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Development of a Data Exchange Protocol between EMME/2 and ARC/INFO

Abstract

Sharing spatial information between a transportation planning software (like EMME/2) and a GIS (like ARC/INFO) is a complicated task, both in terms of data structure and informational needs.

INRO Consultants established guidelines to standardize the creation of a transportation planning coverage and developed a set of tools to transfer information between EMME/2 and ARC/INFO.

In this paper, we identify the motivation for the development of a data exchange procedure between ARC/INFO and EMME/2. Then we identify the corresponding data items in ARC/INFO and EMME/2, discuss the communication process for exchanging data and computed results between the two systems, and develop a user-friendly interface to realize the data exchange. As a concrete example, we present a prototype of the system for the EMME/2 road and transit network, which can be used to display the attributes and results obtained in EMME/2. Future developments and possible applications of this system are discussed as well.

A) Motivation

GIS software packages are used mainly as a tool for managing spatial information and performing associated computations. They have good database management features and boast effective manipulation and representation of spatial data.

Unfortunately, for the purposes of transportation planning, they offer a limited set of tools. The transportation planner deals with an aggregate representation of networks (current and future) and wants to compare different scenarios in order to make a recommendation. This information cannot be obtained from a typical GIS. To assist the planner in more complex and specific tasks other software packages, like EMME/2, offer a working environment that incorporates some spatial data manipulation features and, above all, provide strong network assignment and demand modeling capabilities.

Since much effort is usually invested in the creation of databases (be it at the city, county, or state levels) to manage spatial information within a GIS, it would be beneficial to be able to share data and analysis results in order to expand the database.

It is costly to maintain different databases for different applications in different departments. Therefore, the goal is to integrate these databases into a common multi-purpose database. Our efforts serve as a contribution towards the compatibility of spatial information, as requested by the GIS community.

In this paper we consider ARC/INFO as the GIS software package, and EMME/2 as the transportation planning software package.

B) Objectives

The objectives of this project are:

- To establish the relationship between features and attributes in both software packages;
- To establish guidelines to create a standard information structure that corresponds to a transportation planning infrastructure in ARC/INFO;
- To implement a prototype application following these guidelines to ease the data transfer process between the two software packages.

C) Data models of ARC/INFO and EMME/2

C1) EMME/2 road and transit network data model

The EMME/2 data model is divided into three main categories:

- Network: it describes the transportation infrastructure, and is defined by the following elements:
  - modes: they are grouped in four types:
    - auto mode
    - transit modes (ex.: bus, train, tramway)
    - auxiliary transit modes (ex.: pedestrian)
    - auxiliary auto modes (ex.: trucks, high occupancy vehicles)
  - base network: both road and transit networks are highly integrated in what is called the base network; it consists of nodes and links, which are divided as follows:
    - a regular node may correspond to an intersection, a transit stop, etc.
    - a centroid is a node associated with a zone: all trips from and to the zone originate and end at that node
    - a link is a directional connection between two nodes, using one or more modes
    - a connector link is a link which connects a centroid to a regular node
  - turns: they represent possible turning movements at an intersection; some of them may be penalized or prohibited;
  - transit vehicles: they correspond to vehicles or combinations of vehicles that may be used by a transit line (e.g.: regular or articulated buses, trains consisting of several cars, etc.);
  - transit lines: they correspond to regular transit services (fixed frequencies and travel times) on a fixed itinerary; each itinerary is defined as a sequence of transit segments, each of them

corresponding to a link in the base network.

Each of these elements may have attributes, which are subdivided into three types:

- standard attributes are a part of the basic network data. These attributes have predefined names, most of them have a special meaning (e.g.: link length), and include three user data items.
- extra attributes are other user-defined attributes. They are created by the user, who gives them a name, a description and a default value.
- assignment results, when available, are stored with some network elements (links, turns, and transit line segments).

This network data set forms a scenario, and an EMME/2 data bank may contain several scenarios. For example, one scenario may correspond to the base year, while others may represent different network variants envisaged for future years.

EMME/2 stores information in a "vertically" structured data format (each element attribute, such as link length, is stored in a vector). Compared to a "horizontal" structure, where a row in a table contains all the attributes of an element, a "vertical" one makes efficient use of the available computer memory space and also drastically reduces the number of disk accesses required to quickly and selectively access the EMME/2 data bank.

- Matrices: they are the standard means by which EMME/2 stores zone-related data:
  - Matrices can be used to store input data (demand, socio-economic data, etc.) as well as results (travel time, travel distance, etc.);
  - There are four types of matrices: full (O-D), origin, destination, and scalar;
  - A zone is identified by a centroid number; zones can be grouped into zone groups which are defined as sets within ensembles.
- Functions: they are data structures which contain algebraic expressions describing functional relationships. They are divided into six classes:
  - an auto volume-delay function gives the travel time (in minutes) on a link of the auto network, as a function of link attributes;
  - a turn penalty function gives the time for a turn (in minutes), as a function of turn attributes;
  - a transit time function gives the travel time (in minutes) on a transit line segment, as a function of link, vehicle, line, and segment attributes;
  - an auto demand function gives the auto demand (in persons), as a function of matrices and zone numbers;
  - a transit demand function gives the transit demand (in persons/hour), as a function of

matrices and zone numbers;

- a user-defined function is not linked to the data in the data bank. It permits the user to enter, manipulate and display functions of his choice by using general keywords.

C2) ARC/INFO network data model

ARC/INFO supports many data models (coverage, grid, triangulated irregular network, CAD, etc.) to represent geographic information. A coverage is for vector data, and supports georelational models, that is, it contains both the spatial and attribute data for geographic features. The feature classes, used in the coverage to store geographic features, are:

- points for storing punctual features;
- arc, node and route-system for storing linear features;
- polygon and region for storing areal features.

ARC/INFO stores coordinates only for points, arcs, and nodes, and uses topological relationships for defining networks and polygons. Here are the three topological concepts used to define features:

- The arc-node topology defines the connectivity of arcs; arcs are composed of two nodes and up to 500 vertices, and are connected at nodes; a set of connected arcs can define a network (streets and intersections);
- A polygon is defined as an ordered series of connected arcs, but the first and the last arcs must connect (area definition topology); for each arc, the left and right polygons are identified (left-right topology).

Networks and polygons form the framework for defining the two other feature classes:

- Route-systems are defined as an ordered series of arcs, however the first and last arcs need not connect. They are composed of:
  - Routes, which are linear features composed of one or more sections;
  - Sections, which may be an arc or portion of an arc used to define a route; a section is the most basic component of a route-system.

  In the dynamic segmentation model, route-systems are used to model linear features using route-measures and events, and to associate multiple sets of attributes to any portion of a linear feature.
- Regions are defined as a set of polygons.

To represent transportation networks, ARC/INFO uses the previous feature classes as the basis of the NETWORK data model. The model consists of:

- network links representing the interconnected linear entities that are the conduits for transportation, they are modeled as ARC/INFO arcs; links are bidirectional (by the means of from-to and to-from link impedances: if the impedance is positive, then flow can travel in that direction, if it is negative, the flow is forbidden); the network link attributes are stored in the arc attribute table (AAT);

- network nodes representing the endpoints of network links; they are modeled as ARC/INFO nodes; the node attributes are stored in the node attribute table (NAT);

- stops, which are nodes representing locations visited in a path (shortest path algorithm) or tour (traveling salesman problem); stops and stop attributes are maintained in INFO files, referred to as stop files;

- centers, which are nodes representing resource supply or some type of attraction; centers and center attributes are maintained in INFO files, referred to as center files;

- turns representing transitions from one network link to another network link at nodes; turns are listed and maintained separately in a coverage INFO file called a turntable (TRN).

Since the transit system uses some of the arcs of the transportation network and is defined by different data attributes, it is best represented by dynamic segmentation (route-system and events). It is composed of the following elements:

- a transit line is represented as a route; the transit line attributes are maintained in the route attribute table (RAT);

- a transit line segment is represented as a section; the segment attributes are maintained in the section table (SEC).

C3) Relationship between data elements and features contained in both models

The following table contains general object descriptions found in a transportation planning infrastructure, and the corresponding element in both software packages:

Objects	ARC/INFO items	EMME/2 items
street	route	-
street section	section	-
directed street section	arc	link
intersection	node	node
traffic light	node	node
transit line	route	line
transit section	section (within a route)	segment (within a line)
transit stops	point event, node	node
region	region	zone, group, ensemble
TAZ (traffic analysis zone)	polygon	zone
Origin and Destination	node, center	centroid
O-D matrix	-	matrix
supply center	node	centroid
demand center	node	centroid
turns	turn (arc-node-arc)	turn (at_node-from_node-to_node)
arc-to-arc barrier	arc selection set	turn penalties
drawing	polyline, patterns	annotation, demarcations
text	annotation	annotation

C4) Differences and "inconsistencies" between the two data models

ARC/INFO	EMME/2
- arcs can be bidirectional (with directional attributes)	- links are unidirectional (represent flow of traffic)
- each arc can be composed of up to 500 vertices, including from-node and to-node	- each link is composed of an i-node (from-node) and a j-node (to-node)
- a node is created by the CLEAN command when two arcs crossover (polygon topology)	- links can pass one over another
- bus stops can be stored as point events which are not necessarily represented by nodes at the arc-node level	- bus stops must be represented by a node
- all feature attributes are stored in a	- element attributes are stored in a "vertical"

relational-like data base ("horizontal" structure) that is managed by the INFO information manager (or other external relational data base managers)	structure
- tables are mostly user-defined depending of the user applications and data needs	- many of the attributes are already defined (standard attributes)

D) The communication process

Although it seems natural to consider a direct communication process between an ARC/INFO workspace (Master GIS) and an EMME/2 data bank, there are several difficulties involved. For example, given an ARC/INFO workspace where there are a road network and a transit network, we still have to define traffic zones and decide on a certain aggregation of the network representation for some specific applications. This can only be carried out by the transportation planners and not by an automatic process. In order to establish an automatic process that can exchange information between the two software packages, we decided to establish an EMME/2 coverage in ARC/INFO with a "one-to-one" relationship with the EMME/2 network elements. The communication paths are shown in Figure 1. Note that there is no specific sequence in this figure.

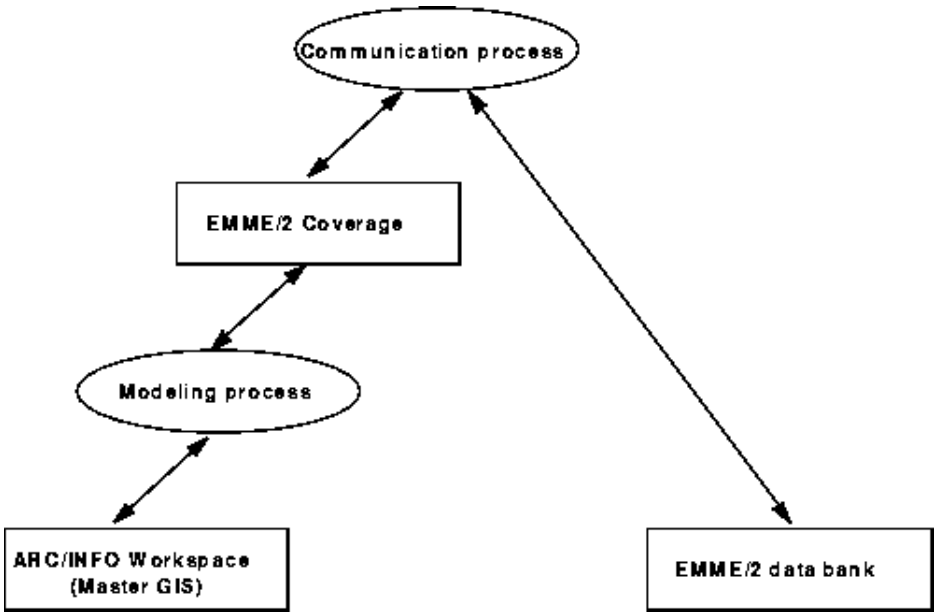

Figure 1 - General components involved in the joint utilization of ARC/INFO and EMME/2

The ARC/INFO workspace is considered to be a database created independently by ARC/INFO users from their organizational point of view (policy, MIS standards, etc.). Therefore, one may expect a variety of data definitions and data contents stored in this database. The representation of real-world entities may vary in detail.

The EMME/2 data bank is an aggregate representation of the transportation infrastructure, the economic activities and the socio-economic characteristics of the urban area studied.

The EMME/2 coverage follows the EMME/2 network representation. This implies:

- the base network is an aggregate representation of reality and must respect the one-to-one relationship of the transit network (one stop equals one node); the road infrastructure and attributes are stored at the arc level;

- for the transit network, the infrastructure is represented by a route-system where one segment corresponds to one arc; the itinerary will be kept within a transit line on the basis of the section measures;

- for the zones, all data will be stored in a different coverage (because we need to use the CLEAN command to create the polygon topology, and that would create unnecessary nodes in the base network).

The goal of the communication process is to integrate the two databases in a standard way. There are four cases to consider:

- Case one: There is an EMME/2 data bank but no ARC/INFO workspace. One must extract information from the EMME/2 bank and then convert it into an ARC/INFO coverage.

- Case two: There is an ARC/INFO workspace but no EMME/2 data bank. The goal is then to export the ARC/INFO coverage and convert it into an EMME/2 format.

- Case three: There is neither an ARC/INFO workspace nor an EMME/2 data bank. In this case, the user will decide which one to establish first depending on the objectives of the applications and timing considerations. In that case, one sees the importance of submitting guidelines to build one and the other.

- Case four: Both the EMME/2 data bank and the ARC/INFO workspace exist but have been built separately. This is the most complex case. The integration of these two networks can be done by using techniques such as rubber sheeting (stretching the coordinates of the elements of one network to match the elements of the other), conflation (aligning two coverages and transferring the attributes from one to the other), etc.

The modeling process represents the transformation of the user network in the master GIS into the EMME/2 coverage. This can be complex or simple depending on the design of the database. In order to create the EMME/2 coverage from an existing master GIS, the planner has to take a road network coverage and convert it into an aggregate representation by removing unnecessary details, merging some arcs together and reevaluating attributes. Also, if the transportation network includes a transit network, the planner has to take the route-system representing transit lines and split underlying arcs at bus stops to create a node. This process must include a procedure to keep the correspondence between the user network and the base network of the EMME/2 coverage. The modeling process is specific to the organization where it is implemented.

E) Data structure of the EMME/2 coverage

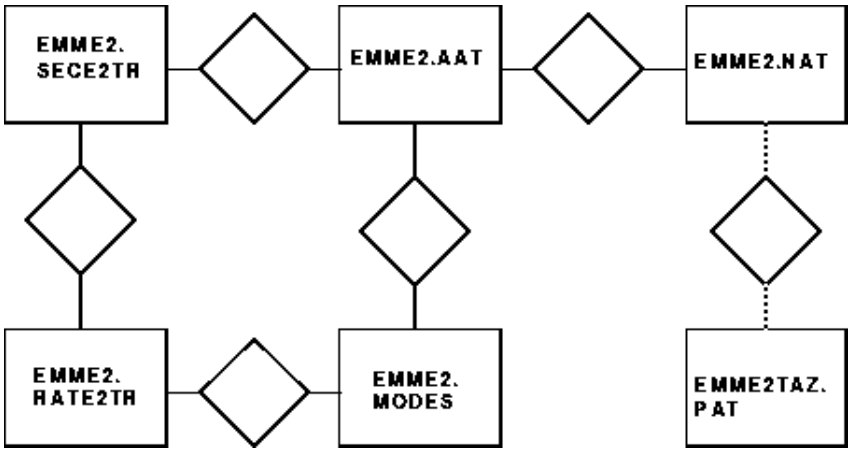

Figure 2 - Entity-Relationship Diagram

The EMME2.AAT table stores information related to the arcs of the EMME/2 coverage, and its definition follows the NETWORK data model of ARC/INFO. This implies that, since one arc may be travelled in two directions, each attribute of the arc is represented by a from-to attribute and a to-from attribute. The first six fields of this table are standard and contain internal information. They are created by ARC/INFO when building the arc-node topology. The EMME2-ID field is used to store a unique arc identifier number in order to maintain the correspondence between an arc in ARC/INFO and a link in EMME/2. If the EMME/2 coverage is derived from an existing user coverage in the master GIS, then this number is already present and can be directly exported to an extra attribute in the EMME/2 data bank. However, if the EMME/2 coverage is derived from an EMME/2 network, this identifier must be evaluated in EMME/2. Since a two-way street, represented by two links in EMME/2, is represented by only one arc in ARC/INFO, one needs to compute the identifier based on the internal link index of the EMME/2 data bank, and keep the result in an extra attribute (by default @arcid). The EMME2-ID is computed as follows:

- the link table is scanned in ascending internal index number, and all links are assigned an index number;

- for all two-way links, the first link encountered will be assigned a positive identification value while the reverse link (the link in opposite direction) will be assigned zero minus this same value.

This is easily done with an EMME/2 macro. This distinction is required in order to establish which information is related to the from-to direction and which to the to-from direction. The table definition of EMME2.AAT can be found in Appendix A.

The EMME2.NAT table stores information related to nodes. The first two fields of this table contain internal information, also created when building the arc-node topology, and are maintained by ARC/INFO. The EMME2-ID field is used to store the EMME/2 node number. Again, if the EMME/2 coverage is derived from an existing user coverage in the master GIS, then this number is already present, and can be directly used as the node identifier in EMME/2. However, if the EMME/2 coverage

is derived from an EMME/2 network, this identifier should be computed using the relation between FNODE# and TNODE# fields of the EMME2.AAT table, and the EMME2# field of the EMME2.NAT table. Since the INODE and JNODE fields of the EMME2.AAT table contain the EMME/2 node number and are related to the FNODE# and TNODE# respectively, the EMME2-ID is computed as follows:

- the FNODE# and INODE information is extracted from the EMME2.AAT table and stored in an INFO file;
- the TNODE# and JNODE information is extracted from the EMME2.AAT table and appended to the same INFO file;
- this INFO file is joined to the EMME2.NAT table based on the internal node number.

The user must also indicate, in a field called CENTROID, which of these nodes are considered as centroids/centers (with a value of 1) and which as regular nodes (value of 0). The table definition of EMME2.NAT can be found in Appendix A.

The EMME2.MODES table is used as a lookup table for the transportation mode definitions, and is maintained by the user. It may be used for query purposes of mode on arcs (EMME2.AAT) or transit lines (EMME2.RATE2TR). It could be directly obtained from the EMME/2 mode definitions. The table definition of EMME2.MODES can be found in Appendix A.

The EMME2.RATE2TR table stores information about transit line definitions, while the EMME2.SECE2TR table is used to store information about transit line segments. The first field of RAT and the first seven fields of the SEC table are maintained by ARC/INFO and are created when a route-system is built. Because we decided to keep a one-to-one relationship between a section and an arc, we have the same relationship between a section (in ARC/INFO) and a segment (in EMME/2). The E2TR-ID field of the EMME2.SECE2TR table is used to store a unique section identifier number which assures the correspondence between a section in ARC/INFO and a segment in EMME/2. If the EMME/2 coverage is derived from an existing user coverage in the master GIS, then this number is already present, and can be directly exported to an extra attribute in the EMME/2 data bank. However, if the EMME/2 coverage is derived from an EMME/2 network, this identifier must be evaluated in EMME/2. One needs to compute the identifier based on the internal segment index of the EMME/2 data bank and keep the result in an extra attribute (by default @segid). The E2TR-ID is computed as follows: for each transit line, the value of each segment within the line is assigned to the internal segment number plus the value of a variable; this variable contains the maximum segment value of the previous transit line evaluated. We thus obtain a unique value for each segment within all transit lines. This is easily done with an EMME/2 macro.

The ROUTE-ID field (of the EMME2.SECE2TR table) contains an integer value representing the transit line number. It is equivalent to the E2TR-ID field of the EMME2.RATE2TR table. In EMME/2, transit lines are identified by a six character string (LINENAME field of EMME2.RATE2TR table) while in ARC/INFO a route is identified by an integer. When exporting to EMME/2, the ROUTE-ID can be directly used as the transit line identifier in EMME/2. When exporting from EMME/2 to ARC/INFO, however, a unique numeric line identifier must be computed from the internal line number. The table definitions of EMME2.RATE2TR and EMME2.SECE2TR are in Appendix A.

The EMME2.TRN table stores information related to turns and is created by the TURNTABLE command. The first seven fields of the TRN table contain internal information and are maintained by ARC/INFO. The TURN-ID field contains a unique value for each turn, and is evaluated with the expression: ARC1-ID * 100000 + ARC2-ID. It is used to facilitate the joining of attribute tables if specific turn attributes are coming from the EMME/2 data bank. The table definition of EMME2.TRN is in Appendix A.

The EMME2TAZ.PAT feature table stores information related to traffic analysis zones. The first three fields of this table are standard and contain internal information. They are created by ARC/INFO when building the polygon topology. The EMME2TAZ-ID field is used to store a unique zone identifier number in order to keep the correspondence between a polygon in ARC/INFO and a zone in EMME/2. Since this zone number is also related to the centroid number, you can relate information from the EMME2TAZ.PAT table and the EMME2.NAT table. If the polygon data is coming from an EMME/2 annotation file, the centroid number must be indicated at the beginning of the polygon definition. Appendix A contains the table definition of EMME2TAZ.PAT.

Other attributes (assignment results, extra attributes, ...) can be added as an additional column in the corresponding table. The name of the column should be the same as the name found in EMME/2.

We have chosen to store the road network information in the AAT instead of in a route-system since it is closest to the one-to-one relationship and since many ARC/INFO users are probably familiar with the NETWORK data model.

F) Implementation

As a test bench, we have implemented a prototype that extracts, converts and inputs ASCII data from EMME/2 to ARC/INFO (E/2->A/I) and vice versa (A/I->E/2). For this implementation, we have considered the first three cases mentioned in the communication process section. The fourth case is more complex, and is not addressed by the prototype. EMARC, the name of the prototype, is composed of:

- AML (Arc Macro Language) scripts and menus: they are used to
    - establish the basis for the graphical user interface (GUI)
    - create the EMME/2 coverage and add the feature attributes
    - call external scripts and macros for data extraction (E/2->A/I) and conversion
    - perform some GIS operations
    - extract coverage data and convert it to EMME/2 format (A/I->E/2)
- EMME/2 macros: they are used for exporting and importing EMME/2 data
- AWK scripts: they are used to convert ASCII outputs from a software into a format readable by the other

The prototype is divided in two main parts: the EMME/2 to ARC/INFO interface and the ARC/INFO to EMME/2 interface.

EMME/2 to ARC/INFO interface

This option converts a specified EMME/2 scenario into an EMME/2 coverage in ARC/INFO. Four different types of information can be converted: the base network and related attributes, the turns and related attributes, the transit lines and related attributes, and the zones and related attributes.

The base network and related attributes

This sub-option allows the user to create the EMME/2 coverage and to input spatial data (arcs and nodes). It uses AML, EMME/2 macros and AWK scripts to punch spatial and standard attribute data from the EMME/2 data bank, convert all punched data into an ASCII format readable by ARC/INFO, create the EMME/2 coverage, input spatial information into that coverage with the GENERATE command, and create the arc-node topology. Also, all standard attribute information is entered into the AAT, the NAT, and mode table, and additional fields are computed to keep the correspondence between the two data bases. The user also has the possibility to add other attributes (assignment results, extra attributes or other derived attributes) to any feature tables by specifying the name of the attribute.

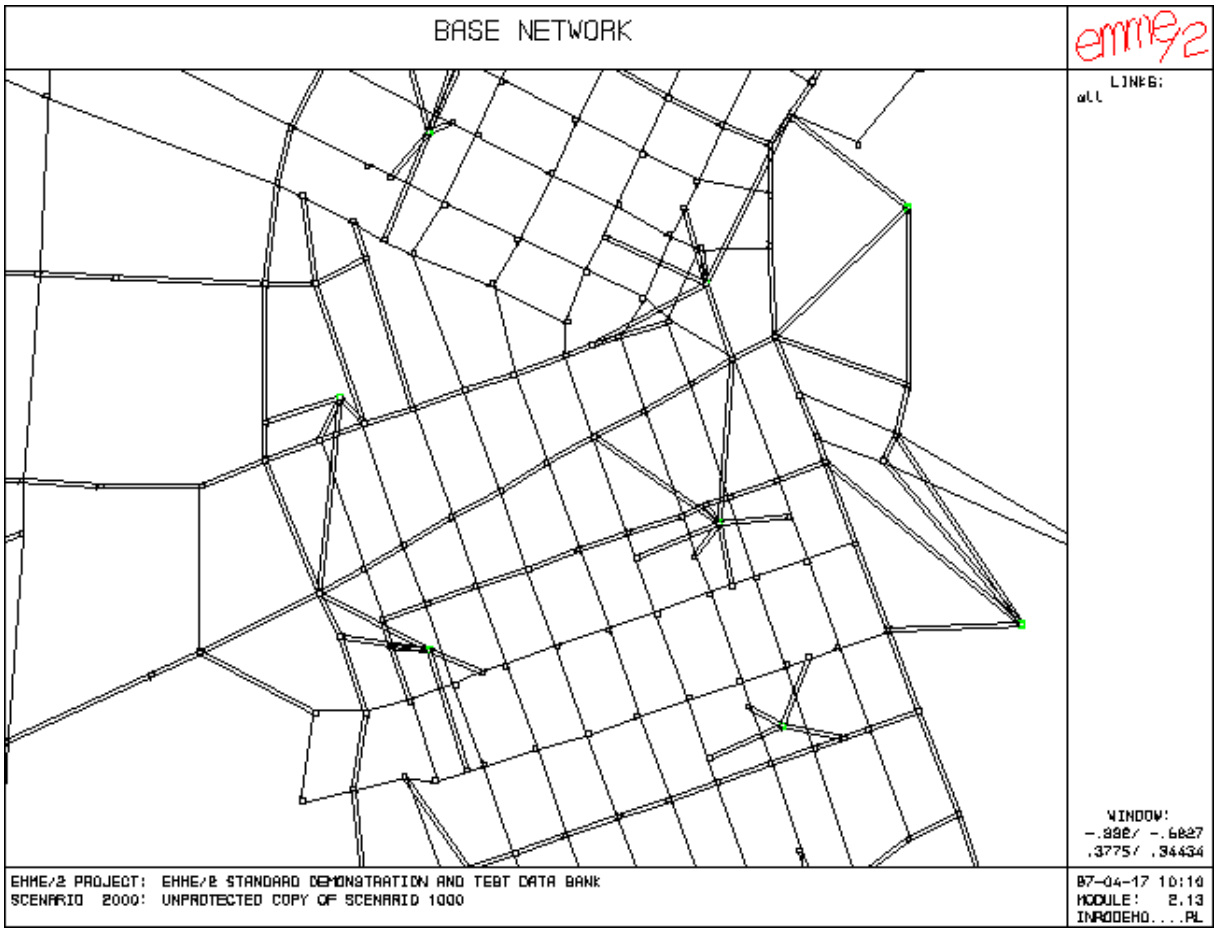

Figure 3 - Base network in EMME/2

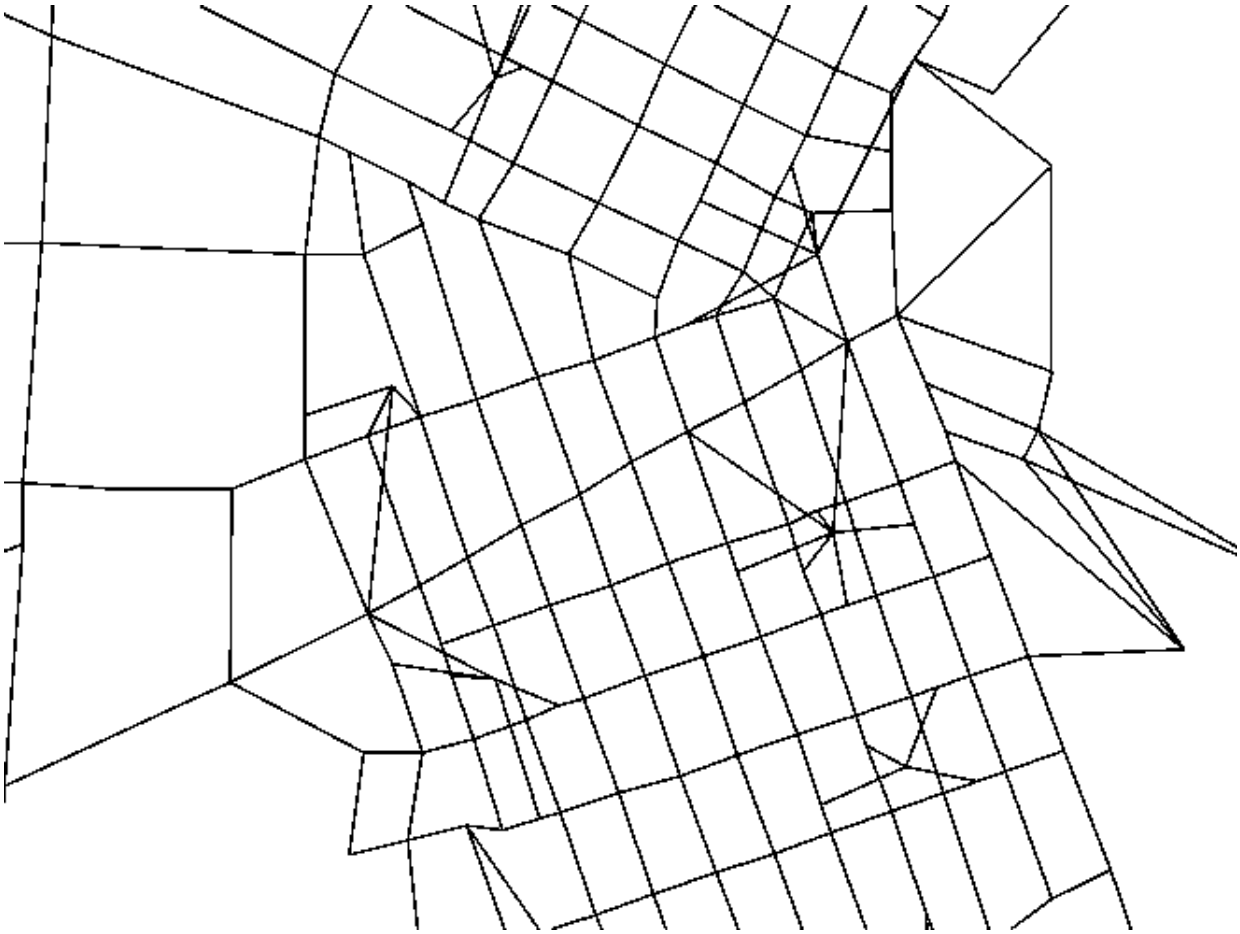

Figure 4 - Base network in ARC/INFO

The turns and related attributes

This sub-option allows the user to input turn definition and attribute data. It uses AML, EMME/2 macros and AWK scripts to punch all turn data and standard attribute data from the EMME/2 data bank, convert all punched data into an ASCII format readable by ARC/INFO, create the coverage TRN file using the TURNTABLE command, and inputs attribute data into that file. The user also has the possibility to add other attributes (assignment results, extra attributes or other derived attributes) to the TRN table by specifying the name of the attribute. The information contained in this table cannot be plotted in ARC/INFO.

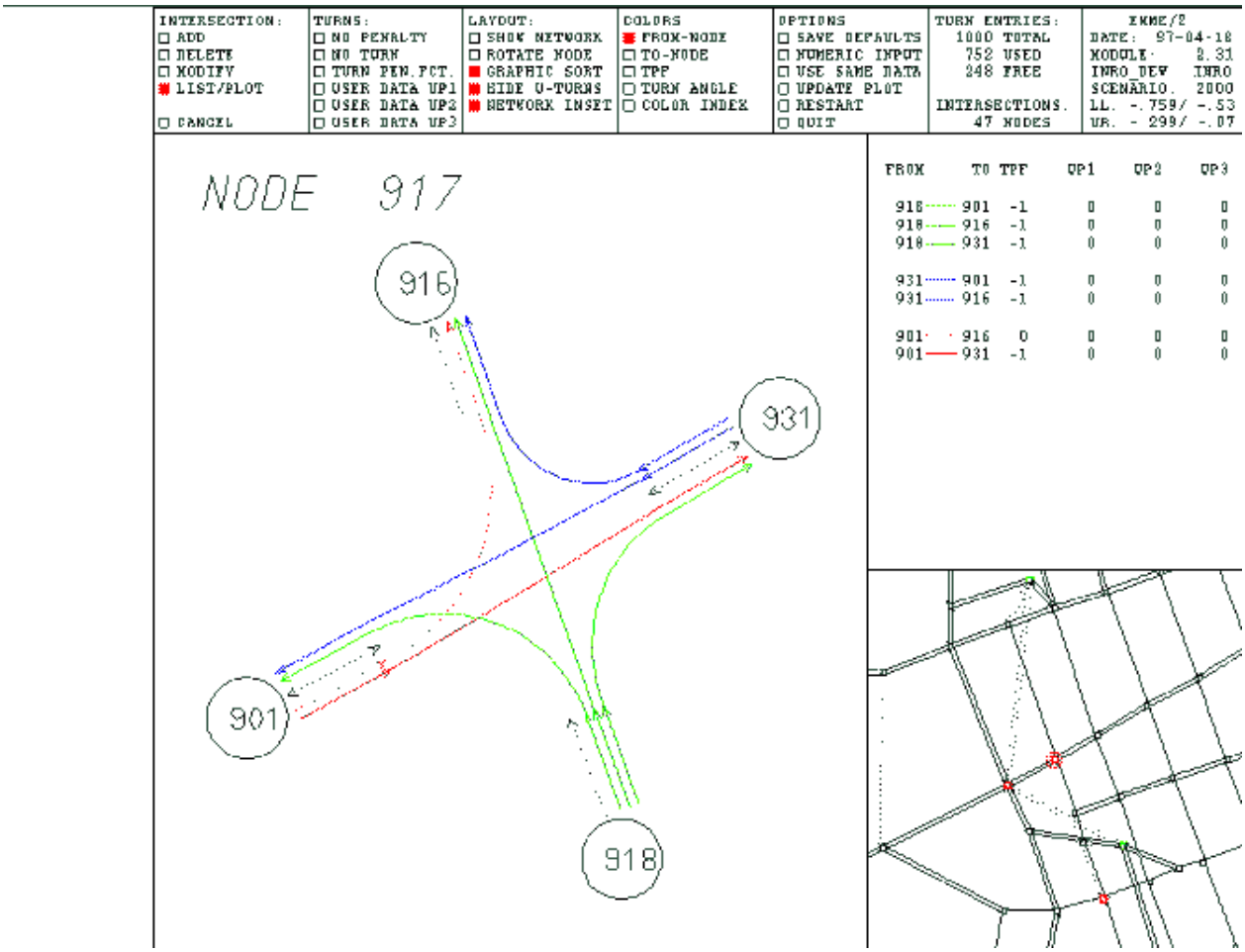

Figure 5 - Turns in EMME/2

The transit network and related attributes

This sub-option allows the user to create a route-system representing the transit network in the EMME/2 data bank, and input standard attribute data for route sections. It uses AML, EMME/2 macros and AWK scripts to punch transit line definitions and standard attribute data from the EMME/2 data bank, and to convert all punched data into an ASCII format readable by ARC/INFO. For the creation of the route-system holding the transit lines, we have investigated and implemented two methods:

- The first method is based on the PATH command of the NETWORK module. It uses as input a stop file containing a node number for each stop, and a value representing the order in which the nodes will be visited.

- The second method is an iterative method which, for each transit line, creates the route using the MAKEROUTE command of ARCEDIT. It appends all the sections iteratively using the APPEND command of ARCEDIT, until the end of the transit line.

Our experience shows that whenever the NETWORK module is available, the first method should be used, because it is much faster than the iterative method. Again, the user also has the possibility to add other attributes (assignment results, extra attributes or other derived attributes) to the SEC table by specifying the name of the attribute.

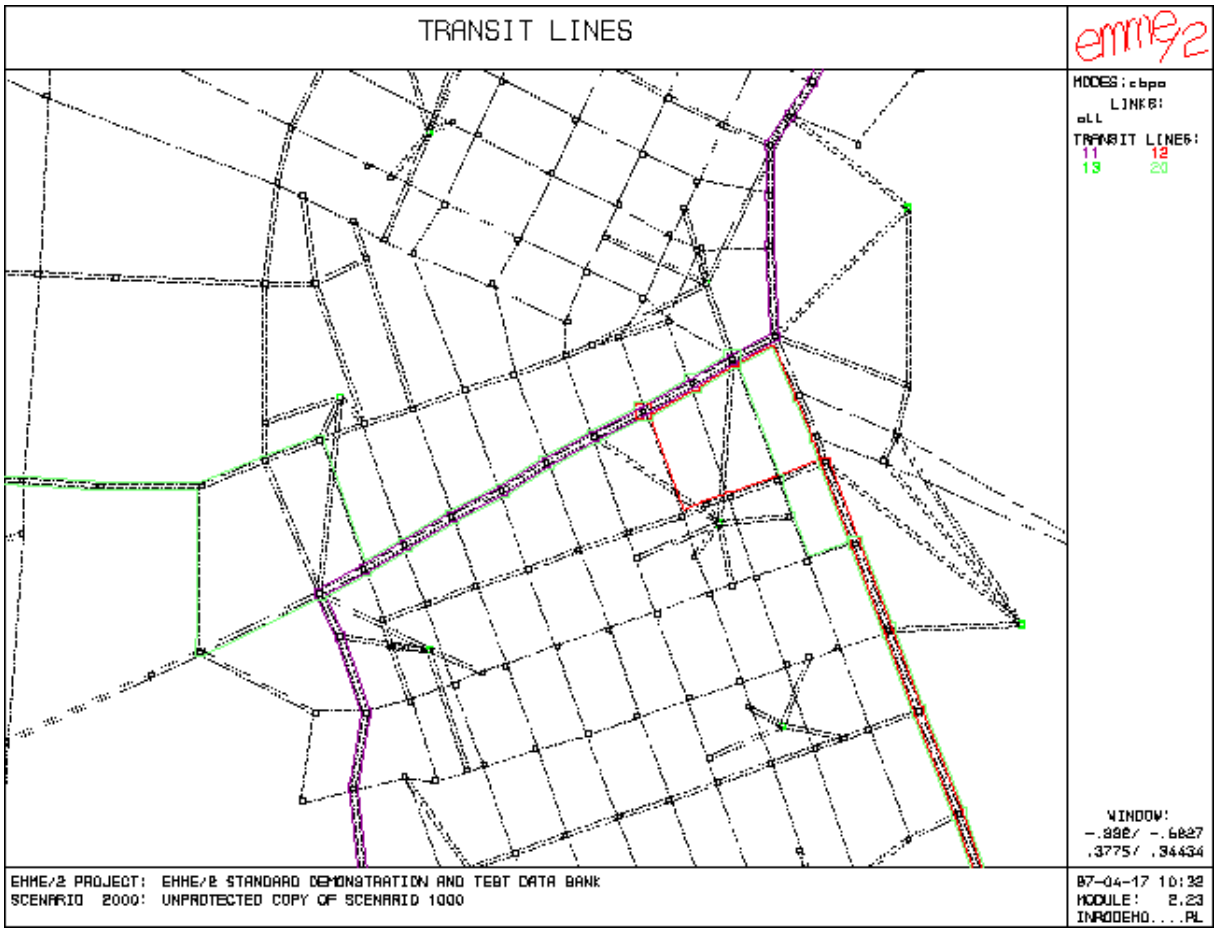

Figure 6 - Transit network in EMME/2

Figure 7 - Transit route-system in ARC/INFO

The zones and related attributes

This sub-option allows the user to create the EMME/2 polygon coverage and to input zone attribute data into the Polygon Attribute Table (PAT). It uses AML and AWK scripts to convert EMME/2 annotation files into an ASCII format readable by ARC/INFO, creates the EMME/2 polygon coverage, inputs spatial information into that coverage with the GENERATE command, and creates the polygon topology. Finally, the polygon attributes are entered in the PAT. While in the current implementation we do not transfer origin or destination matrix data into the PAT, we consider this is an easy task.

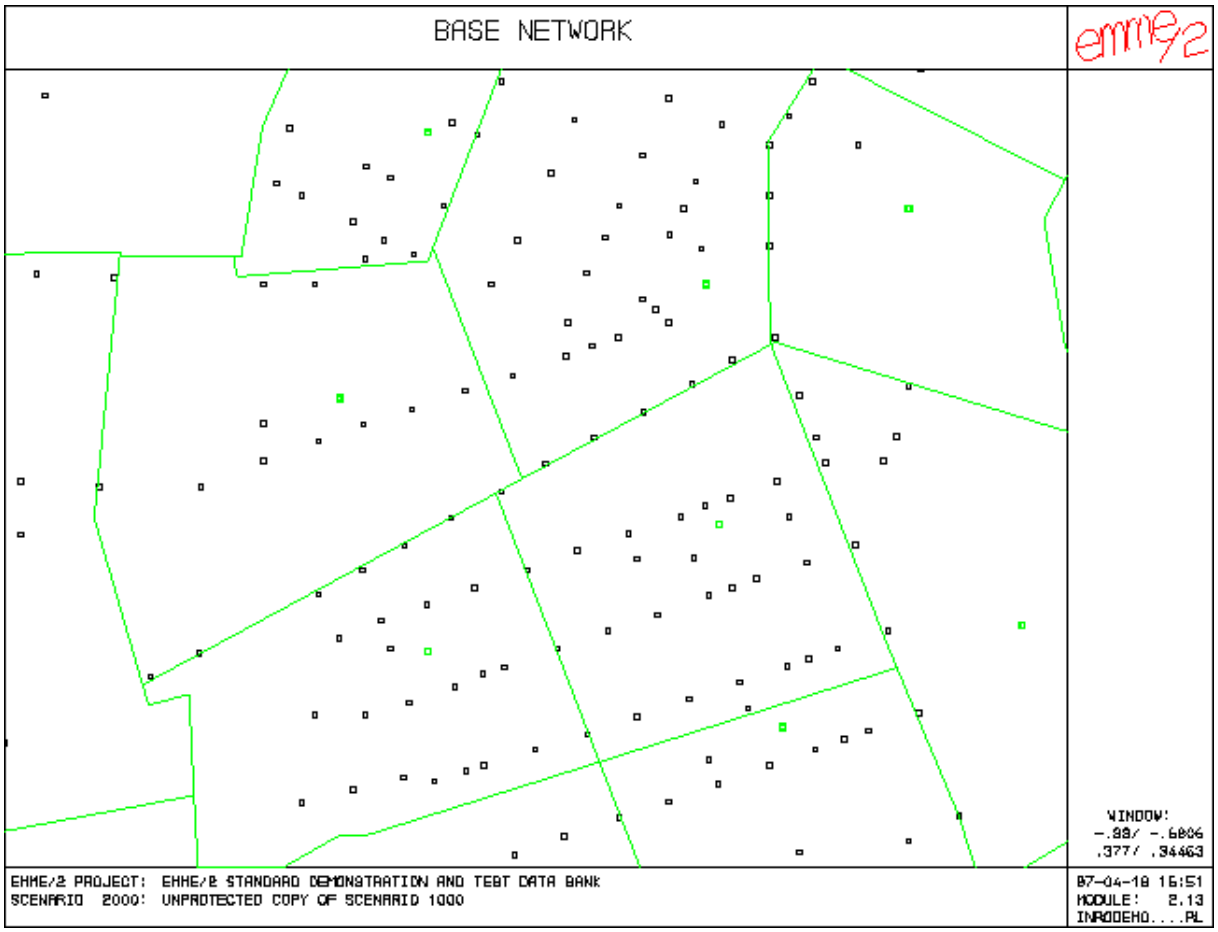

Figure 8 - Zones in EMME/2

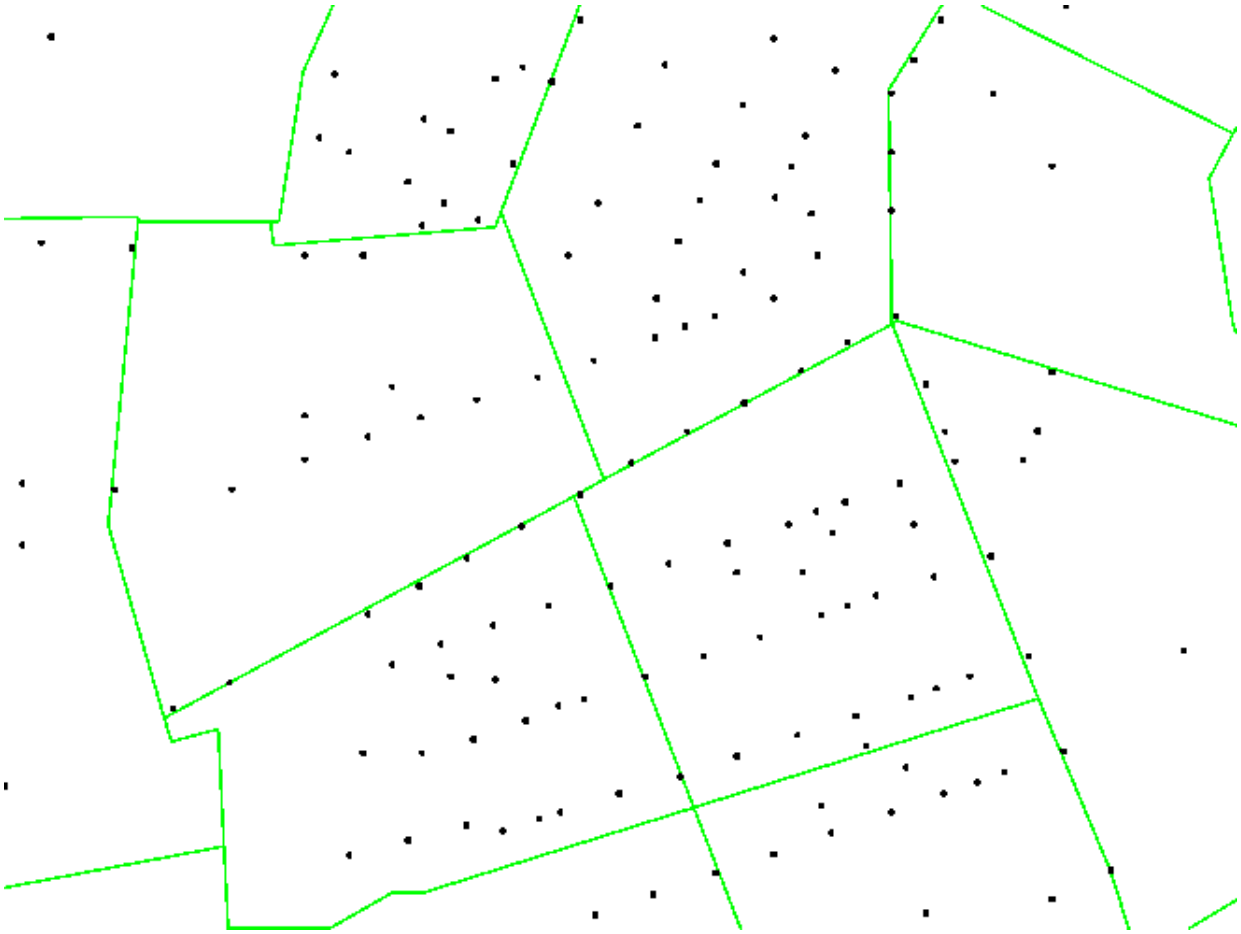

Figure 9 - Polygons in ARC/INFO

The whole importing process takes about 120 seconds (on a SPARC 1000E) to transfer a small network of 150 zones, 2975 links, 67 transit lines, and 4205 line segments.

ARC/INFO to EMME/2 interface

This option converts a specified EMME/2 coverage of the ARC/INFO data base into a specified scenario of the EMME/2 data bank. It uses the EXPORT command of the ARC module to export feature tables (AAT, NAT, PAT, TRN) in ASCII format. The UNLOAD command of the TABLES module is also used to create ASCII files for non-feature tables (MODES, etc.). Some AWK scripts are used to convert these ASCII files into EMME/2 data files, which are then read into the EMME/2 data bank using EMME/2 macros.

The whole exporting process takes about 100 seconds (on a SPARC 1000E) to transfer the same small network (150 zones, 1607 arcs, 67 transit lines, and 4205 line segments).

Other option

Another option included in the prototype lets the user plot the base network of the EMME/2 coverage in

terms of its directional attributes. A specified attribute is presented in each direction in terms of bar and color depending on the attribute value.

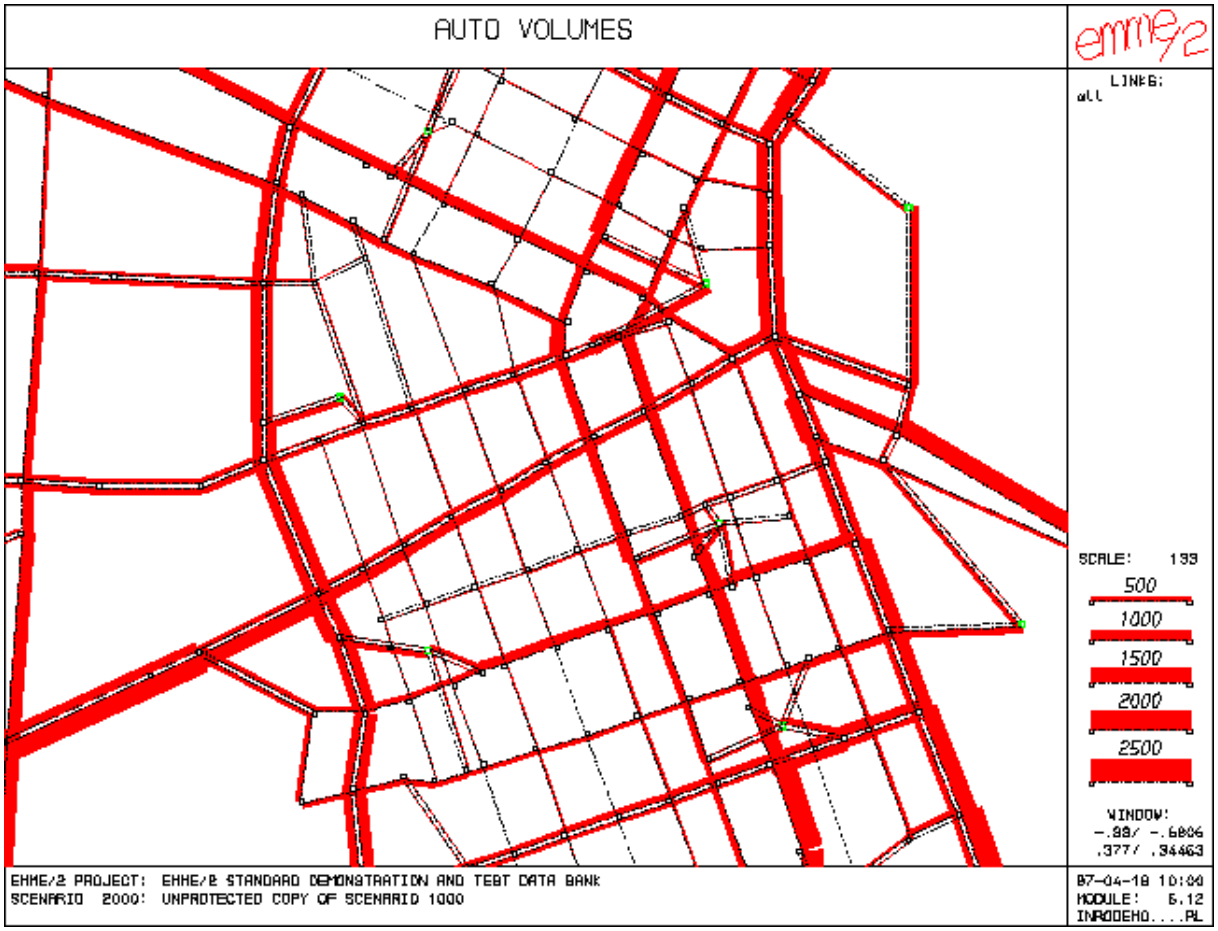

Figure 10 - Attribute on base network in EMME/2

Figure 11 - Attribute on base network in ARC/INFO

While the prototype described here uses ASCII files for the conversion process, the guidelines and data structures that we have developped can equally be used in the context of binary data exchange.

G) Conclusion

The one-to-one relationship constraint imposed on the EMME/2 coverage eases the process of exchanging data between the EMME/2 data bank and the ARC/INFO data base. However, when both the EMME/2 and ARC/INFO data bases were designed independently, this constraint implies that the modeling process (see Figure 1) may be very complex, depending on the design of the network coverage in the master GIS. Therefore, there is a need to develop more tools to ease the task of extracting sub-area network from a network contained in an ARC/INFO master GIS.

The data exchange process described here is static in nature and does not address the dynamic aspect of the problem: if small modifications are made in one data bank, the complete data set must be exported again. However, we see the current communication process as a necessary starting point toward a dynamic connection.

H) References

INRO Consultants Inc., EMME/2 User's Manual, Montreal, Quebec, CANADA, 1996.

ESRI Limited, ArcDoc ver. 7.0.4, Redlands, CA, USA, 1995.

Appendix A

This appendix contains the INFO table definitions of the EMME/2 coverage.

Road Network data:

DATAFILE NAME: EMME2.AAT 03/12/1997

27 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	FNODE#	4	5	B	-	Internal node number of the from-node of the arc
5	TNODE#	4	5	B	-	Internal node number of the to-node of the arc
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	EMME2#	4	5	B	-	
25	EMME2-ID	4	5	B	-	A unique arc identifier number which assures the correspondence between an arc in ARC/INFO an a link in EMME/2
29	INODE	8	8	I	-	EMME/2 node number for the from-node
37	JNODE	8	8	I	-	EMME/2 node number for the to-node
45	LEN	4	12	F	3	EMME/2 link length
49	LENR	4	12	F	3	Same as above for the opposite directio
53	LANES	4	8	F	1	Number of lanes
57	LANESR	4	8	F	1	Same as above for the opposite directio
61	TYPE	6	6	I	-	EMME/2 link type
67	TYPER	6	6	I	-	Same as above for the opposite directio
73	VDF	6	6	I	-	EMME/2 volume delay function number
79	VDFR	6	6	I	-	Same as above for the opposite directio
85	UL1	4	8	F	2	EMME/2 user defined link data
89	UL1R	4	8	F	2	Same as above for the opposite directio
93	UL2	4	8	F	2	See UL1
97	UL2R	4	8	F	2	See UL1R
101	UL3	4	8	F	2	See UL1
105	UL3R	4	8	F	2	See UL1R
109	MODE	6	6	C	-	List of modes allowed on the link
115	MODER	6	6	C	-	Same as above for the opposite directio
121	SYMBOLS	4	8	F	2	Information used by the plotting routin
125	SYMBOLSR	4	8	F	2	Same as above for the opposite directio

DATAFILE NAME: EMME2.NAT 03/12/1997

9 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	ARC#	4	5	B	-	
5	EMME2#	4	5	B	-	
9	EMME2-ID	4	5	B	-	EMME/2 node number
13	CENTROID	4	5	B	-	Centroid indicator
17	UI1	4	8	F	2	EMME/2 user defined node data
21	UI2	4	8	F	2	See UI1

25	UI3	4	8	F	2	See UI1
29	LABEL	6	6	C	-	Optional node label

DATAFILE NAME: EMME2.MODES 03/24/1997

9 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	MODE	1	1	C	-	EMME/2 mode identifier
2	DESCRIPTION	10	10	C	-	Mode description
12	TYPE	4	4	I	-	Number which identifies the type (auto (1), transit (2), auxiliary transit (3) or auxiliary auto (4))
16	PLOT	4	4	I	-	EMME/2 plot code
20	CTC	4	8	F	2	Operating cost/hour factor
24	CDC	4	8	F	2	Operating cost/length unit factor
28	ETC	4	8	F	2	Energy consumption/hour factor
32	EDC	4	8	F	2	Energy consumption/length unit factor
36	SPEED	4	8	F	2	

Transit network data:

DATAFILE NAME: EMME2.RATE2TR 03/12/1997

11 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	E2TR#	4	5	B	-	
5	E2TR-ID	4	5	B	-	Line identifier
9	LINENAME	6	6	C	-	EMME/2 line name
15	MODE	2	2	C	-	Mode of the line
17	VEH	6	6	I	-	Vehicle type for this line
23	HEADWAY	4	8	F	2	Vehicle headway in minutes
27	SPEED	4	8	F	2	Vehicle default speed in length units per hour
31	DESCRIPTION	20	20	C	-	
51	UT1	4	8	F	2	EMME/2 user defined line data
55	UT2	4	8	F	2	See UT1
59	UT3	4	8	F	2	See UT1

DATAFILE NAME: EMME2.SECE2TR 03/12/1997

19 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	ROUTELINK#	4	5	B	-	
5	ARCLINK#	4	5	B	-	
9	F-MEAS	4	12	F	3	
13	T-MEAS	4	12	F	3	
17	F-POS	4	12	F	3	
21	T-POS	4	12	F	3	
25	E2TR#	4	5	B	-	
29	E2TR-ID	4	5	B	-	A unique section identifier number which assures the correspondence between a section in ARC/INFO and a segment in EMME/2
33	ROUTE_ID	4	5	B	-	Line identifier
37	DWT	4	8	F	2	EMME/2 dwell time per line segment in minutes
41	DWTF	4	8	F	2	EMME/2 dwell time factor in minutes per length unit
45	NOALI	4	4	I	-	EMME/2 indicator for no-alighting
49	NOBOA	4	4	I	-	EMME/2 indicator for no-boarding
53	TTF	4	4	I	-	EMME/2 transit time function on number on links and turns

57	TTFT	4	4	I	-	EMME/2 transit time function number on turns
61	US1	4	8	F	2	EMME/2 user defined segment data
65	US2	4	8	F	2	See US1
69	US3	4	8	F	2	See US1
73	LAY	4	8	F	2	Layover time in minutes

Turn data:

DATAFILE NAME: EMME2.TRN 03/12/1997

14 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	NODE#	4	5	B	-	
5	ARC1#	4	5	B	-	
9	ARC2#	4	5	B	-	
13	AZIMUTH	4	12	F	3	
17	ANGLE	4	12	F	3	
21	ARC1-ID	4	5	B	-	
25	ARC2-ID	4	5	B	-	
29	TURN-ID	10	10	I	-	A unique indentifier for each turn
39	ARCID1	5	5	I	-	Identifier of the from-arc (see EMME2-ID in EMME2.AAT)
44	ARCID2	5	5	I	-	Identifier of the to-arc (see EMME2-ID in EMME2.AAT)
49	TPF	8	8	F	2	EMME/2 turn penalty function number
57	UP1	8	8	F	2	EMME/2 user defined turn data
65	UP2	8	8	F	2	See UP1
73	UP3	8	8	F	2	See UP1

Zone data:

DATAFILE NAME: EMME2TAZ.PAT 03/24/1997

6 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC	Description
1	AREA	4	12	F	3	
5	PERIMETER	4	12	F	3	
9	EMME2TAZ#	4	5	B	-	
13	EMME2TAZ-ID	4	5	B	-	A unique zone identifier number which assures the correspondence between a polygon in ARC/INFO and a zone in EMME/2
17	COLOR	4	4	I	-	EMME/2 color code
21	PATTERN	4	4	I	-	EMME/2 line pattern code

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