USER'S MANUAL

FOR

THE TEXAS LARGE SYSTEMS TRAFFIC ASSIGNMENT PROGRAMS

RESEARCH REPORT NUMBER 60-6

by

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sponsored by

The Texas Highway Department

Project No. 2-8-63-60

in cooperation with the

U.S. Department of Commerce, Bureau of Public Roads

HPR-1(6)

Texas Transportation Institute

Texas A & M University

College Station, Texas

November, 1966

D I S C L A I M E R

This paper is based on research of the Texas Transportation Institute and the Texas Highway Department in cooperation with the U.S. Department of Commerce, Bureau of Public Roads.

The procedures and programs described in this publication have been successfully executed by experienced personnel of the Texas Highway Department and the Texas Transportation Institute. It is suggested that a user initially run the different programs with his own test data in order to observe the operation of each program. The Texas Highway Department and the Texas Transportation Institute cannot accept any responsibility for the use or operation of any programs.

NOTE TO USERS

This edition (November 1966) of the User's Manual is indicated for use with program library tape Version II of 15 November 1966.

As programs are modified, new pages for this manual will be prepared as necessary and distributed with subsequent library program tapes. All revised and additional pages will have the revision (issue) date in the upper left hand corner. In order to minimize confusion that may result as revisions are made to the various programs, an on-line and off-line message is written which gives the assembly date of each program when the program is called. When using the several programs, the user should note if this assembly date agrees with the date given in the program write-up (description) he is using.

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C H A P T E R O N E

INTRODUCTION

The Texas Large Systems Traffic Assignment Package (TEXAS-BIGSYS) was developed by the Texas Transportation Institute for the Texas Highway Department.

Insofar as possible, the package represents an effort to incorporate the battery of traffic assignment programs as a subsystem of IBSYS. In order to accomplish this, it was considered necessary to design new programs around the monitor and to minimize the approach of a system conversion based on earlier assignment packages.

Further, the need for a traffic assignment system that could handle more than 4096 nodes was eminent. Through application of the partitioning technique developed by Blumentritt, [1,2]* a system capability of a network maximum of 16,000 nodes and 4,800 centroids was programmed for the IBM 7090/7094 computer. The more general machine independent objective should be cited, however; this was to research the general properties of network partitioning with emphasis on the application to traffic assignment. With the advent of multiprocessors and time sharing monitors, it is hoped that network partitioning principles may be used to even greater advantage in the future.

The algorithm for network partitioning utilized is totally new and should not be confused with a procedure which simply divides a network into smaller networks to which assignments are made separately. In the TEXAS-BIGSYS package, the Build Network Description and Build Trees is done in a manner so that a single, total network is available and used by the Load Network program.

*Numbers in parentheses refer to entries in the list of References.

Some programs and/or program options are available to accept or generate the proper card/tape formats for compatibility with data associated with the Revised Texas Traffic Assignment System.[3] Also, a program relating to a magnetic tape inventory is included merely for its possible utility and it should not be regarded as necessary for any phase of the assignment process.

Machine Requirements

The various programs comprising the Large Systems Package are written for a two channel, 32K IBM 7094 having an on-line printer and on-line card reader. The minimum number of tape drives required on each channel in order to execute the several programs is a function of the number of subnets in the network and varies from program to program. The user should consult the description for each subject program in order to determine the number of tape drives required to execute each program for the specific number of subnets he is using; the following tabulation is given for general information purposes only.

Number of Subnets	Number of Tape Drives Required	
	A Channel	B Channel*
1	3	2
2	5	3
3	6	4
4	6	5

*The numbers indicated are minimum and will require considerable tape handling in the execution of certain programs such as Load Network.

In order to conserve core capacity, the IBSYS Input-Output routines have been greatly modified for the Large Systems Package. The following indicates the correspondence between the Logical Input-Output (BLIO) and the A and B Channel units:

	Unit	
BLIO	Channel	Tape
1	A	1
2	A	6
3	A	3
4	A	4
5	Card Reader	
6	A	6
7	A	7
8	A	8
9	A	9
10	A	0
11	B	1
12	B	2
13	B	3
14	B	4
15	B	5
16	B	6
17	B	7
18	B	8
19	B	9
20	B	0

All program control cards are read from the on-line card reader. The details concerning the specific cards required together with their respective formats are given in the program descriptions.

Program Efficiency

In order to obtain a measure of the relative efficiency, a number of program functions were performed utilizing the same trip data and network with both the Revised Texas Control Package and the Large Systems Traffic Assignment Package. The size of the network and the magnitude of the assignment are reflected by the following:

1,506	-	nodes
447	-	centroids
2,959	-	link data cards
30,366	-	trip cards

The results tabulated below are believed to correctly represent the performance capability of the two packages.

Program Function		Time in Minutes Revised Texas		BIGSYS	
Build Binary Trips	(Home Based Work)	1.91		0.39	
	(Home Based Non-Work)	2.66		0.46	
	(Non Home Based)	3.73		0.80	
Total for Build Trips			8.30		1.65
Sum Trip Ends	(Home Based Work)	1.11		0.24	
	(Home Based Non-Work)	0.89		0.24	
	(Non Home Based)	0.71		0.24	
	(merge above)	0.90		0.26	
Total for Sum Trip Ends			3.61		0.98
Merge Trips			3.02		0.49
Build Network Description			1.30		1.13
Output Network Description			0.71		0.46
Build and Output 4 Test Trees			0.73		0.64
Build 447 (all) Trees			5.34		3.70
Load Minimum Paths			4.29		2.43
Output Loaded Network			2.26		1.60
FRATAR Forecast (Non Home Based Trips)			10.86		1.69

The summary comparison for the following networks shown below serves to partially point out the affect of size of the coded network on run time.

	Dallas-Fort Worth	Texarkana	San Angelo
number of subnets	4	1	1
number of centroids	2,631	310	195
number of nodes (other than centroids)	7,196	682	579
total number of link data cards	15,489	1,593	1,244
program run time:			
Build Network Description	3.4 min.	0.7 min.	0.6 min.
Search Minimum Paths	124 min.	1.3 min.	0.8 min.
Load Network	73 min.	1.3 min.	0.8 min.
Output Loaded Network	4.1 min.	0.5 min.	0.3 min.

The run time will vary some what from run-to-run for the same data. Therefore, the above figures are given to the nearest whole minute or tenth of a minute (depending on the size of the number) even though the computer output is in hundredths of a minute.

The total run time required to execute the sequence of programs necessary to obtain a loaded network output is a function of the degree-of-detail in the coded network. Increased detail of course increases the time required to search minimum paths since the number of possible paths to be considered increases.

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This relationship between run time and degree-of-detail is evident from the execution of the various programs for the Waco detailed network. This network was coded in maximum detail (nearly every street on the ground was represented by a link in the coded network) for research purposes. This resulted in nearly as many link data cards as in the Dallas-Fort Worth coded network. The effect of extreme detail as opposed to a network of lesser detail but of a similar number of link data cards is indicated by the following summary.

	Dallas-Fort Worth	Waco-detailed
number of subnets	4	2
number of centroids	2,631	1,885
number of nodes (other than centroids)	7,196	5,719
number of link data cards	15,489	12,323
program run time:		
Build Network	3.4 min.	2.6 min.
Search Minimum Paths	124 min.	242 min.
Load Network	73 min.	22 min.
Output Loaded Network	4.1 min.	7.1 min.

C H A P T E R T W O

CONTROL PROGRAM

The Texas Large Systems Traffic Assignment Package operates under the IBM 7090/7094 Operating System Monitor (IBSYS). The programs comprising the package are written in a combination of FORTRAN and MAP; in general, the FORTRAN is used for overall control to call MAP subroutines. The Overlay feature of IBLDR is used to assemble individual program links and the ABSCDS option of IBJOB is used in conjunction with IBEDT to build a permanent system tape.

Although the Texas Large Systems Traffic Assignment Package (TEXAS-BIGSYS) uses IBSYS - Version 13 as the senior monitor, major modifications have been made to IBSYS for its use in this capacity. These include complete revision of the input-output routines for specific incorporation in BIGSYS as well as certain modifications in the accounting routines made by the Data Processing Center of Texas A&M.

The control program (submonitor) functions as Link Zero of an IBSYS overlay job, and remains resident in core at all times. Its purpose is to address the reader and obtain a control card. Once it has control, either a program will be called into core by means of the overlay control routine, a pause will occur, another control card will be read, or control will be returned to IBSYS. The nature of the control card determines the action to be taken by the control program. The function and format of each control card is given in succeeding sections of this chapter. Each control card that is read is printed on-line as well as off-line. Further, each on-line message printed by a link is also written off-line.

Elapsed time and time between individual program executions is obtained from the core clock. The clock is read prior to the reading of

any control cards by the control program, and thereafter is read each time the control program receives control through completion of the execution of any link that can be reached by supplying a program call card. The core clock reading routine causes the following message to be printed on-line, with the appropriate times in minutes and hundredths supplied within:

CUMULATIVE TIME = XX.XX

TIME SINCE LAST QUERY = XXX.XX

If the particular computer used does not have a core clock the time printed will be zero; this will not interfere with program execution in any way.

Control Cards

All control cards described in this chapter are read from the on-line card reader. A brief statement of the function together with the format of each follows:

Date Card

This must be the first (1st) card read from the on-line card reader. Upon reading the $DATE Card the date is stored for use by IBSYS and BIGSYS. The format is:

Columns	Contents
1-5	$DATE
6-15	blank
16-17	Month
18-19	Day
20-21	Year

Job Card

This card initializes the printer clock; it must be the second (2nd) card read from the on-line card reader. The format is:

Columns	Contents
1-4	$JOB
5-6	blank
7-72	any desired comments

$EXECUTE BIGSYS Card

This must be the third (3rd) card read. Upon reading this card, the supervisory program Link Zero is read from the Large Systems library tape and made resident in core.

Columns	Contents
1-8	$EXECUTE
9-15	blank
16-21	BIGSYS

Program Call Card

The programs in the Large Systems Traffic Assignment Package are called by name. A dollar sign must be in column one, followed by the program name, including embedded blanks, beginning in column two. The specific column contents for the call card for each program is given in the program description.

Pause Card

The reading of this card results in a transfer to a FORTRAN PAUSE. Press START to resume execution.

Columns	Contents
1-6	$PAUSE
7-72	any desired comments

Comment Card

The card is printed on-line and another control card is read immediately.

Columns	Contents
1-6	$COMNT
7-72	any desired comments

Header Card

Columns	Contents
1-6	$HEADR
7-72	Header Information

The information punched in columns 7-72 of the Header Card is placed in columns 1-66 of a header array that is 132 characters in length. Characters 67-120 all contain blanks, and characters 121-132 contain the date in BCI. The resulting 132 character array is used as a header for any link which generates BCD off-line output, other than that resulting from on-line messages. The reading of a $HEADR card always results in a destructive store in columns 1-66 of the header array, regardless of the previous contents. The date is initially determined through reference to the system cell SYSDAT, and remains unchanged otherwise.

Return to Supervisor

Control is returned to IBSYS upon reading this card.

Columns	Contents
1-6	$IBSYS
7-72	Ignored

The sequence of cards - $JOB, $EXECUTE BIGSYS, Program Call, Pause, Comment, and Header - may be repeated following the Return to Supervisor Card for execution of additional jobs.

Stop Card

A $STOP must follow the $IBSYS Card and must be the last card read from the on-line card reader.

Columns	Contents
1-5	$STOP
6-72	blank

Upon reading the $STOP card the cumulative time since the last $JOB Card will be printed and the machine will halt.

Listing of Typical Control Card Deck

The following is a listing of a typical control deck set-up for a single subnet that utilizes a majority of the programs currently in the Large Systems Traffic Assignment Package. These cards are read from the on-line card reader.

```
#DATE          112166              NOVEMBER 21,1966
$JOB  28654318OG2                TEXAS TRANSPORTATION INSTITUTE WACO-E2
$PAUSE  MOUNT BIGSYS LIBRARY TAPE ON A1

$EXECUTE       BIGSYS

$COMNT   TRIP PREPARATION
$PAUSE MOUNT BCD TRIPS ON A6, SCRACH ON B7
$HEADR WACO E-2 ONE SUBNETWORK SYSTEM TRIP VOLUME
$PREPARE CARD TRIP VOLUMES
#24HR
#REEL       1
     1      1   221
$OUTPUT TRIP VOLUMES
$SUM TRIP ENDS

$HEADR  WACO E-2  NETWORK DESCRIPTION
$COMNT    PREPARE THE WACO NETWORK
$PAUSE  MOUNT LINK DATA ON A5,  SCRACH ON A4,B5
$PREPARE NETWORK
$OUTPUT NETWORK

$PAUSE  SEARCH MINIMUM PATH  MOUNT SCRACH ON B1
$HEADR  WACO E-2  TEST TREES
$SEARCH MINIMUM PATHS
#TURN      20
#TREE       5.   14.   30.   55.   92.  139.  205.
```

```
$HEADR   MACO E-2 TREES WITH TURN PROHIBITS
$SEARCH PROHIBITED PATHS
*TURN     020
*TREE       1    221


$HEADR  MACO E-2  LOADED NETWORK
$COMMT  LOAD MACO WITH TRIP VOLUMES ON B7, TREES ON B1,
$PAUSE INTERSECTION NAMES ON B6, NETWORK DESCRIPTION ON A4, OUTPUT A3
$LOAD NETWORKS


$COMMT   PEREORM A FRATAR FORCAST ON MACO E-2
$HEADR FORCAST FRATAR ON MACO E-2
$COMMT  PLEASE MOUNT TRIP VOLUMES ON B7, GROWTH FACTORS ON A6,
$PAUSE   SCRACH ON A7, FORCASTED BINARY TRIP VOLUMES OUT ON B7
$FORECAST FRATAR
    20     10
*24HR
$COMMT  TRIP PREPARATION
$PAUSE MOUNT BCD TRIPS ON A6, SCRACH ON B7,B8
$HEADR  MACO E-3 TWO SUBNETWORKS
$PREPARE CARD TRIP VOLUMES
*24HR
*REEL       3
     2      1   921  4001  4974


$HEADR  MACO E-3  NETWORK DESCRIPTION
$PAUSE MOUNT LINK DATA ON A6, SCRACH ON A4,B6
$PREPARE NETWORK
$OUTPUT NETWORK


$HEADR MACO E-3 TEST TREES
$PAUSE SEARCH MINIMUM PATHS SCRACH ON B1,B2
$SEARCH MINIMUM PATHS
*TURN     000
*TREE      5.   95.  300.  553.  910.
*TREE  4001. 4140. 4320. 4497. 4875. 4912.


$HEADR  MACO E-3 LOADED NETWORK
$COMMT TRIP VOLUMES ON B7,B8, TREES ON B1,B2, INTERSECTION NAMES ON B6,
$PAUSE NETWORK DESCRIPTION ON A4, OUTPUT ON A3
$LOAD NETWORK


$LBSYS
$STOP
```

System Tape Assignments

The following tape assignments are common to all programs comprising the Large Systems Traffic Assignment Package (BIGSYS):

Tape Unit	Function
A1	Large Systems Library Program Tape
A3	BCD Output and off-line messages

The Large Systems package has been designed so that the various programs utilized to make a complete run from "Prepare Network Description" through "Output Loaded Network" can be made with a minimum of tape handling. Only the tapes mounted on the units designated A6 need to involve handling at the end of intermediate program operation.

All program control cards explained in the preceding section are read from the on-line card reader.

C H A P T E R T H R E E

PREPARATION OF NODE MAP AND LINK DATA CARDS

The general precedure of the preparation of the node map for the Large Systems Traffic Assignment Package (TEXAS-BIGSYS) are similar to those for the TEXAS and BELMN traffic assignment programs previously available. It is presumed that the user is familiar with all facets of the data collection and preparation of a node map. Hence, this chapter is concerned with the aspects of coding the node map and link data that are unique to BIGSYS as developed by the Texas Transportation Institute at Texas A&M University.

The potential user who may not be familiar with the various aspects of preparing a node map, link data cards, and obtaining the necessary data therefore is referred to the Traffic Assignment Manual[4] prepared by the U.S. Department of Commerce, Bureau of Public Roads, June 1964.

Define the Network

The problems and procedures of selecting the network, location of nodes, and connection of centroids are the same as for previously existing traffic assignment programs. The only difference being that the analysist has the capability of specifying a maximum size network that is about four times larger than that which he was previously able to use.

The definitions of link types based on the classes of the two nodes which define a link are:

link types	node classes defining the link
local	one centroid on one arterial node
arterial	two "arterial" nodes or one "arterial" and one freeway node
freeway	two freeway nodes

Because of the increased network density that is possible under TEXAS-BIGSYS, the meaning of a "arterial" link may be quite different than in networks under the smaller capacity TEXAS and BELMN programs. The reason of course is that with the increased network density possible, streets that are collector or even local streets by a functional classification may and probably will be included in the assignment network. These facilities will be coded in the range of "arterial" node numbers.

Table III-1 presents a summary of the network limitations for the Large Systems Traffic Assignment Package. The maximum time and distance that can be represented internally by the computer is 10.23. The distance and time/speed fields on the link data cards however consist of three columns each; hence the maximum value that can be coded on the link data cards is 9.99. When using distance and speed as the link parameters, the user is cautioned to avoid combinations that will result in a calculated time of more than 10.23 minutes.

TABLE III-1

NETWORK RESTRICTIONS

Maximum number of nodes and centroids: each subnet = 4,000

Maximum number of centroids: each subnet = 1,200

Maximum number of subnets in a network = 4

Maximum length of a link = 10.23 miles*

Maximum link time, including turn penalty = 10.23 minutes*

Maximum number of links outbound from a node or centroid = 4

Centroids (internal zones and external stations) and partition-local nodes** must be numbered in an unbroken sequence within subnets

Each centroid must have at least one connector

Duplicate node numbers are not permitted (i.e., a node number can be used only once in any network even though it may consist of more than one subnet)

Maximum value of any node number = 32,767

*The value of 10.23 is the maximum that can be represented internally in the computer; 9.99 is the maximum that can be read in from the three column fields on the link data card.

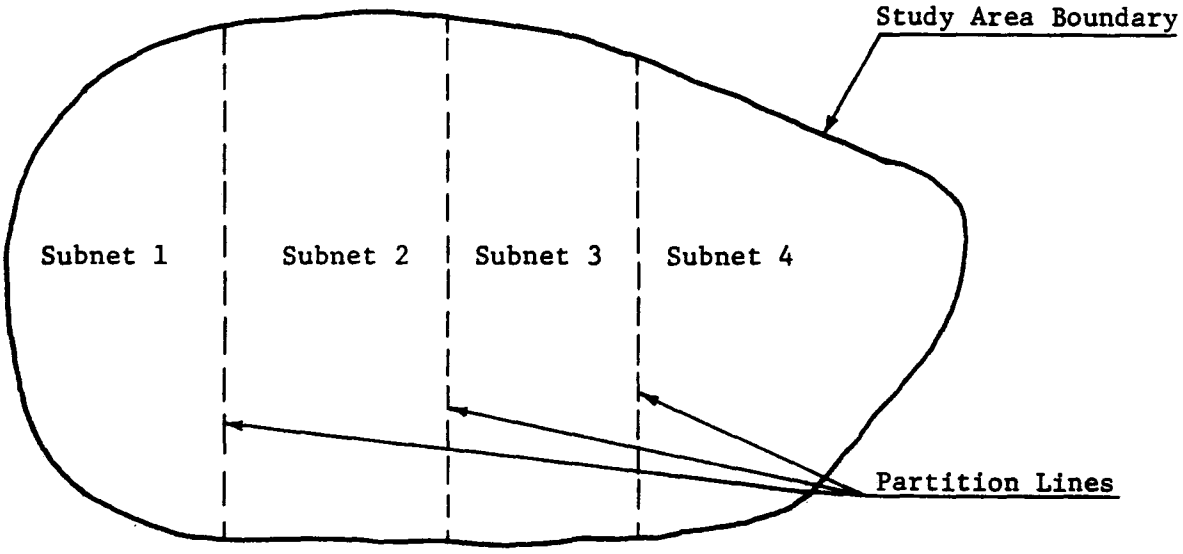
**A partition-local node is a partition node where a centroid connector crosses.

Network Partitioning

The concept of network partitioning utilized in the Large Systems Traffic Assignment Package is totally new and should not be confused with a procedure which simply divides a network into smaller networks to which assignments are made separately. In the TEXAS-BIGSYS package, the Build Network Description and Build Trees are done in a manner so that a single total network is available and used in the load network phase.

The partitioning line defines an imaginary boundary between subnets within a network. These partitioning lines are utilized by the computer program to "fit" the different subnets together.

Two and only two subnets may be adjacent across any partition line and these adjacent subnet numbers must be numbered in sequence. For example, subnet 1 and subnet 3 must not (can not) share a partion line. The correct method of partitioning is indicated schematically below; any other arrangement is not acceptable.

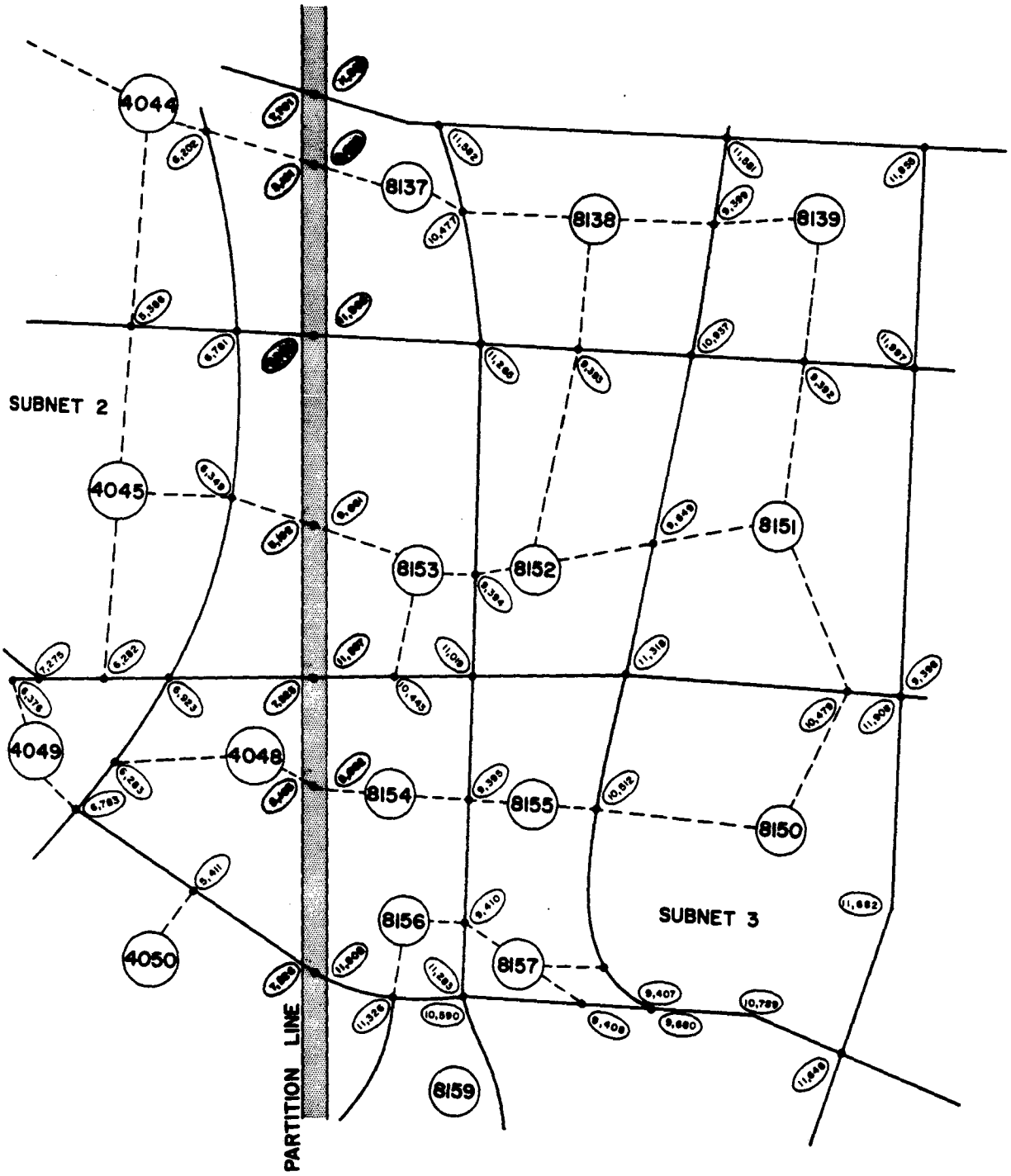


SCHEMATIC REPRESENTATION OF A CORRECTLY PARTITIONED NETWORK

The number of subnets comprising a network can, of course, be one, two, three, or four. Each subnet is limited to a maximum size of 4,000 nodes with 1,200 centroids. Hence the maximum size network is 16,000 nodes with 4,800 centroids.

When the network is divided into two or more subnets, some computer efficiency is gained if the subnets are of approximately equal size (i.e. number of nodes). Thus, it is recommended that subnets of greatly different sizes be avoided. For example, it would not be efficient to use near the maximum (say 3,900 nodes) in each of two subnets of a three-subnet network and a very small number (say 600) of nodes in the remaining subnet - a total of 8,400 nodes. Better practice would be to utilize about 3,000 nodes in each of two of the subnets and the remaining 2,400 nodes in the third subnet.

The partition line(s) may be located in any convenient location within the restriction of subnet arrangement previously mentioned; however for coding ease and computer efficiency, it is recommended that the partition line(s) be positioned so that the partition line is at right angles to the various link which it cuts and that a minimum number of such links be involved. An example of such partitioning is shown in Figure III-1. As indicated in this figure, a partition line node must be located where any link (including a centroid connector) is "cut" by the partition line; such nodes, called partition-local nodes, must be within the numbering sequence for centroids and partition-local node number. A maximum of 100 partition line crossings (i.e. partition line nodes) may be used on each partition line. Partition line nodes must have two, and only two, ways out. These and other basic rules governing network partitioning are summarized in Table III-2.



PORTION OF DALLAS-FORT WORTH NETWORK SHOWING PARTITIONING AT "RIGHT ANGLES" TO LINKS

FIGURE III-1

TABLE III-2

SUMMARY OF RULES FOR NETWORK PARTITIONING

Maximum number of subnets = 4
Partition line nodes must have 2, and only 2, ways out
Partition line node numbers must be in the numbering sequence of their respective subnet
When a centroid connector crosses a partition line the partition line node partition-local number must be within the centroid-partition local numbering sequence (see Parameter Card write-up).
Partition node numbers must be within the proper numbering sequence for arterials and freeways if correct totals vehicle-miles and vehicle-hours are to be obtained.
The maximum number of partition line nodes on each partition line is 100.

It is also possible to position the partition line so that it follows a street included in the network. An example of a partition line positioned in such a manner is given in Figure III-2. It will be noted that the street is represented by links in each subnet, one on each side of the partition line. This will be the case if the street is one-way or two-way in order to allow proper determination of the minimum path in view of the double crossing restriction. Hence, in order to obtain link volumes, two numbers must be added together manually. In Figure III-2, for example, the volume assigned to link 1164-1166 must be added to that for link 5225-5227. This of course requires time and mistakes in addition may result; further, clerical personnel may forget to add the appropriate values when posting assigned volumes.

Furthermore, if a partition line is selected that follows a street, care should be taken to insure that corresponding links are equal in travel

time. Using Figure III-2 as an example, link 1164-1166 should be coded so that distance, speed (or time) and sign and flag are identical to link 5225-5227; link 1166-1168 should be coded the same distance, speed (or time) as link 5229-5229; etc.

It must also be kept in mind that the partitioning in this manner necessarily creates artifical links. Again referring to Figure III-2, links 1164-1165, 5225-5226, etc. are artifical in nature and should be coded as zero distance. For these reasons the partitioning scheme of Figure III-1 is recommended over that of Figure III-2.

It must be remembered that, regardless of the location of the partition line, DOUBLE CROSSINGS OF THE PARTITION LINE ARE NOT ALLOWED. That is, the minimum path algorithm permits a minimum path between two zones to cross the same partition line once and only once. Such a problem may arise in the following two circumstances.

(1) When two high speed arterials intersect close to a partition line.

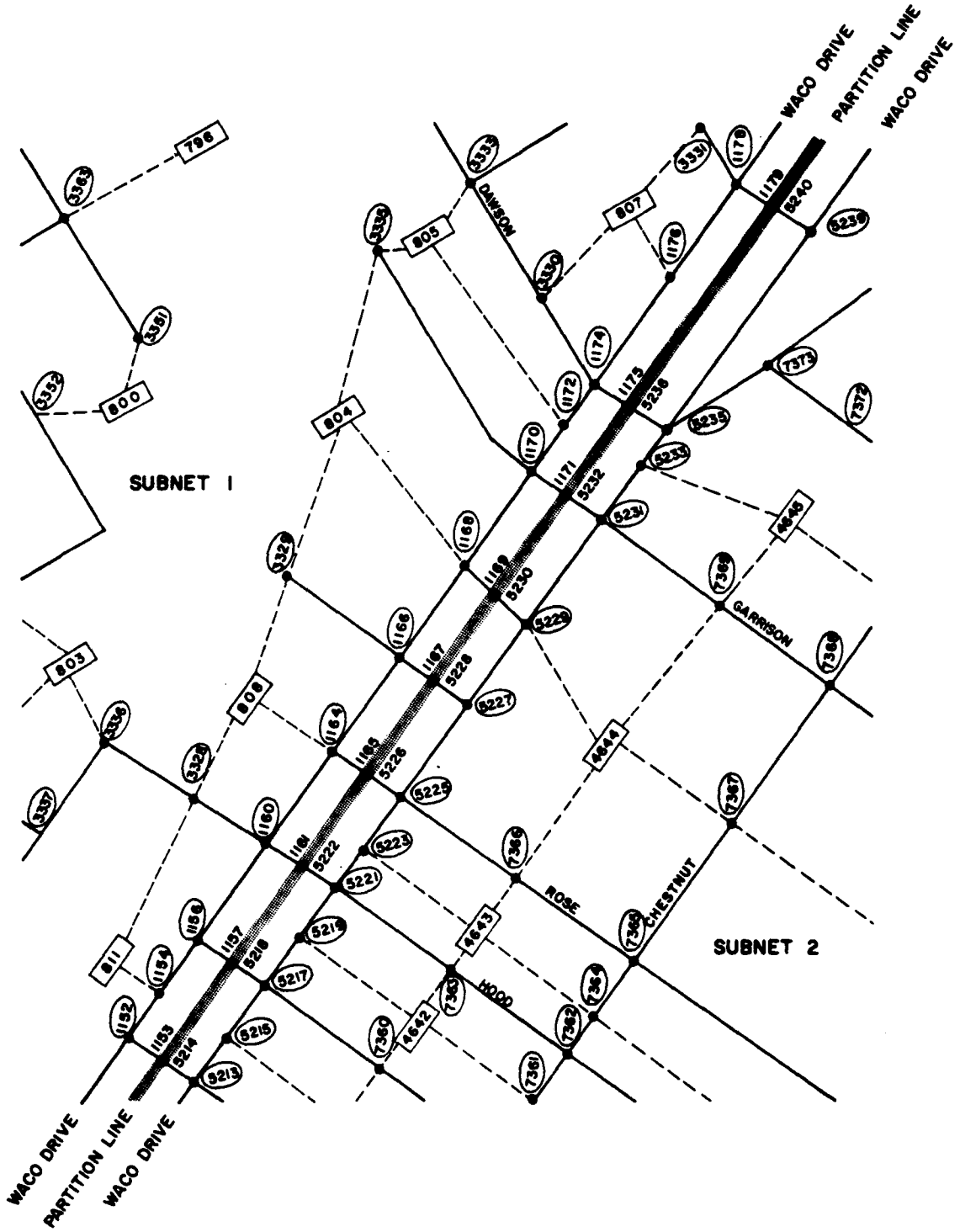
(2) When a partition line intersects the only connector to a centroid.

Figure III-3A and III-3B show both of these situations together with possible solutions. In the case of two intersecting arterials, it is quite possible that the minimum path between some zone pairs in subnet 2 should include links 7589-11899 and 11899-7591. This would of course violate the double crossing restrictions. In Figure III-3B this has been solved by the insertion of the "dummy" link 7590-7653. Distance and speed (or time) coded on this dummy link would be equal to that from node 7590 to 7654 via 11899. The partition node numbering on the centroid connectors 4026-11,672 and 4013-10,369 should be noted.

Also, shown in Figure III-3A, centroid 4026 has direct access to Arterial 'A' at node 11,672. While the partition line does not intersect the only connector between a centroid and a traffic carrying facility, it does intersect the only one from centroid 4026 to a very high speed facility. For this reason, a "dummy" connector was inserted from centroid 4026 to 7591. It, of course will be coded with the total travel time (including turn penalties) from 4026 to 11,672 to 11,899 to 7591.

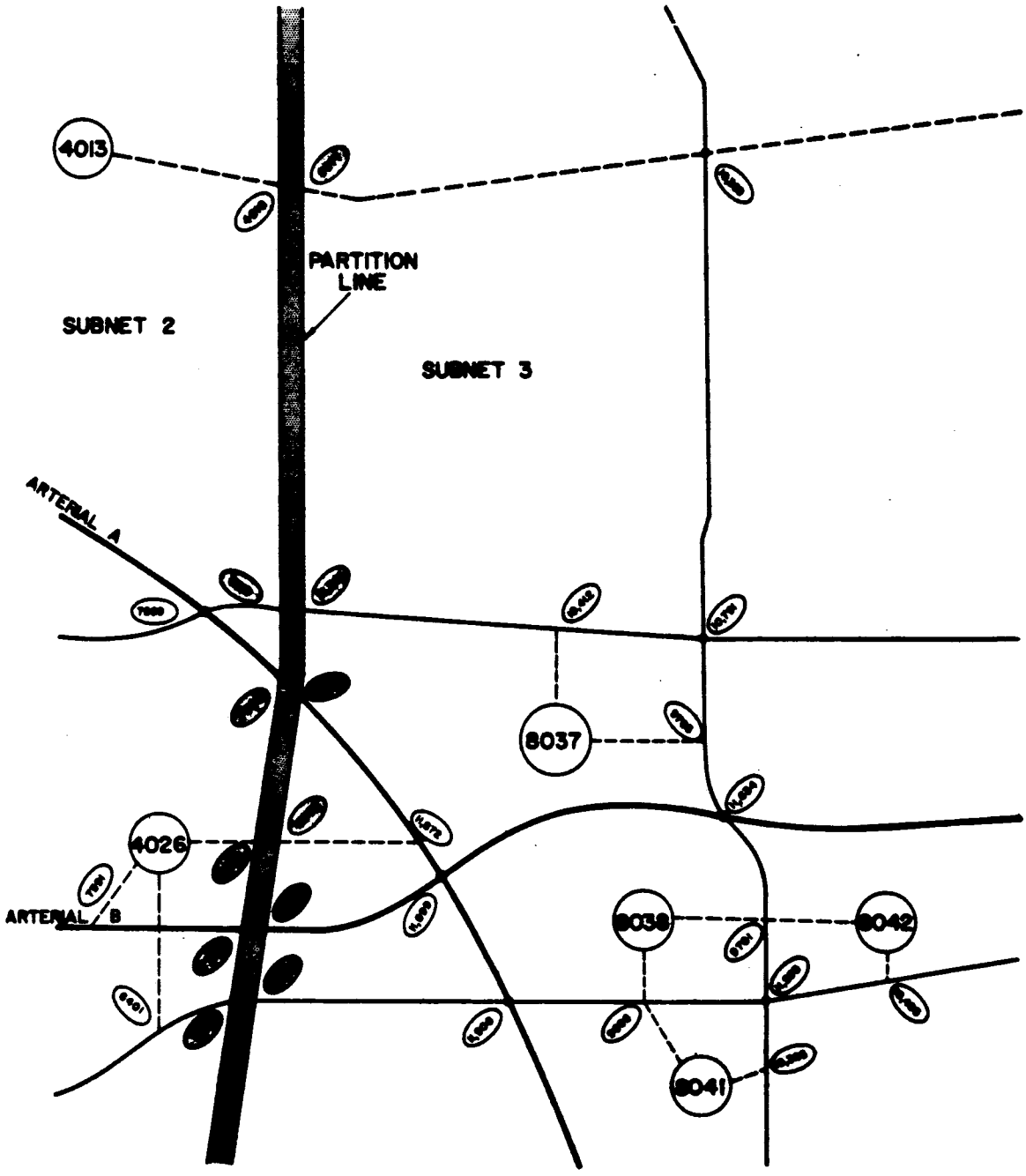
In the process of coding the node map, care must be taken when connecting external stations to the network. Figure III-4 shows the correct and an incorrect method. It will be noted that the centroid connector must attach the external station to a node in the network other than a partition line node. As shown in Figure III-4, centroid 1109 must be connected to node 2516 as they are numbered in the same subnet.

The connection would of course be made to node 7318 if the external station were numbered in the centroid numbering sequence of subnet 2. Each external station should be connected to a node that is in the same subnet as the external station although if it should be desirable to connect an external station to a node in another subnet, the partition line must be extended, intersecting the connector and this intersection coded as a partition-local node.



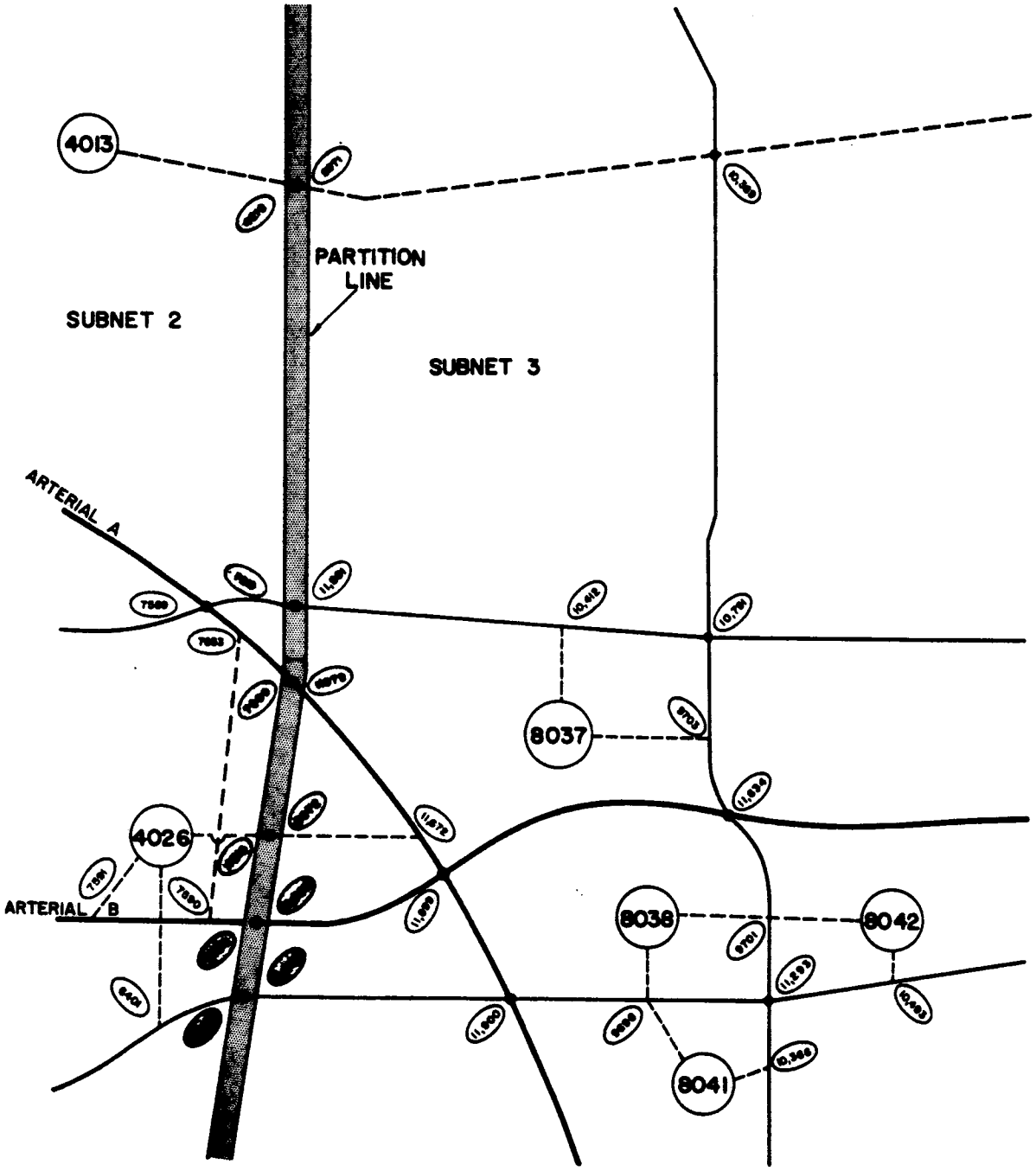
PORTION OF WACO DETAILED NETWORK SHOWING PARTITIONING ALONG AN ARTERIAL STREET

FIGURE III-2



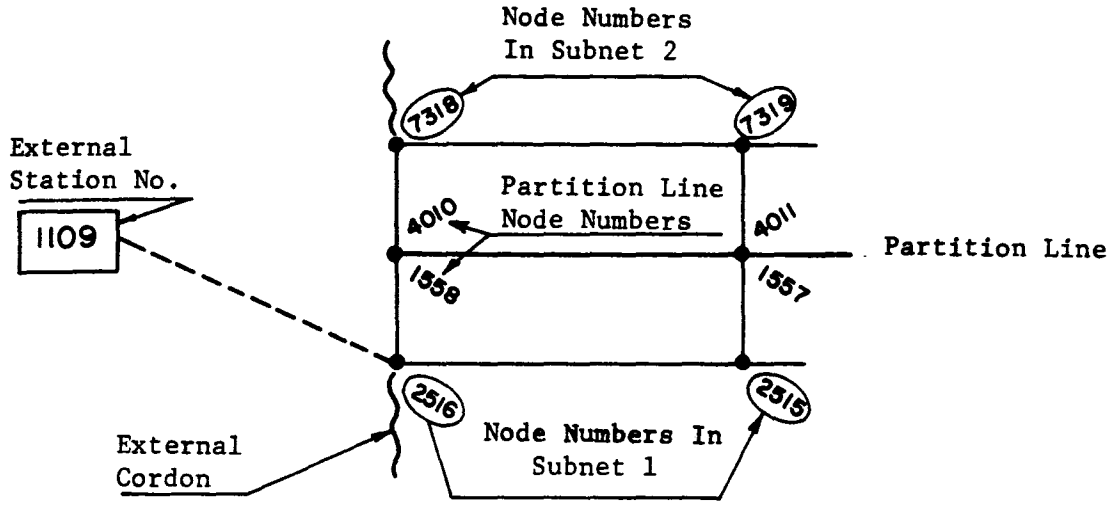
PORTION OF A NETWORK IN WHICH THE LOCATION OF THE PARTITION LINE COULD CAUSE "VIOLATION" OF NO-DOUBLE-CROSSING RESTRICTION

FIGURE III-3A

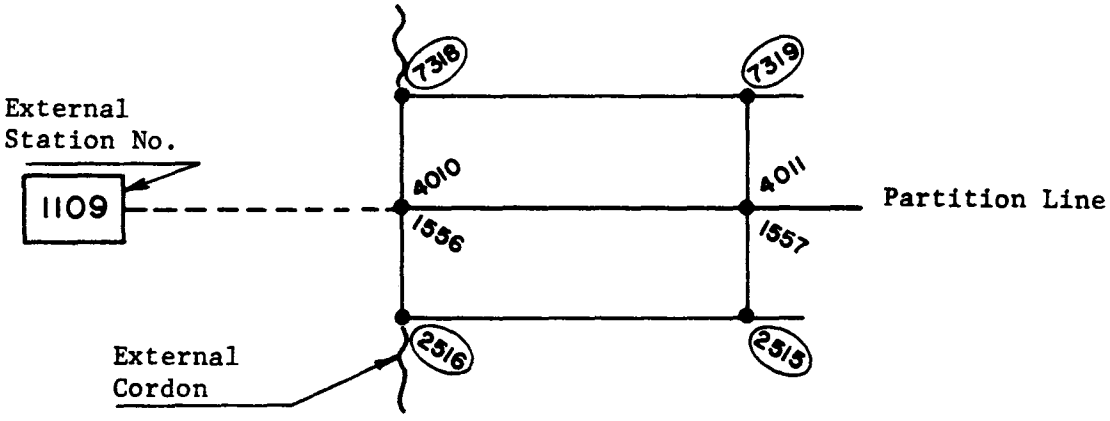


PORTION OF A NETWORK SHOWING USE OF A "DUMMY LINK" TO AVOID NEED FOR DOUBLE CROSSING OF PARTITION LINE

FIGURE III-3B



CORRECT METHOD



INCORRECT METHOD

METHOD OF CONNECTING EXTERNAL STATIONS TO THE NETWORK WHEN THE PARTITION LINE FOLLOWS AN ARTERIAL STREET

FIGURE III-4

Node Numbering Convention

A unique range of numbers must be used within each subnet (i.e. a node number of numbers in one subnet must not fall within the range of numbers used in another subnet). It is not necessary that the numbering sequence from one subnet to another be continuous. For example, in a two subnet system, the numbers 1 through (say) 3,586 might be used for nodes (and centroids) in subnet one and numbers 4,000 through (say) 7,621 used in subnet two.

The Large System Traffic Assignment Package also requires that assignment centroids (internal zones and external stations) be given the lowest range of numbers and that they be numbered in continuous unbroken sequence within subnets. Partition-local nodes (partition line nodes where a centroid connector crosses a partition line) must also be numbered at the high end of this sequence. If the zones are not so numbered originally, they must be renumbered. This is most conveniently done by arraying the zones low to high with external stations on the high order end of the array. A table of the survey zone numbers indicating the corresponding assignment zone centroid number is then prepared. Data processing is facilitated by "writing" the appropriate assignment zone centroid number on each trip record or zone summary card utilizing a computer.

Although centroids and partition-local nodes must be numbered in an unbroken sequence within subnets there is no such restriction on node numbers. In other words, nodes (other than centroids) need not be numbered consecutively nor is it necessary to use all numbers within the range for a subnet.

A table of node numbers should be prepared for each subnet prior to numbering the nodes and centroids. This is even more important than with smaller capacity assignment packages because of the more difficult job of "bookkeeping" that results from the much larger number of nodes.

The user of course may use any convenient numbers as the limits for the range of centroid, arterial, and freeway nodes so long as the following limitations are not violated:

maximum number of centroids in any subnet 1,200

maximum number of nodes (total) in any subnet 4,000

the largest node number used 32,767

The general scheme of the table of node numbers is given in Table III-3.

If it is desired to use even numbers only in numbering the non-centroid nodes or to provide "gaps" between groups of node numbers the range of numbers can of course be increased so long as the previously mentioned restrictions are observed. For example the following is permissible:

	node type	number of nodes	range
Subnet 1	centroids	say 1,200	1 to 1,200
	"arterial" nodes	say 2,000	1,500 to 4,500
	freeway nodes	say 800	5,000 to 6,600
	Total	4,000	
		.	
		.	
		.	
		etc.	
		.	
Subnet 4	centroids	say 1,000	23,000 to 24,000
	"arterial" nodes	say 2,000	25,000 to 29,000
	freeway nodes	say 1,000	30,000 to 32,000
	Total	4,000	

However, if the node numbering practice of using only even (or odd) numbers is followed, very close "bookkeeping" will be necessary in order to make certain that the total nodes in the subnet does not exceed 4000.

The following method for numbering nodes in a subnet that approaches the 4000 node limitation will facilitate "bookkeeping" relative to:

1. Number all centroids, external stations, and partition-local nodes.
2. Provide a "break" in the numbering sequence and then number arterial nodes. The size of the "break" would depend upon the anticipated number of additional centroids that might be required for future analysis.
3. Begin freeway partitions nodes at 3999 and following with freeways in a descending order.

Another advantage of this method is that it will provide the greatest possible number of available arterial and freeway node numbers for future network modification.

In the node numbering process, the user also anticipates the nodes at which turn movements are most desired. Due to the limitations of core storage, there are 800 "word records" allocated for storing data which will be used in calculating turn volumes. This should produce directional turn volumes at about 1600 intersection nodes. The exact number depends upon the structure of the network (i.e. the number of one-way streets links and the number of three and four-way intersections). Calculation of turn volumes will start with the highest number and continue in a descending order until all intersection nodes are complete or until core capacity is reached.

TABLE III-3

FORMAT OF A TABLE OF NODE NUMBERS

Node Group	Node Type	Generalized Node Number Range	Example of Node No. Range
A_1	centroids (1) in subnet 1	1 to a	1 to 950
B_1	"arterial" nodes (2) in subnet 1	b to c	1000 to 3000
C_1	freeway nodes (3) in subnet 1	d to e	3100 to 3900
	where a < b < c < d < e		
A_2	centroids (1) in subnet 2	i to j	4001 to 5200
B_2	"arterial" nodes (2) in subnet 2	k to l	5201 to 7000
C_2	freeway nodes (3) in subnet 2	m to n	7001 to 8000
	where i > e and i < j < k < l < m < n		
A_3	centroids (1) in subnet 3	o to p	8001 to 9100
B_3	"arterial" nodes (2) in subnet 3	q to r	9101 to 11,200
C_3	freeway nodes (3) in subnet 3	s to t	11,201 to 12,000
	where o > n and o < p < q < r < s < t		
A_4	centroids (1) in subnet 4	u to v	12,001 to 13,000
B_4	"arterial" nodes (2) in subnet 4	w to x	14,001 to 15,000
C_4	freeways nodes (3) in subnet 4	y to z	15,001 to 16,000
	where u > t and u < v < w < x < y < z		

(1) including partition nodes on centroids connectors (partition-local nodes)
(2) including partition nodes on arterials
(3) including partition nodes on freeways

Partition Table Cards

Once the partition line nodes have been numbered in both subnets, the partition table cards can be prepared. These cards supply the information needed for the program to build trees into and through adjacent subnets.

The partition table identifies partition nodes which are common to two subnets (each such node being numbered in the sequence once in the sequence of node numbers in each subnet). Since this is not a directional relationship, it is necessary to supply the partition table only once between each pair of link data cards.

Figure 5 shows a form for coding the partition line formation. The left partition node corresponds to the number in subnet 'n' and the right to the number in subnet 'n + 1'.

It is necessary that the partition nodes in the subnet containing the node numbers of the lower numerical value be entered in the left partition node field (columns 7 through 12). Therefore it follows that the partition nodes in the subnet containing the higher node numbers be centered in the right partition node field (columns 13 through 18).

All field or the partition table cards are right-justified. As indicated in Figure III-5, columns 19-72 are not used. Partition line numbers are coded only on this format. They are <u>not</u> included in the link data cards.

PARTITION LINE CODING FORM

						LEFT PARTITION NODE						RIGHT PARTITION NODE					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													
P	A	R	T	N													

EXAMPLE OF PARTITION LINE CODING FORM

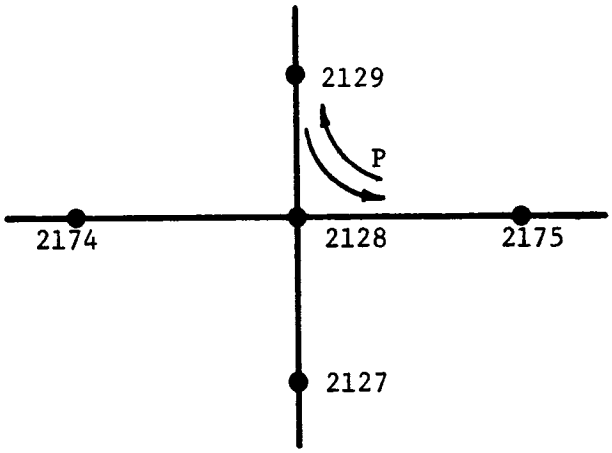
FIGURE III-5

Turn Penalties and Turn Prohibitors

The process of coding the node map is the same as that presented in the Traffic Assignment Manual prepared by the Bureau of Public Roads.

Turn prohibitors may be indicated on the node map in similar manner as described in the Traffic Assignment Manual. However, the coding of the turn prohibits and the card format are different.

The TPHBT punch in columns 1-5 identify the card as a turn prohibit card. A set of node triplets is used to describe two adjacent links and to specify the turn movement that is prohibited. One card is of course required for each prohibited movement. The following is an example of the coding where a turn movement is prohibited in both directions.



Columns 1-5	Approach Node Columns 7-12	Pivot Node Columns 13-18	Terminal Node Columns 19-24
TPHBT	2129	2128	2175
TPHBT	2175	2128	2129

If trees involving prohibited turns are desired, the Search Prohibited Paths program must be used. If the user contemplates using turn prohibitors, it should be realized that the run time is approximately doubled under the Search Prohibited Paths program. Hence, if only a few turns are to be prohibited it is recommended that, if at all possible these prohibited movements be coded into the network using one-way links.

There is a limit to the number of directional movements that can be prohibited in large subnets. It is recommended that no more than four directional movements be prohibited at any one intersection. This feature has not been fully tested as yet. However, the program has been observed to function improperly in cases where all turns were prohibited at an intersection; it has functioned properly in situations where four to six turn movements were prohibited.

Even though turn prohibits have been coded and the turn prohibit cards included in the network-link data card deck, it is possible to build trees in which turn prohibits are not included. This is accomplished by utilizing the Search Minimum Paths program. This program does not honor the prohibits and hence it is not necessary to remove or delete the turn prohibit cards in order to build trees that are free of prohibited turns.

Link Data Cards

Two link data card formats may be used. One, shown in Figure III-6

is the same as that used for BELMN and TEXAS Control programs. Since five digit node numbers may be (will be) used under TEXAS-BIGSYS, this format does not provide for separation between the 'A' and 'B' Node fields; this of course is awkward when handling or editing link data cards. For this, and other reasons the format shown in Figure III-7 was developed.

Most fields indicated on the coding form shown in Figure III-7 represent little or no change in meaning from that which the user is familiar with under BELMN and TEXAS Control. For convenience each field is explained below (also see the section on Network-Link Data Card Formats).

Jurisdiction: This one column field refers to a political subdivision within the study area. A total of eight jurisdictions (0,1,2,3, 4,5,6, and 7) may be used.

Link Class: This is the functional (or other) classification of the link. Four different classifications (0,1,2, and 3) may be used, such as:

freeway-expressway
arterial
collector
local

Summaries of vehicle-miles, vehicle-hours and vehicle-miles/vehicle-hours are printed off-line.

'A' Node, 'B' Node: The maximum size number that may be used is 32,767. Either end of a two-way link may be coded as the 'A' node. For a one-way link the 'A' node must be the node (intersection) from which the movement is made and the 'B' node the node (intersection to which the movement is made. For convenience in manual editing and up-dating of the link data cards, it is suggested that all two-way links be coded with the

low numbered node as the 'A' node and the high numbered node as the 'B' node*.

It is not necessary for the link data cards to be in sort on 'A' node for execution of the Prepare Network Description program; however it is recommended that they be so sorted in order to facilitate manual changes in the link data card deck.

Sign: Optional, the sign of the link at the 'A' node end is coded if turn penalties are to be used. If the sign of the link at the 'A' node end is plus (+) a zero (0) is coded in this field; if the sign is minus (-) a one (1) is coded.

Flag: Optional, used in conjunction with the "sign" when turn penalties are to be used. If the sign at the 'B' node end of the link does not differ from that of the 'A' node end a zero (0) is coded in this field; if the sign at the 'B' node end is different a one (1) is coded. Distance: The length of the link to in miles and hundreds (0.00 miles) is coded in this field.

Time or Speed: A 'T' is coded if the data in the Time/Speed Fields is time in minutes and hundreds (0.00 minutes). A 'S' is coded if the entry(s) in the Time/Speed Fields is speed. Speed is read to the tenth of a mile per hour (00.0 mph); however, when speed is coded the entry may be to a one mile per hour and the right most column in each field, which is lightly shaded, left blank.

Location of 'A' Node: This information is used by the Prepare Network Description program to prepare the Node Name Directory. Any combination of numeric and alpha characters may be used.

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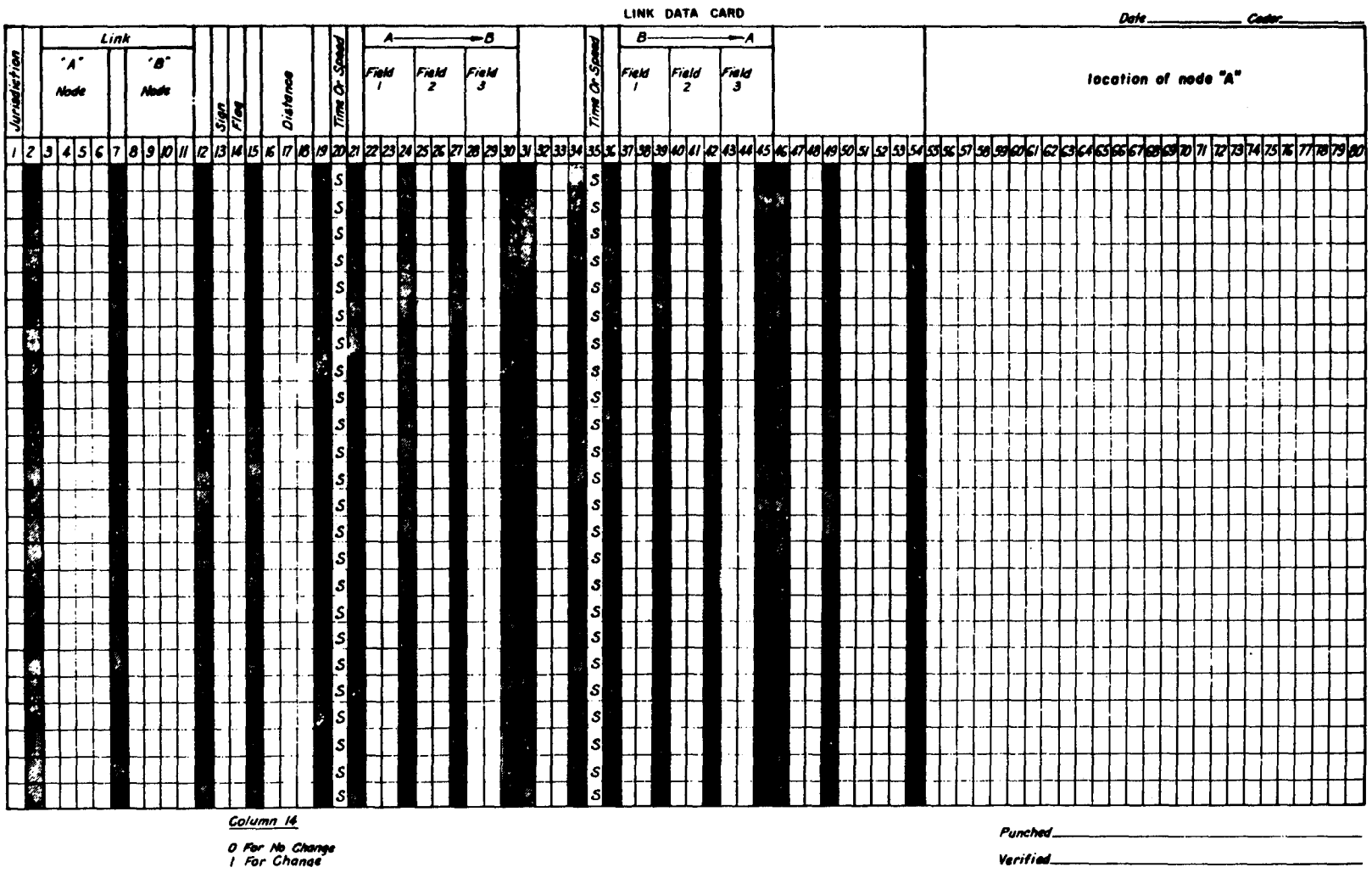
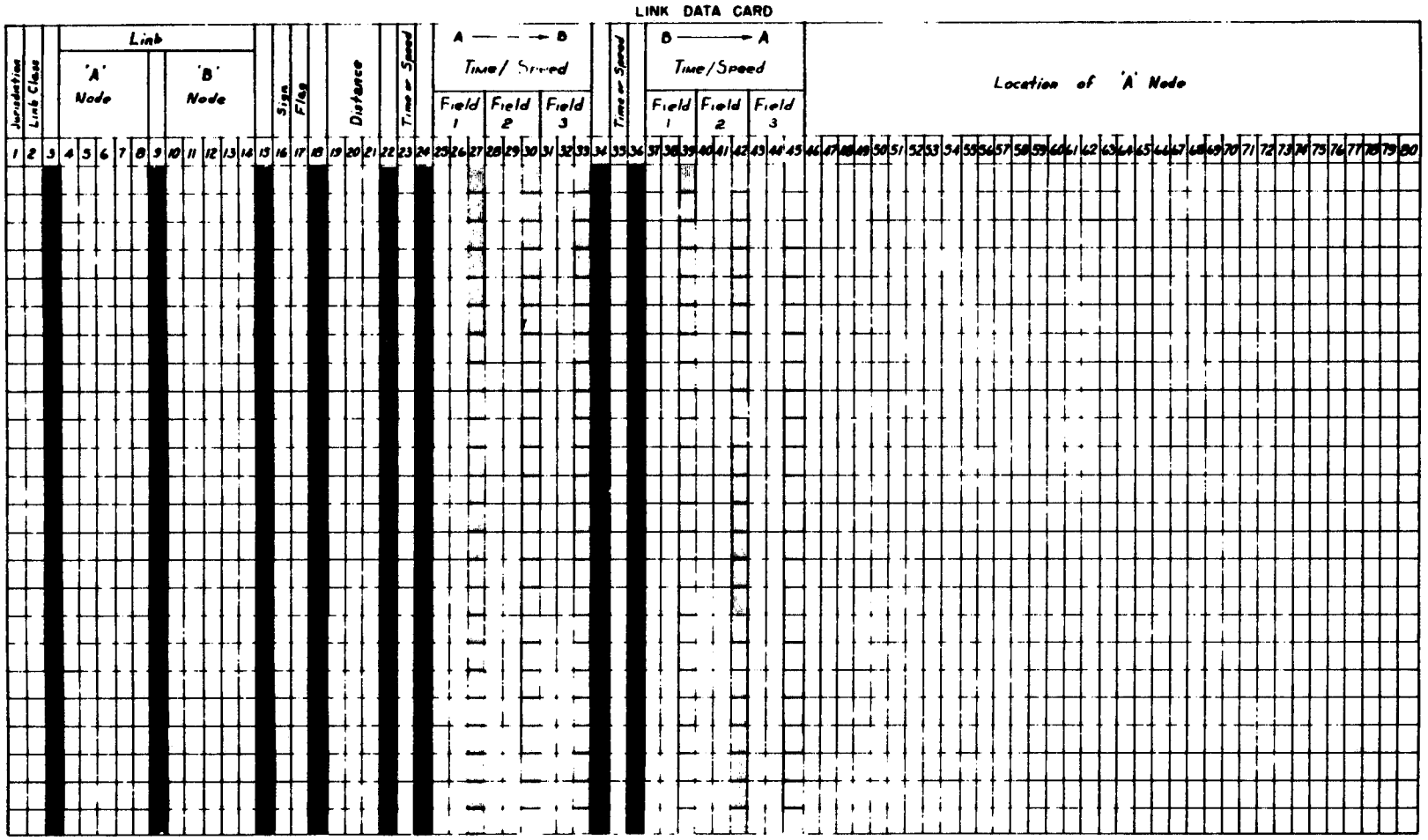
*The procedure will also significantly reduce the run time for the up-date Link Data Card File program now under preparation.



LINK DATA CODING FORM FOR BELMN AND TEXAS CONTROL PACKAGES

FIGURE III--6



LINK DATA CARD CODING FORM FOR TEXAS-LARGE SYSTEMS TRAFFIC ASSIGNMENT PACKAGE

FIGURE 7

C H A P T E R F O U R

PROGRAM DESCRIPTIONS

Prepare Network Description

Assembly Date 15 November 1966

Program Function The Prepare Network Description accepts the Network-Link Data Card Deck and builds the binary network description by subnet. Routines included in the program edit the link data cards and the partition line cards.

This program also builds the node name directory.

Call Card

Column	Contents
1-16	$PREPAREbNETWORK
17-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments**

Input: A6 - Network Link Data Card Deck

Output: A3 - BCD
A4 - Binary Network Description
B6 - Node Name Dictionary

*Refer to the chapter of this manual entitled Network-Link Data Card Formats and Deck Configurations for the function and format of each card comprising this deck.

**The Large Systems library program tape is mounted on A1; this is the same for all programs as indicated in the section on System Tape Assignments.

Normal Operation Tapes A6 (Link Data), A4 (Binary Network Description), and B6 (Intersection Names) are rewound. The number-of-subnetworks header card is read from A6 and printed on-line with the message: THERE ARE XXXXXX SUBNETWORKS THIS JOB. A header record with the same information is written on A3. Next, a subnetwork parameter card is read and the following on-line information is displayed:

FIRST NODE NUMBER XXXXXX - - LAST NODE NUMBER XXXXXX

LAST CENTROID OR PARTITION LOCAL NUMBER = XXXXXX

LAST ARTERIAL NUMBER = XXXXXX

LAST FREEWAY NUMBER = XXXXXX

After the header card information is displayed and check parameters established, the link data cards for that subnetwork are read and checked for validity, until an ENDLNK card is read; partition table cards followed by turn prohibit cards (if any) are read and checked for validity until an ENDNET card is encountered. If any of the link data cards, partition line cards for turn prohibit cards fail to pass their respective edit routine, an appropriate error message is printed; the operator must use these messages to decide if execution of subsequent programs is desirable.

The network description is then analyzed topologically and the binary network description is written on A4; turn tables are then constructed and written on A4. The process of reading batches of link data cards partition line cards, and turn prohibit cards is then repeated until the specified number of subnetworks are complete. At the end of each batch the message SUBNETWORK XXXXXX LINK DATA HAS BEEN PROCESSED, JOB PROCEEDING is printed. At the conclusion of the process of constructing turn tables, either of the following 2 groups of messages will be given:

TURN TABLES STORAGE ALLOCATION EXCEEDED WHILE PROCESSING

NODE XXXXXX IN SUBNETWORK XXXXXX

FIRST TURN NODE NUMBER = XXXXXX

LAST TURN NODE NUMBER = XXXXXX

or

ALL TURNS WILL BE KEPT IN SUBNETWORK XXXXXX

XXXXXX STORAGE LOCATIONS REMAINING IN TURN TABLE ALLOCATION AREA

The choice of which of the above messages is written is under program control, and depends entirely on the density of the network. Node processing begins with the last freeway node number and continues in a descending numerical sequence until either storage allocation is exceeded or the first arterial node is processed.

When the link data tape (A6) has been completely processed, it is unloaded, A4 and B6 are end filed and rewound, and the final message NETWORK PROCESSING COMPLETE is written.

Error Messages

SUBNETWORK XXXXXX LINK DATA POSITIONED IN PLACE OF SUBNETWORK XXXXXX

NETWORK PROCESSING CANNOT CONTINUE - RETURNING TO CONTROL PROGRAM - PAUSE

Columns 1-6 of the general subnetwork header card does not correspond to the expected serial sequence of subnetwork processing. Press start to return to control program, unready if the next program call is not preceded by a pause

INVALID NODE NUMBER FOR SUBNETWORK XXXXXX

An invalid node number for the current specified subnetwork has been found in either the 'A' Node of 'B' Node field a link data card. The erroneous card is printed on-line and ignored.

MORE THAN 4 LINKS CONNECTING NODE XXXXXX

The specified node already has four other nodes connected to it and the error card is printed immediately following the above message. If the A-B link of this card caused the message, the B-A link will still be checked for insertion if a two way link has been defined. In either case of error, the link will be ignored.

MORE THAN 4 WAYS INTO NODE XXXXXX

The specified node has been designated a 'B' node 4 times by previous link definitions. The current link is ignored and no further processing is attempted for this card.

NO VALID CHARACTER FOUND FOR TIME OR SPEED INDICATOR OR PRIMARY LINK DATA CARD IGNORED (ACCEPTABLE CHARACTERS ARE T, S, 1, OR 2)

This specified card is ignored.

LINK TIME EXCESSIVE-DIST/VEL CHANGED TO OBTAIN MAX LINK TIME OF 10.23

The caculated link travel time exceeds the acceptable program maximum of 10.23 minutes. The distance specified on this link is changed to 10.23 miles and the speed is changed to 60.0 MPH. These link parameter changes will be reflected on the listing obtained by the Output Network Description Program.

NO VALID SIGN CHARACTER FOUND ON LINK DATA CARD

SIGN ARBITRARILY SET NEGATIVE AND PROCEEDING

Column 13 of the specified link data card has a character other than

blank, 0, +, -, or 1. The sign character is assumed to be negative and the link is accepted for further processing.

NO VALID FLAG CHARACTER FOUND ON LINK DATA CARD

NO FLAG ASSUMED, ARROW SIGN OF LINK EQUATED TO RESPECTIVE SHAFT SIGN

Column 14 of the specified link data card has a character other than blank, 0, or 1. No flag is assumed and the link is accepted for further processing.

NO VALID CHARACTER ON THIS CARD FOR EITHER TWO WAY OR ONE WAY INDICATOR

ALL LINK INFORMATION GIVEN BY THIS CARD WILL BE IGNORED

Columns 35 of the specified link data card contains a character other than blank, 0, T, 1, S, or 2. The A-B link, which has already been entered in the network, is removed and the card is ignored.

A DUPLICATE LINK HAS BEEN DEFINED CONNECTING NODES XXXXXX AND XXXXXX LINK IGNORED

A duplicate link has been found connecting the specified nodes, which are given in A-B order. The full card is printed after the message, and the possibility exists for a similar message to be printed if the reverse link exists and is also duplicated.

INVALID PARTITION OR TURN PROHIBIT CARD READ-
CARD IGNORED

This message is used to indicate one of several error conditions associated with the turn prohibit and partition table cards. Since an ENDLNK card must be read before partition or turn cards are accepted, the program will scan for the characters PARTNb, TPHBTb. or ENDNET in Columns

1-6. If more of these character specifications are found, the above message will be given and the card ignored. A missing ENDNET card will cause repetition of the message for each card read until either a redundancy occurs or a match is found for cards pertaining to the following subnetwork, yet to be processed. Further error messages would then occur until an out of sequence subnetwork header card is read and interpreted. Operator intervention would be expected to occur prior to this time, however.

If the node triplet specified by the TPHBT card does not correspond to a valid set of sequentially connected nodes, the above message is given.

If Columns 7-12 or 13-18 are blank on the partition table card, this message occurs. Also, the contents of the field specified by Columns 7-12 must be numerically less than the contents of the field specified by Columns 13-18.

EXCESSIVE CONNECTION TO PARTITION NODE XXXXXX

CHECK NODE NUMBERS XXXXX, XXXXX, XXXXX

The specified partition node has more than one link connected to it; the second line of the error message lists the node(s) to which the partition node is connected. Program execution is continued after the error message is printed.

ERROR IN SETTING UP TURN TABLES FOR NODE XXXXXX

A halt occurs immediately after this message is printed. An interval processing error has occurred and any possible signs of computer abnormality should be checked. Press start to continue processing but do not exercise any subsequent program functions which require turn table usage.

Output Network

Assembly Date 15 October 1966

Program Function The Output Network Program accepts the binary network description and writes the BCD network representation on the output tape.

Call Card

Column	Contents
1-15	$OUTPUTbNETWORK
16-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A4 - Binary Network Description

Output: A3 - BCD Network Description

Normal Operation Tape A4 is rewound and the initial header record is read to determine the number of subnetworks. Subsequently, each subnetwork description and its associated partition tables are read, converted to the BCD format, and written out on A3. This process continues until the network is completed and A4 is rewound. Return is then made to the control program.

Error Messages

None

Search Minimum Paths

Assembly Date 15 October 1966

Program Function The Search Minimum Paths Program searches paths from designated centroids to all other nodes in the network, using a minimization principle based on given link parameters. Prohibited turns are not honored by this routine, even though TPHBT cards are present in the link data deck that described the network. Specified trees are BCD output.

Call Card

Column	Contents
1-21	$SEARCHbMINIMUMbPATHS
22-72	blank

Cards Read On-Line

(1) Call Card

(2) Turn Penalty Card (*TURN), which specifies the amount of time penalty to apply during the minimum path Search in simulating a turning penalty:

Column	Contents
1-5	*TURN
6	blank
7-12	Turn Penalty in hundredths (a decimal point is assumed between columns 10/11)

(3) Tree Selection Cards (*TREE), which specify those centroids from which trees should be built. One *TREE card is required for each subnet, and a minimum of one to a maximum of 1200

centroids is permissible within each subnet. Each card may specify various groups of one or more trees in any order, but proper functioning of the load process requires that the trees must be built in an unbroken ascending numerical sequence. The format of the Tree card is as follows, the six column selection fields are each composed of two subfields A and B of five columns and one column respectively as indicated.

Column	Contents	
1-5	*TREE	
6-7	blank	
8-12	Subfield A	first selection field
13	Subfield B	
14-18	Subfield A	second selection field
19	Subfield B	
20-24	Subfield A	third selection field
25	Subfield B	
26-30	Subfield A	fourth selection field
31	Subfield B	
32-36	Subfield A	fifth selection field
37	Subfield B	
38-42	Subfield A	sixth selection field
43	Subfield B	
44-48	Subfield A	seventh selection field
49	Subfield B	
50-54	Subfield A	eighth selection field
55	Subfield B	
56-60	Subfield A	ninth selection field
61	Subfield B	
62-66	Subfield A	tenth selection field
67	Subfield B	
68-72	Subfield A	eleventh selection field
73	Subfield B	

A comma (,) may be punched in column 73 if desired when subfield 68-72 is used. However, columns 73-80 are not read; the program places the comma when volumes 68-72 are punched.

Subfield A may contain any valid centroid number for the current subnet. Subfield B functions as a delimeter and may contain a blank, comma, or period. Any other character will give an error message. A period used as a delimeter causes all trees built within its control range to be automatically output BCD in matrix form for inspection. This does not affect the tree building process otherwise, except for the delay involved in writing the output.

In processing selection fields from left to right, the occurrence of two consecutive 'A' Subfields separated by a blank 'B' Subfield will initiate a control setup for inclusive tree building beginning with the centroid specified by the first 'A' Subfield and ending with the centroid specified by the second 'A' Subfield. A comma in the second 'B' Subfield is optional for this situation, since the starting and ending centroids have been found for a search group. The occurrence of two successive 'B' Subfields containing either commas (may be implied as mentioned above) or periods, causes a single centroid to be specified, i.e., a control setup for inclusive tree building beginning and ending with the centroid specified in the intermediate 'A' Subfield.

For example, to build trees 1 through 90, with BCD output of trees 1 and 50, the following control card would be required.

Column	Contents
1-5	*TREE
6-7	blank
8-13	bbbb1.
14-19	bbbb2b
20-25	bbb49b
26-31	bbb50.
32-37	bbb51b
38-43	bbb90b

Tape Assignments

Input: A4 - Binary Network Description

Output: (Single Subnet) A3 - BCD Output
B1 - Binary Trees

(2 Subnets) A3 - BCD Output
A6 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2

(3 Subnets) A3 - BCD Output
A6 - Scratch
A7 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2
B3 - Binary Trees Subnet 3

(4 Subnets) A3 - BCD Output
A6 - Scratch
A7 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2
B3 - Binary Trees Subnet 3
B4 - Binary Trees Subnet 4

Normal Operation Tape A4 is rewound and a header record is read to determine the number of subnetworks. The card reader is then selected for the *TURN card. Then *TREE cards are read, one for each subnetwork. At the termination of this card reading process, the following messages are

printed on line:

THE TREE CARDS HAVE ESTABLISHED THE FOLLOWING PARAMETERS

TURN PENALTY = XXXXXX

FOR SUBNETWORK XXXXXX SEARCH MINIMUM PATHS FROM ZONES XXXXXX

TO XXXXXX INCLUSIVE AND OUTPUT

or

TO XXXXXX INCLUSIVE AND SUPPRESS OUTPUT

The appropriate latter message is repeated as often as necessary to describe the various control ranges for the tree search as interpreted by the program.

Continuing, all relevant tree and scratch tapes are rewound as determined by the number of subnetworks. A rightward scanning procedure is used to read separately each subnetwork description from A4, together with associated partition tables. Initially, all selected subtrees that originate in the current subnetwork are searched and partition line information necessary for extending subtrees into adjacent subnetworks is recorded on the proper scratch tape. Next, any subtrees built within previous subnetworks are extended through the current subnetwork by obtaining similar entering partition line information from a scratch tape. The extensions of these non-rooted subtrees likewise have partition line information recorded on the proper scratch tape. The net result is that, while a particular subnetwork description is within core on the right scan, all component subtrees with trends to the right through the current subnetwork are completed. This process is continued until the last subnetwork is processed, at which time only those trees origining within the first subnetwork are complete.

Then, the left scan is initiated, beginning with the description of the next to last subnetwork, and continuing successively with subnetworks to the left in a manner which reverses the trend of the subtrees, i.e., a leftward movement.

The console sense lights are displayed to correspond to the subnetwork of origin for a subtree, and the current subnetwork for which subtrees are being built. The sense lights 1, 2, 3, and 4 correspond to subnetworks of the same number. The relevant sense light will alternate on and off with every other tree that is built, the light number corresponding to the current subnetwork. A steady light indicates the subnetwork of origin for the phase being processed. The following examples indicate some light sequences for particular cases of three successive subtrees:

Sense Light				Processing Method
1	2	3	4	
	0	0	0	Subtrees origin in subnet 1 and are currently in subnet 1 ("right scan" phase)
0	0	0	0	
	0	0	0	
1	2	3	4	
	0		0	Subtrees origin in subnet 1 and are currently in subnet 3 ("left scan" phase)
	0	0	0	
	0		0	
1	2	3	4	
0			0	Subtrees origin in subnet 3 and are currently in subnet 2 ("left scan" phase)
0	0		0	
0			0	

At the completion of the left scan, all trees are complete and all tapes are rewound.

Error Messages

INVALID TURN PENALTY OR TREE CARD READ

REPLACE WITH NEW CARD AND PRESS START

The error card has been printed just prior to this message. Columns 1-6 contain characters other than *TURNb or *TREEb. Correct error card, replace in reader and press start.

THE FIRST FIELD OF THE TREE CARD IS BLANK

PLACE VALID TREE CARD IN READER AND PRESS START

The error card has been printed just prior to this message. Columns 7-12 are not punched and no tree selection can be made. Each subnetwork must have at least one centroid specified to complete the tree building process. Correct and try again.

ILLEGAL FIELD SEPARATION CHARACTER IN TREE CARD

REPLACE WITH CORRECTED TREE CARD AND PRESS START

The error card has been printed just prior to this message. A character other than blank, period, or comma has been detected in the B subfield of a selection field. See previous section on "Cards Read by Program." Replace with corrected card and press start.

SUBNETWORK XXXXXX READ OUT OF SEQUENCE FROM NETWORK DESCRIPTION TAPE

CHECK FOR INCORRECT TAPE MOUNTED ON A4

PRESS START WHEN READY TO RE-READ A4

Unsuitable parameters have been read from tape A4. Check for proper tape mounted and press start to restart this function.

NODE XXXXXX, AN ISOLATE NODE, HAS BEEN PLACED IN THE SEQUENCE TABLE

WHILE SEARCHING MINIMUM PATHS IN SUBNETWORK XXXXXX

LAMBDA VALUES SET TO ZERO FOR THIS TREE AND EXECUTION CONTINUING

An internal error has occurred during the minimum path search process. Check the node number specified for isolation. Execution will continue.

Search Prohibited Paths

Assembly Date 15 October 1966

Program Function The Search Prohibited Paths Program functions similarly to the Search Minimum Paths Program, with the exception that prohibited turns are recognized as specified by the TPHBT cards of the link data deck. The overall minimization principle is followed, however, subject to the prohibit constraints.

Call Card

Column	Contents
1-24	$SEARCHbPROHIBITEDbPATHS
24-27	blank

Cards Read On-Line

(Same as for Search Minimum Paths program)

(1) Call Card

(2) Turn Penalty Card, specifies the amount of the time penalty imposed during the search minimum paths; its format is:

Column	Contents
1-5	*TURN
6	blank
7-12	Turn Penalty in hundredths (a decimal point is assumed between columns 10 and 11

(3) Tree Selection Cards (*TREE), which specify those centroids from which trees should be built. One *TREE is required for each subnet, and a minimum of one to a maximum of

1200 centroids is permissible within each subnet. Each card may specify various groups of one or more trees in any order, but proper functioning of the load process requires that the trees must be built in an unbroken ascending numerical sequence. The format of the TREE card is as follows, the six column selection fields are each composed of two subfields A and B of five columns and one column respectively as indicated.

Column	Contents	
1-5	*TREE	
6-7	blank	
8-12	Subfield A	first selection field
13	Subfield B	
14-18	Subfield A	second selection field
19	Subfield B	
20-24	Subfield A	third selection field
25	Subfield B	
26-30	Subfield A	fourth selection field
31	Subfield B	
32-36	Subfield A	fifth selection field
37	Subfield B	
38-42	Subfield A	sixth selection field
43	Subfield B	
44-48	Subfield A	seventh selection field
49	Subfield B	
50-54	Subfield A	eighth selection field
55	Subfield B	
56-60	Subfield A	ninth selection field
61	Subfield B	
62-66	Subfield A	tenth selection field
67	Subfield B	
68-72	Subfield A	eleventh selection field
73	Subfield B	

A comma (,) may be punched in column 73 if desired when subfield 68-72 is used. However, columns 73-80 are not read; the program places the comma when volumes 68-72 are punched.

Subfield A may contain any valid centroid number for the current subnet. Subfield B functions as a delimeter and may contain a blank, comma, or period. Any other character will give an error message. A period used as a delimeter causes all trees built within its control range to be automatically output BCD in matrix form for inspection. This does not affect the tree building process otherwise, except for the delay involved in writing the output.

In processing selection fields from left to right, the occurrence of two consecutive 'A' Subfields separated by a blank 'B' Subfield will initiate a control setup for inclusive tree building beginning with the centroid specified by the first 'A' Subfield and ending with the centroid specified by the second 'A' Subfield. A comma in the second 'B' Subfield is optional for this situation, since the starting and ending centroid have been found for a search group. The occurrence of two successive 'B' Subfields containing either commas (may be implied as mentioned above) or periods, causes a single centroid to be specified, i.e., a control setup for inclusive tree building beginning and ending with the centroid specified in the intermediate 'A' Subfield.

For example, to build trees 1 through 90, with BCD output of trees 1 and 50, the following control card would be required.

Column	Contents
1-5	*TREE
6-7	blank
8-13	bbbb1.
14-19	bbbb2b.
20-25	bbb49b
26-31	bbb50.
32-37	bbb51b
38-43	bbb90b

Tape Assignments

Input: A4 - Binary Network Description

Output: (Single Subnet) A3 - BCD Output
B1 - Binary Trees

(2 Subnets) A3 - BCD Output
A6 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2

(3 Subnets) A3 - BCD Output
A6 - Scratch
A7 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2
B3 - Binary Trees Subnet 3

(4 Subnets) A3 - BCD Output
A6 - Scratch
A7 - Scratch
A8 - Scratch
B1 - Binary Trees Subnet 1
B2 - Binary Trees Subnet 2
B3 - Binary Trees Subnet 3
B4 - Binary Trees Subnet 4

Normal Operation

(same operation as for Search Minimum Paths program)

Error Messages

(same messages as for Search Minimum Paths Program)

Prepare Card Trip Volumes

Assembly Date 15 October 1966

Program Function The Prepare Trip Volumes Program reads and converts summary trip data into a format suitable for further trip processing or loading.

Call Card

Column	Contents
1-26	$PREPAREbCARDbTRIPbVOLUMES
27-72	blank

Call Options

Column	Contents
1-37	$PREPAREbCARDbTRIPbVOLUMESbANDbOUTPUT
38-72	blank

Cards Read On-Line

(1) Call Card

(2) Volume Field Specification Card, which denotes the field of the trip volume card from which the number of trips is to be selected. One of the following cards is required:

	Column	Contents
a)	1-5	*24HR - Select the trip volume from Columns 13-18 of the card input.
b)	1-5	*AMPK - Select the trip volume from Columns 19-24 of the card input.
c)	1-5	*PMPK - Select the trip volume from Columns 25-30 of the card input.

(3) Number of Reels Card, which specified the number of reels of trip volume input to be processed:

Column	Contents
1-5	*REEL
6	blank
7-12	Number of reels, right justified
13-72	Ignored

(4) Centroid Parameter Card:

Column	Contents
1-6	Number of Subnets
7-12	First Centroid Number Subnetwork 1
13-18	Last Centroid Number Subnetwork 1
19-24	First Centroid Number Subnetwork 2
25-30	Last Centoids Number Subnetwork 2
31-36	First Centroid Number Subnetwork 3
37-42	Last Centroid Number Subnetwork 3
43-48	First Centroid Number Subnetwork 4
49-54	Last Centroid Number Subnetwork 4
55-72	Ignored

Note: Only the centroid information as specified by the number of subnetworks in Columns 1-6 is required, and non-relevant fields are ignored.

Tape Assignments

Input: A6 - BCD Trip Volumes (card images; see Trip Volume Card Format below)

Output: (Single Subnet) A3 - BCD Output
B7 - Binary Trip Volumes

(2 Subnets) A3 - BCD Output
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2

(3 Subnets) A3 - BCD Output
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3

(4 Subnets) A3 - BCD Output
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3
B0 - Binary Trip Volumes, Subnet 4

Trip Volume Card Format Trip volume cards contain the O-D trip information as expanded and summarized according to serial zone. The format of the trip volume cards as required by the Prepare Card Trip Volumes Program is:

Column	Contents
1-6	Zone of Origin
7-12	Zone of Destination
13-18	24 hour volume
19-24	AM peak volume
25-30	PM peak volume

The data tape or tapes containing the trip volume cards should be sorted on columns 1-12.

The Number of Reels Card is then read and checked for validity. A valid card will result in the following information message:

THERE ARE XXXXXX REEL(S) OF TRIP VOLUME DATA TO BE INPUT THIS JOB

Following this, the Centroid Parameter Card is read and interpreted for the following message, the length determined by the number of subnetworks:

THE FOLLOWING CENTROID PARAMETERS HAVE BEEN ESTABLISHED FOR A SYSTEM OF XXXXXX SUBNETWORKS

SUBNET NUMBER	FIRST CENTROID NO.(EXTERNAL)	LAST CENTROID NO. (EXTERNAL)	FIRST CENTROID NO. (INTERNAL)	LAST CENTROID NO. (INTERNAL)
- - -	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -
XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX

The external centroid numbers are the actual map numbers and represent the valid range of centroid numbers for each subnetwork. The internal centroid numbers represent the serialization of the entire range of centroids, thus the last internal centroid number for the last subnetwork represents the total number of centroids in the system.

The binary trip volume tapes are then rewound and centroid header information is written on B7. The BCD input tape A6 is then rewound and the reading of input data commences. Binary trips are written on B7, B8, B9, and B0 as required, and the process continues until the input is exhausted. At the conclusion of the processing of origin zones within each subnetwork, the following message is printed:

TRIP VOLUME CARD PROCESSING FOR SUBNETWORK XXXXXX COMPLETE

If more than one reel of input has been specified, the following message is printed when an end of file is encountered on an intermediate reel of input:

END OF REEL - DIAL IN REEL XXXXXX OF INPUT DATA AND PRESS START

The reel just ended is unloaded and an operator action pause results. Press start when the next reel of the input sequence is ready.

The end of the final reel of input is signaled by the message:

END OF TRIP VOLUME INPUT DATA

The file is then unloaded. Further writing on the binary trip tapes may occur if zero "fill" trips are required to satisfy the given centroid parameters. When trip volume processing is complete, the binary trip tapes are end-filled and rewound.

Error Messages

CENTROID PARAMETER CARD IN ERROR
CORRECT AND PRESS START FOR RE-READ

The centroid parameters are incorrectly stated. The error card has been printed immediately before this message. Check the card format for proper positioning of parameters in their respective fields, correct and replace before continuing.

ILLEGAL ORIGIN ZONE ON THIS CARD
CARD IGNORED

Columns 1-6 of the trip card contains an origin zone number outside the range established by the Centroid Parameter Card. The card is ignored and processing continues.

ILLEGAL DESTINATION ZONE ON THIS CARD
CARD IGNORED

Columns 7-12 of the trip card contains a destination zone number outside the range established by the Centroid Parameter Card. The card is ignored and processing continues.

DUPLICATE TRIP VOLUME CARD HAS BEEN READ -- CARD IGNORED

The zone to zone movement given by this card has been previously processed. The card is ignored and processing continues.

INVALID VOLUME SPECIFICATION CARD READ -- REPLACE AND PRESS START

The card printed immediately preceding this message has characters in Columns 1-5 other than *24HR, *AMPK, *PMPK, with a blank Column 6. Replace with valid card and press start to reread.

INVALID NUMBER-OF-REELS CARD READ--REPLACE AND PRESS START

The error card printed immediately preceding this message is invalid. Check for proper format, replace and press start.

ORIGIN ZONE OUT OF SORT

The specified card has an origin zone number in Columns 1-6 that is less than a value previously processed. The card is ignored.

DESTINATION ZONE OUT OF SORT BY SUBNETWORK

Although it is permissible to have destination zones out of sort within a subnetwork, the destination zones must be grouped in sorted order according to subnetwork of destination, thus a minor sort on Columns 7-12 with major sort on Columns 1-6 is tacitly implied. The indicated card is ignored.

Prepare Trip Volumes

Assembly Date 15 October 1966

Program Function (same as for Prepare Card Trip Volumes program)

This program requires that the records be blocked 30 x 100. The Prepare Trip Volumes Program reads and converts summary trip data into a format suitable for further trip processing or loading.

Call Card

Column	Contents
1-21	$PREPAREbTRIPbVOLUMES
22-72	blank

Call Options

Column	Contents
1-32	$PREPAREbTRIPbVOLUMESbANDbOUTPUT
33-72	blank

Cards Read On-Line

(same as for Prepare Card Trip Volumes program)

(1) Call Card

(2) Volume Field Specification Card, which denoted the field of the trip volume card from which the number of trips is to be selected. One of the following cards is required:

	Column	Contents
a)	1-5	*24HR - Select the trip volume from Columns 13-18 of the card input.
b)	1-5	*AMPK - Select the trip volume from Columns 19-24 of the card input.
c)	1-5	*PMPK - Select the trip volume from Columns 25-30 of the card input.

(3) Number of Reels Card, which specifies the number of reels of trip volume input to be processed:

Column	Contents
1-5	*REEL
6	blank
7-12	Number of reels, right justified
13-72	Ignored

(4) Centroid Parameter Card

Column	Contents
1-6	Number of Subnetworks
7-12	First Centroid Number Subnetwork 1
13-18	Last Centroid Number Subnetwork 1
19-24	First Centroid Number Subnetwork 2
25-30	Last Centroid Number Subnetwork 2
31-36	First Centroid Number Subnetwork 3
37-42	Last Centroid Number Subnetwork 3
43-48	First Centroid Number Subnetwork 4
49-54	Last Centroid Number Subnetwork 4
55-72	Ignored

Note: Only the centroid information as specified by the number of subnetworks in Columns 1-6 is required, and non-relevant fields are ignored.

Tape Assignments

(same as for Prepare Card Trip Volumes program)

Input: A6 - BCD Trip Volumes (blocked 30 x 100; see Trip Volume Format below)

Output: (Single Subnet) A3 - BCD Output

B7 - Binary Trip Volume

(2 Subnets)	A3 - BCD Output
	B7 - Binary Trip Volumes, Subnet 1
	B8 - Binary Trip Volumes, Subnet 2
(3 Subnets)	A3 - BCD Output
	B7 - Binary Trip Volume, Subnet 1
	B8 - Binary Trip Volume, Subnet 2
	B9 - Binary Trip Volume, Subnet 3
(4 Subnets)	A3 - BCD Output
	B7 - Binary Trip Volume, Subnet 1
	B8 - Binary Trip Volume, Subnet 2
	B9 - Binary Trip Volume, Subnet 3
	B0 - Binary Trip Volume, Subnet 4

Trip Volume Format Trip volume cards contain the O-D trip information as expanded and summarized according to serial zone. The format of the trip volume cards as required by the Prepare Trip Volumes Program is:

Column	Contents
1-6	Zone of Origin
7-12	Zone of Destination
13-18	24 hour volume
19-24	AM peak volume
25-30	PM peak volume

The data tape or tapes containing the trip volume cards should be sorted on columns 1-12.

The Prepare Trip Volumes Program accepts the same trip volume data as above, with the exception that it must be blocked 30 characters/record,

100 records/block. The last record should be padded with blanks.

Normal Operation

(same as for Prepare Card Trip Volumes program)

The Volume Field Specification Card is read and checked for validity. A valid card will cause one of the following messages to be printed:

AM PEAK VOLUME HAS BEEN SELECTED (CARD COLUMNS 19 THRU 24)

or

PM PEAK VOLUME HAS BEEN SELECTED (CARD COLUMNS 25 THRU 30)

or

24 HOUR VOLUME HAS BEEN SELECTED (CARD COLUMNS 13 THRU 18)

The Number of Reels Card is then read and checked for validity. A valid card will result in the following information message:

THERE ARE XXXXXX REEL(S) OF TRIP VOLUME DATA TO BE INPUT THIS JOB

Following this, the Centroid Parameter Card is read and interpreted for the following message, the length determined by the number of subnetworks:

THE FOLLOWING CENTROID PARAMETERS HAVE BEEN ESTABLISHED FOR A SYSTEM OF XXXXXX SUBNETWORKS

SUBNET NUMBER	FIRST CENTROID NO. (EXTERNAL)	LAST CENTROID NO.(EXTERNAL)	FIRST CENTROID NO. (INTERNAL)	LAST CENTROID NO.(INTERNAL)
XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX

The external centroid numbers are the actual map numbers and represent the valid range of centroid numbers for each subnetwork. The internal centroid numbers represent the serialization of the entire range of centroids, thus

the last internal centroid number for the last subnetwork represent the total number of centroids in the system.

The binary trip volume tapes are then rewound and centroid header information is written on B7. The BCD input tape A6 is then rewound and the reading of input data commences. Binary Trips are written on B7, B8, B9, and B0 as required for origin zones within each subnet; when processing of data for zones in a subnet is completed, the following message is printed:

TRIP VOLUME CARD PROCESSING FOR SUBNETWORK XXXXXX COMPLETE.

If more than one reel of input has been specified, the following message is printed when an end of file is encountered on an intermediate reel of input:

END OF REEL - DIAL IN REEL XXXXXX OF INPUT DATA AND PRESS START

The reel just ended is unloaded and an operator action pause results. Press start when the next reel of the input sequence is ready.

The end of the final reel of input is signaled by the message:

END OF TRIP VOLUME INPUT DATA

The file is then unloaded. Further writing on the binary trip tapes may occur if zero "fill" trips are required to satisfy the given centroid parameters. When trip volume processing is complete, the binary trip tapes are end-filed and rewound.

Error Messages

(same as for Prepare Card Trip Volumes program)

CENTROID PARAMETER CARD IN ERROR
CORRECT AND PRESS START FOR RE-READ

The centroid parameters are incorrectly stated. The error card has been printed immediately before this message. Check the card format for

proper positioning of parameters in their respective fields, correct, and replace before continuing.

ILLEGAL ORIGIN ZONE ON THIS CARD
CARD IGNORED

Columns 1-6 of the trip card contains an origin zone number outside the range established by the Centroid Parameter Card. The card is ignored and processing continues:

ILLEGAL DESTINATION ON THIS CARD
CARD IGNORED

Columns 7-12 of the trip card contains a destination zone number outside the range established by the Centroid Parameter Card. The card is ignored and processing continues.

DUPLICATE TRIP VOLUME CARD HAS BEEN READ--CARD IGNORED

The zone to zone movement given by this card has been previously processed. The card is ignored and processing continues.

INVALID VOLUME SPECIFICATION CARD READ--REPLACE AND PRESS START

The card printed immediately preceding this message has characters in Columns 1-5 other than *24HR, *AMPK, *PMPK, with a blank Column 6. Replace with valid card and press start to reread.

INVALID NUMBER-OF-REELS CARD READ--REPLACE AND PRESS START

The error card has an origin zone number in Columns 1-6 that is less than a value previously processed. The card is ignored.

DESTINATION ZONE OUT OF SORT BY SUBNETWORK

Although it is permissible to have destination zones out of sort within a subnetwork, the destination zones must be grouped in sorted order according to subnetwork of destination, thus a minor sort on Columns 7-12 with major sort on Columns 1-6 is tacitly implied. The indicated card is ignored.

Output Trip Volumes

Assembly Date 15 October 1966

Program Function The Output Trip Volumes Program reads the binary trip volumes as prepared by the Prepare Trip Volumes or Prepare Card Trip Volumes Program, and outputs a BCD representation of the trip matrix. The output is in the same format as that produced by the 'ANDbOUTPUT' options of the trip preparation programs.

Call Card

Column	Contents
1-20	$OUTPUTbTRIPbVOLUMES
21-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input:	(Single Subnet)	B7 - Binary Trip Volumes
	(2 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
	(3 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
		B9 - Binary Trip Volumes, Subnet 3
	(4 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
		B9 - Binary Trip Volumes, Subnet 3
		B0 - Binary Trip Volumes, Subnet 4

Output: A3 - BCD Output

Normal Operation

B7 is rewound and centroid parameters are read. The remainder of the trip tapes, if any, are not rewound. The tapes are read in a cyclic manner, corresponding to a row of the trip matrix. The BCD output is then written on A3 and this process is continued until all rows of the trip matrix have been output. The binary trip tapes are unloaded at the conclusion of the program.

Error Messages

None

Sum Trip Ends

Assembly Date 15 October 1966

Program Function The Sum Trip Ends Program determines pertinent trip volume summary statistics for each zone. These data include the zone number, number of trips entering, number of trips exiting, number of intrazonal trips, number of trip ends, number of zones entering and number of zones exiting. A final summary of the total trips, total trip ends, and total interzonal trip ends is also given.

Call Card

Column	Contents
1-14	$SUMbTRIPbENDS
15-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments

Input:	(Single Subnet)	B7 - Binary Trip Volumes
	(2 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
	(3 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
		B9 - Binary Trip Volumes, Subnet 3
	(4 Subnets)	B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2
		B9 - Binary Trip Volumes, Subnet 3
		B0 - Binary Trip Volumes, Subnet 4
	Output:	A3 - BCD Output

Normal Operation B7 is rewound and centroid parameters are read. The remainder of the file is then read, summarized and rewound. Thereafter, each succeeding trip tape is rewound and similarly read and summarized. This process continues until all subnetwork trip tapes have been summarized, at which time the BCD summary is written on A3.

Error Message

None

Load Network

Assembly Date 15 October 1966

Program Function The Load Network Program applies trips to the network according to the pattern governed by the minimum path trees. Link loadings are accumulated directionally, as well as the intersection turning movements.

Call Card

Column	Contents
1-13	$LOADbNETWORK
14-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input:	(Single Subnet)	A4 - Binary Network Description
		B1 - Binary Trees
		B7 - Binary Trip Volumes
	(2 Subnets)	A4 - Binary Network Description
		A7 - Scratch
		B1 - Binary Trees, Subnet 1
		B2 - Binary Trees, Subnet 2
		B7 - Binary Trip Volumes, Subnet 1
		B8 - Binary Trip Volumes, Subnet 2

(3 Subnets) A4 - Binary Network Description
A7 - Scratch
A8 - Scratch
B1 - Binary Trees, Subnet 1
B2 - Binary Trees, Subnet 2
B3 - Binary Trees, Subnet 3
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3

(4 Subnets) A4 - Binary Network Description
A8 - Scratch
A9 - Scratch
B1 - Binary Trees, Subnet 1
B2 - Binary Trees, Subnet 2
B3 - Binary Trees, Subnet 3
B4 - Binary Trees, Subnet 4
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3
B0 - Binary Trip Volumes, Subnet 4

Output: All cases, 1 through 4 Subnet

A3 - Output BCD
A6 - Binary Loaded Network

Normal Operation

The Network Description tape A4 is rewound, read to determine the number of subnetworks parameter, and rewound again. Next, the binary loaded network tape is rewound, as well as all the relevant trip tapes. Loading then proceeds sequentially beginning with the first centroid. If the network is partitioned, segmented loading will occur in a manner roughly equivalent to the tree building process in reverse. Since all loading occurs in reverse, i.e. the trips are first loaded at the destination and

proceed by successive connecting links toward the origin, partitioned network loading begins within the subnetwork containing the destination zone. The console sense lights are used as indicators of which portions of the total network are currently being loaded. The concept is similar to the one used for tree building process, where in this case a steady light indicates subnetwork of origin, and a blinking light indicates the subnetwork through which the load is currently proceeding. When the subnetwork of origin coincides with the loading subnetwork, a single blinking light indicating the respective subnetwork is displayed.

The results of each subnetwork load are written on A6 after each phase. Since multi-file tree tapes are constructed by the minimum path routine in the case of multi-subnetwork systems, an appropriate file search is made prior to a particular subnetwork load sequence for location of the proper trees. Trees are then read singly and the respective sub-section of the row of the trip matrix is read. After the primary load of these trips, associated loads carrying over the partition line for the current tree are also loaded. This, of course, applies only to multi-subnetwork systems. The current subtree is rewound at the end of each load phase.

At the termination of loading, scratch tapes are rewound, the binary loaded network is end filed and rewound, and the trip tape(s) are unloaded. Also, the current subnetwork tree tape is unloaded after all zones within the home subnetwork have been loaded.

Normally, only 2400' reel of tape for the trees origining from a particular subnetwork is adequate for containing all tree records at 800 bpi. If, however, a particular reel overflows, it will be necessary to perform special tape handling procedures during the loading of the network. The

message MOUNT ALTERNATE REEL OF TREES AND PRESS START is given as a signal to mount the second reel of trees origining within the particular subnetwork that is currently being loaded. Press start to continue.

A second message INITIALIZE SUBNETWORK SERIAL TREE REEL SEQUENCE is given after loading is complete for the tree file that spans the two tapes, and the first reel of trees should again be mounted. Press start to continue.

If more than one reel of tape has been obtained as pointed out above, the Load Network Program expects a split file to have occurred during writing of the last file of trees. No provision has been made to accept splits of earlier files.

Special Notes

The normal termination of the Load Network Program results in an automatic call to the Output Loaded Network Program. See Output Loaded Network, page 37 for a description of the Output Loaded Network Program.

Error Messages

NUMBER OF SUBNETWORKS ESTABLISHED BY NETWORK DESCRIPTION TAPE=XXXXXX

NUMBER OF SUBNETWORKS ESTABLISHED BY BINARY TRIP VOLUME TAPE=XXXXXX

CHECK FOR PROPER REELS MOUNTED ON A7 AND B7-PRESS START TO RE-READ

The header record on the binary network description tapes does not match the header record on the first binary trip volume tape. An improper reel has been mounted. Press start to re-enter program at starting location.

HEADER WORD ON LOGICAL XXXXXX INDICATES SUBNETWORK XXXXXX TREES

MOUNTED IN PLACE OF SUBNETWORK XXXXXX TREES

MOUNT PROPER SUBNETWORK TREES AND PRESS START

A tree tape has been mounted in a different logical unit than it was originally written from. Check proper mounting of tree tapes and press start to continue normal operation.

LOAD ERROR HAS OCCURRED WHILE LOADING TREES FROM SUBNETWORK XXXXXX

During the load sequence, a noncontiguous tree number has been found and thus the current load volumes cannot be added to the network. Check for proper procedure during the tree building process. A tree has either been skipped, duplicated, or overlapped.

Output Loaded Network

Assembly Date 15 November 1966

Program Function The Output Loaded Network Program interprets the binary loaded network and prepares BCD representation of directional and nondirectional link volumes, directional turning movements and intersection names. A summary of vehicle miles and vehicle hours by jurisdiction and link classification is also provided.

Call Card

Column	Contents
1-22	$OUTPUTbLOADEDbNETWORK
23-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A4 - Binary Network Description
A6 - Binary Loaded Network
B6 - Intersection Names

Output: A3 - BCD Link Volumes and Turns

Normal Operation Units A4, A6, and B6 are rewound and the number of subnetworks parameter is read from A4. Beginning with subnet 1, a summation process is initiated for all loads accumulated for subnet 1, characterized by reading the full file of the binary loaded network. Tape A6 is then

rewound and BCD ouput of the link loadings and turning movements are written on A3. Then the binary network description is read to accumulate system vehicle miles and vehicle hours.

The above process is continued for each subnetwork defined, and the termination of the sequence is noted by the printing of a portion of the jurisdiction summary on-line. A4, A6, and B6 are unloaded and control is returned to the control program.

Error Messages

None

Forecast Fratar

Assembly Date 15 October 1966

Program Function The Forecast Fratar Program accepts a deck of zonal growth factors and uses the method of successive approximations developed by Fratar to generate a new trip matrix suitable for loading to the network. Each approximation of the matrix constitutes an iteration, and the number of iterations is governed by either a count factor or convergence criterion parameter read by the program.

Call Card

Column	Contents
1-16	$FORECASTbFRATAR
17-72	blank

Call Options

None

Cards Read On-Line

(1) Iteration/Deviation Card

Column	Contents
1-6	Maximum Number of Iterations
7-12	Maximum Acceptable Deviation (From 1.00 In hundredths.

(2) One of the following "B" Deck Field Specification Card

Column	Contents	Comments
1-5	*24HR	(Card Columns 19-24 of "B" deck contain zone growth factors)
1-5	*AMPK	(Card Columns 25-30 of "B" deck contain zone growth factors)
1-5	*PMPK	(Card Columns 31-36 of "B" deck contain zone growth factors)

Cards Read From Data Tape The Fratar "B" deck is used in conjunction with the Fratar Forecast Program and supplies the individual zone growth factors used in the first iteration. The card format is

Column	Contents
1-6	Zone Number
7-12	Number of Existing Trips
13-18	Number of Future Trips
19-24	24 Hour Growth Factor in hundredths (Decimal point should not be punched)
25-30	AM Peak Growth Factor
31-36	PM Peak Growth Factor

Tape Assignments

Input: (Single Subnet) A6 - "B" Deck of Growth Factors
B7 - Binary Trip Volumes

(2 Subnets) A6 - "B" Deck of Growth Factors
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2

(3 Subnets) A6 - "B" Deck of Growth Factors
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3

(4 Subnets) A6 - "B" Deck of Growth Factors
B7 - Binary Trip Volumes, Subnet 1
B8 - Binary Trip Volumes, Subnet 2
B9 - Binary Trip Volumes, Subnet 3
B0 - Binary Trip Volumes, Subnet 4

Output: (Single Subnet) A3 - BCD Output

A7 - scratch

B7 - Forecasted Binary Trip Volumes

(2 Subnets) A3 - BCD Output

A7 - scratch

A8 - scratch

B7 - Forecasted Binary Trip Volumes, Subnet 1

B8 - Forecasted Binary Trip Volumes, Subnet 2

(3 Subnets) A3 - BCD Output

A7 - scratch

A8 - scratch

A9 - scratch

B7 - Forecasted Binary Trip Volumes, Subnet 1

B8 - Forecasted Binary Trip Volumes, Subnet 2

B9 - Forecasted Binary Trip Volumes, Subnet 3

(4 Subnets) A3 - BCD Output

A7 - scratch

A8 - scratch

A9 - scratch

A0 - scratch

B7 - Forecasted Binary Trip Volumes, Subnet 1

B8 - Forecasted Binary Trip Volumes, Subnet 2

B9 - Forecasted Binary Trip Volumes, Subnet 3

B0 - Forecasted Binary Trip Volumes, Subnet 4

Normal Operation

The Forecast Fratar Program is divided into Phase I and Phase II. Phase I reads the iteration/deviation card, the 'B' deck field specification card, performs a trip end summary on the input trip tapes, reads and edits the 'B' deck and calculates the total convergent trip ends for all zones.

Phase II is permitted to continue if no data errors were found in Phase I. The 'L' factors are computed and the iterative process begins, to be terminated by successful convergence or fulfillment of the iteration factor.

Phase I: The iteration/deviation card is read and checked for validity. A parameter 'x' in columns 1-6 such that $0<x<11$ will cause this message to be printed:

MAXIMUM OF XXXXXX ITERATIONS HAS BEEN SPECIFIED.

A parameter 'y' in columns 7-12 such that $y<11$ will cause the following message to be printed:

MAXIMUM OF XXXXXX HUNDREDTHS DEVIATION FROM 1.00 HAS BEEN SPECIFIED

Next, the 'B' deck selection card is read and interpreted. According to a valid interpretation, one of the following messages will be printed:

24 HR. FIELD SPECIFIED OF B DECK CARDS (CARD COLUMNS 19-24)

AM PEAK FIELD SPECIFIED OF B DECK CARDS (CARD COLUMNS 25-30)

PM PEAK FIELD SPECIFIED OF B DECK CARDS (CARD COLUMNS 31-36)

B7 is then rewound and the centroid header parameters are read. Then the remainder of the trip input tapes (if any) are rewound. The trip tapes are read one by one to obtain the basic trip end summary, with a rewind after each pass.

The 'B' deck tape (A6) is rewound and read to determine the growth factors for each zone. Error checking is performed and each card is written off-line on A3 as a check list. This listing is header LISTING OF B DECK AS INPUT. At the conclusion of the 'B' deck input, further error checking is performed and the total convergent trip ends are calculated for each zone. The 'B' deck file is then unloaded and the program proceeds to Phase II.

Phase II: Checks one mode for an abort indicator created by errors encountered in data by Phase I. If none are present, the program proceeds to rewind the relevant scratch tapes for the iteration. Next, the input trip tapes are again read one by one to calculate the 'L' factors for each zone. A rewind follows the completion of the reading of each trip tape. Then the input trip tapes are read for a third time and expanded trip volumes are written on the scratch tapes in a one-to-one correspondence. At the end of the iteration, new growth factors are calculated for the next iteration, a pass is made on the trip tapes just written for purpose of calculating new 'L' factors, and a second pass is made to generate the next iteration, which will be written on the original units beginning with B7. Thus an alternating procedure is used, whereby units beginning with B7 are used on even numbered iterations. Also, at the end of each even iteration, the following convergence statistics are printed on-line:

CONVERGENCE DISTRIBUTION AT THE END OF ITERATION XXXXXX

less than	FACTOR	NUMBER
	0.90	XXXXXX
	0.90	XXXXXX
	0.91	XXXXXX
	0.92	XXXXXX
	0.93	XXXXXX

	0.94	XXXXXX
	0.95	XXXXXX
	0.96	XXXXXX
	0.97	XXXXXX
	0.98	XXXXXX
	0.99	XXXXXX
	1.00	XXXXXX
	1.02	XXXXXX
	1.03	XXXXXX
	1.04	XXXXXX
	1.05	XXXXXX
	1.06	XXXXXX
	1.07	XXXXXX
	1.08	XXXXXX
	1.09	XXXXXX
	1.10	XXXXXX
greater than	1.10	XXXXXX

An indication of how well the system has converged is given by how closely the listed growth factors approach 1.00, so indicated by the number of zones in each group.

At the end of the 1st iteration only, the input tapes beginning with B7 are unloaded, and alternate tapes must be mounted in their position to receive the final expanded trip volumes. The program will terminate only on an even iteration, thus the expanded trip volume output may be expected to occupy the same units as were used for binary trip tape input.

When all zones fall within the plus or minus deviation specified on the iteration/deviation card, or when the maximum specified number of iterations has been reached, the following message is printed on line followed by a program pause:

RETAIN FORECASTED TRIP TAPES/PRESS START WHEN READY . . . . . .

Note that convergence criterion is applied only on even iterations, and specification of a maximum number of iterations that is odd will cause an iteration count comparison to be made with one plus the number specified.

All scratch tapes used and final trip tapes will be rewound at the conclusion of the Fratar procedure.

Error Messages

INVALID NUMBER OF ITERATIONS SPECIFIED IN COLUMNS 1 THRU 6

THIS PARAMETER MUST BE NON-ZERO AND LESS THAN OR EQUAL TO 10

REPLACE CARD AND PRESS START

The specified card has an improper parameter specified.

INVALID MAX DEVIATION OF GROWTH FACTORS SPECIFIED IN COLUMNS 7 THRU 12

PROGRAM PARAMETER RANGE ALLOWABLE IS + OR - 0.10

REPLACE CARD AND PRESS START

The maximum allowable deviation is greater than 10.

INVALID B DECK FIELD SPECIFICATION CARD READ

REPLACE CARD AND PRESS START

Columns 1 thru 6 of the card contain characters other than *24HRb, *AMPKb, or *PMPKb.

ILLEGAL ZONE NUMBER SPECIFIED IN COLUMNS 1-6 OF CARD-CARD IGNORED

A "B" deck card has been read which contains a zone number outside the allowable range.

DUPLICATE ZONE INFORMATION REPORTED - CARD IGNORED

A "B" deck card has been encountered for a zone that has already been given a growth factor.

EXISTING TRIPS REPORTED AS XXXXXX COMPUTER AS XXXXXX FOR ZONE XXXXXX

This message may occur only if the 24 hour field of the "B" deck columns has been specified. Otherwise, no existing trips are expected to be reported in the "B" deck columns 7-12. If, however, the 24 hour field is being used, a comparison is made between the existing trips reported in columns 7-12 of the "B" deck and the existing trips determined by the trip end summary from the input trip tapes. Any discrepancy detected results in the above message being printed for information purposes only, and the trips obtained by the trip end summary are still used for computation purposes.

GROWTH FACTORS REPORTED AS XXXXXX COMPUTED AS XXXXXX FOR XXXXXX ZONE XXXXXX
---COMPUTED GROWTH FACTOR USED---

This message may occur only if the 24 hour field of the "B" deck has been specified. Otherwise, columns 7-12 of the "B" deck, existing trips, and columns 13-18 of the "B" deck, future trips, are ignored. If, however the 24 hour field is being used, the future trips are divided by the existing trips to obtain a computed growth factor. If a discrepancy exists between the computed growth factor and the one reported in columns 19-24, the above error message will result. The growth factor as computed is accepted and the given growth factor is rejected.

GROWTH FACTOR MISSING FOR INTERNAL ZONE NUMBER XXXXXX

FATAL ERROR FOR FRATAR FORECAST-ERROR SCAN CONTINUES, DELETION EMINENT

A growth factor has not been given for the specified internal zone number. Recall that the internal zone number may differ from the external zone number as indicated in III E, the description of the Prepare Card Trip Volume Program. Each zone will be checked for this error, thus the message may

appear more than once. An abort switch is set as a result of this error, and Phase II of the Forecast Fratar Program will be bypassed.

Note: There are no error messages in Phase II.

Merge Trip Volumes

Assembly Date 15 October 1966

Program Function The Merge Trip Volumes Program accepts sets of trip volume tapes (the number is determined by the order of the merge) and performs matrix addition of the trip volume matrixes thus represented. The summation obtained is written as a new set of trip volume tapes.

Call Card

Column	Contents
1-12	$MERGEbTRIPS
13-72	blank

Call Options

None

Cards Read On-Line

Call Card

Merge Order Card

Column	Contents
1-6	*ORDER
7-12	Merge Order

The Merge Order Card specifies the number of different groups of trip volumes that may be merged into a single trip volume tape(s). The order of the merge must be at least one but not greater than 3. If more than three groups are desired to be merged, intermediate merges may be performed to compound groups until a final merge may be performed.

Tape Assignments

Input:

1st Order Merge	A7
2nd Order Merge	A7
	A8
3rd Order Merge	A7
	A8
	A9

Output:

1 Subnet	A3 - BCD Messages
	B7
2 Subnets	A3 - BCD Messages
	B7
	B8
3 Subnets	A3 - BCD Messages
	B7
	B8
	B9
4 Subnets	A3 - BCD Messages
	B7
	B8
	B9
	B0

Normal Operation

The merge order card is read and interpreted. Following successful validity checks, the following message is printed on-line:

MERGE ORDER OF XXXXXX HAS BEEN SPECIFIED

The summation (merge) is performed by subnetwork. A valid trip volume tape for Subnetwork 1 must be mounted on A7 at execution time of this program. The tape is rewound and the number-of-subnets parameter is obtained. Immediately thereafter a sequence of mounting instructions is printed on-line followed by a program pause.

The message

MOUNT MERGE TAPE FOR SUBNETWORK XXXXXX ON A XXXXXX

is printed the number of times corresponding to the order of the merge. Beginning with subnet 1, the message is repeated for each subsequent subnet following the completion of each merge by subnet.

The message

MOUNT FINAL MERGE TAPE ON B XXXXXX -- PRESS START WHEN READY

is given before each merge by subnetwork. An example of the messages for a 3rd order merge of a 3 subnetwork system is given below:

MOUNT MERGE TAPE FOR SUBNETWORK 1 ON A7

MOUNT MERGE TAPE FOR SUBNETWORK 2 ON A8

MOUNT MERGE TAPE FOR SUBNETWORK 1 ON A9

MOUNT FINAL MERGE TAPE ON B7 - PRESS START WHEN READY

MOUNT MERGE TAPE FOR SUBNETWORK 2 ON A7

MOUNT MERGE TAPE FOR SUBNETWORK 2 ON A8

MOUNT MERGE TAPE FOR SUBNETWORK 2 ON A9

MOUNT FINAL MERGE TAPE ON B8 - PRESS START WHEN READY

MOUNT MERGE TAPE FOR SUBNETWORK 3 ON A7

MOUNT MERGE TAPE FOR SUBNETWORK 3 ON A8

MOUNT MERGE TAPE FOR SUBNETWORK 3 ON A9

MOUNT FINAL MERGE TAPE ON B9 - PRESS START WHEN READY

The tapes to be merged and the final merge tape are rewound prior to merging. At the completion of the merge by subnetwork, the final merge tape is rewound, and the merge inputs are unloaded.

Error Messages

ILLEGAL ORDER-OF-MERGE CARD SPECIFIED-REPLACE AND PRESS START

Columns 1-6 of the merge order specification card contains characters other than *ORDER. Correct and replace.

COLUMNS 7-12 OF *ORDER ARE BLANK - REPLACE AND PRESS START

No punches are in columns 7-12 of the merge order card. Correct and replace.

MERGE ORDER EXCEEDS 3 ON ORDER CARD - REPLACE AND PRESS START

Columns 7-12 of the merge order card have a parameter greater than 3. A maximum of 3 is permitted. Reduce the parameter and replace card.

INVALID TRIP TAPE REEL NOW UNLOADING -- REPLACE AND PRESS START

For the initial merge, a subnetwork 1 trip tape has been mounted with header information that does not correspond with the number of subnetworks determined from the tapes on A7. Check for proper mounting of reels and press start to restart this function.

MISMATCH OF RECORDS ON MERGE TAPES -- CHECK FOR PROPER TAPE MOUNTED

PRESS START TO CONTINUE THIS FUNCTION

Trip records with dissimilar zones of origin have been encountered with an attempted merge. Check for proper merge tapes mounted. Under ordinary circumstances, this is an irrecoverable error.

Block Trip Cards

Assembly Date 15 October 1966

Program Function The Block Trip Cards Program reduces the input records to 30 characters in length and blocks them 3000 characters per block on B6. Regardless of input format option used, output is in 30 character records arranged in the following format:

Column	Contents
1-6	Zone of Origin
7-12	Zone of Destination
13-18	24 Hour Volume
19-24	AM peak volume
25-30	PM peak volume

Call Card

Column	Contents
1-12	$BLOCKbTRIPS
13-72	blank

Call Options

None

Cards Read On-Line

(1) Call Card

(2) Format Specification Cards - One of the following input format specification cards must be supplied:

Input Format Type I

Column	Contents
1-4	*666
5-6	blank
7-72	ignored

The "666 punch denotes the trip volume cards to be input are in the following format:

Columns	Contents
1-6	Zone of Origin
7-12	Zone of Destination
13-18	24 Hour Volume
19-24	AM peak volume
25-30	PM peak volume

Input Format Type II

Columns	Contents
1-4	*336
5-6	blank
7-72	ignored

The "336 punch denotes the trip volume cards to be input are in the following format:

Columns	Contents
1-3	Zone of Origin
4-6	Zone of DEstination
7-12	24 Hour Volume
13-18	AM peak volume
19-24	PM peak volume

Input-Output

Input: A6 - BCD Trip Volume Cards

Output: A3 - BCD Messages
B6 - Blocked BCD Trip Volume Cards

Normal Operation The input format specification card is read, printed on line, and checked for validity. Tape units A6 and B6 are rewound and accumulation of input records from A6 proceeds until a block is complete, which is then written on B6.

If required, the last record is padded with blanks. Only one file on input is allowed, and A6 and B6 are unloaded after completion of the program.

Error Messages

INVALID FIELD SPECIFICATION-REPLACE WITH *336 OR *666 CARD-PRESS START

A field/format specification card has been read with characters other than *336 or *666 in columns 1 thru 4. Replace with proper card and press start.

Unblock Trips

Assembly Date 15 October 1966

Program Function The Unblock Trips Program accepts 3000 character blocks and generates card image records of 30 columns each from the block, with the remainder of the card padded with blanks.

Call Card

Column	Contents
1-14	$UNBLOCKbTRIPS
15-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A6 - Blocked BCD Trip Records

Output: A3 - BCD Messages
B6 - BCD Trip Cards

Normal Operation Tape units A6 and B6 are rewound; blocks are read from A6 and card images are generated on B6. Only one reel of blocked input is permitted, but as many reels of output as necessary will be written. Both units are unloaded at the conclusion of the program.

Error Messages

None

Convert Binary Trips

Assembly Date 15 October 1966

Program Function The Convert Binary Trip Program accepts a TEXAS control format binary trip volume tape and generates a tape of BCD card images.

Call Card

Column	Contents
1-21	$CONVERTbBINARYbTRIPS
22-72	blank

Call Options

None

Cards Read On-Line

(1) Call Card

(2) Card Output Format Specification Card - One of the following output format specification cards must be supplied:

Output Format I

Column	Contents
1-4	*336
5-6	blank

The "336" punch specifies that card image output will be written in the following format.

Column	Contents
1-3	Origin Zone
4-6	Destination Zone
7-12	Trip Volume
13-80	blank

Output Format II

Column	Contents
1-4	*666
5-6	blank

The "666" punch specifes that card image output will be written in the format indicated by the following 2nd card layout.

Column	Contents
1-6	Origin Zone
7-12	Destination Zone
13-18	Trip Volume
19-80	blank

Tape Assignments

Input: B1 - TEXAS Format Binary Trip Tape

Output: A3 - BCD Messages
B2 - BCD Trip Volume Cards

Normal Operation

The message MOUNT BINARY TRIP VOLUME TAPE ON B1, CONVERT TAPE ON B2 is printed followed by a program pause. Then units B1 and B2 are rewound and the Card Output Specification card is read, interpreted and checked for validity. Then the BCD card images are generated for each consecutive record read from the binary trip volume tape, according to each non zero entry in the record. The input records are N + 1 words long, where N is the number of zones as specified in the address of the first word. The zone number is in the decrement of the first word, and the N words following represent the volumes to zones 1 through N by their position in the record.

Only one reel of tape may be input, but multireels of card images may be written. The input tape and final output tapes are unloaded at the con-

clusion of the program and the message REMOVE B1 AND B2 is printed. There is no pause.

Error Messages

INVALID FORMAT SPECIFICATION CARD (NEEDS *336 OR *666 IN COLUMNS 1-6)

An invalid card output format specification card has been read. Correct and press start to reread.

Generate Trip Cards

Assembly Date 15 October 1966

Program Function The Generate Trip Cards Program accepts binary trip volume tapes as built by the large systems package and recreates BCD card input tapes from which the binary trip tapes were first obtained.

Call Card

Column	Contents
1-20	$GENERATEbTRIPbCARDS
21-72	blank

Call Option

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: (Single Subnet) B7 - Binary Trees

(2 Subnets) B7 - Binary Trees, Subnet 1
B8 - Binary Trees, Subnet 2

(3 Subnets) B7 - Binary Trees, Subnet 1
B8 - Binary Trees, Subnet 2
B9 - Binary Trees, Subnet 3

(4 Subnets) B7 - Binary Trees, Subnet 1
B8 - Binary Trees, Subnet 2
B9 - Binary Trees, Subnet 3
B0 - Binary Trees, Subnet 4

Output: all network sizes 1 through 4 subnets
A3 - BCD Messages
B6 - BCD Card Trip Volumes

Normal Operation The binary trip volume tape for subnet 1 is rewound and read to obtain trip parameters. The remainder of the trip tapes, if any, are not rewound. For each origin zone, trip cards by subnet of destination are written after reading the appropriate binary trip tape. The format of the card images generated is:

Column	Contents
1-6	Origin Zone Number
7-12	Destination Zone Number
13-18	Trip Volume
19-80	blank

The output is thus sorted on minor destination zone and major on origin zone. All tapes are unloaded at the completion of the program.

Error Messages

ERROR IN PROCESSING EXTERNAL CENTROID XXXXXX

An excessively long trip record has been found which exceeds the trip parameters. Check for proper reels mounted. All trip tapes will be unloaded and control returned to the control program.

Update Tape Inventory

Assembly Date 15 October 1966

Program Function The Magnetic Tape Inventory Program updates the existing tape inventory and provides up-to-date inventory listings. The updated inventory is listed by job number and by tape number for convenient cross reference.

Note: This is a special purpose program coded for operational activities by the Texas Highway Department and does not represent a phase of the traffic assignment technique.

Call Card

Column	Contents
1-22	$UPDATEbTAPEbINVENTORY
23-72	blank

Call Options

None

Cards Read On-Line

(1) Call Card

(2) In addition, more cards may be read by this program. An *END card must be supplied as the last card in each run, the function of which is to terminate the update procedure and cause an updated file to be generated. The six types of cards are:

(1) Identification Cards

Column	Contents
1-12	Transportation Study Area Alphanumeric Name
13	blank

14-17	Job Number
18	blank
19-20	Survey on Forecast Year
21	blank
22-54	Description of Data
55-56	blank
57-60	Date Prepared (57-58=month, 59-60=year)
61	blank
62-64	Type of Tape (PDC or THD)
65	blank
66-68	Tape Number
69-71	blank
72	blank of "c"
	"c" designates that a continuation card follows in the following format: Columns 1-54 = Additional comments (Only 1 continuation card will be accepted for each update card)

(2) Add-To-Job Card

Column	Contents
1-4	*ADD

The update cards following this control card will be added to the existing inventory only if their job number can be matched with that of one already in inventory. Otherwise an appropriate error message will be printed on the printer, followed by a halt.

(3) New Job Card

Column	Contents
1-4	*NEW

This control card can only follow an *ADDbb card. The update cards following this control card will be added to the existing inventory if their job number can not be matched with that of an existing inventory item.

(4) Delete-From-Job Card

Column	Contents
1-6	*DELETE

Each of the following update cards will be deleted from inventory if they are located in the existing inventory, otherwise an error message will be printed and a halt occurs.

(5) Change Tape Number Card

Column	Contents
1-6	*CHANGE

The tape number of each update item is matched against those of the existing inventory. If the number is matched the corresponding item is deleted from the existing invetory and the update is merged into the proper location of the inventory. If the number cannot be matched, an error message is printed followed by a halt.

(6) End Update Inventory Card

Column	Contents
1-6	*END

This card terminates the inventory update. No more cards will be read by this program.

Tape Assignments

Input: B6 - Magnetic Tape Inventory

Output: A3 - BCD Output
B6 - Magnetic Tape Inventory

Normal Operation

The inventory tape on logical 16 is rewound and control/update cards are read from the reader until an *END card is encountered. Then the updated inventory is written on 16 and written on the normal output tape. The letter BCD output is sorted both by job number and tape number, and the vaults listed separately.

Intersection Stringing

Program Function The intersection stringing program interprets the binary loaded network and prepares selected BCD representation of directional and non-directional link volumes, directional movements, and intersection names. Printed output is in the same form as that for Output Loaded Network except that information for the specified nodes is printed.

Call Card

Columns	Contents
1-23	$INTERSECTIONbSTRINGING
24-72	Blank

Call Options

None

Cards Read On-Line

(1) Call Card

(2) Node Selection Cards (*NODE) which specify those link
are desired for output. One *NODE card is requi
network. Each card may specify various gro
nodes in any order. The format of the
lows, the six column selection fie
two subfields A and B of five
spectively as indicated.

ıa.
ınce
ıld will
node
specified

Column	Contents	
1-5	*NODE	
6-7	blank	
8-12	Subfield A	first selection field
13	Subfield B	
14-18	Subfield A	second selection field
19	Subfield B	
20-24	Subfield A	third selection field
25	Subfield B	
26-30	Subfield A	fourth selection field
31	Subfield B	
32-36	Subfield A	fifth selection field
37	Subfield B	
38-42	Subfield A	sixth selection field
43	Subfield B	
44-48	Subfield A	seventh selection field
49	Subfield B	
50-54	Subfield A	eighth selection field
55	Subfield B	
56-60	Subfield A	ninth selection field
61	Subfield B	
62-66	Subfield A	tenth selection field
67	Subfield B	
68-72	Subfield A	eleventh selection field
73	Subfield B	

A comma (,) may be punched in column 73 if desired when subfield 68-72 is used. However, columns 73-80 are not read; the program places the comma when volumes 68-72 are punched.

Subfield A may contain any valid node number for the current subnet. Subfield B functions as a delimeter and may contain a blank or a comma.

In processing selection fields from left to right, the occurrence of two consecutive 'A' Subfields separated by a blank 'B' Subfield will initiate a control setup for inclusive nodes beginning with the node specified by the first 'A' Subfield and ending with the node specified

by the second 'A' Subfield. A comma in the second 'B' Subfield is optional for this situation, since the starting and ending centroids have been found for a search group. The occurrence of two successive 'B' Subfields containing either commas (may be implied as mentioned above) causes a single node to be specified. For example, to list the assigned link volumes and turn movements on the portion of Arterial A shown in Figure III-3A on page III-11, the following cards would be required.

Card for Subnet 1

Column	Contents
1-5	*NODE
6-7	blank
8	(as desired)

Card for Subnet 2

Column	Contents
1-5	*NODE
6-7	blank
8-13	b7589,
14-19	b7699,
20-80	blank

Card for Subnet 3

Column	Contents
1-5	*NODE
6-7	blank
8-13	11979,
14-19	11672,
20-25	11899,
26-31	11900,

At the present time, one and only one *NODE card can be used for each subnet each time the program is called. If a long string of non-consecutively numbered nodes is desired, the program must be recalled for each additional *NODE card. This limitation will hopefully be eliminated in the near future.

The program can be used to print the assigned volumes for centroid connectors. For example, if it were desired to print the volumes on the connectors for centroids 1 through 11, 21 through 23, 157 and 199 the following card would be needed.

Column	Contents
1-5	*NODE
6-7	blank
8-13	bbbb1b
14-19	bbb11,
20-25	bbb21b
26-31	bbb23,
32-37	bb157,
38-43	bb199,
44-80	blank

Tape Assignments

Input: A4 - Binary Network Description

A6 - Binary Loaded Network

B6 - Intersection Names

Output: A3 - BCD Link Volumes and turns

Normal Operation Units A4, A6, and B6 are rewound. A summation process is initiated for the nodes indicated in the parameter card(s). Tape A6 is then rewound and BCD output of the specified link loading and turning movements are written on A3. This process is continued for each subnetwork. A4, A6, B6 are unloaded.

Error Messages

None

Selected Zone Matrix

Assembly Date 15 June 1967

Program Function

The Selected Zone Matrix Program generates a selected zone trip matrix (table) from an existing (total) trip matrix. The new trip matrix contains only the zonal interchanges between all combinations of the two groups of specified zones; interchanges between zones in the same group are not included.

Call Cards

Column	Contents
1-21	$SELECTEDbZONEbMATRIX
22-72	blank

Cards Read On-Line

(1) Call Card

(2) ANODE Selection Cards. On these cards are the zones which are in the first group of selected zones. There can be as many of these cards as are necessary.

Column	Contents	
1-6	*ANODE	
7	blank	
8-12	Subfield A	first selection field
13	Subfield B	
14-18	Subfield A	second selection field
19	Subfield B	
20-24	Subfield A	third selection field
25	Subfield B	

26-30	Subfield A	fourth selection field
31	Subfield B	
32-36	Subfield A	fifth selection field
37	Subfield B	
38-42	Subfield A	sixth selection field
43	Subfield B	
44-48	Subfield A	seventh selection field
49	Subfield B	
50-54	Subfield A	eighth selection field
55	Subfield B	
56-60	Subfield A	ninth selection field
61	Subfiled B	
62-66	Subfield A	tenth selection field
67	Subfield B	
68-72	Subfield A	eleventh selection field
73	Subfield B	

A comma (,) may be punched in column 73 if desired when subfield 68-72 is used. However, colums 73-80 are not read; the program places the comma when volumes 68-72 are punched.

(3) BNODE Selection Cards. These cards indicate the second group of selected zones. There can be as many of these cards as are necessary.

Column	Contents
1-6	*BNODE
7-72	(Same format as the ANODE Selection Card)

(4) END ZONES Card. This card terminates the input data.

Column	Contents
1-4	*END
5-72	blank

Tape Assignments

Input:	(Single Subnet)	B7 - Existing (Total) Trip Table
Output:		B1 - Selected Zone Trip Table
Input:	(2 Subnets)	B7 - Existing (Total) Trip Table Subnet 1
		B8 - Existing (Total) Trip Table Subnet 2
Output:		B1 - Selected Zone Trip Table Subnet 1
		B2 - Selected Zone Trip Table Subnet 2
Input:	(3 Subnets)	B7 - Existing (Total) Trip Table Subnet 1
		B8 - Existing (Total) Trip Table Subnet 2
		B9 - Existing (Total) Trip Table Subnet 3
Output:		B1 - Selected Zone Trip Table Subnet 1
		B2 - Selected Zone Trip Table Subnet 2
		B3 - Selected Zone Trip Table Subnet 3
Input:	(4 Subnets)	B7 - Existing (Total) Trip Table Subnet 1
		B8 - Existing (Total) Trip Table Subnet 2
		B9 - Existing (Total) Trip Table Subnet 3
		B0 - Existing (Total) Trip Table Subnet 4
Output:		B1 - Selected Zone Trip Table Subnet 1
		B2 - Selected Zone Trip Table Subnet 2
		B3 - Selected Zone Trip Table Subnet 3
		B4 - Selected Zone Trip Table Subnet 4

Normal Operation

The input tapes and output tapes are rewound. The program reads the selected zone cards on-line, prints them, and forms two arrays, one of the BNODE zones and one of the ANODE zones. Then each record on the existing trip tape(s) are read and examined to determine which of the trips will be saved. The only trips which are left on the new trip tape are the interzonal interchanges between all the ANODE zones and all the BNODE zones. No zonal movements between zones in the same zone data set will be saved. That is, no trips from any zone in the ANODE set to any other zone in the ANODE set will be saved. For example:

A Node Group	B Node Group
Centroid 1	Centroid 10
2	11

For these specified groups of centroids the following zone (centroid) interchanges will be included on the selected zone matrix:

1 to 10 and 10 to 1
1 to 11 and 11 to 1
2 to 10 and 10 to 2
2 to 11 and 11 to 2

Error Messages

UNEXPECTED CARD ENCOUNTERED, *END CARD ASSUMED

The card read in was not an *ANODE, *BNODE, or *END card. The program assumes that there is no more data and proceeds from there.

INVALID FIELD SEPARATOR

A card does not have a blank, a comma, or a period following one of the data fields. The program ignores this card and proceeds.

ZONE XXXXXX IS IN ERROR

The zone number indicated in this message does not fall within the zone numbers on the existing trip tables. From here on, the program ignores this zone and proceeds normally.

C H A P T E R F I V E

LINK DATA CARD FORMATS AND DECK CONFIGURATIONS

The several cards presented in this chapter comprise the network-link data deck. This deck must be read card-to-tape blocked 1 x 84 for input to the Build Network Description program.

Network - Link Data Card Formats

The cards in the network-link data deck furnish all the information required to form the basic network description for the traffic assignment process. The network cards provide data for the relationship between subnets. These cards must be written on tape for input on A6 for the Prepare Network Description program.

Following is a description of each card type that comprises the network and link data deck.

1. Network Parameter Card

This is always the first card of the link data deck, and it appears only once. Its function is to specify the number of subnets, the format of the link data cards, and the field from which the link speed or time parameter is to be read from the link data card. The format is:

Column	Contents
1-5	blank
6	Number of Subnets (1,2,3,or 4) included in this link data deck
7-11	blank
12	Speed/Time option
13-17	blank
18	Format option
19-72	ignored

The option for reading speed/time is exercised by the appropriate punch in column 12 as follows:

Punch in Column 12	Speed/Time
1	read from field 1
2	read from field 2
3, blank, or 0	read from field 3

The option for specifying the link data card format is exercised by the appropriate punch in column 18 as follows:

Punch in Column 18	Format Option Selected
blank or 0	BELMN and TEXAS Control Format
1	TEXAS-BIGSYS Format

2. Subnet Parameter Card

This is always the second card of the link data deck, and it may appear more than once as needed to present the proper subnetwork parameters. This card is used as a header for the link definition cards for each subnetwork. The format is:

Column	Contents
1-5	blank
6	Subnet Number
7-12	First Centroid Number
13-18	Last Centroid Node Number
19-24	Last Arterial Node Number
25-30	Last Freeway Node Number
31-72	Ignored

3. Link Data Card

These cards normally comprise the bulk of the cards in the link data deck. Only the link data cards that are coded for the subnet number indicated on the Subnet Parameter Card may follow it for processing. As many link data cards as necessary to describe the network may be supplied behind the Subnetwork Parameter card.

For convenience in card handling, the link data cards may be sorted on the 'A' node but this is not a requirement for input to the Build Network Description program.

As previously indicated, two formats may be used; the format option is exercised as explained under the Network Parameter Card writeup. The fields used and their contents are given below for both formats; all fields are right justified.

BELMN and TEXAS Control Format

Columns	Contents
1	Jurisdiction (0,1,2,3,4,5,6, or 7 a blank is equivalent to zero)
2-6	"A" node (may not exceed 32767)
7-11	"B" node (may not exceed 32767)
12	blank
13	Sign (Blank, 0, + interpreted as +; 1 or - interpreted as -)
14	Flag (Blank or 0 denotes no flag; 1 interpreted as a flag)
15	blank
16-18	link distance in miles and hundredths
19	blank
20	Link time/speed ('T' or 1 denotes time given, S or 2 denotes speed given in Columns 28-30)

21	blank	
22-24	Speed/Time field 1	Speed in MPH and tenths; or Time in minutes and hundredths
25-27	Speed/Time field 2	
28-30	Speed/Time field 3	
31-34	blank	
35	Two-way link indicator (Blank or 0 indicates A-B link one way only; T or 1 indicates link is two way and time given for B-A direction in Columns 43-45; S or 2 indicates link is two way and speed given for B-A direction in Columns 43-45)	
36	blank	
37-39	Speed/Time field 1	Speed in MPH and tenths; or Time in minutes and hundredths
40-42	Speed/Time field 2	
43-45	Speed/Time field 3	
46-54	blank	
55-72	Hollerith description of link (this field will be appended to the corresponding "A" node when the Output Loaded Network Program is executed)	

BIGSYS Format

Column	Contents	
1	Jurisdiction (0,1,2,3,4,5,6, or 7; a blank is equivalent to zero)	
2	Link Classification (0,1,2, or 3)	
3	blank	
4-8	A Node (may not exceed 32767)	
9	blank	
10-14	B Node (may not exceed 32767)	
15	blank	
16	Sign (Blank, 0, + interpreted as +; 1 or - interpreted as -)	
17	Flag (Blank or 0 denotes no flag; 1 interpreted as a flag	
18	blank	
19-21	Link Distance (0.00 miles)	
22	blank	
23	Link time or speed ('T' for time 'S' for speed)	
24	blank	
25-27	Speed/Time field 1	Speed in MPH and tenths; or Time in minutes and hundredths
28-30	Speed/Time field 2	
31-33	Speed/Time field 3	
34	blank	
35	Link time or speed for two-way link	
36	blank	
37-39	Speed/Time field 1	Speed in MPH and tenths, or Time in minutes and hundredths
40-42	Speed/Time field 2	
43-45	Speed/Time field 3	
46-54	blank	
55-80	Location of 'A' Node	

4. End-of-Link-Data Card

This card follows the last link data card of the subnetwork and signals that all link data has been read for that subnetwork.

The format is:

Columns	Contents
1-6	ENDLNK
7-72	ignored

5. Partition Table Card

This card type is used to define equivalent nodes along the partition line in order that proper linkages are available for connecting the subnetworks. Considering a subnetwork sequence that is numbered from left to right, it is necessary to supply Partition Table Cards only for the right hand partition line, since the resulting definition is equivalent to the left hand partition line of the succeeding network. Thus for a system of 'n' subnetworks, 'n-1' sets of Partition Table Cards will be needed. No partition line definition is necessary for a single network system. The format of the Partition Table Card is

Columns	Contents
1-5	PARTN
6	blank
7-12	Partition line node within the subnetwork 'n' defined by the subnetwork Parameter Card.
13-18	Equivalent partition line node that appears in subnetwork 'n+1'.

Note: Both of the partition line nodes defined on this card must have exactly one connection to adjacent nodes within their respective subnetworks.

6. Turn Prohibit Card

The turn prohibit cards are used to describe a set of node triplets that define two adjacent links. Such an arrangement is adequate to specify a given turning movement through which flow is to be disallowed, and will be treated accordingly by the Search Prohibited Paths Program. The resulting "minimum" paths are sought that minimize the travel time from the designated zone subject to the constraint that the prohibited movements may not be used.

The format of the turn prohibit card is:

Columns	Contents
1-5	TPHBT
6	blank
7-12	Approach node of turning movement
13-18	Pivot node of turning movement
19-24	Terminal node of turning movement

7. End-of-Subnetwork Card

The End-of-Subnetwork card signals the end of all previous card types for a particular subnetwork, and causes final processing of the current subnetwork to be initiated. This is always the last card of the link data deck, since it appears at the end of the data cards for each subnetwork.

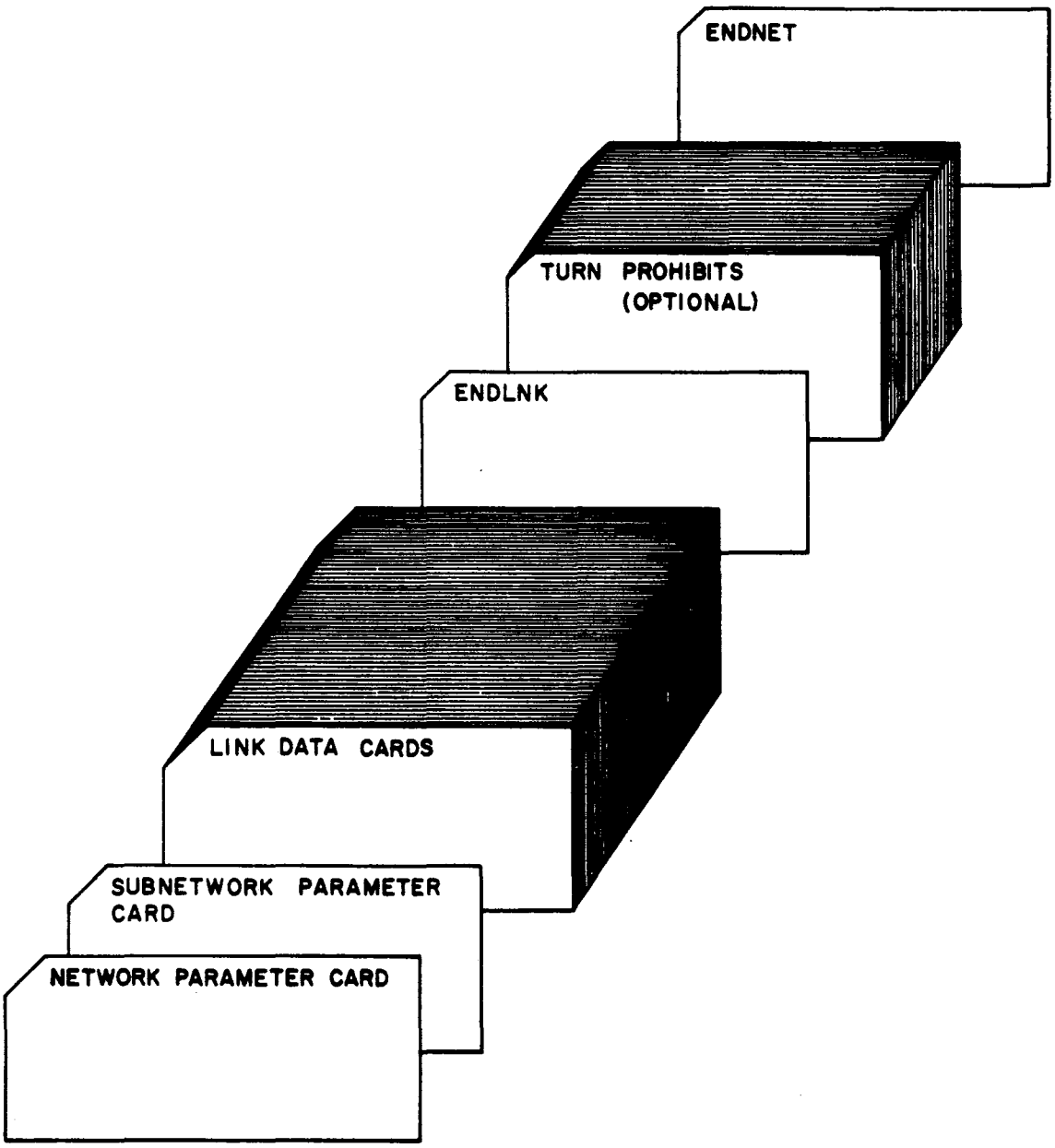
Columns	Contents
1-6	ENDNET

Typical Network-Link Data Deck Configurations

Figures V-1 and V-2 show the configuration of the network-link data decks for a one and a two subnet respectively. As is indicated in Figure V-2, the following cards are repeated for subnet 2:

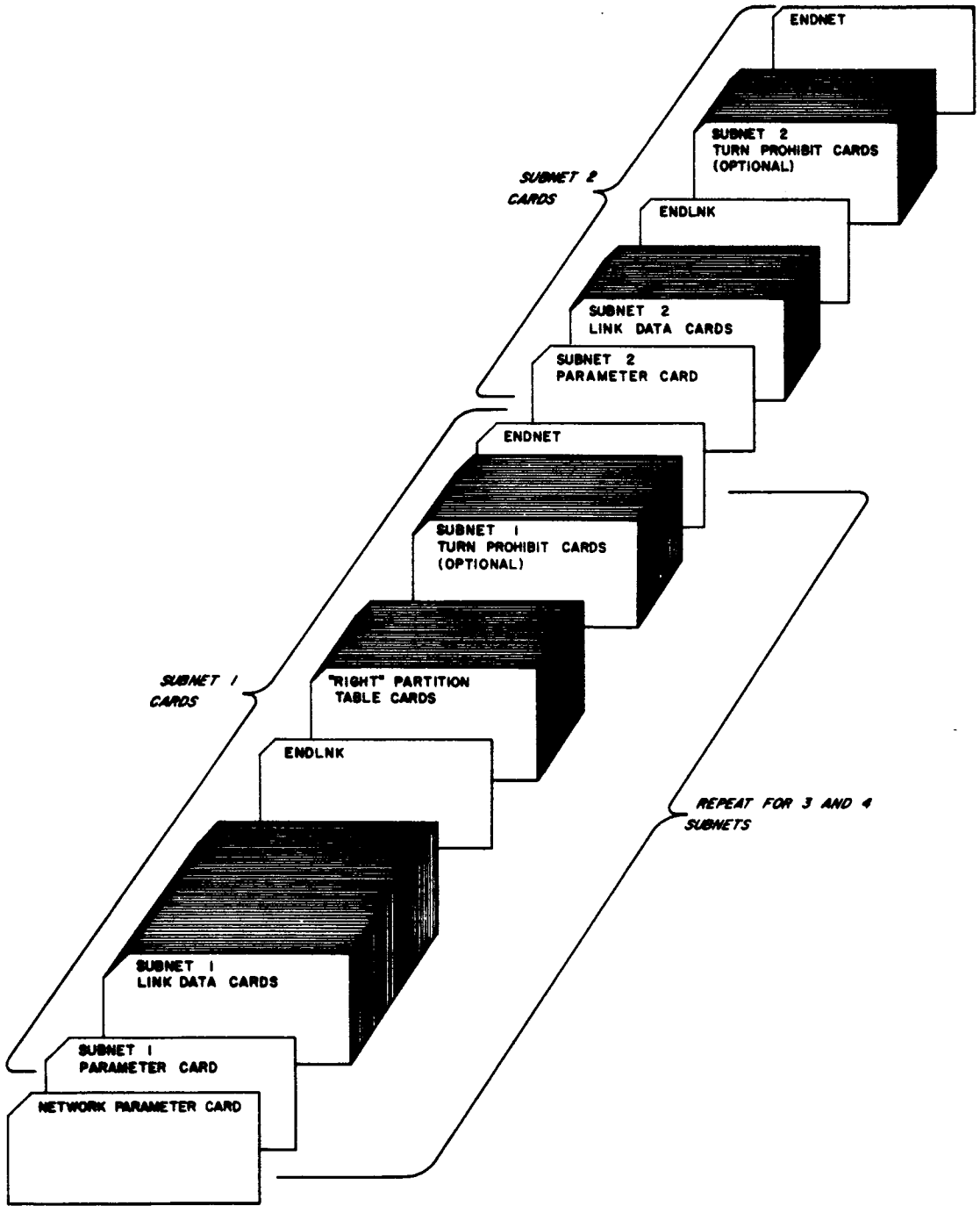
Subnet Parameter Card
Subnet Link Data Cards
ENDLNK
"Right" Partition Table Deck
Subnet Turn Prohibit Cards
ENDNET

For a third and fourth subnet, these cards would of course follow the ENDNET Card for subnets 2 and 3 respectively. It will be noted that the number of "right" Partition Table Decks is one less than the number of subnets. This results from the fact that the partition table defining the "connections" from, for example, subnet 1 to subnet 2 which are the "connecting points" for the reverse direction, subnet 2 to subnet 1 as well.



NETWORK-LINK DATA DECK CONFIGURATION FOR A NETWORK OF ONE SUBNET

FIGURE V-1



NETWORK-LINK DATA DECK CONFIGURATION FOR A NETWORK COMPRISED OF TWO SUBNETS

FIGURE V-2

C H A P T E R S I X

EXAMPLES OF COMPUTER PRINTOUT

EXAMPLES OF COMPUTER PRINTOUT

An example of the printout of the Output Network program is shown in Figure VI-1. As can be readily seen, the network description is output in-sort on "back" node. For each "back" node, all the "front" nodes (a maximum of 4) together with the link parameters are listed. The direction of one-way links is also indicated. For example, the link 6671-6670 is one-way in the opposite direction; the parameters for this link is shown where 6670 is given as the "back" node.

Figure VI-2 shows an example of the Output Loaded Network program. Volumes are given both directional and non-directional. The directional volume is of course for the direction 'A' Node to 'B' Node. One-way links are indicated as shown below:

B NODE	VOLUME	B NODE	VOLUME
6673	10327	6671(1WAY)	10370
6673(1WAY)	10327	6672(1WAY)	10327
6674	4744	(6674- 6826)	879
6674	6911		
(6668- 6674)	1216		
(6672- 6674)	3528		

Turn volumes are retained and output for the approximately 1600 highest numbered nodes in each subnet. The format of the turn volume is:

The node number given as the 'A' Node is the "pivot" node.

The first number in parenthesis is the "approach" node for the turn movement.

The second number in parenthesis is the terminal node of the movement. For example, for the node number 6903 given as the 'A' Node in the example output shown in Figure VI-2.

```
6903  DIR    6902              16
6903 NDIR    6902              68
     TURNS( 6920- 6902)        16
     TURNS( 6902- 6904)         9
     TURNS( 6783- 6920)      1609
```

The approach node is 6920 for the first movement listed, 6903 is the pivot node, and the terminal node is 6902; the turn volume for this movement (directional) is 16 vehicles. The sketch shown in Figure VI-3 portrays this and other turn volumes at the intersections represented by node number 6903.

The Output also lists the location of the 'A' Node. For example, the location of node 6903 is given as:

```
6903 AT S 3RD              10
```

The number "10" to the right of S(outh) 3rd is the sheet number of the node map on which the node is located.

Figure VI-4 shows the format of the trees output by the Search Minimum Paths program. All times shown in this output are cumulative time from the origin zone of the tree. The adjacent (ADJ) node is the last previous node on the minimum path. For example, the minimum path time from zone 760 to zone 1 is 17.61 minutes and the path to zone 1 is through node 3554.

Figures VI-5 and VI-6 show the output from the Sum Trip Ends program. 'Enter' is of course synonymous with 'Ins' and 'Exit' synonymous with 'Outs' of the BELMN and TEXAS Control programs.

The last two columns in Figure VI-5 are unique to the BIGSYS Sum Trip Ends program. The column "No. Zones Entering" gives the number of zones from which trips come that enter each zone. For example, the 717 trips that enter (have a destination) in zone 4 come from 96 different zones. Similarly, the "No. Zones Exiting" column gives the number of zones to which trips from a particular zone are destinated. Continuing with the example of zone 4, the 744 trips that exit (leave) zone 4 go to (i.e. enter) a total of 98 other zones.

Figure VI-6 shows the optional output which indicates the number of trips from a zone to all other zones. For example, this example output shows there were 164 trips from zone 22 to zone 8 and 170 trips from zone 22 to zone 154. If there are no entries in a particular line, that line of print will be omitted. In Figure VI-6 there are no trips from zone 22 to zones 160 through 169; hence, this line of print has been omitted.

NETWORK DESCRIPTION

BACK NODE	FRONT NODE	SA	J	DIST (MI)	SPEED (MPH)	TIME (MIN)	FRONT NODE	SA	J	DIST (MI)	SPEED (MPH)	TIME (MIN)	FRONT NODE	SA	J	DIST (MI)	SPEED (MPH)	TIME (MIN)	FRONT NODE	SA	J	DIST (MI)	SPEED (MPH)	TIME (MIN)
6651	6650	++	2	.09	24.0	.22	4412	--	2	.08	15.0	.32	6652	+-	2	.03	24.0	.07						
6652	6651	-+	2	.03	24.0	.07	6648	++	2	.06	26.0	.13	6847	--	2	.08	27.0	.17	6653	++	2	.07	26.0	.16
6653	4412	--	2	.07	15.0	.28	6652	++	2	.07	26.0	.16	4448	--	2	.03	15.0	.12	6654	++	2	.07	26.0	.16
6654	6653	++	2	.07	26.0	.16	6655	++	2	.04	26.0	.09	6843	--	2	.08	15.0	.32						
6655	6654	++	2	.04	26.0	.09	6505	--	2	.08	15.0	.32	6656	++	2	.04	26.0	.09						
6656	4413	--	2	.07	15.0	.28	6655	++	2	.04	26.0	.09	4447	--	2	.03	15.0	.12	6660	++	2	.04	26.0	.09
6657	4407	++	2	.06	15.0	.24	6658	--	2	.03	15.0	.12												
6658	4413	++	2	.03	15.0	.12	6657	--	2	.03	15.0	.12	6659	--	2	.04	15.0	.16	6663	++	2	.08	15.0	.32
6659	4414	++	2	.06	15.0	.24	6658	--	2	.04	15.0	.16	6660	--	2	.04	15.0	.16						
6660	6656	++	2	.04	26.0	.09	6659	--	2	.04	15.0	.16	6661	++	2	.03	26.0	.06						
6661	6660	++	2	.03	26.0	.06	6662	++	2	.05	26.0	.11	6838	--	2	.08	15.0	.32						
6662	4414	--	2	.03	15.0	.12	6661	++	2	.05	26.0	.11	4446	--	2	.04	15.0	.16	6667	++	2	.09	26.0	.20
6663	4407	--	2	.03	15.0	.12	6658	++	2	.08	15.0	.32	4414	--	2	.04	15.0	.16	6665	++	2	.08	15.0	.32
6664	4407	++	2	.07	15.0	.28	6637	--	2	.09	15.0	.36	4406	++	2	.07	15.0	.28	6665	--	2	.03	15.0	.12
6665	6663	++	2	.08	15.0	.32	6664	--	2	.03	15.0	.12	6666	--	2	.04	15.0	.16	6669	++	2	.09	15.0	.36
6666	4415	++	2	.07	15.0	.28	4414	++	2	.07	15.0	.28	6665	--	2	.04	15.0	.16	6667	--	2	.03	15.0	.12
6667	6662	++	2	.09	26.0	.20	6666	--	2	.03	15.0	.12	6668	++	2	.08	26.0	.18	6832	--	2	.04	15.0	.16
6668	4415	--	2	.03	15.0	.12	6667	++	2	.08	26.0	.18	6673	++	2	.07	26.0	.16	4445	--	2	.03	15.0	.12
6669	4406	--	2	.04	15.0	.16	6665	++	2	.09	15.0	.36	6671	++	2	.07	15.0	.28	4415	--	2	.04	15.0	.16
6670	4406	++	2	.06	15.0	.24	6671	--	2	.03	32.0	.05	6636	-ONE WAY IN-										
6671	6669	++	2	.07	15.0	.28	6672	--	2	.05	32.0	.09	6675	++	2	.04	15.0	.16	6670	-ONE WAY IN-				
6672	4415	++	2	.06	15.0	.24	4416	++	2	.02	15.0	.08	6673	--	2	.03	32.0	.05	6671	-ONE WAY IN-				
6673	6668	++	2	.07	26.0	.16	6826	--	2	.05	31.0	.09	6674	++	2	.04	25.0	.09	6672	-ONE WAY IN-				
6674	4416	--	2	.03	15.0	.12	6673	++	2	.04	25.0	.09	6679	++	2	.04	25.0	.09	4444	--	2	.04	15.0	.16
6675	4405	--	2	.03	15.0	.12	6671	++	2	.04	15.0	.16	6677	--	2	.04	15.0	.16	4416	--	2	.04	15.0	.16
6676	4404	++	2	.04	15.0	.16	4405	++	2	.03	15.0	.12	6484	--	2	.21	29.0	.43	6677	-ONE WAY IN-				
6677	6675	--	2	.04	15.0	.16	6676	--	2	.04	29.0	.08	6681	++	2	.04	15.0	.16	6678	-ONE WAY IN-				
6678	4416	++	2	.04	15.0	.16	4417	++	2	.04	15.0	.16	6677	--	2	.04	29.0	.08	6679	-ONE WAY IN-				
6679	6674	++	2	.04	25.0	.09	6680	++	2	.04	25.0	.09	6678	--	2	.04	29.0	.08	7755	-ONE WAY IN-				
6680	4443	--	2	.03	15.0	.12	6679	++	2	.04	25.0	.09	4417	--	2	.04	15.0	.16	6685	++	2	.04	25.0	.09
6681	4417	--	2	.04	15.0	.16	4404	--	2	.04	15.0	.16	6677	++	2	.04	15.0	.16	6683	++	2	.04	15.0	.16
6682	4403	++	2	.04	15.0	.16	6635	--	2	.08	15.0	.32	4404	++	2	.04	15.0	.16	6683	--	2	.04	15.0	.16
6683	6682	--	2	.04	15.0	.16	6681	++	2	.04	15.0	.16	6684	--	2	.04	15.0	.16	6687	++	2	.04	15.0	.16
6684	4418	++	2	.04	15.0	.16	6683	--	2	.04	15.0	.16	4417	++	2	.04	15.0	.16	6685	--	2	.04	15.0	.16
6685	6684	--	2	.04	15.0	.16	6680	++	2	.04	25.0	.09	6814	--	2	.04	15.0	.16	6686	++	2	.04	25.0	.09
6686	4442	--	2	.04	15.0	.16	6685	++	2	.04	25.0	.09	4418	--	2	.04	15.0	.16	6691	++	2	.04	25.0	.09
6687	4418	--	2	.04	15.0	.16	6683	++	2	.04	15.0	.16	6689	++	2	.04	15.0	.16	4403	--	2	.04	15.0	.16
6688	4403	++	2	.04	15.0	.16	4402	++	2	.07	15.0	.28	6689	--	2	.04	15.0	.16	6633	--	2	.04	15.0	.16
6689	6687	++	2	.04	15.0	.16	6688	--	2	.04	15.0	.16	6690	--	2	.04	15.0	.16	6693	++	2	.08	15.0	.32
6690	4418	++	2	.04	15.0	.16	4419	++	2	.08	15.0	.32	6691	--	2	.04	15.0	.16	6689	--	2	.04	15.0	.16
6691	6690	--	2	.04	15.0	.16	6692	++	2	.08	25.0	.19	6686	++	2	.04	25.0	.09	6808	--	2	.04	15.0	.16
6692	4419	--	2	.04	15.0	.16	6691	++	2	.08	25.0	.19	6697	++	2	.08	25.0	.19						
6693	4402	--	2	.04	15.0	.16	6689	++	2	.08	15.0	.32	4419	--	2	.04	15.0	.16	6695	++	2	.08	15.0	.32
6694	4402	++	2	.07	15.0	.28	6630	--	2	.04	15.0	.16	4401	++	2	.07	15.0	.28	6695	--	2	.04	15.0	.16
6695	6694	--	2	.04	15.0	.16	6699	++	2	.04	15.0	.16	6693	++	2	.08	15.0	.32	6696	--	2	.04	15.0	.16
6696	4419	++	2	.08	15.0	.32	4420	++	2	.03	15.0	.12	6695	--	2	.04	15.0	.16	6697	--	2	.04	15.0	.16
6697	6692	++	2	.08	25.0	.19	4480	--	2	.21	15.0	.84	6696	--	2	.04	15.0	.16	6698	++	2	.04	25.0	.09
6698	4420	--	2	.03	15.0	.12	6702	++	2	.04	25.0	.09	6697	++	2	.04	25.0	.09						
6699	6695	++	2	.04	15.0	.16	6700	++	2	.04	15.0	.16	4420	--	2	.03	15.0	.12						
6700	4401	--	2	.03	15.0	.12	6699	++	2	.04	15.0	.16	6701	--	2	.04	15.0	.16	6703	++	2	.04	15.0	.16

EXAMPLE OF NETWORK DESCRIPTION PRINTED BY 'OUTPUT NETWORK' PROGRAM

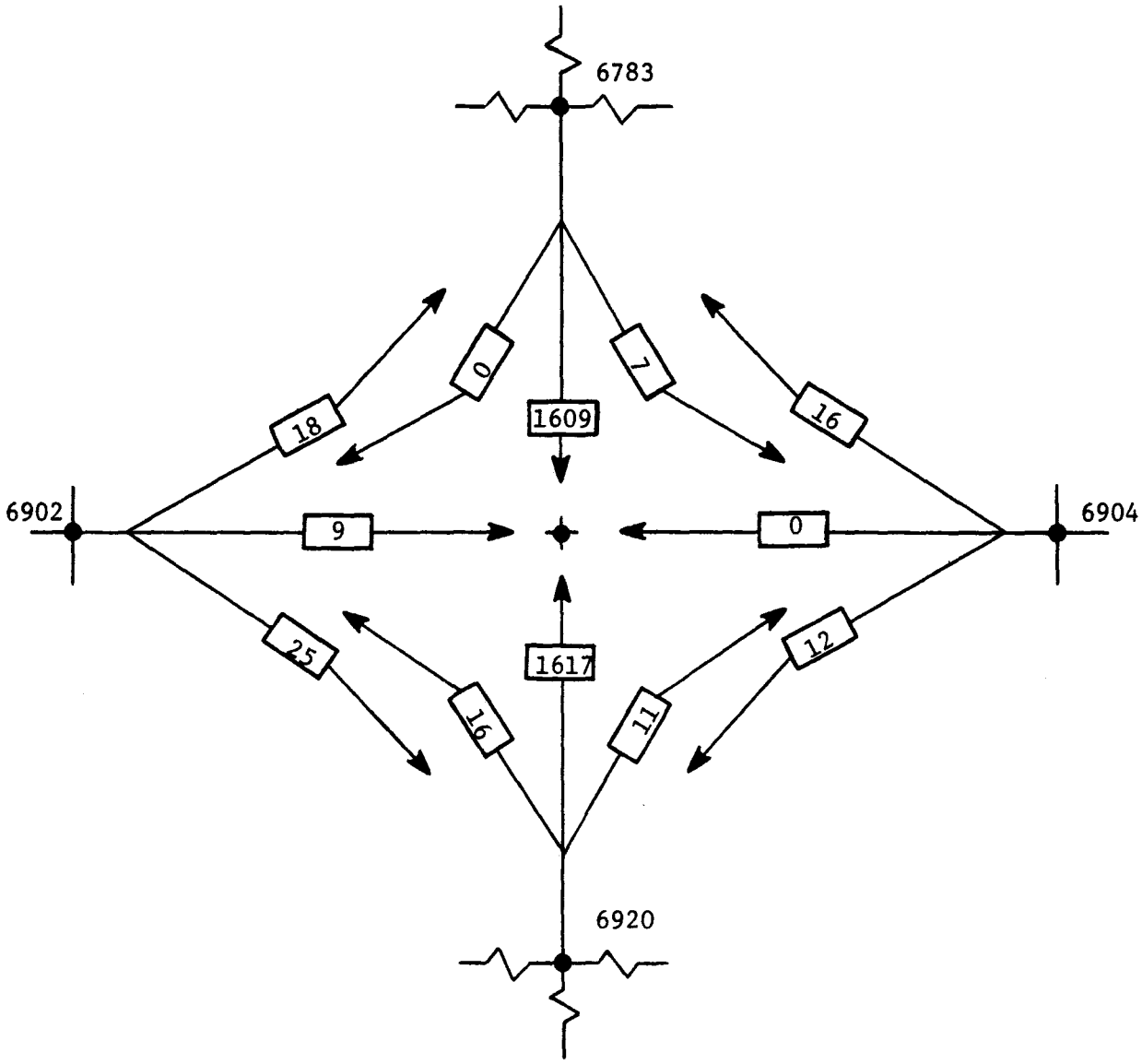
FIGURE VI-1

MAC: DETAILED ASSIGNMENT 6 --- TRIPS 24 HOUR TOTAL T.P.=0.00 AUG 27, 1966

LINK VOLUMES A NODE	B NODE	VOLUME	B NODE	VOLUME	B NODE	VOLUME	B NODE	VOLUME	NAME OF INTERSECTION	
6900 DIR	6899	310	4473	32	6901	9	4466	0	6900 AT CLEVELAND	10
6900 NDIR	6899	351	4473	54	6901	297	4466	0		
TURNS(	4473- 6899)	22	(6901- 6899)	288	(6899- 4473)	32	(6901- 4473)	0		
TURNS(	6899- 6901)	9	(6899- 4466)	0	(6901- 4466)	0	(4466- 6899)	0		
TURNS(	4466- 4473)	0	(4473- 4466)	0	(4473- 6901)	0	(4466- 6901)	0		
6901 DIR	6900	288	6929	444	6902	52	6784	2207	6901 AT S 4TH	10
6901 NDIR	6900	297	6929	2916	6902	68	6784	2701		
TURNS(	6929- 6900)	263	(6902- 6900)	0	(6900- 6929)	0	(6902- 6929)	0		
TURNS(	6900- 6902)	9	(6900- 6784)	0	(6902- 6784)	16	(6784- 6900)	25		
TURNS(	6784- 6929)	444	(6929- 6784)	2191	(6929- 6902)	18	(6784- 6902)	25		
6902 DIR	6901	16	4472	0	6903	52	4467	0	6902 AT CLEVELAND	10
6902 NDIR	6901	68	4472	0	6903	68	4467	0		
TURNS(	4472- 6901)	0	(6903- 6901)	16	(6901- 4472)	0	(6903- 4472)	0		
TURNS(	6901- 6903)	52	(6901- 4467)	0	(6903- 4467)	0	(4467- 6901)	0		
TURNS(	4467- 4472)	0	(4472- 4467)	0	(4472- 6903)	0	(4467- 6903)	0		
6903 DIR	6902	16	6920	1646	6904	27	6783	1651	6903 AT S 3RD	10
6903 NDIR	6902	84	6920	3290	6904	55	6783	3267		
TURNS(	6920- 6902)	16	(6904- 6902)	0	(6902- 6920)	25	(6904- 6920)	12		
TURNS(	6902- 6904)	9	(6902- 6783)	18	(6904- 6783)	16	(6783- 6902)	0		
TURNS(	6783- 6920)	1609	(6920- 6783)	1617	(6920- 6904)	11	(6783- 6904)	7		
6904 DIR	6903	26	4471	5	6905	27	4468	0	6904 AT CLEVELAND	10
6904 NDIR	6903	55	4471	5	6905	60	4468	0		
TURNS(	4471- 6903)	0	(6905- 6903)	28	(6903- 4471)	0	(6905- 4471)	5		
TURNS(	6903- 6905)	27	(6903- 4468)	0	(6905- 4468)	0	(4468- 6903)	0		
TURNS(	4468- 4471)	0	(4471- 4468)	0	(4471- 6905)	0	(4468- 6905)	0		
6905 DIR	6782	0	6904	33	6915	0	4469	27	6905 AT S 2ND	10
6905 NDIR	6782	0	6904	60	6915	0	4469	60		
TURNS(	6904- 6782)	0	(6915- 6782)	0	(6782- 6904)	0	(6915- 6904)	0		
TURNS(	6782- 6915)	0	(6782- 4469)	0	(6915- 4469)	0	(4469- 6782)	0		
TURNS(	4469- 6904)	33	(6904- 4469)	27	(6904- 6915)	0	(4469- 6915)	0		
6906 DIR	4469	0	6781	63	6913	39	4470	0	6906 AT S 1ST	10
6906 NDIR	4469	0	6781	102	6913	102	4470	0		
TURNS(	6781- 4469)	0	(6913- 4469)	0	(4469- 6781)	0	(6913- 6781)	63		
TURNS(	4469- 6913)	0	(4469- 4470)	0	(6913- 4470)	0	(4470- 4469)	0		
TURNS(	4470- 6781)	0	(6781- 4470)	0	(6781- 6913)	39	(4470- 6913)	0		
6907 DI	4470	16	6908	0	6912	20			6907 AT RIVER	10
6907 NDIR	4470	36	6908	0	6912	36				
TURNS(	4470- 6908)	0	(4470- 6912)	20	(6912- 6908)	0	(6908- 6912)	0		
TURNS(	6908- 4470)	0	(6912- 4470)	16						
6908 DI	4520	0	6907	0	6909	0			6908 AT RIVER	10
6908 NDIR	4520	0	6907	0	6909	0				
TURNS(	4520- 6907)	0	(4520- 6909)	0	(6909- 6907)	0	(6907- 6909)	0		
TURNS(	6907- 4520)	0	(6909- 4520)	0						

EXAMPLE OF PRINTOUT FROM 'OUTPUT LOADED NETWORK' PROGRAM

FIGURE VI-2



SKETCH SHOWING POSTED TURN VOLUMES

FIGURE VI-3

TEST TREE WACO DETAILED NETWORK II TURN PENALTY 00 JUL 29, 1966

TREE NO. 760

DESTN NODE	ADJ NODE	TIME (MIN)	DESTN NODE	ADJ NODE	TIME (MIN)	DESTN NODE	ADJ NODE	TIME (MIN)	DESTN NODE	ADJ NODE	TIME (MIN)	DESTN NODE	ADJ NODE	TIME (MIN)
1	3554	17.61	2	3554	17.16	3	3553	16.43	4	3542	14.42	5	3550	14.75
6	3549	13.75	7	3540	13.96	8	3548	12.58	9	3545	11.58	10	3533	10.54
11	3534	8.26	12	3535	9.97	13	3520	8.51	14	3529	7.68	15	3515	8.30
16	3514	7.94	17	3513	7.69	18	3513	7.85	19	3524	7.51	20	3509	7.50
21	3502	9.67	22	3545	16.65	23	3753	10.63	24	3500	9.69	25	3495	10.45
26	3493	8.95	27	2729	7.73	28	2725	8.01	29	3389	8.67	30	3472	9.75
31	3471	8.45	32	3467	8.60	33	3465	8.44	34	3464	8.20	35	3459	7.73
36	3409	9.46	37	3453	6.84	38	3452	7.13	39	1204	6.93	40	3401	6.40
41	3394	6.95	42	3376	6.56	43	3399	7.77	44	3408	7.48	45	3451	6.33
46	3444	6.32	47	3437	6.24	48	3443	6.10	49	3433	5.85	50	3432	6.05
51	3431	6.63	52	3417	5.78	53	3422	5.99	54	3410	5.32	55	3414	5.79
56	1186	5.77	57	1190	6.03	58	1200	6.25	59	3475	7.19	60	3478	6.94
61	1214	7.26	62	3481	7.70	63	3481	8.06	64	1226	8.55	65	3483	9.51
66	3484	9.81	67	3486	9.78	68	1431	11.61	69	3675	11.22	70	3677	11.90
71	3704	11.94	72	3705	10.60	73	3711	9.26	74	3699	10.24	75	3679	9.01
76	3691	8.72	77	3673	11.54	78	3670	11.07	79	3671	10.75	80	3674	10.25
81	3669	11.09	82	3683	9.42	83	3680	9.35	84	3690	8.78	85	3652	8.66
86	3662	8.61	87	3683	9.46	88	3650	9.49	89	3628	8.80	90	3632	8.98
91	3643	10.01	92	3641	10.17	93	3571	8.94	94	3604	9.49	95	3634	9.17
96	3639	9.81	97	3635	9.53	98	3616	8.75	99	3616	8.83	100	3618	8.70
101	3613	9.46	102	3582	9.29	103	3567	8.92	104	3573	8.94	105	3574	8.87
106	3575	8.69	107	3577	8.58	108	3578	8.23	109	3578	8.27	110	3583	9.41
111	3613	9.16	112	3585	7.33	113	3711	8.98	114	2778	8.18	115	3698	9.03
116	3696	8.36	117	3695	7.81	118	3750	8.52	119	3695	8.01	120	3622	8.29
121	2268	7.78	122	2174	8.06	123	3592	7.42	124	2876	9.47	125	2872	8.95
126	2880	8.59	127	2881	8.43	128	3708	8.74	129	2873	8.59	130	2868	8.19
131	2865	8.03	132	2864	7.82	133	2860	7.62	134	2859	7.33	135	2858	6.94
136	2847	7.03	137	2849	6.65	138	2852	7.12	139	2853	7.40	140	2842	7.72
141	2839	7.96	142	2834	8.63	143	2766	8.85	144	2824	8.72	145	2822	8.11
146	2821	7.79	147	2820	7.59	148	2818	6.98	149	2846	6.86	150	2847	6.47
151	2807	6.81	152	2811	6.57	153	2812	6.28	154	2817	6.75	155	2782	8.00
156	2772	8.72	157	2778	8.18	158	2689	7.83	159	2691	7.82	160	2767	7.77
161	2694	7.49	162	2696	7.24	163	2786	7.48	164	2701	6.76	165	2787	7.20
166	2756	6.92	167	2791	6.77	168	2706	6.11	169	2795	6.46	170	2748	6.05
171	2708	5.98	172	2746	5.69	173	2812	6.44	174	2745	5.77	175	2800	6.61
176	2801	6.37	177	2746	5.69	178	2742	6.27	179	2716	6.03	180	2737	6.50
181	3723	6.82	182	2731	7.38	183	2643	7.31	184	2723	7.30	185	2718	6.34
186	2716	6.03	187	2653	5.61	188	2713	5.49	189	2659	5.81	190	2660	5.93
191	2623	6.49	192	2702	6.79	193	2700	7.05	194	2665	6.78	195	2666	7.10
196	2668	7.68	197	2682	7.98	198	2685	7.31	199	2677	7.21	200	2671	7.88

EXAMPLE OF OUTPUT OF TREE TRACE

FIGURE VI-4

ZONE NO.	NO. TRIPS ENTERING	NO. TRIPS EXITING	NO. INTRAZONAL	NO. TRIP ENDS	NO. ZONES ENTERING	NO. ZONES EXITING
1	0	0	0	0	0	0
2	23	23	0	46	3	3
3	135	135	0	270	13	13
4	717	744	74	1609	96	98
5	43	43	0	86	5	5
6	0	0	0	0	0	0
7	6	6	0	12	2	2
8	81	81	0	162	17	20
9	316	303	8	635	55	51
10	302	302	5	614	34	32
11	115	145	6	260	15	16
12	275	275	0	550	26	26
13	127	128	0	255	11	10
14	109	95	0	204	12	12
15	235	261	0	496	15	15
16	442	431	9	891	38	34
17	427	425	0	852	37	37
18	944	930	8	1890	93	85
19	224	230	0	454	21	23
20	96	102	0	198	13	17
21	0	0	0	0	0	0
22	307	296	32	667	55	60
23	17	17	0	34	2	2
24	27	27	0	54	2	2
25	1	0	0	1	1	0
26	0	0	0	0	0	0
27	215	215	0	430	15	14
28	93	94	0	187	12	11
29	0	0	0	0	0	0
30	155	142	0	297	19	15
31	132	129	0	261	20	20
32	205	202	0	407	22	18
33	82	85	0	167	9	9
34	74	74	0	148	6	7
35	141	157	0	298	12	11
36	185	183	34	436	17	15
37	294	322	0	616	26	26
38	153	161	0	314	10	10
39	159	164	0	323	17	19
40	55	75	0	130	8	10
41	127	118	0	245	15	14
42	202	209	0	411	17	18
43	225	204	0	429	25	22
44	952	868	5	1830	76	76
45	94	101	0	195	11	11
46	69	60	5	129	8	9
47	120	117	0	237	11	12
48	20	20	0	40	4	4
49	32	31	0	63	4	3
50	199	203	9	420	25	24

EXAMPLE OF OUTPUT FROM 'SUM TRIP ENDS' PROGRAM

FIGURE VI-5

WACO E-2 TRIP END SUMMARY OCT 19, 1966

TRIPS FROM ZONE 22 TO ALL ZONES

ZONE	0	1	2	3	4	5	6	7	8	9
0		164	0	0	130	87	0	82	164	20
10	263	0	82	0	0	0	0	0	328	164
20	0	96	48	48	294	0	0	0	0	0
30	246	87	246	0	328	376	0	0	0	0
40	0	0	0	0	0	0	0	0	782	0
50	0	0	82	0	0	89	0	82	82	0
60	0	588	0	0	0	0	0	0	0	0
70	0	0	0	0	0	44	82	0	0	0
80	0	0	0	0	83	0	0	0	0	167
90	0	0	0	170	135	0	0	48	0	86
100	344	86	86	0	0	0	0	391	536	0
120	0	0	0	0	0	0	172	602	0	431
130	0	0	0	0	0	0	0	0	0	126
140	0	0	0	0	0	135	0	0	0	0
150	0	0	0	0	170	0	0	0	0	48
170	0	0	0	87	0	44	0	0	0	0
180	0	0	45	82	0	86	0	0	0	0
190	0	0	0	0	100	0	0	0	0	0
200	0	0	0	0	0	0	0	0	40	0
210	14	0	36	0	0	0	62	0	0	0

EXAMPLE OF OPTIONAL OUTPUT FROM 'SUM TRIP ENDS' PROGRAM

FIGURE VI-6

C H A P T E R S E V E N

prepared by

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Supervisor of Programming, T.T.I.

SPIDER NETWORK PROGRAMS

Spider Network-Link Data Card Format and Deck Configuration

The cards in the spider network-link data deck furnish all the information required to form the spider network description. Limitations on the spider-network are as follows:

Maximum number of nodes = 3500
Maximum number of connections to any node = 8
Centroids are numbered 1 thru X
External stations are numbered X + 1 thru Y
Nodes are numbered Y + 1 thru X

The following is a description of each card type that comprises the network and link data deck. The network-link data deck configuration is shown in Figure VII-1. The cards in this deck must be written on tape for input on A6 (BCD) for the Prepare Spider Network Description.

1. Spider Link Data Card

These cards are the actual link definition cards. The format is as indicated below and by the example coding form shown in Figure VII-2.

Columns	Contents
1	blank
2-6	'A' Node Number (1-3500)
7	blank
8-12	'B_1' Node Number (1-3500)
13	blank
14-16	A-B_1 distance in miles and hundredths
17	blank
18	Speed/Time indicator; T denotes time, S denotes speed.
20-22	Speed/Time Field
23-24	blank

25-29	'B_2' Node Number
30	blank
31-33	A-B_2 distance in miles & hundredths
34	blank
35	Speed/Time indicator
36	blank
37-39	Speed/Time Field
40-41	blank
42-46	'B_3' Node Number
47	blank
48-50	'A-B_3' distance in miles & hundredths
51	blank
52	Speed/Time Indicator
53	blank
54-56	Speed/Time Field
57-58	blank
59-63	'B_4' node number
64	blank
65-67	A-B_4 distance in miles & hundredths
68	blank
69	Speed/Time Indicator
70	blank
71-73	Speed/Time field
74-80	Any desired identification information

Each node may have as many as 8 connections to it, two cards are completed when a node has more than 4 connections. If a node has fewer than four ways out, the link data card is filled out from left to right.

2. ENDLNK Card

This card signifies the end of the link data.

Columns	Contents
1-6	ENDLNK
7-80	blank

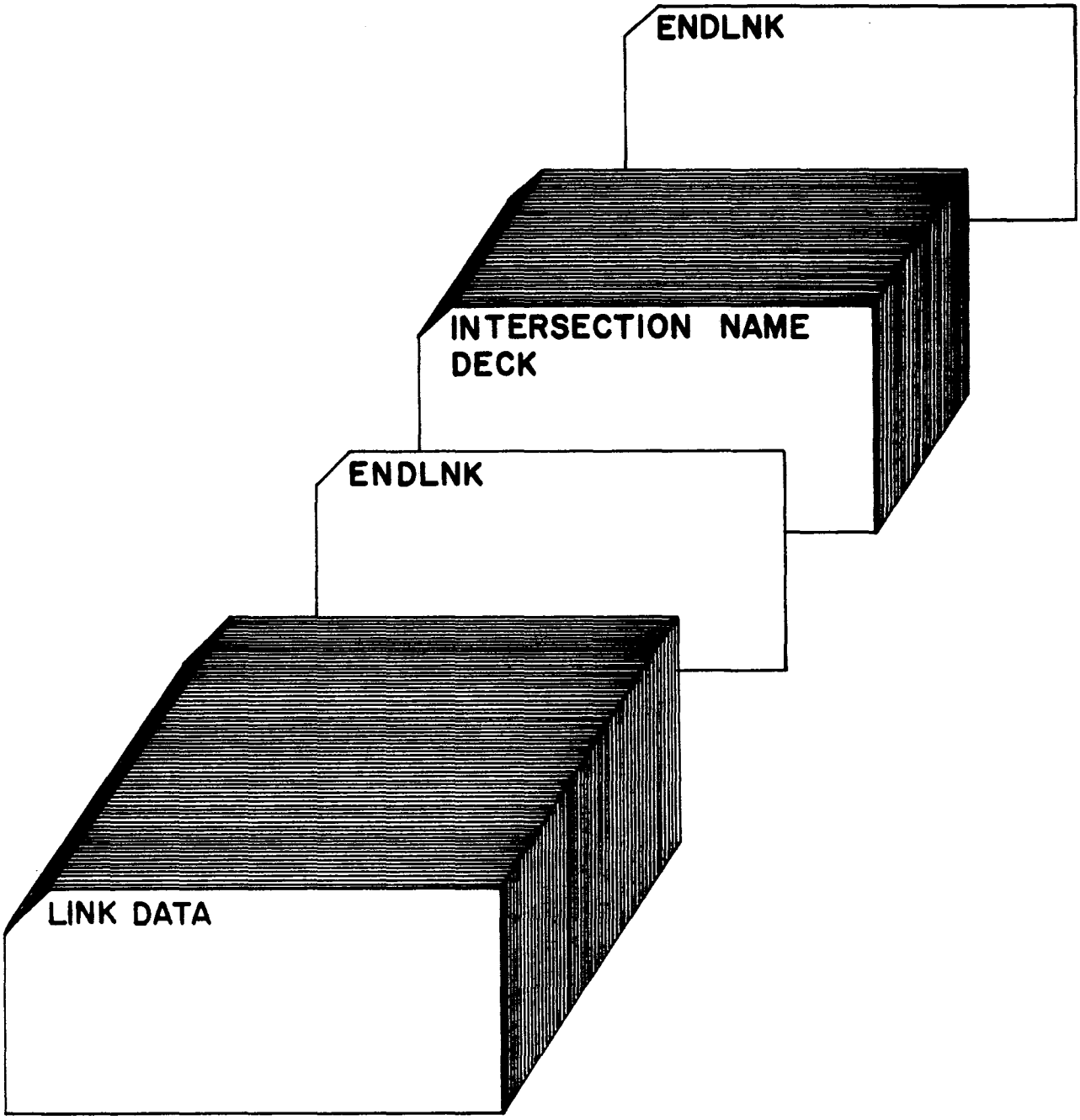
3. Intersection Name Card

This card carries any additional information about a node such as intersection name.

Columns	Contents
1-2	
3-6	Node Number
7-24	Intersection Name

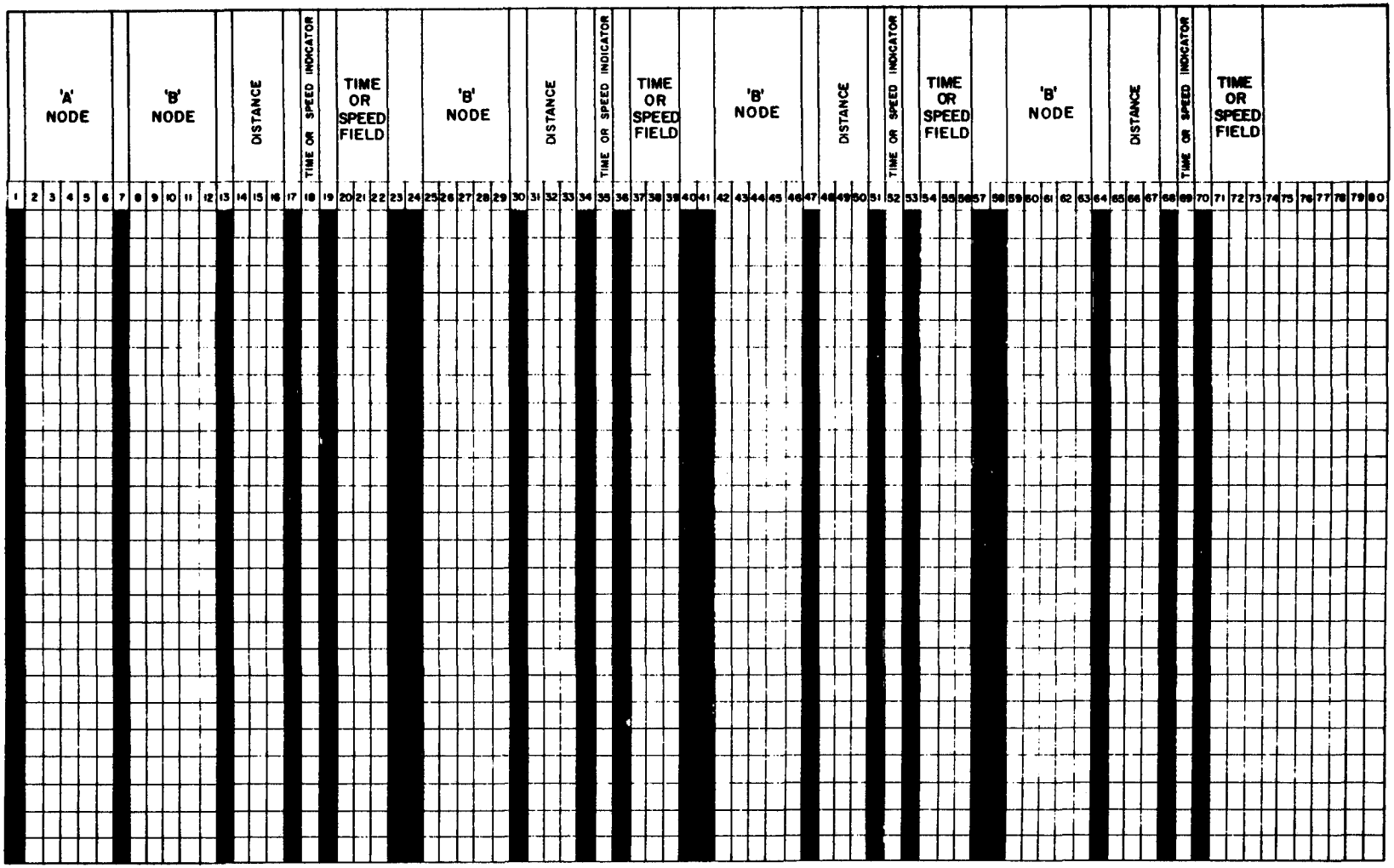
4. ENDLNK Card

This card signifies the end of the Intersection name cards and therefore the end of the spider link data deck.



SPIDER NETWORK LINK DATA DECK CONFIGURATION

FIGURE VII-1



CODING FORM FOR SPIDER NETWORK LINK DATA CARDS

FIGURE VII-2

Spider Network Trip Volume Deck

The spider trip volume deck contains the interzonal volumes used to load the Spider Network Description. The data must be sorted on the first field and have only one volume between a set of zones. The configuration of the spider network trip volume deck is shown in Figure VII-3.

1. Number of Node Cards

   This card must contain the largest node number in the spider network.

Columns	Contents
1-2	
3-6	Largest Node Number
7-80	

2. Trip Volume Card

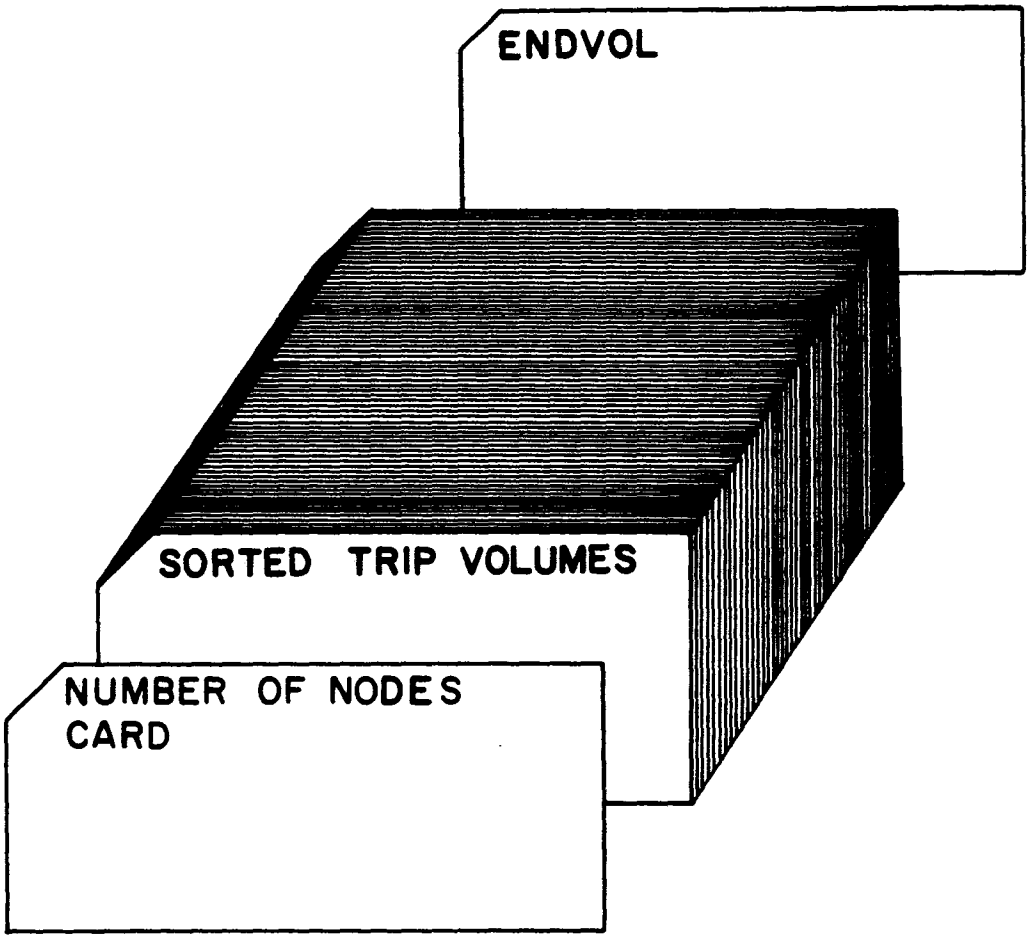
   This card contains the directional volume between zone 'A' and zone 'B'.

Columns	Contents
1-2	
3-6	Zone 'A'
7-8	
9-12	Zone 'B'
12-18	Total Volume

3. ENDVOL Card

   This card signifies the end of Spider card trip volume deck.

Columns	Contents
1-6	ENDVOL
7-80	



SPIDER NETWORK TRIP VOLUME DECK

FIGURE VII-3

Prepare Spider Network Description

Program Function

The Prepare Spider Network Description Program accepts the Spider Link Data Card Deck and builds the spider network description. The user must specify whether the time or speed parameter will be read from the link data card; this is done by exercising the option as specified under the write-up of the Spider Link Data Deck.

Call Card

Column	Contents
1-23	$PREPAREbSPIDERbNETWORK
24-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A6 - Spider Network Link Data Card Deck

Output: A3 - BCD Output
A4 - Binary Spider Network Description
B6 - Node Name Dictionary

Normal Operation Tapes A6 (Link Data), A4 (Binary Network Description) and B6 (Intersection Names) are rewound. The link data cards are read in and checked for validity, until an ENDLNK card is read. The node name table is then read in followed by another ENDLNK card.

Error Messages

MORE THAN EIGHT WAYS OUT FOR NODE XXXXXX XXXXXX XXXXXX

The specified node already has 8 nodes connected to it. The error message also contains the back node, front node, and link cost for the link.

ILLEGAL NODE DESIGNATED ON THIS CARD XXXXXX

The specified node number is a number larger than 3500.

LINK TIME CALCULATED OR GIVEN EXCEEDS 12 BITS XXXXXXXXXXXXXXXXX

The specified node connection has a time cost higher than is allowed.

If any of the diagnostics occur the message will be printed and processing will continue.

Output Spider Network Description

Program Function

The Output Spider Network program accepts the binary spider network description and writes the BCD network representation on the output tape.

Call Card

Columns	Contents
1-23	$OUTPUTbSPIDERbNETWORKbDESCRIPTION
24-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignment

Input: A4 Binary Spider Network Description

B6 Intersection Names

Output: A3 - BCD Spider Network Description

Normal Operation Tapes A4, B6 are rewound. The binary spider network is read in and written out. The intersection names are also read and matched with the proper node and outputed.

Error Messages

None

Prepare Spider Card Trip Volumes

Program Function

The prepare spider card trip volume program reads and converts summary trip data from the spider card trip volume deck into a format suitable for further trip processing or loading.

Call Card

Column	Contents
1-33	$PREPAREbSPIDERbCARDbTRIPbVOLUME
34-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A6 - Card Trip Volumes

Output: B7 - Binary Trip Volumes

Normal Operation Tapes A6, B7 are rewound and the trip volume cards are read in and converted into the binary trip volumes until an 'ENDVOL' card is encountered.

Error Messages

VOLUME DATA OUT OF SORT XXXXXXXXXXXXXXXXX

The data indicated by the nodes specified by the message is out of sort in the data deck.

DUPLICATE SET OF VOLUME DATA XXXXXXXXXXXXXXXXX

The data indicated by the nodes specified by the message has already been processed.

Search Spider Minimum Paths

Program Function

The Search Spider Minimum Paths program searches paths from designated centroids to all other centroids in the network, using a minimization principle based on given link parameters.

Call Card

Column	Contents
1-28	$SEARCHbSPIDERbMINIMUMbPATHS
29-72	blank

Cards Read On-Line

(1) Call Card

(2) Tree Selection Card (*TREE) which specifies the limits of the paths to the Searched.

Column	Contents
1-5	*TREE
6-8	blank
9-12	The first centroid from which minimum paths will be searched.
13-14	blank
15-18	The last centroid from which minimum paths will be searched.

Tape Assignments

Input: A4 - Binary Spider Network

Output: B2 - Spider Trees

Normal Operation The program read and interrogates the parameter card. The binary spider network is read in and trees are built.

Error Messages

Improper Control Card

CORRECT CARD, PLACE IN CARD READER, AND PRESS START.

This message indicates that a *TREE card was not encountered in the card reader.

Output Spider Trees

Program Function

The Output Spider Trees program reads the binary tree tape and outputs the BCD trees.

Call Cards

Column	Contents
1-20	$OUTPUTbSPIDERbTREES
21-72	blank

Cards Read On-Line

Call Card (only)

Tape Assignments

Inout: B2 - Binary Spider Trees

Output: A3 - BCD Spider Trees

Normal Operation Tapes B2, A3 are rewound. Binary Spider trees are read in and converted to BCD and outputed.

Error Messages

None.

Load Spider Network

Program Function The Load Spider Network applies trips to the spider network according to the pattern governed by the minimum path trees.

Call Card

Column	Contents
1-20	$LOADbSPIDERbNETWORK
21-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A4 - Binary Spider Network Description
B2 - Binary Spider Trees
B7 - Binary Trip Volumes

Output: A6 - Loaded Binary Network Description
A3 - BCD Output

Normal Operation The program rewinds the network description tape A4 and prints the following message "MOUNT REEL 1 OF TREES ON B2, REEL 1 OF TRIPS ON B7." Trees and trips are then read in and matched and the network is loaded. If more than one reel of trips are required the following message will occur "MOUNT NEXT REEL OF TRIP ON B7." If more than one reel of trees are required, they will be placed on B3 and will automatically be selected when needed and

no message will be printed, B2 will then be rewound. It is noted that two passes are necessary for a load, and after the first pass, the tree tape B2 and the trip tape B7 will be rewound and the second pass will start with the first message being printed again. "MOUNT REEL 1 OF TREES ON B2, REEL 1 OF TRIPS ON B7". When the second pass is finished the trip and tree tape are rewound.

Error Message

TREE RECORD XXXXXX, TRIP RECORD XXXXXX MISMATCH

Either the trip volume tape was written in error or not all trees were built in the network. It is best to build the trees over first, checking the *TREE card making sure all desired trees will be built.

Output Loaded Spider Network

Program Function

The Output Loaded Spider Network program interprets the binary loaded network and prepares BCD representation of the directional volumes, non-directional link volumes, and intersection names.

Call Card

Column	Contents
1-29	$OUTPUTbLOADEDbSPIDERbNETWORK
30-72	blank

Call Options

None

Cards Read On-Line

Call Card (only)

Tape Assignments

Input: A6 - Binary Loaded Spider Network

B6 - Intersection Names

Output: A3 - BCD Output

Normal Operation The message MOUNT BINARY LOADED NET ON A6, INTERSECTION NAME TAPE ON B6 is printed. Tapes A6, B6 are rewound. The loaded network is read in, formated, and written out. The intersection names are matched with the proper nodes and written out.

Error Messages

None.

C H A P T E R E I G H T

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NETWORK PLOT PROGRAMS

Introduction

The plot programs described herein were prepared to operate as part of the Texas Large Systems Traffic Assignment Package. The programs are written to execute on an IBM 7094 computer and produce a special formatted output tape for use on a Cal-Comp* 760 Plotting System. By use of a special IBM 1401 computer program, this tape may also be used to operate a CAL-COMP plotter Model 565 or 563 which is attached to an IBM 1401. The IBM 1401 computer must have the following configuration:

Serial I/O device
High-Low Equal Compare
Advanced Programming
4000 positions of memory
1 tape drive (7330 or 729)
1 printer
1 card reader

The general operation of the programs is to produce the special formatted tape using a description of the network structure to be plotted and the X and Y coordinate for each node in the given network structure. The network description may come from a Binary Network tape, a Loaded Binary Network tape or a Tree tape. The Binary Network tape is used when a plot of the network is desired. The Loaded Binary Network tape is used when a plot of the network with link volumes printed beside each link is desired. The Tree tape is used when plots of certain specified trees are desired.

The programs have input options to scale the plots to a particular size and to set the increment size for the particular model of Cal-Comp plotter which will be used. The programs are capable of plotting a network structure

*California Computer Products, Inc.

which is scaled larger than the physical dimensions of the plotter. When this is the case, several smaller plots are made which can be later fitted together to form the entire network structure.

Plot Network or Loaded Network with Volumes

Assemble Date March 1967

Program Function

This program is used to generate a data tape which can be used on a CAL-COMP Model 760 Plotting System to graph a traffic assignment network. If desired, it will also print the volumes of the individual links on the graph. The program uses as input a Binary Network (a Loaded Binary Network if link volumes are to be printed) and a tape containing the node coordinates of the network.

Call Card

Column	Contents
1-13	$PLOT
14-72	blank

Cards Read On-Line

(1) Call Card

(2) Plot Parameter Card, which specifies which subnetworks to plot, whether volumes should be printed, maximum and minimum values for the coordinates, what scale to use, and the plotter width and step size.

Column	Contents
1-6	First subnetwork to be plotted
7-12	Last subnetwork to be plotted
16	A "V" if the Loaded Network is to be plotted with volumes. An "N" if the Binary Network is to be plotted
17-24	Maximum X coordinate

25-30	Minimum X coordinate
31-36	Maximum Y coordinate
37-42	Minimum Y coordinate
43-48	Scale units/inch
49-54	Plotter width (hundreths of inches)
60	Plotter step size (blank or 0) if .01 inch; 1 if .005 inch)

The first two fields, columns 1 thru 6 and 7 thru 12 respectively, determine which subnetwork(s) is to be plotted. If a single subnetwork is to be plotted then the number of the subnetwork is entered in columns 6 and also in column 12. If more than one consecutive subnetworks are to be plotted, the subnetwork with the lowest number is entered in column 6 and the subnetwork with the highest number is entered in column 12. When two or more subnetworks are to be plotted and they are not consecutively numbered, the subnetworks must be treated as single subnetworks, and the plot network program must be executed separately for each subnetwork.

When link volumes are to be printed beside each link in the network, a "V" is entered in column 16. This indicates to the program that the Loaded Binary Network tape must be used. A "N" in column 16 indicates that the Binary Network is to be plotted.

The maximum and minimum values of X and Y coordinates determine what part of the network is to be plotted. Any coordinates read from the Coordinate tape which are not within the limits specified are ignored and the corresponding part

of the network will not be plotted. It is possible then to enter the limits of the Central Business District and have only the CBD plotted.

The scale to which the network is to be plotted is entered in columns 43 thru 48 (right adjusted). The scale is defined as units per physical inch of plotter paper. The units are the same as those used to specify the coordinates of the network. It is allowable to specify a scale which will create a plot larger than the physical size of the plotter. This condition is determined by the program from the plotter width which is entered in columns 49 thru 54. When this condition occurs, the program will plot as many separate smaller plots as are necessary to complete the network. These smaller plots can then be fitted together to form the entire network.

The plotter width is the physical width of usable paper on the plotter. The value must be in hundredths of inches and is entered in columns 49 through 54 (right adjusted).

The plotter step size indicates to the program the step increment of the plotter to be used. If a blank or zero (0) is entered in column 60, the program assumes the plotter has a step increment of .01 inches. A one (1) in column 60 indicates a plotter with a step increment of .005 inches.

Assignments

Input: A4 - Binary Network or Loaded Network tape depending on which is requested. A "Y" in Column 16 of the parameter card specifies the Loaded Network tape. A "N" in column 16 specifies the Binary Network tape.

B2 - Coordinate tape. Coordinates for each subnetwork must be loaded on a separate tape.

Output: B6 - CAL-COMP plot tape

Scratch: A9 - Always needed

B7 - Used only if volumes are requested

Normal Operations

The parameter card is read and the plot control program is initialized. The coordinate tape is then read. All nodes with coordinates which do not fall within the limits specified on the parameter card are ignored. Next the Binary or Loaded Network tape is searched for the first subnetwork specified on the parameter card. A message indicating which Network tape to mount is printed on-line just prior to reading the network tape. The optimized plotter movements are then calculated and written on the scratch tape on A9. If volumes are requested, they are written on B7 at this time. Both tapes are then rewound and a list of all nodes with missing coordinates is written on the normal output tape, A3.

The scratch tape on A9 is then read and the actual plotter commands are generated and written on the CAL-COMP plot tape, B6. All scaling and strip segmenting is done at this time. At the completion of each strip, the scratch tape on B7 is read and those volumes for links on the current strip are printed, if volumes were requested. This tape is then rewound. The above actions are repeated until all nodes in the subnetwork with valid coordinates have been plotted and the volumes have been printed.

At this time, the graph for the subnetwork is complete. If more than one subnetwork is requested, all of the above processes are repeated; otherwise, all tapes except the CAL-COMP plot tape are rewound and control returns to main program. The CAL-COMP plot tape is positioned such that other graphs may be added to the tape. It is recommended however, that a separate tape be used for each network plot.

The coordinate tape contains card images which contain the node number and its corresponding X and Y coordinate for a subnetwork. The format of the card is:

Columns	Contents
1-6	Node Number
7-12	X Coordinate (right justified)
13-18	Y Coordinate (right justified)

Error Messages

COORDINATES MISSING FOR NODE XXXXXX

All nodes with missing coordinates are listed on the normal output tape, A3.

Plot Trees

Assemble Date June 1967

Program Function

This program is used to generate a data tape which can be used on a CAL-COMP Model 760 Plotting System to graph minimum path trees of a traffic assignment network.

Call Card

Column	Contents
1-11	$PLOT
12-72	blank

Cards Read On-Line

(1) Call Card

(2) Plot Parameter Card which specifies the subnetworks containing the trees to be plotted, maximum and minimum values for the coordinates, what scale to use, and the plotter width and step size.

Column	Contents
1-6	First subnetwork from which trees are to be plotted
7-12	Last subnetwork from which trees are to be plotted
16	A "T"
19-24	Maximum X coordinate
25-30	Minimum X coordinate
31-36	Maximum Y coordinate
37-42	Minimum Y coordinate

43-48	Scale (units/inch)
49-54	Plotter width (hundredths of inches)
60	Plotter step size (blank or 0 of .01 inch; 1 if .005 inch)

The first two fields, columns 1 thru 6 and 7 thru 12 respectively, determine which subnetwork tree tapes will be required to plot the specified trees. If the specified trees are contained on only one subnetwork tree tape, then the subnetwork number is placed in column 6 and also in column 12. If the trees are contained on more than one consecutive subnetwork tree tapes, then the subnetwork number of the lowest numbered tree tape is placed in column 6 and the highest number is placed in column 12. If the trees do not reside on consecutively numbered subnetwork tree tapes, then the trees must be grouped by subnetworks and the plot program must be executed separately for each group of trees.

A "T" in column 16 indicates to the plot control program that trees are to be plotted.

The maximum and minimum values of X and Y coordinates determine what part of the tree network is to be plotted. Any coordinates read from the Coordinate tape which are not within the limits specified are ignored and the corresponding part of the tree network will not be plotted.

The scale to which the tree network is to be plotted is entered in columns 43 thru 48 (right adjusted). The scale is

defined as units per physical inch of plotter paper. The units are the same as those used to specify the coordinates of the tree network. It is allowable to specify a scale which will create a plot larger than the physical size of the plotter. This condition is determined by the program from the plotter width which is entered in columns 49 thru 54. When this condition occurs, the program will plot as many separate smaller plots as are necessary to complete the tree network. These smaller plots can then be fitted together to form the entire tree network.

The plotter width is the physical width of usable paper on the plotter. The value must be in hundredths of inches and is entered in columns 49 thru 54 (right adjusted).

The plotter step size indicates to the programs the step increment of the plotter to be used. If a blank or zero (0) is entered in column 60, the program assumes the plotter has a step increment of .01 inches. A one (1) in column 60 indicates a plotter with a step increment of .005 inches.

(3) TREE Selection Cards (*TREE) which specify those TREES which are desired for plotting. One *TREE card is required per subnetwork. Each card may specify various groups of one or more trees. The format of the *TREE card is as follows, the six column selection fields are each composed of two subfields A and B, five columns and one column respectively.

Column	Contents
1-5	*TREE
6-7	blank

8-12	Subfield A	first selection field
13	Subfield B	
14-18	Subfield A	second selection field
19	Subfield B	
20-24	Subfield A	third selection field
25	Subfield B	
26-30	Subfield A	fourth selection field
31	Subfield B	
32-36	Subfield A	fifth selection field
37	Subfield B	
38-42	Subfield A	sixth selection field
43	Subfield B	
44-48	Subfield A	seventh selection field
49	Subfield B	
50-54	Subfield A	eighth selection field
55	Subfield B	
56-60	Subfield A	ninth selection field
61	Subfield B	
62-66	Subfield A	tenth selection field
67	Subfield B	
68-72	Subfield A	eleventh selection field
73	Subfield B	

A comma (,), may be punched in column 73 if desired when subfield 68-72 is used. However, columns 73-80 are not read; the program places the comma when volumes 68-72 are punched.

Subfield A may contain any valid node number for the current subnet. Subfield B functions as a delimeter and may contain a blank or a comma.

In processing selection fields from left to right, the occurrence of two consecutive 'A' Subfields separated by a blank 'B' Subfield will initiate a control setup for inclusive nodes beginning with the node specified by the first 'A' Subfield and ending with the node specified

by the second 'A' Subfield. A comma in the second 'B' Subfield is optional for this situation, since the starting and ending centroids have been found for a search group. The occurrence of two successive 'B' Subfields containing either commas (may be implied as mentioned above) causes a single node to be specified.

Tape Assignments

Input: B1 - Tree tape for subnetwork requested

B2 - Coordinate tape. Coordinates for each subnetwork must be loaded on a separate tape.

Output: B6 - CAL-COMP plot tape

Scratch: A9

Normal Operation

The parameter card is read and the plot control program is initialized. The first *TREE card is then read the trees to be plotted are determined. Mounting instructions to mount the proper subnetwork coordinates are printed and the coordinates are read. All nodes that have coordinates which do not fall within the limits specified on the parameter card are ignored. Mounting instructions to mount the proper subnetwork tree tape are then printed. The first subnetwork on the tree tape is searched for the first tree specified on the *TREE card. Once the tree is found the coordinates for the tree are sequenced and written on A9. This tape is then rewound and the CAL-COMP plot tape, B6, is written. All scaling and strip segmenting is done at this time. The number of strips which are required to graph a particular subnetwork is determined by the scale value and the maximum Y coordinate specified on the parameter card. As many strips as are necessary to graph all the nodes to the scale specified will be

drawn. After all the nodes of the tree have been plotted, the tree tape is searched for the next tree to be plotted.

When all the trees in the first subnetwork of the tree tape have been plotted, mounting instructions to mount the coordinate tape for the next subnetwork are issued. The process is repeated, and the trees in the next subnetwork on the tree tape are plotted. When all the trees have been plotted for this subnetwork tree tape, mounting instructions to mount the next subnetwork tree tape are printed and the total operation is repeated.

If there is more than one reel of trees for a particular subnetwork and one of the trees to be plotted is stored on a reel other than the first reel, the message MOUNT ALTERNATE REEL OF TREES AND PRESS START will be given.

Error Messages

INVALID TREE CARD READ

REPLACE WITH NEW CARD AND PRESS START

The error card has been printed just prior to this message. Columns 1-6 contain characters other than *TREEb. Correct error card, replace in reader and press start.

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