, analysis, manipulation, management, display, and output. PC ARC/INFO software is flexible, providing device-independent drivers to permit users to select from a variety of standard display monitors, digitizers, and plotters. It gives your organization the capability to gradually expand and distribute your geographic information system (GIS) as your needs grow and your budget allows.

Together with desktop data management tools, PC ARC/INFO meets today's demanding GIS requirements for such features as polygon overlay, network analysis, buffering, continuous spatial database management, map digitizing, data transfer, relational database

management, cartographic display, query, interactive graphics editing, address geocoding, and report generation.

The PC ARC/INFO package consists of six modules designed to meet the specific needs of your organization. The combination of the proven power of ARC/INFO software for diverse applications with the convenience and flexibility of DOS-based PC-compatible hardware results in a GIS for your desktop.

Notes about the DOS Environment

ESRI has chosen to support PC ARC/INFO in the DOS environment because of market demand. A full 85 percent to 90 percent of the PC marketplace is still based on DOS and Microsoft Windows. The PC UNIX market is small and appears to be getting smaller. It is important to understand that limitations of the PC ARC/INFO software are generally due to limitations in the processing power, memory space, and storage capabilities of the average PC platform.

Given the growing popularity of Microsoft's Windows environment, PC ARC/INFO now includes Windows Extensions for the graphics modules PC ARCPLOT and PC ARCEDIT.

PC ARC/INFO: A Series of Modules

PC ARC/INFO consists of six modules. The six PC ARC/INFO modules are listed below:

■ PC ARC/INFO STARTER KIT™: file transfer and communications facilities, map data processing, and preparation capabilities.

■ PC ARCEDIT™: advanced digitizing and interactive data editing.

■ PC ARCPLOT™: sophisticated cartographic display and editing.

■ PC OVERLAY™: polygon overlay and analysis.

■ PC NETWORK™: network analysis and address matching.

■ PC DATA CONVERSION™: vector data and grid cell conversion utilities.

Why Is PC ARC/INFO So Popular?

Several factors combine to make PC ARC/INFO one of the most successful products in the history of the GIS industry:

■ PC ARC/INFO runs on the world's most common computing platform, IBM PC-compatible 386/486 machines running DOS and Windows.

■ PC ARC/INFO is affordable.

■ PC ARC/INFO is the most powerful GIS available in the personal computer environment.

■ PC ARC/INFO is fully integrated with ARC/INFO, the world's leading GIS which is available on workstations, minicomputers, and mainframes, and is in use at thousands of locations throughout the world.

■ PC ARC/INFO is flexible, enabling development of numerous types of sophisticated GIS applications.

■ PC ARC/INFO is the only GIS that offers a long-term track record for superior GIS functionality and performance on the PC platform.

Commitment to Users

User support is a very important service at ESRI; thus, each module has available a comprehensive manual and videotape, and the PC ARC/INFO STARTER KIT comes with detailed installation instructions and a test database. Telephone support exists for fast response to problems encountered during work with PC ARC/INFO. ESRI is fully committed, not only to delivering PC ARC/INFO software, but also to providing you with service and support on a continuing basis.

PC ARC/INFO Capabilities

The PC ARC/INFO software system offers the technological means for managing multiple and wide-ranging types of spatial and attribute data. PC ARC/INFO offers a comprehensive set of tools for the storage and handling of geographic data. Not only can PC ARC/INFO organize, store, and provide a base for such data, it can also compare, integrate, and combine (i.e., overlay) different data sets (e.g., census information, land use data, highway and network information, property value data, and information about natural resources) to analyze, interpret, and model geographic phenomena.

Furthermore, PC ARC/INFO software offers the ability to perform various types of cartographic analysis and display such as land suitability and capability studies, census or other statistical mapping of areas for study of demographic trends and economic patterns, basic spatial analyses such as flow analysis, and related interlocational analyses. These capabilities provide the analytical tools for a variety of applications.

PC ARC/INFO GIS Functional Capabilities

PC ARC/INFO software consists of a set of sophisticated, yet easy-to-use, geoprocessing capabilities that represent the state of the art in GIS technology. ESRI believes software packages that aim to meet geoprocessing needs must, at a minimum, have the generic capabilities presented in the following list. PC ARC/INFO software features these capabilities and much more.

- *Cartographic database generation and management:* digitizing, editing, and updating of cartographic data; conversion of data from other formats.

- *Tabular database generation and management:* tabular data entry and update, file management, and tabular report generation.

- *Cartographic analysis:* interpretive mapping, polygon overlay, point-in-polygon calculations, buffer, and other types of spatial analyses.

- *Cartographic display:* polygon, line, and point mapping; labeling and map annotation, in hard-copy output as well as interactive display.

■ *Query capabilities:* searches given areas for cartographic or tabular data related to those areas; searches for areas with a given set of characteristics.

■ *Customization:* simple to use yet powerful macro language for the development of customized user interfaces and applications.

ESRI® PC ARC/INFO software provides you with a set of geoprocessing capabilities that give you the ability to specifically address its GIS applications.

PC ARC/INFO Description and Specifications

PC ARC/INFO software provides you with a full range of geoprocessing capabilities. These can be grouped into three basic categories:

■ *Map automation:* programs for the entry of x,y coordinates and related attribute information of geographic features (points, lines, and polygons).

■ *Data manipulation, analysis, and management:* programs for modeling, distance search, map overlay, spatial statistical analysis, network analysis, and other functions.

■ *Output and display:* functions for making displays on graphic terminals, printer maps, pen plots in monochrome or color, and other products.

PC ARC/INFO software is focused on the integrated management of many forms of geographic data as a single database. The software has many important features that give the database a high degree of utility among users with diverse levels of training. PC ARC/INFO software provides a single system with the following benefits:

■ PC ARC/INFO software is complete and well tested. The software, as a whole or in part, has been installed and used at thousands of locations worldwide.

■ PC ARC/INFO software is flexible. The software is designed so that it can accept and work with a wide variety of data types,

perform a wide variety of analyses, and output data in a number of useful graphic and tabular formats. The software is built around generic GIS functions that are commonly required in geoprocessing and geographic data management. These functions provide users with a "toolbox" of capabilities, which can then be combined in ways that specifically meet their individual needs.

■ PC ARC/INFO software provides integrated tabular database management. The dBASE file format is fully integrated with PC ARC/INFO software. The query functions allow subsets of databases to be identified according to user-specified criteria. Subsets can then be displayed, listed, and/or saved. Reports can be developed and generated based on various types of query and analysis operations performed on the database. Users can also incorporate external database management software, such as dBASE or FoxPro, to extend PC ARC/INFO software's database management capabilities.

■ PC ARC/INFO software is well documented. Each module comes with a user manual. Comprehensive training videotapes and workbooks are optionally available.

■ ESRI provides complete and ongoing user support. PC ARC/INFO support includes telephone technical support, invitations to annual user conferences, and software updates and enhancements. Subscriptions for technical support provide additional assistance in subsequent years. Software upgrades are available on a fee-based update system.

ESRI is committed to keeping its software technology up to date and innovative in a competitive industry. As client needs grow and change over the years, ESRI continues to provide updated software packages and technical expertise. This allows users to expand their capabilities in step with technological advances.

PC ARC/INFO Concepts and Data Model

A map is a graphic representation of geographic features or other spatial phenomena that occur in the environment. It conveys several types of information about the area represented on the map. Locational information describes the location on the earth's surface of particular geographic features as well as the spatial relationships between various features; for example, the shortest path from a fire station to the library. A map also contains information that describes attributes of the various geographic features represented such as what the feature is, its name, and perhaps some quantitative information such as its area or length.

The information conveyed by a map is represented graphically as a set of map components. Locational information is represented by points—for features such as wells or spot elevations; lines—for features such as streams or pipelines; and areas—for features such as lakes or counties. Descriptive information about geographic features is presented as annotation or symbols. For example, streams can be shown using blue lines and labeled with their names; well locations can be drawn using special marker symbols, and so on.

The PC ARC/INFO Data Model

The backbone of ESRI's PC ARC/INFO GIS is its simple yet powerful data model. PC ARC/INFO is based on a georelational data model, which abstracts geographic information into a series of independently defined layers or coverages. This approach borrows heavily from the concepts of a relational database management system. The integration of PC ARC/INFO with the dBASE file structure, the de facto standard relational database management system for DOS-based computers, further extends the strengths of the PC ARC/INFO georelational data model.
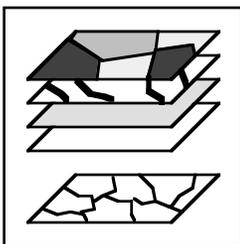
The PC ARC/INFO data model is a hybrid georelational data model based on a cartographic database. Data are stored using a topological data structure in a collection of coverages. Coverages are basic units of data storage and can represent several types of geographic features. The power and success of PC ARC/INFO can be attributed to the strength and flexibility of the data model.

The basic PC ARC/INFO data model is generic and very simple. It describes abstract geographic features—points, lines, and areas—

whose attributes are kept in database tables. Each PC ARC/INFO application builds a specific data model on the base generic data model. For example, a transportation application specifically models roads using the generic line data feature.

A detailed description of the PC ARC/INFO data model can be divided into the following specific areas:

- The cartographic database
- The georelational data model
- The coverage concept
- The feature class concept
- Topological data structure
- Seamless, continuous database

In developing an understanding of the data model, it is important to keep in mind the basic definition of PC ARC/INFO; that is, the integration of graphic data and information. "ARC" is a generic term referring to graphic data. "INFO" is an abbreviation referring to information and refers to the type of descriptive or attribute information that can be stored in a tabular database. The acronym "ARC/INFO" refers to the integration of a variety of graphic and nongraphic data types and sources by a single geoprocessing system. PC ARC/INFO represents the integration of maps and other "information" data sets in the DOS environment.

The Cartographic Database

ESRI's PC ARC/INFO is a cartographic system built around a hybrid data model. It organizes geographic data using a georelational and topological model, as described in detail below. This facilitates efficient handling of the two generic classes of geographic data: locational data, graphically describing the location and topology of point, line, and area features; and attribute data, the information describing the characteristics of these features. The PC ARC/INFO cartographic database is a collection of spatial data and related descriptive data organized for efficient storage and retrieval by many users.

Arc ID	Coordinate Data	Left/Right Poly

Poly ID	VAR 1	VAR 2	VAR 3

Polygons

Arc ID	Coordinate Data

Arc ID	VAR 1	VAR 2	VAR 3

Lines

Point ID	Coordinate Data

Point ID	VAR 1	VAR 2	VAR 3

Points
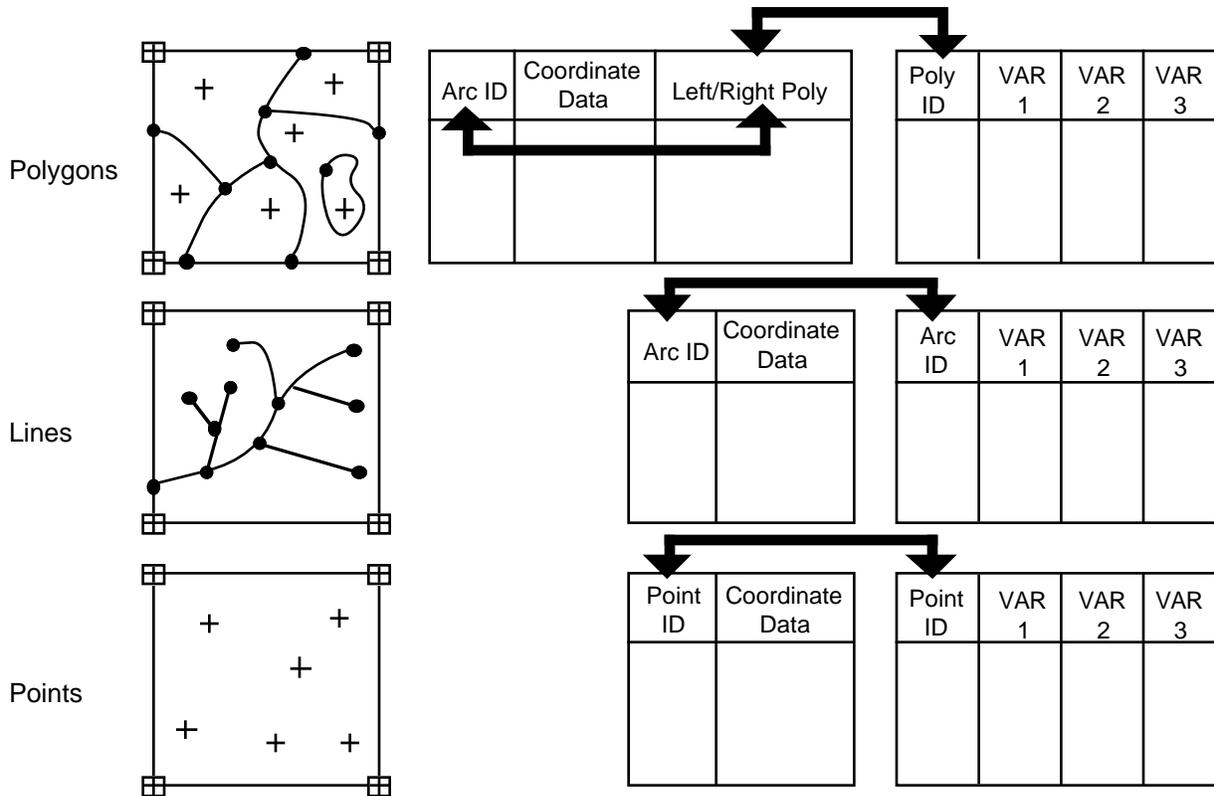
The Georelational Data Model

ESRI has implemented an advanced georelational approach to GIS in its PC ARC/INFO software because it gives our users the most powerful and flexible data management and analysis tools available for working with geographic data. This georelational approach also allows the software to be used successfully for a broad range of applications.
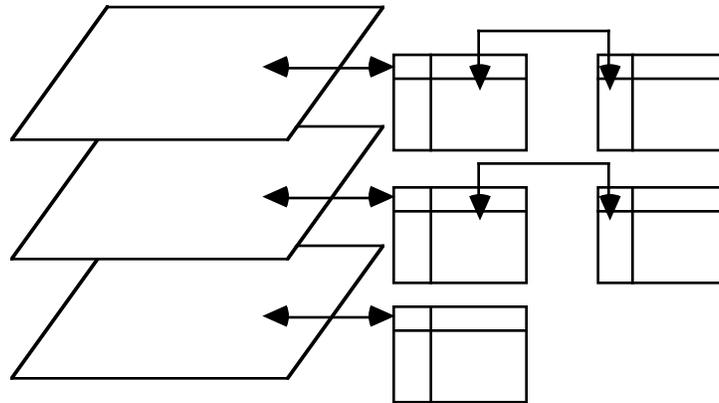
The Georelational Model

The georelational approach involves abstracting geographic information into a series of independently defined layers or coverages, each representing a selected set of closely associated geographic features (e.g., roads, streams, and forest stands). With this approach, users can combine simple features in the data model quickly and flexibly to create complex feature sets representing complex relationships in the real world. This approach borrows heavily from the concepts of relational database management systems (DBMS), and is typically closely integrated with such systems.

The Coverage Concept   The basic unit of data management in PC ARC/INFO is the coverage, which defines locational and thematic attributes for map features in a given area. A coverage is a digital version of a single map sheet layer and usually describes one type of map feature such as roads, parcels, soil units, or forest stands. The coverage concept is based on the topological model of geographic information and may contain several types of geographic information in the form of various feature classes of data.

Coverage SOILS
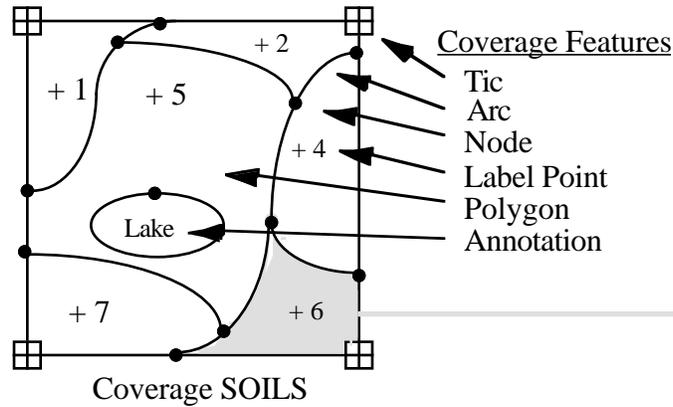
Feature Attribute Table SOILS.PAT

RECNO	AREA	PERIMETER	SOILS#	SOILS-ID	SOIL	CLASS	SUITABILITY
1	-36.0	24.0	1	0	—	—	—
2	3.0	9.0	2	1	A3	113	HIGH
3	2.5	8.5	3	2	C6	95	LOW
4	15.0	15.0	4	3	B7	212	MODERATE
5	4.0	8.5	5	4	B13	201	MODERATE
6	2.0	4.5	6	5	Z22	86	LOW
7	5.5	12.0	7	6	A6	77	HIGH
8	4.0	7.0	8	7	A1	117	LOW

In a coverage, map features are stored as simple points, arcs, or polygons. The locational data about these features may be represented explicitly (as a series of x,y coordinates) or topologically (as a combination of other features). For example, city streets might be represented by a set of arcs and stored as sets of ordered x,y coordinates that define each street, whereas each city block might be defined by the set of streets comprising its border.

*The Feature
Class Concept*

The feature class is the fundamental unit of the PC ARC/INFO geographic database. A coverage can contain several feature classes. A feature class represents a specific type of geographic data. Each feature class may have associated attribute tables. Each table defines the attributes, called items, for all features of that class in the coverage. Each individual feature has a record in its attribute table. The feature attribute tables are an integral part of the coverage and are processed by PC ARC/INFO for all commands that affect the coverage. The basic feature classes used in PC ARC/INFO and the specific types of geographic information they represent are summarized below.

■ Arc: An arc is a continuous string of x,y coordinate pairs (vertices) beginning at one location and ending at another location, having length but no area. An arc is a digital line.

■ Node: Nodes are the beginning and ending locations of an arc, and are topologically linked to all arcs that meet at the node.

■ Polygon: A polygon is an areal feature topologically defined by the series of arcs comprising its boundary, and contains a label point inside its boundaries, and has attributes.

■ Label Point: Label points are used to represent point features (such as telephone poles, well sites, or mountain peaks), or to identify a polygon so that additional attribute information can be related to the feature.

■ Annotation: Annotation is descriptive text used to label coverage features, is not topologically linked with other features, and is used only for display purposes, not for analysis.

■ Tic: A tic is a registration or geographic control point.

■ Coverage Extent: The coverage extent is the bounding limit of the coverage.

Common tics can be used to register adjacent coverages, as well as "layers" of coverages for the same area.
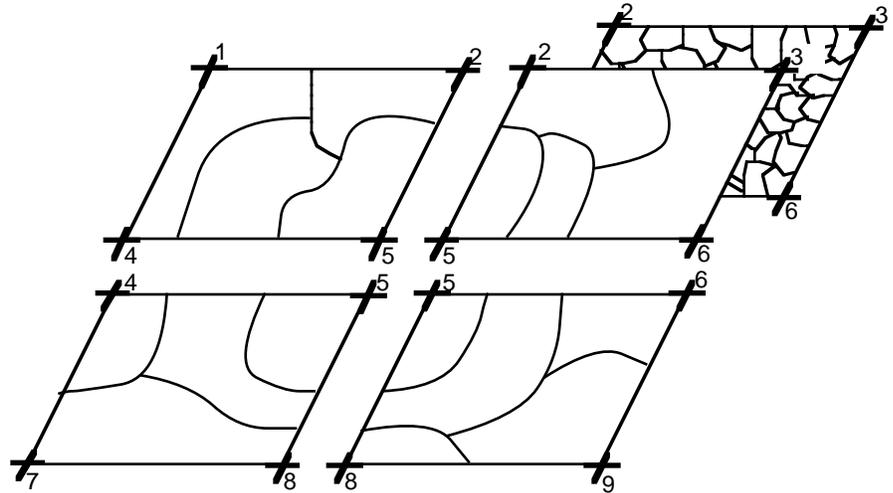
Topological Data Structure

Topology is the spatial relationships between connecting or adjacent coverage features (e.g., arcs, nodes, polygons, and points). For example, the topology of an arc includes its from- and to-nodes (beginning of an arc and ending of an arc) and its left and right polygons. Topological relationships are built from simple elements into complex elements: points (simplest elements), arcs (sets of connected points), and areas (sets of connected arcs). Redundant data (coordinates) are eliminated because an arc may represent both a linear feature (or part of a linear feature) and part of the boundary of an area feature.

Example of arc–node topology

Polygon	No. of Arcs	List of Arcs
1	3	-1, -2, 3
2	4	2, -7, 5, 0, -6
3	3	-3, -5, 4
4	1	6

•   Node

1   Polygon number 1

7   Arc number 7

Arc digitized in the
direction of the arrow
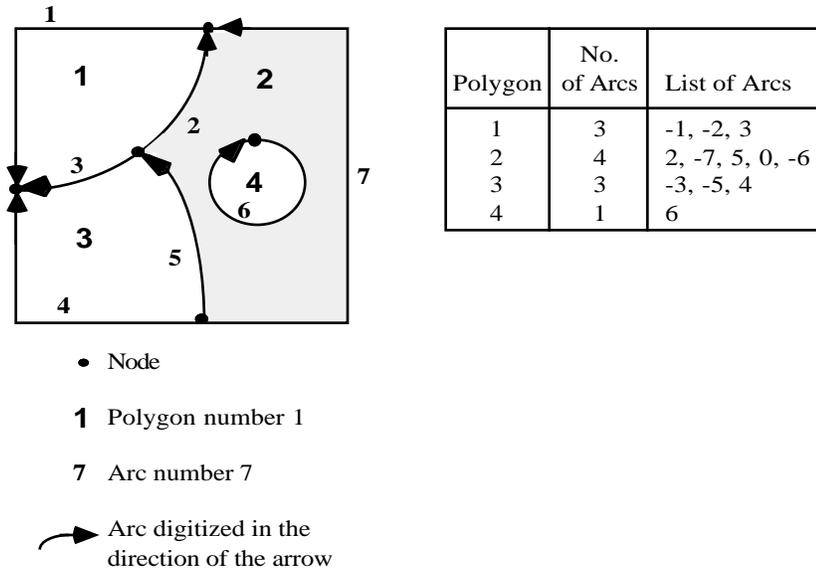
PC ARC/INFO explicitly represents all map features by sets of arcs
and label points and as topological relationships between connected
lines and points. For example, a polygon in PC ARC/INFO is
defined by the set of arcs that makes up its boundary. In this case, an
arc is the border between two polygons. Also, an arc could be part of
a path connecting other arcs. For example, arcs can be used to
represent streets and the routes that pass through them.

The relationships used to represent the connectivity or contiguity of
these features is referred to as topology. By storing information about
the location of a feature relative to other features, topology provides
the basis for many types of geographic analyses without having to
access the absolute locations held in the coordinate files (e.g.,
connectivity, route finding, and contiguity are all derived through
topology).

Seamless, Continuous Database

PC ARC/INFO stores spatial information in a seamless, continuous
database. Spatial data are not tiled or otherwise partitioned. As in any
modern GIS, PC ARC/INFO gives the user capabilities to break

extremely large and complex databases into small, more manageable pieces. But this is completely optional and need only be done at the user's discretion.

PC ARC/INFO STARTER KIT Module

The PC ARC/INFO STARTER KIT module has capabilities for topology generation and for uploading and downloading files to and from a host computer running ARC/INFO.

The PC ARC/INFO STARTER KIT is the foundation of the PC ARC/INFO software system. The STARTER KIT includes CLEAN and BUILD functions to create map coverage features (topology) from raw coordinates; functions to build map feature attribute tables; and a simple tabular data creation, manipulation, and file management system called TABLES. There are commands such as HELP and LOG for assisting the user during a PC ARC/INFO session, commands for copying, renaming and managing map coverages, and commands for transferring map coverages and other data files between your PC and other ARC/INFO platforms. The STARTER KIT also contains the ESRI plot system for viewing maps and sending maps to a plotter or graphics printer, as well as the Simple Macro Language (SML™), which provides a basic set of customization and programming tools.

Functions and Capabilities

As described above, PC ARC/INFO includes utility commands, data transfer commands, disk storage management commands, topology creation commands, attribute manipulation commands, display commands, and a macro programming language. These capabilities are described here in more detail.

ARC Command Processor

The ARC command processor represents the architecture within which PC ARC/INFO operates. The command processor is the program environment for PC ARC/INFO within which ARC commands and SML directives or macros are executed. This command processing environment provides control of your PC ARC/INFO session as well as powerful capabilities for customized application development through SML.

Enhanced DOS Capabilities

The PC ARC/INFO STARTER KIT includes PC ARC/INFO utility commands that permit you to move more easily through your DOS directory structure and supply some useful operating system functions. Included are commands for attaching to existing subdirectories; moving up or over in your directory tree structure; deleting, renaming, or copying entire subdirectories; listing the number of bytes of free random access memory (RAM); redefining function keys; changing the color of the screen dialog lines; and sorting plot files by pen number. These commands are available for use at the DOS-system level.

Coverage and File Transfer

If you have access to an ARC/INFO database on another ESRI-supported computer platform, such as a Sun or other workstation, you can take advantage of the PC ARC/INFO STARTER KIT data transfer capabilities with the commands SEND and RECEIVE. These allow the full transfer of ARC/INFO coverages, individual database data files, ASCII files, or any combination of these between your PC and other platforms. Since SEND and RECEIVE ensure that your transmitted data are error free and automatically perform all machine-dependent format translations, you can immediately begin using data sets after their transfer.

Topology Creation

The CLEAN and BUILD functions are used to generate and update correct topology for new map coverages and to create the feature attribute tables that store thematic data about coverage features. Polygon, line, and point features with attributes are created from digitized coverages, coverages generated from known coordinates, or coverages transferred from another computer using the PC ARC/INFO command RECEIVE. In addition to building polygon and line topology, the CLEAN command can perform a geometric analysis of coverage arcs to identify new intersections, and automatically resolve overshoot and undershoot errors after digitizing.

Associating Attributes with Map Coverage Features

PC ARC/INFO gives you capabilities to add descriptive data to your map coverages. Using the relational database management system data model, tables are built and maintained that hold descriptive data about each point, line, or area on a map. The PC ARC/INFO STARTER KIT includes many capabilities to associate descriptive attributes with points, lines, and polygons. New fields can be added

to these tables, related tables can be merged, or a subset of fields can be extracted from the tables. New field values for features (point, line, or polygon) can be calculated or changed, and a set of features can be selected based upon their attributes. Additionally, new data files can be created that contain descriptive information about map features.

Viewing and Plotting Map Coverages

With the PC ARC/INFO STARTER KIT, you can create simple error and verification plots of map coverages. These can be interactively viewed on your PC graphics screen or sent to a plotter or graphics printer. More sophisticated maps created with PC ARCPLOT can also be viewed or plotted with the PC ARC/INFO STARTER KIT.

Simple Macro Language (SML)

SML is a set of commands that constitute a simple macro programming language for PC ARC/INFO. This includes features such as expression evaluation, handling of input and output, and directing program flow of control. You can use SML to organize repetitive operations into a set of files called macros, which can then be run as often as you wish. You can also use SML to create macros that prompt for input and then take a particular action based on the response given. In addition, SML macros can be used to customize the PC ARC/INFO user interface for user-specific applications including popup and pulldown menu interfaces.

PC ARCEDIT Module

The PC ARCEDIT module is used for interactive digitizing and editing of PC ARC/INFO databases. PC ARCEDIT allows the user to edit the attributes associated with graphic features while these features are displayed on screen. These editing capabilities include moving, adding, and deleting individual vertices in arcs, and reshaping and splining of coverage features. Annotation text can be interactively positioned on coverages to follow the orientation of features. Features are selected for editing either with the cursor or by specifying their attributes, allowing considerable flexibility in making precise coverage changes.

PC ARCEDIT Functional Description

PC ARCEDIT is a unique graphics and database editor. It combines the sophisticated capabilities of computer-aided design (CAD) functions with the power of a geographic database. Both locational as

well as descriptive data can be edited and manipulated within
PC ARCEDIT. These capabilities are important not only for
automating and maintaining geographic databases, but for the creation
of high-quality maps produced as a product of PC ARC/INFO
software's analytical capabilities.

PC ARCEDIT provides all of the facilities for digitizing coverages
with a comprehensive set of graphic editing commands. You can edit
feature attributes, add text annotation, use other database layers as
background displays or attribute transfer, and easily diagnose and
correct digitizing errors.

PC ARCEDIT takes advantage of feature-based editing. You can
move, copy, delete, reshape, and undelete arcs, label points, map
annotation, tics, and nodes. Even individual vertices within a line can
be moved, added, or deleted. Because arcs represent important spatial
features and are the most difficult to represent accurately,
PC ARCEDIT has numerous functions for arc coordinate editing.
Arcs can be reshaped, splined, aligned, and split; corners can be
squared; and lines copied and moved. Cartographic annotation can be
created and edited in PC ARCEDIT to produce production-quality
maps. Annotation text can be scaled, rotated, spaced proportionally
between two points, or shaped to follow curvilinear features.

Feature attribute tables can be created and updated with
PC ARCEDIT. In addition to calculating new values for selected
features, you can transfer attributes from one coverage to another and
interactively update attributes for selected features.

PC ARCEDIT Design
PC ARCEDIT has a simple and consistent user interface. This user
interface allows maximum flexibility with the minimum of command
entry and redundancy. The implementation is based on the concepts
of "edit environments" and "feature-oriented editing."

PC ARCEDIT Edit
Environments
Commands are available to set various edit environments in
PC ARCEDIT. For example, environment-setting commands are
used to tell PC ARCEDIT which hardware devices you will use, the
coverages you want to work with, the kinds of features you want to
edit, and, in general, how you want to interact with PC ARCEDIT.

They are intended to provide maximum versatility for how PC ARCEDIT can be used while minimizing the amount of work for the user. Environment-setting commands let you tailor a PC ARCEDIT work session to meet your immediate needs.

Feature-Oriented Editing

PC ARCEDIT employs feature-oriented editing procedures to increase the speed and efficiency of an editing session. Feature-oriented editing is a three-stage process. First, you specify the feature class to edit. Choices are tic, arc, node, label, or annotation. Then you select specific features within the edit feature class to be edited. Last, you edit the selected features using various editing commands (e.g., copy, move, rotate, and delete).

The feature class and the selected features remain until explicitly changed. Therefore, you do not have to respecify them each time you enter an edit command. In contrast, command-oriented editing requires the command and the features to be respecified each time.

Database Integrity

With PC ARCEDIT, you are always editing a copy of your database. Your changes are never permanent until you commit them by saving them into the original coverage or specifying a new coverage to hold your edits.

PC ARCPLOT

The PC ARCPLOT software module produces a variety of map graphics, from simple screen displays to high-quality cartographic plots for reports and presentations. Features from any number of coverages can be selected for display and drawn with different symbols according to their geographic attributes. The module comes with extensive default symbols and facilities for customizing symbols including a font editor and an interactive line symbol editor. PC ARCPLOT also includes query functions for managing data. You use the cursor to indicate any coverage feature displayed on the screen. That feature's attributes are immediately retrieved and listed. The SML, included with the PC ARC/INFO STARTER KIT, allows the creation of macros to greatly enhance the design of plot files.

Map Display and Output Considerations

There are three different types of graphic output devices capable of supporting map display through PC ARCPLOT: PC graphic monitors, pen plotters, and graphics printers. The output quality and characteristics of each of these device types varies widely across the range of available options. This diversity will influence the way you design your maps for the various devices you install as part of your PC ARC/INFO workstation. Factors such as display resolution, map size and scale, and the range of symbols and colors available for a particular device define the suitability of the various devices for specific applications.

PC ARCPLOT uses the computer graphics interface (CGI) system to send graphics to the PC monitor screen or to a printer, and uses either CGI or the ESRI plot system to send graphics to a pen plotter, depending on the plotter you are using. The PC ARC/INFO *Technical Guide to Hardware Options* contains information on CGI, the ESRI plot system, and the differences between the two.

The ESRI Plot System

The ESRI plot system allows you to store a map as a plot file that can then be sent to a graphic output device. The PC ARC/INFO STARTER KIT and PC ARCPLOT both contain several commands for displaying plot files. Once the plot file is created, it can be sent to a CGI-driven plotter or graphics printer or a CalComp, Hewlett–Packard, Bruning Zeta, or other plotter for hard copy. It can also be displayed on the PC monitor screen.
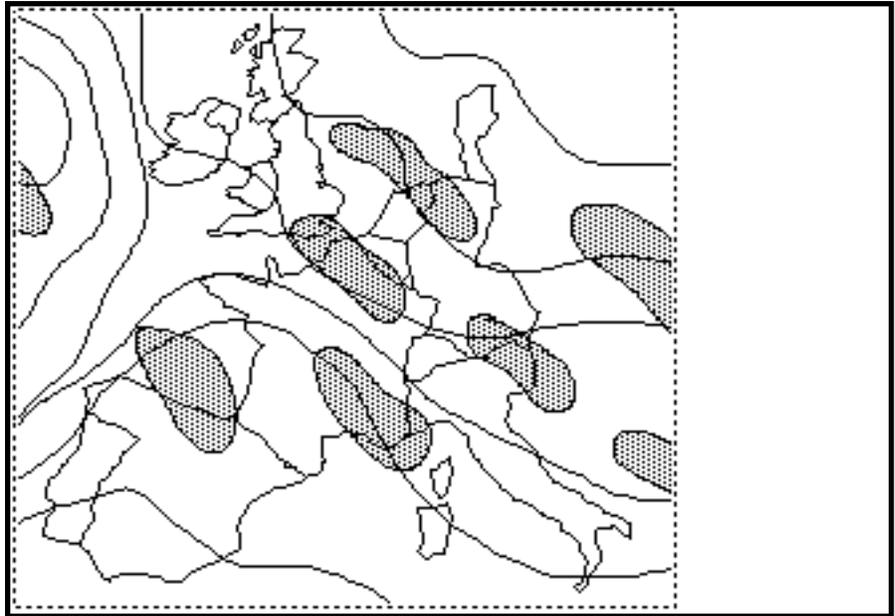
Map Compositions Maps can also be stored as map compositions in PC ARC/INFO. Map compositions are created interactively on your PC's monitor screen and can be stored at anytime during a PC ARCPLOT session. A map composition is actually a subdirectory containing a set of ESRI plot system files. The advantage of storing maps as map compositions is that they can be redisplayed quickly on the screen and interactively edited.

PC DATA CONVERSION Module PC DATA CONVERSION provides special functions permitting data exchange between PC ARC/INFO coverages and a variety of vector and grid cell formats. A direct benefit of this interchange is the ability to integrate data originating from different format sources into one common format. For example, data originating from satellite sensors can be incorporated with data gathered from the ground, and vice versa. PC DATA CONVERSION also includes commands for converting one grid cell format to another and for describing and displaying grid cell files. The coverage-to-grid conversion specifies the number of grid cells in the gridded output, as well as the size of the grid cells. The user also controls which attribute codes are

assigned to grid cells for specific coverage features. In the grid-to-coverage conversion, the polygons in the output coverage are automatically assigned the same attribute codes as the grid cells they represent. The file formats supported by the PC DATA CONVERSION module are detailed below.

Supported Vector File Formats

PC DATA CONVERSION currently supports nine vector file formats:

■ ATLAS: ATLAS*GRAPHICS export format file containing data from the Strategic Mapping Inc. ATLAS*GRAPHICS desktop mapping package. These data may consist of points, lines, and/or closed loop polygons and primary and secondary names.

■ DIME: Dual Independent Map Encoding file containing geographic coordinates of line segments and census area codes. It was used by the U.S. Bureau of Census for the 1980 census and has been replaced by TIGER format files.

■ DLG: Digital Line Graph file used by the U.S. Geological Survey. It includes information such as transportation, contours, and survey boundaries.

■ DXF: AutoCAD ASCII Drawing Interchange format file created by AutoCAD to transfer AutoCAD drawings.

■ ETAK: Etak MapBase files are similar to DIME format files. Each record represents a single linear feature with addresses and census information.

■ IGES: Initial Graphics Exchange Standard (version 3.0 uncompressed ASCII format file) published by the U.S. Department of Commerce.

■ MOSS: Map Overlay Statistical System format file readable by the U.S. Department of Interior's MOSS public domain GIS.

■ SHAPE: ESRI's shapefile format used by ArcView® Version 2.

■ TIGER: Topologically Integrated Geographic Encoding and Referencing system used by the U.S. Bureau of Census to support 1990 census programs and surveys. This file type has replaced the DIME file format used for the 1980 census.

Supported Grid File Formats

The PC DATA CONVERSION product allows the user to transfer data between PC ARC/INFO coverage and grid cell formats. The grid file formats are compatible with the ESRI ARC GRID™ software and with the ERDAS Image Processing System. PC DATA CONVERSION currently supports the following eight grid file formats:

■ Noncompressed ASCII: stores one attribute code for each grid cell on a cell-by-cell basis.

■ Compressed ASCII: stores one attribute code for each group of contiguous cells having the same code value.

■ ERDAS 4-bit data: a binary file that stores two cell values per byte.

■ ERDAS 8-bit data: a binary file that stores cell values one cell per byte.

■ ERDAS 16-bit data: a binary file that stores cell values one cell per two bytes.

■ EPPL7: a binary file that stores cell code values by cell position.

■ GRID Card Image: an ASCII file that stores one attribute code for each cell according to a specified format.

■ MIADS: Map Information Assembly Display System (MIADS) file from the U.S.D.A. Soil Conservation Service.

PC OVERLAY Module

The PC OVERLAY product consists of a full range of geographic information manipulation and analysis capabilities. Coverages are overlaid by geometrically intersecting the features from each coverage to produce a new set of features. Geographic attributes for these new features are combined from the original coverages. For example, overlaying a soils coverage with a land use coverage would reveal information such as the location of residential areas built on unstable soils.
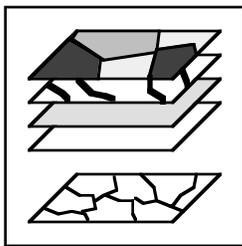
PC OVERLAY is a PC ARC/INFO module designed to add specific geoprocessing and analysis capabilities to a PC ARC/INFO workstation. PC OVERLAY provides advanced capabilities for manipulating and analyzing geographic information including polygon overlay, line and point-in-polygon overlay, buffer creation, dissolve functionality, and more—all based on the PC ARC/INFO georelational, topological data structure.

PC OVERLAY Capabilities

PC OVERLAY provides you with special functions designed for spatial analysis operations, giving you almost unlimited possibilities for geographic information manipulation and analysis. Six functions—CLIP, ERASECOV, IDENTITY, INTERSECT, UNION, and UPDATE—provide a different type of overlay operation, thereby giving you maximum flexibility for geographic data management and analysis. Using PC OVERLAY, you can perform map feature integration of point-in-polygon, line-in-polygon, and polygon-on-polygon data.

In polygon overlay, features from two map coverages are geometrically intersected to produce a new set of features. Map attributes for these new features are derived from the attributes of both of the original coverages, thereby creating new spatial and attribute data relationships.

You can use TABLES or your relational database manager to perform tabular analyses on the resulting data. For example, you can classify residential areas according to their suitability for construction based upon criteria such as their soil characteristics, slope, and proximity to flood zones. You can also overlay zoning, utility lines, flood zones,

crime statistics, and other urban data to track many of the day-to-day activities of a city.
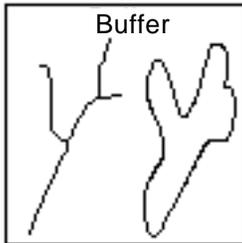
Buffer

PC OVERLAY comes with BUFFER, a function you can use to define a zone of a specified distance around a selected map feature. Different sized buffers can be generated around selected features based on associated attribute data. For example, the widths of environmentally sensitive areas, or greenbelts, around roads can be automatically adjusted based on road class. PC OVERLAY automatically resolves overlapping buffers by checking interior lines to produce continuous buffer zones.
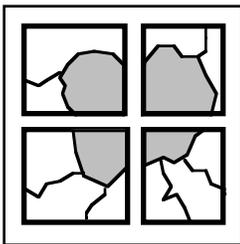
PC OVERLAY provides a means for handling large geographic databases that have a number of layers stored for many map sheets. Included are the MAPJOIN command to merge adjacent maps into one large map, and the SPLIT command that can optionally be used to partition a map into smaller pieces if the user so desires.

Other tools included in PC OVERLAY are DISSOLVE and ELIMINATE. These functions can be used to merge selected polygons in a single map coverage to create new polygon features. For example, ELIMINATE can be used to remove sliver polygons resulting from an overlay operation of two polygon coverages.

Using PC OVERLAY software's RESELECT command, sets of map features can be extracted from a map coverage when their attributes match user-specified spatial or logical criteria. For example, only those water bodies in which the pH content indicates high acidity might be extracted for an acid rain study.

The PC OVERLAY powerful tools are easy to use. Command names accurately describe the operations they perform. For example, INTERSECT merges two maps, keeping only those areas common to both maps; CLIP performs a clip operation on a map to remove features that fall outside the area of a specified "cookie cutter"; and SPLIT splits maps into smaller pieces.

J-5951

PC OVERLAY Functionality

PC OVERLAY features each perform a different type of overlay, providing maximum flexibility for analysis. Arc and point features can be included in overlays.

Spatial Join

■ IDENTITY: The PC OVERLAY identity function computes the geometric intersection of two coverages, preserving only those features overlaying the feature extent of the first specified coverage. Feature attributes from both coverages are joined in the output coverage.

■ INTERSECT: The intersect function in PC OVERLAY computes the geometric intersection of two coverages. Only those features in the area common to both are preserved. Feature attributes from both coverages are joined in the output coverage.

■ UNION: The PC OVERLAY union function computes the geometric intersection of two polygon coverages. All features and attributes of both coverages are preserved.

Buffer Generation

■ BUFFER: The buffer function in PC OVERLAY creates buffer polygons around selected coverage features (points, lines, or polygons).

Feature Extraction

■ CLIP: The PC OVERLAY clip function extracts features from a coverage that overlap another coverage using the clip coverage as a "cookie cutter."

■ ERASECOV: The erasecov function in PC OVERLAY erases features from a coverage that overlaps another coverage.

■ RESELECT: The PC OVERLAY reselect function extracts map features from a coverage based on feature attribute values.

Feature Merging

■ DISSOLVE: The dissolve function in PC OVERLAY merges adjacent polygons that have the same value for a specified item.

■ ELIMINATE: The PC OVERLAY eliminate function merges selected polygons with neighboring polygons by dropping the longest shared border between them.

Map Database Merging
and Splitting

■ MAPJOIN: The mapjoin function in PC OVERLAY combines up to fifty adjacent coverages into one coverage.

■ SPLIT: The PC OVERLAY split function breaks a single coverage into many coverages.

Map Update

■ UPDATE: The update function in PC OVERLAY replaces areas in a coverage using a "cut-and-paste" operation.

PC NETWORK Module

PC NETWORK can be used to analyze networks such as roads, rivers, or electric power grids stored in PC ARC/INFO coverages. It allows you to closely model the behavior of actual networks because attributes such as direction of movement and impedance to movement can be stored for the features in the network coverage.
PC NETWORK consists of two primary functions. ROUTE locates optimum paths to move resources through a network. ALLOCATE locates centers, such as schools or power substations, serving a given network.

PC NETWORK also allows the user to relate data in tabular address files to geographic locations in Etak files, DIME files, and PC ARC/INFO coverages. This capability automatically processes address ranges and solves inconsistencies in street name spellings. With address-matched coverages, any address-based data (e.g., parcel zoning codes, census figures) can be analyzed and mapped with the full range of PC ARC/INFO tools. This means that marketing research, service provision, and mailing list generation can be fully integrated with GIS applications.

PC NETWORK Functional Overview

Networks are systems of connected linear features that form a framework through which resources flow. You can use PC NETWORK to simulate or model many types of networks. For example, water flows from a reservoir throughout a network of pipes, electricity moves from a power station to customers across a network of power lines, and vehicles travel along a network of streets. Once you build the network data set with the necessary information, you can then use it to allocate resources between centers and arcs, or route

resources along optimal paths. PC NETWORK provides the flexibility to support the requirements of a broad range of applications.

Route   The ROUTE function determines optimal paths for the movement of resources through a network. For each route, you define a path by specifying the origin, points through which the route will pass, stops that must be made, and the destination. You can use ROUTE to look at the impact of different routes. For example, what happens if another stop has to be made? Which route can add a stop with the least amount of delay? How should a route be detoured if certain roads are under construction? ROUTE has the tools to help answer all these questions.

Network arcs
Optimum route
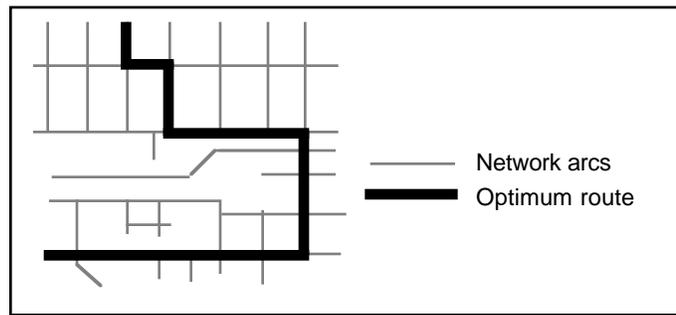
Allocate   ALLOCATE is the PC NETWORK function used to perform an allocation analysis. Allocation finds the nearest center (minimum travel cost) for each link in the network. For example, allocation can be used to find the closest fire station from each street in a city, or to identify the nearest school for each student.

ALLOCATE lets you model how resources are distributed between centers (e.g., schools, fire stations, and reservoirs) and their surrounding arcs (which may represent streets, power lines, waterways, and so on). Each center has a resource capacity. A school has a capacity for a number of students; a reservoir has a capacity for a certain volume of water. Resources along the linear features of the network are assigned to a center based on its capacity. Resources are allocated according to a variety of criteria, such as the distance or time from a center, and the total resource capacity of a center.

Allocation also helps identify potential districts. Districting involves the aggregation of features such as streets or city blocks. This is invaluable for applications such as zoning and redistricting. For example, districting can be used to design delivery districts for newspaper distribution.
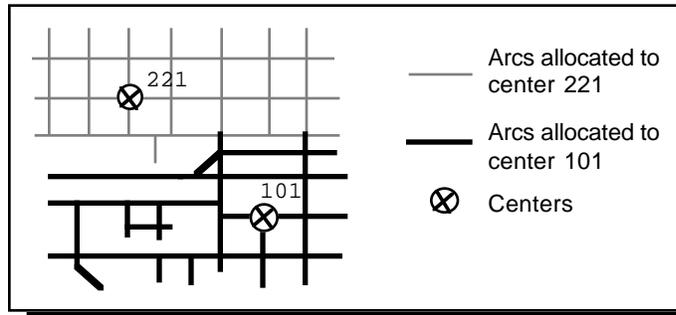
Address Matching   The geocoding functions of PC NETWORK relate data in tabular address files to geographic locations in PC ARC/INFO coverages. A special coverage file is created in PC ARC/INFO to store addresses for every feature. Once you have an address coverage, you can execute a program to help identify possible errors in the addresses.

PC NETWORK also shows you how to prepare any tabular file containing addresses for address matching and, finally, how to match the file to an address coverage. Address matching creates a point coverage containing a point feature for each record in the data file. The features in this point coverage show the location of each student, customer, or other types of data from the tabular address file. You can use this point file in a variety of analyses; for example, add it to a network data set in ROUTE or ALLOCATE or overlay it with other coverages using other PC ARC/INFO functions.

ROUTE, ALLOCATE, and PC ARCPLOT also take advantage of geocoding. In ROUTE and ALLOCATE, you can find a location by entering an address, intersection, or street name. Identifying locations by address is a helpful tool when you know the address of a feature but are not sure exactly where it is located on the map.

PC ARCPLOT has a command to plot the location of addresses by either reading addresses from a tabular database data file or by interactively entering an address. This is an easy way to show the location of, for example, all the companies handling hazardous waste materials within a given area.

Examples of PC NETWORK Applications

PC NETWORK can be applied to a variety of planning, administrative, and operational activities that distribute resources throughout a network.

Vehicular and Pedestrian Routing

- Transportation planners can look at pedestrian needs, such as evaluating the safety of alternative pedestrian routes or identifying areas that are not within a specified walking distance of bus stops.

- School districts can select efficient bus routes and safe bicycle routes. They can also use street network information to identify streets and intersections where safety signs or crossing guards are needed.

- City engineers can analyze alternative garbage collection routes and add new routes.

Emergency Services Planning and Operations

- PC NETWORK can be used to evaluate potential sites for emergency vehicles, thereby minimizing response time.

- Emergency dispatchers can enter a location and determine who should respond, then route emergency vehicles and personnel to that location.

- Planners can use PC NETWORK in their disaster planning, for example, to create evacuation plans and identify emergency vehicle routes.

- Networks can store information about roads that can be used for a variety of purposes. For example, transportation departments can identify and prioritize streets for snow removal, determine routes, and locate areas for displaced snow.

Districting ■ A government office can determine poll locations and polling districts based on the number and location of voters.

■ A company can model the distribution of goods from warehouses to customers to determine whether another center and district are needed for more efficient delivery.

Facility Siting and Design ■ Utility companies can analyze customer needs by modeling the flow of resources within a pipeline network.

■ City planners can calculate service and parking demands for public facilities such as libraries, schools, and shopping centers.

■ Planners can also use PC NETWORK to analyze airport access requirements and assess the impact of possible designs.

Natural Resource Management ■ Water companies can record data about wells, streams, reservoirs, channels, and so on, and use the data to model water availability and distribution.

■ Hydrologists can simulate sources of water pollution and analyze their downstream effects. Networks can also be used to model storm run off.

■ Forestry departments will find PC NETWORK a useful tool in management studies such as testing the feasibility of logging system transportation plans.

■ Wildlife managers can use PC NETWORK to assess the potential environmental impacts on wildlife migration routes.

Geocoding Applications

There are a variety of planning, administrative, and operational activities that use geographic data in the form of addresses.

■ A company can match customer addresses against a coverage of their distributor service areas in order to know which distributor will handle a customer. The information could also be used to perform marketing analysis for each service area.

■ Geocoding can be an important tool in route planning. If a trucking company maintains their stops by address, these stops can be entered as coordinates in ROUTE and used for route analysis.

■ A police department can use geocoding functions of PC ARC/INFO to analyze crimes by address. These locations can be mapped and analyzed with other demographic data.

■ A school district can use geocoding to match student addresses against a street map of a city. Once the homes of students are located, school assignments and busing plans can be created and analyzed.

■ Environmental engineers can identify potential impacts of storage facilities for hazardous materials in populated areas by matching the site addresses to an ARC/INFO coverage containing census data.

PC ARC/INFO Software's SML Developer's Tools

PC ARC/INFO software's SML is a set of commands that constitute a macro programming language for PC ARC/INFO, having some of the features of a high-level programming language. This includes features such as expression evaluation, handling of input and output, and directing program flow of control. You can use SML to organize repetitive operations into a set of files called macros that can then be run as often as you wish. You can also use SML to create macros that prompt for input and then take a particular action based on the response given. SML macros can also be used to customize the PC ARC/INFO user interface for user-specific applications including popup and pulldown menu interfaces.

Note that SML is not a separate module; it is included in the PC ARC/INFO STARTER KIT. The STARTER KIT also includes a toolkit of SML macros that can be used to assist in the development of SML-based applications.

SML Developer's Toolkit

The SML developer's toolkit is a library of general-purpose SML macros that can be used to help you create your own SML applications. The toolkit is a set of generic SML macros that provides many higher-level PC ARC/INFO and SML functions to assist a developer in building SML applications. By providing a set of tested SML utility functions, the developer can avoid having to "reinvent the wheel." All toolkit routines can be used as specified in the command references without modification. However, users are encouraged to modify or customize the toolkit routines for their particular applications.

The SML toolkit is divided into modules categorized by functionality. The source code for each toolkit module is stored in a subdirectory named for that module. The following modules are provided as part of the SML developer's toolkit:

Module Name	Function
COVER	Returns information about coverages.
DATAFILE	Returns information about dBASE data files.
GET	Gets information from a user in a popup window.
ITEM	Returns information about items in a dBASE data file.
MESSAGE	Displays messages to a user in a popup window.
STRING	Manipulates character strings in SML variables.
SYSTEM	Returns information about various system parameters.
MISC	Miscellaneous functions.

SML Compiler

PC ARC/INFO includes an SML compiler and associated compiler tools. While the SML compiler is not a true compiler in the sense that it does not produce stand-alone executable programs (you still have to

run your macros from within PC ARC/INFO), it does perform several compiler-like activities. These activities include code encryption and compression, which allow you to protect your investment in application development; code reduction, which allows you to minimize storage space and improve macro execution speed; and code organization, which allows you to build macro libraries that can be used by other applications. The compiler also checks your code and reports syntax errors and some types of logic errors. In addition to the compiler, there are also two additional compiler tools: a macro linker, which will link your compiled macros and library routines into a single compiled macro file, and a macro librarian, which allows you to organize and manage compiled macros into libraries.

SML Compiler-Related Functions

SML also includes some capabilities that can only be used in conjunction with the compiler. These functions facilitate coding by providing higher-level language constructs, which allow you to develop more structured, readable code. These constructs include commands for structured IF statements such as &IF, &ELSE, &ELSEIF, &END, &AND, and &OR; commands for structured WHILE loops such as &WHILE, &DO, &END, &CONTINUE, and &BREAK; and commands to help manage and maintain your macros such as &DEFINE, &DELIM, &INCLUDE, and &ROUTINE. These functions can only be used in SML macros you compile. When the compiler encounters any of these new commands in an SML macro, it translates these commands into standard SML commands. Once the commands have been translated, the compiler encrypts and compresses the code just like an ordinary macro file and stores the results in a library file (.LML file).

SML Utility Tools

To help you get the most out of SML, ESRI has developed a suite of utility macros that provide a variety of useful functions. These macros are provided in their original source file format (.SML files) and have also been compiled into libraries (.LML files). You can review the original source files for examples of coding technique and structure. Because the macros have already been compiled, you can begin using them right away in your own application development activities. The functions provided by these utility tools include coverage information functions, database data file information functions, database item

functions, string handling functions, DOS functions, user interface, and display list functions. A complete user guide explaining how to use each function comes with the utilities and a sample application user interface for PC ARCPLOT, built using these utility macros, is included as an example of how to use the tools to build application systems.

Tabular Data Management

PC ARC/INFO creates and maintains feature attribute tables compatible with dBASE file format structures. You can use either TABLES, provided with the PC ARC/INFO STARTER KIT, or other database managers for managing and viewing your attribute data. Both TABLES and dBASE can access the same data files and use similar conventions for command names and operations. Both can be used to create, manipulate, list, update, and query attribute tables.

TABLES is a simple data management and retrieval system that helps you to create, manipulate, list, and manage attribute tables. PC ARC/INFO keeps track of and updates coverage feature attribute tables by maintaining the relationships between each coverage feature and a corresponding tabular record. You can use TABLES to manipulate and update each feature's attributes by performing logical and arithmetic operations on the rows and columns of the table.

DBMS Features

There may be occasions when you require the advanced functions of a complete relational database management system such as dBASE. Some of the features supported by relational database management systems include

■ Report Generation: Create reports with column headings, sort and break on various item values, total item fields, and average fields.

■ Screen Management/Forms: These are user-designed forms that appear on your screen. A form may be designed that allows you to enter values to prompts on your screen (e.g., Enter Last Name:, Address:, ZIP Code:). Forms can include rules for entry such as defining a set of legal values or ranges (e.g., AGE > 0) or illegal values; rules for forcing values (e.g., if COVER =

WATER, then SLOPE = 0). Forms can be used for data entry, query, and update.

■ Programs: You can write special programs or macros to perform your analysis and query operations.

Feature Attribute Data PC ARC/INFO stores attribute data about coverage features in four different database data files: a TIC file, a Boundary (BND) file, a Polygon Attribute Table or Point Attribute Table (PAT), and an Arc Attribute Table (AAT). These files hold descriptive information about a coverage and are accessed in TABLES for query, analysis, updating, and reporting.

Also, with TABLES you can create and manage additional related data files.

Tabular structure of a TABLES data file

COUNTY_ID	NAME	POPULATION	AVG_INCOME
101	Clark	108500	6315.23
102	Kern	161683	6700.50
103	Orange	2951377	7251.75
104	Alpine	23255	5493.12
105	San Bernardino	1316888	5991.23

RECORD ◄ (points to row 101)

ITEM ↓

The TABLES Data File Structure The relational database model represents data as a set of "flat" logical tables where columns represent attribute fields, and rows contain all of the attribute values for each record. The rows of a table are called records, and the columns or fields are called items. Each record in the table always has the same items, and each set of columns always represents the same item.

Item Definitions   In TABLES, the specification of the record format for a data file is referred to as the item definitions. Each record can be up to 128 items or 4,000 characters (i.e., bytes) long. Items are defined by their name, the data type, the number of characters (or bytes) used to store values, and for decimal numbers, the number of decimals you wish to display. TABLES uses the following conventions to define the format of each item in a data file:

■ Item name: any name with up to ten alphanumeric characters.

■ Item width: number of spaces (or bytes) used to store item values.

■ Item type: the data type of the item.

■ Number of decimals: the number of digits to the right of the decimal place for item types which hold decimal numbers.

Item Types   The table below shows item types supported by PC ARC/INFO.

Valid Item Types in TABLES

ITEM TYPE	VALID WIDTHS	DESCRIPTION
C (Character)	1 - 254 characters	Character strings are fixed length. The item width defines the number of spaces reserved for a character string.
D (Date)	8 digits	Dates are stored as YYYYMMDD. Dates are displayed as: MM/DD/YY (output width = 8).
N (Numeric)	1 - 16 digits	A number with or without a decimal point. If the item represents a real number, then the decimal point takes up a space in the storage space (thus you can have up to 15 digits).

If you have dBASE, consult your dBASE documentation for more information regarding item definitions.

Windows Extensions

PC ARC/INFO Windows Extensions provide extra functionality for users of Microsoft Windows 3.1. This functionality includes the following:

■ Multitasking: The ability to run more than one application at a time and transfer information between applications provides a more intuitive and efficient work environment for your desktop GIS requirements.

■ Better device driver support: Graphics display and output is performed by Microsoft Windows. Any display or output device that is supported by Windows should also work with the PC ARC/INFO Windows Extensions.

■ Local pan and zoom: Graphics are drawn to a graphics window. Menu commands are provided to pan and zoom within the window. For example, in PC ARCPLOT you may zoom into an area to achieve more precise placement of text during a map composition.

■ Clipboard support: Once graphics are drawn to the graphics window they can be copied to the clipboard. This provides temporary storage for information you want to transfer into other applications. For example, you can transfer graphics from the PC ARCPLOT window to a graphics application (for further editing and enhancement), to a word processing application (for including graphics in a document), or to any other Windows application that supports the clipboard.

■ Patterns: Windows Extensions now allow user-defined shade patterns, editable through an SML utility PAT.CML.

■ Text cut and paste: The ability to cut and paste text allows you to transfer lines of text from one application to another. For example, while developing a series of commands in an SML

macro using a notepad application, you could preview the results of the commands by cutting them from the notepad window and pasting them to the PC ARC/INFO dialog window.

■ PC ARC/INFO Windows Extensions use the same commands as PC ARC/INFO: All of the functionality of PC ARC/INFO is included in the PC ARC/INFO Windows Extensions. With only very minor changes your SMLs, compiled SMLs, and other command files will all perform as before. This includes all the SML Developer's Toolkit commands. You may continue to use your PC ARC/INFO software from the DOS environment as you have in the past, or use both PC ARC/INFO Windows Extensions and PC ARC/INFO for DOS.

■ Multiple PC ARC/INFO sessions can operate simultaneously: You can have multiple sessions of PC ARC/INFO running at the same time, each session using all the multitasking options available within the Windows environment.

■ PC ARC/INFO Windows Extensions use memory more effectively than PC ARC/INFO for DOS: Because Windows provides display and output, there is no need to load any CGI drivers. As a result, PC ARC/INFO with Windows Extensions uses between 50 K and 100 K less RAM than PC ARC/INFO for DOS.

■ Improved hard-copy output support and WYSIWYG printing: You can print the graphics window to any device that Windows supports. If you pan and zoom within the graphics window, what you see in the window is what is printed on the printer.

■ An undo menu option facilitates graphic display: The graphics window options menu contains an undo option that enables you to delete any or all of the displayed graphic elements. This allows simplified "map composition" without using any map composition commands.

■ The dialog and graphics windows can be moved and resized: The command dialog area and graphics area are now displayed in two

separate windows, the dialog window and graphics window, respectively. You can scroll through the dialog window, resize it, minimize it, or perform other standard Windows operations.

■ Improved text font functionality: You can access Windows text fonts via the PC ARCPLOT TEXTFONT or TEXTSYMBOL commands. Any 8-bit Windows font can be used to display graphics text.

■ Windows help: Standard windows help files, accessible through the F1 key for the Windows Extensions.

■ A multifunction WIN command allows your SMLs to interact with the Windows environment. The WIN command allows your SML programs to read and write clipboard text to SML variables, Windows dialog boxes, menus, and message boxes; or start DOS and Windows applications.

PC ARC/INFO Platform Requirements

PC ARC/INFO is designed to serve as a complete GIS workstation. It can be used in concert with ArcView, or ARC/INFO on a host computer, or as a stand-alone system. Using PC ARC/INFO as a workstation, in conjunction with a host version of ARC/INFO, offers several advantages to a host computer environment. For example, you can

■ Use your PCs to access and manipulate parts of larger geographic databases stored and managed on different platforms.

■ Use your PC as a cartographic display and query workstation.

■ Reduce the need for upgrading an existing ARC/INFO platform by offloading some tasks to the PC.

■ Take advantage of other PC software for use with ARC/INFO data sets (e.g., output to business graphics and spreadsheet programs).

■ Make your GIS accessible to your remote sites.

The PC ARC/INFO design objectives provide a set of software products organized by the GIS functions and capabilities one might require from a GIS workstation. For example, the PC could be used as a digitizing station for map coverage creation and file transfer with the PC ARC/INFO STARTER KIT, as a remote map creation and query workstation by adding PC ARCPLOT, and so on. This allows users to purchase only the necessary peripheral equipment and install the necessary PC ARC/INFO software products required to meet their particular needs. Not all hardware options are required for each application, nor are all PC ARC/INFO software products necessarily required.

An important design objective of PC ARC/INFO is to remain as hardware independent as possible. Additionally, ESRI has designed the graphic input and output capabilities of PC ARC/INFO to support as many devices as possible.

The Computer and Peripheral Hardware Components

The PC ARC/INFO workstation is a geoprocessing workstation built around the architecture of an Intel-based 386/486 or compatible computer running DOS. This section describes the PC and peripheral hardware components and identifies how each can be used with PC ARC/INFO. The requirements for each component are also listed.

The Microcomputer
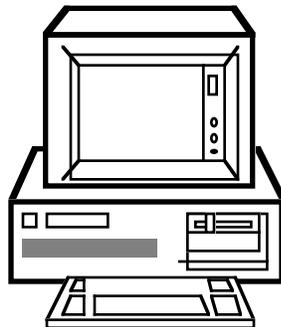
By itself, can be used for:
- Workspace, directory, and file management
- Command execution
- File transfer
- Attribute file creation and update
- Topology creation and update
- Geographic analysis operations (e.g., polygon overlay and buffer)
- Data conversion
- Nongraphic display
- Macro building

Intel 386/486 Compatibility

PC ARC/INFO software is designed, programmed, and tested on IBM-compatible computers. It is expected to work on many compatibles or clones that meet the minimum requirements outlined below. If your PC does not meet the minimum configuration, we cannot guarantee its successful use with PC ARC/INFO.

PC ARC/INFO directly uses many features of DOS on IBM and
compatible personal computers. It is essential that your PC be
successfully running this operating system (version 5.0 or greater) for
successful execution of PC ARC/INFO.

**Minimum
Configuration**

■ Intel-based 386/486 or compatible.

■ High-density floppy disk drive.

■ DOS version 5.0 or higher.

■ 640 K of RAM.

■ 40 MB hard-disk space.

■ Math coprocessor compatible with your computer (PC ARC/INFO
will not run without a math coprocessor).

■ One parallel port (optional, for a printer).

**Recommended
Configuration**

■ Intel-based 386- or 486-based PC.

■ High-density floppy disk drive or CD–ROM.

■ DOS version 5.0 or higher.

■ 4 MB of RAM.

■ 70 MB or more of hard-disk space.

■ 80387 math coprocessor (80486 PCs do not require a math
coprocessor).

■ One parallel and two serial communications ports (one for a
digitizer, another for a plotter and/or host communications).

Cable Requirements

■ One null modem cable for each serial communications port to be used with devices having Data Communications Equipment (DCE) ports.

■ One straight-through cable for each serial communications port to be used with devices having Data Terminal Equipment (DTE) ports.

The Graphics Card and Monitor
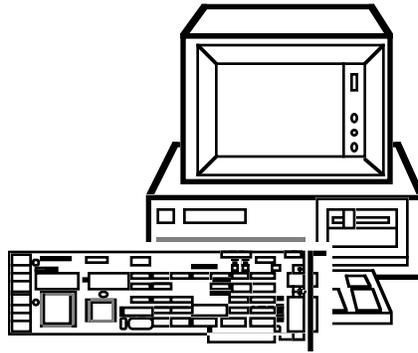
Adds capabilities for:
- Interactive graphics
- Map drawing and query
- Plot file display and review
- Cursor input for simple digitizing and editing

Requirements

■ Uses CGI graphics standard for screen graphics. A CGI software driver must be available for the graphics card.

■ Monitor compatible with your graphics card.

■ PC ARC/INFO Windows Extensions uses Windows graphics drivers.

Note: Not all CGI device drivers have been tested at ESRI.

The Graphic Hard-
Copy Device

Adds capabilities for:
- Map production
- Hardcopy plotting
- Verification maps
- Final production maps
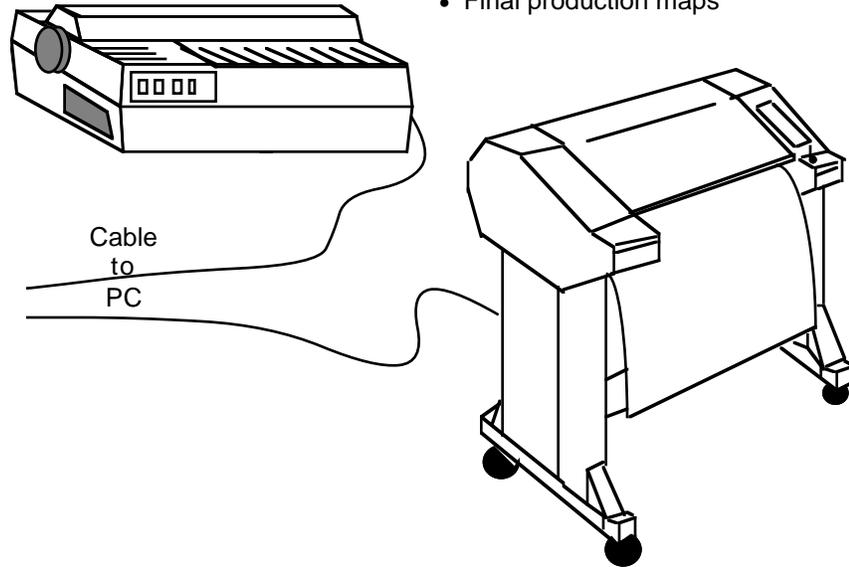
Cable
to
PC

Requirements   ■ Uses CGI graphics standard (a CGI software driver must be available) or ESRI plot system.

■ Connects via cable to either parallel port (printers) or serial port (plotters).

■ PC ARC/INFO Windows Extensions uses Windows output drivers.

Note: Not all CGI device drivers have been tested at ESRI.

The Digitizer

RS-232
Serial Cable
to PC
←

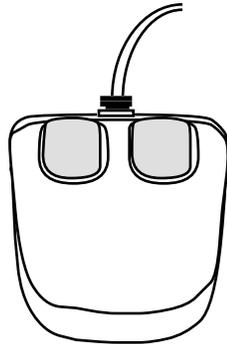**Adds capabilities for:**
• Digitizing
• Interactive editing
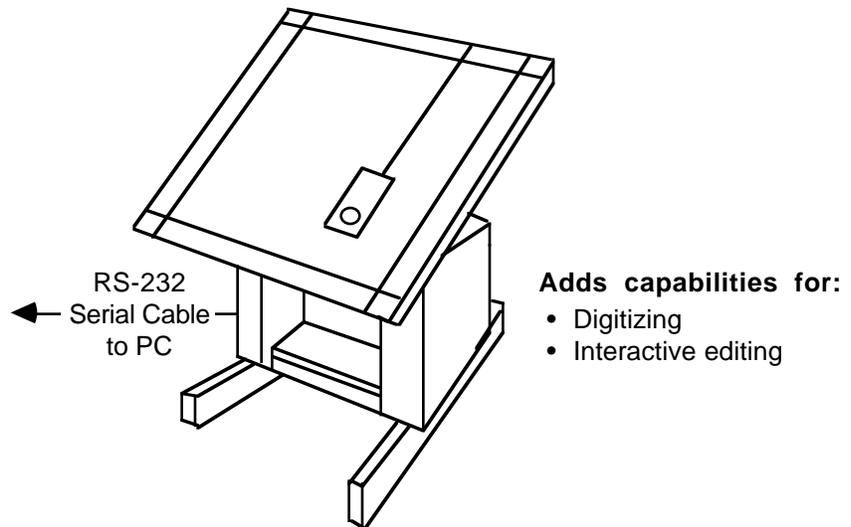
Requirements   PC ARC/INFO will work with almost any digitizer. The following
requirements apply:

■ Must connect to any of the PC's serial communications ports via
RS-232C.

■ Should have a 12+ button cursor (a 4-button cursor will also
work).

■ Must return fixed coordinates (as opposed to relative coordinates).

■ Must be configured for a standard baud rate.

■ Must transmit data in point mode or stream mode.

■ Must transmit data in ASCII format (vs. binary format).

The Mouse

Adds capabilities for:
• Interactive editing
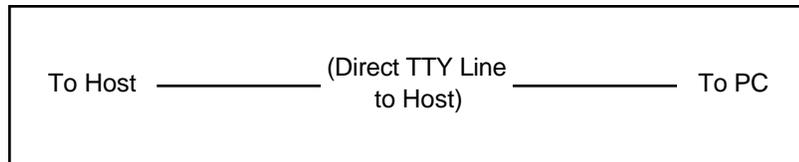• Interactive graphic query
• Plot composition

Requirements ■ Must be compatible with the Microsoft mouse interface.
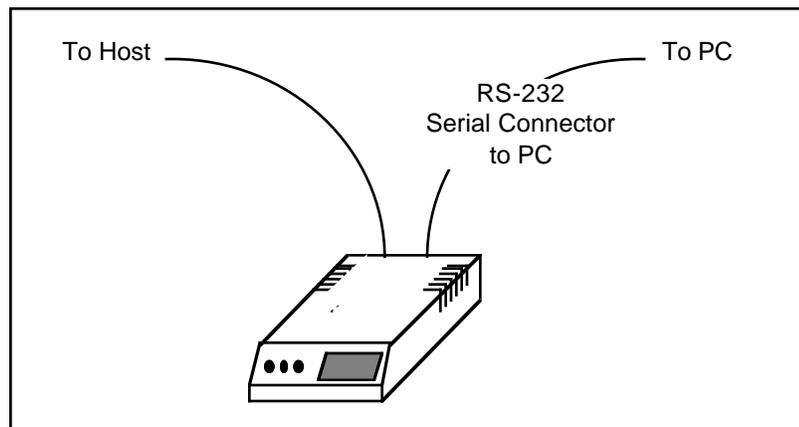■ Connects via cable to either serial port or bus adapter.

The Modem Adds capabilities for

■ Data transfer with host mainframe or minicomputer.
■ Terminal emulation.
■ Connection to ESRI on-line support forums.

To Host —————————— (Direct TTY Line to Host) —————————— To PC

OR

To Host   To PC

RS-232
Serial Connector
to PC

Requirements   ■ Modem (or direct TTY line) to connect to a host computer on which ARC/INFO is installed.

■ The modem connected to your PC must be compatible with the modem on the host.

■ Terminal emulation software (KERMIT is provided with the STARTER KIT as an alternative).

Using PC ARC/INFO on a Network

As the popularity of networking PCs increases, so does the interest in running PC ARC/INFO software in network environments. It is possible to make PC ARC/INFO work on a network if certain conditions can be met and certain precautions are taken.

Memory Management

Usually the most troublesome aspect of using PC ARC/INFO and many other DOS-based applications on a network is not having enough RAM to run both the network software and the applications simultaneously. Since network software must be loaded into memory whenever the network is active, there is often not enough RAM in the lower 640 K of memory to run PC ARC/INFO. While this problem is much less prevalent with DOS 5.0, the solution to "RAM cram" prior to DOS 5.0 requires the use of utility products called "memory managers." These products allow you to load certain types of programs and device drivers into "upper" memory between 640 K and 1 MB on 80386 PCs. By experimenting with a memory manager, it is possible to load enough of these programs or drivers in upper memory, such that there will be sufficient memory for both the network software and for PC ARC/INFO.

There are two memory manager products ESRI has tried with PC ARC/INFO that seem to work reasonably well. These are listed below, along with the vendor name and address for each product.

Hi386
RYBS Electronics, Inc.
2590 Central Avenue
Boulder, Colorado 80301
(303) 444-7927

QEMM-386
Quarterdeck Office Systems
150 Pico Boulevard
Santa Monica, California 90405
(213) 392-9701

The major difference between these two products is that while the QEMM-386 will load the CGI graphic device drivers for PC ARC/INFO into upper memory, it will not access them properly. The Hi386 will correctly load and access the CGI graphic device drivers for PC ARC/INFO. Many other types of device drivers and memory resident programs seem to work with either product. With experimentation, it is possible to get the network software and PC ARC/INFO working, using either product.

Database Management

If you can get the network software to work in upper memory, then you should have no trouble using PC ARC/INFO on the network as long as you adhere to the following precautions. It is important to remember when using PC ARC/INFO over a network that there are no built-in features to control concurrent access to the same database, files, or records. This means that you may encounter unpredictable results if two people are attempting to write to the same database or file at the same time. You will have to either set up appropriate data access policies or implement some other type of arrangement to protect the data. Here are some guidelines for using PC ARC/INFO in a network.

Running PC ARC/INFO on a File Server

You can put one copy of PC ARC/INFO on a file server and run it from other PCs on the network. However, when you start PC ARC/INFO, the software is loaded into the local PC memory.

Note: Your license agreement for PC ARC/INFO is for one copy of the software per machine. If you plan to put PC ARC/INFO on a network server, you are still required to license the number of PC ARC/INFO copies that will be used.

PC ARC/INFO writes important temporary files in the directory in which ARC is started. If more than one user starts ARC from the same directory, there will be a conflict with the temporary files

between users. To avoid this, each network user should start ARC from a unique directory and then change directories, if necessary. It is also important to remember that you should never run two PC ARC/INFO processes in the same directory, at the same time, as the temporary files for the processes may also conflict.

Sharing ARC/INFO Data on a File Server

You can also put ARC/INFO data on the file server and access it from any PC on the network. Appropriate database administration policies and data access procedures will have to be defined to assure data integrity. These policies and procedures are the responsibility of the users of the system and should be defined prior to using PC ARC/INFO in a network environment. If the data are to be accessed for display purposes only, then there should be no problem. However, if the data need to be updated or manipulated, they should be copied to the local PC for processing and then copied back to the file server when the changes or analytic activities have been completed, in accordance with the policies and procedures established for the facility.

Caution: Failure to establish and adhere to appropriate policy and procedure will inevitably result in data corruption or loss. PC ARC/INFO is not designed to assure the integrity of your data when used in network environments.

PC ARC/INFO Networked with a Host Computer

By networking your PC ARC/INFO workstation with a host computer on which the master database and ARC/INFO software reside, the PC can reduce the work load of this host computer when a part of the master database is downloaded to the PC. The full array of PC ARC/INFO software capabilities can then be used to edit, analyze, or manipulate the subdata set. After the work on the PC is finished, the subdata set can be returned to the master database.

In situations where analysis tasks might take too much of the processing capabilities of the PC, the work can be sent back in batch mode to the host computer for further processing. However, if the user is working mainly with single map sheets, we envision the strength of the PC, especially for digitizing, editing, and querying of the map features, to be more than sufficient for interactive processing.

It is not only possible to link PC ARC/INFO workstations to a host computer, but also to other PCs to form a network. These networks provide for shared use of larger databases and fast exchange of information.

PC ARC/INFO Support

ESRI is committed to helping you get the maximum performance from your PC ARC/INFO software. The more you know about our software, the better equipped you will be to use it.

Support Founded on Education

Our commitment begins with quality documentation. Often, the answers to your questions can be found in the user's guides provided with your PC ARC/INFO software. In addition, the *Understanding GIS* self-study workbook is included. Our commitment continues with optional video training kits for all PC ARC/INFO modules. Furthermore, training courses are available at ESRI regional offices, selected universities, and from certified PC ARC/INFO distributors.

Additional sources of information include our newsletter, on-line support, and our annual user's conference. All registered users receive a complimentary subscription to ESRI's quarterly newsletter *ARC News*™. Each issue contains information about our current activities, new software developments, news for user groups, descriptions of many user projects using ESRI software, and much more. The on-line support includes discussion groups on CompuServe and the Internet network. While these discussion forums are not official channels to ESRI's Technical Support Center, you can download technical information, exchange public messages with other users, and join on-line conferences with other users and ESRI staff. All registered users are invited to the week long ESRI User Conference held each spring in Palm Springs. As the world's largest gathering of GIS users, it is a tremendous opportunity for learning and sharing information.

Telephone Support

Registered users in the United States are eligible to receive complimentary support directly from ESRI's Technical Support Center for a period of ninety days. The support period begins with your first call for technical support. Once the complimentary support period has ended, users in the United States may purchase technical

support on an as-needed basis or by subscribing to one of our Annual Support Assistance Programs (ASAP). ASAP is designed to provide desktop users with unlimited access to ESRI's Technical Support Center for one year. Direct support for users outside of the United States is provided by the International Distributor responsible for the licensing and distribution of ESRI's desktop software in your country.

Related ESRI Products	PC ARC/INFO is a full-featured GIS for DOS-based PC compatibles. As a member of the ESRI product line, PC ARC/INFO is fully integrated with other ESRI products, giving you access to an extensible system that meets your needs today and tomorrow. Whether you use PC ARC/INFO as a stand-alone system or in conjunction with other ESRI products, you are assured that your investments in technology and data are completely compatible.
ARC/INFO	ARC/INFO is ESRI's flagship software product, a high-end GIS that consists of a complete geoprocessing toolbox for the automation, modification, management, analysis, and display of geographic information. Optional extension products are available for surface modeling, raster modeling, network analysis, and coordinate geometry applications.
ArcCAD	ArcCAD is a revolutionary software product that combines ARC/INFO capabilities with Autodesk, Inc.'s AutoCAD software, and allows the user to display, modify, and query ARC/INFO databases, all within the familiar AutoCAD environment. ArcCAD stores geographic data in native PC ARC/INFO format and brings PC ARC/INFO software's comprehensive geoprocessing capabilities to the AutoCAD environment.
ArcView	ArcView is a highly affordable, easy-to-learn software tool that enables you to quickly select and display different combinations of data for creatively visualizing information. Available on PC-compatibles, Apple Macintoshes, and a variety of UNIX workstations, ArcView works directly with your ARC/INFO or PC ARC/INFO-formatted databases.

ArcData ArcData is a data publishing program that supplies ready-to-use geographic and demographic data in the world's most widely used and preferred GIS format, ARC/INFO. Many vendors offer hundreds of different data products designed to fit global, national, regional, and local needs, and include national political geographies, census geographies, satellite imagery, postal geographies, business and marketing geographies, and much more. Whether you use ArcData products as off-the-shelf, complete solutions or as a basis for developing more specialized databases, they save you time and money.

Summary

PC ARC/INFO is a full-featured vector GIS for DOS or Windows-based personal computers. Like ARC/INFO, PC ARC/INFO offers a generic toolkit of functionality that can be applied to a myriad of applications.

Typical PC ARC/INFO applications are

■ Data entry and update of a company's geographic data.

■ Research and education in a university geography department.

■ Development and analysis of the general plan for a small city.

■ Mapping species distribution at a nonprofit preservation organization.

To purchase PC ARC/INFO software, or obtain additional information on GIS software solutions, contact your local distributor or ESRI.

■ Telephone   1-800-447-9778
■ Electronic Mail   *info@esri.com*

ESRI GIS SOLUTIONS

For over 25 years ESRI has been helping people manage and analyze geographic information. ESRI offers a framework for implementing GIS in any organization with a seamless link from personal GIS on the desktop to enterprisewide GIS client/server and data management systems. Our GIS solutions are flexible and can be customized to meet the needs of our users. ESRI is a full-service GIS company, ready to help you begin, grow, and build success with GIS.

ArcView® *software enables users to quickly select and display different combinations of data and to creatively visualize information from their desktops.*

ARC/INFO® *software is a high-end GIS with capabilities for the automation, modification, management, analysis, and display of geographic information.*

PC ARC/INFO® *software is a full-featured GIS for DOS and Windows™-based PCs.*

ArcCAD® *software links ARC/INFO, the world's leading GIS software, to AutoCAD®, the world's leading CAD software.*

SPATIAL DATABASE ENGINE (SDE™) *software is a high-performance spatial database that employs a true client/server architecture to perform fast, efficient spatial operations and management of large, shared geographic sets.*

For more information, call
1-800-447-9778 (1-800-GIS-XPRT)
Send E-mail inquiries to info@esri.com
Visit ESRI on the World Wide Web at http://www.esri.com

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