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MULTIPATH CAPACITY LIMITED TRANSIT ASSIGNMENT USING UTPS PACKAGE

By
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ABSTRACT

At present most patronage predictions of transit system are performed using UMTA's UTPS package or some adaptation of it. The transit assignment produced by a typical UTPS system can be classified as an All-or-Nothing limited equilibrium assignment. However passenger loads assigned to a transit line can far exceed the line capacity. In such a case line headway has to be reduced to provide enough capacity to accommodate transit demand. If the increase in frequency is not accounted for by iterating again through the mode choice and assignment models, the equilibrium assumptions are violated. If equilibrium between demand and supply is achieved it might occur at a point which requires transit capacity much beyond economically feasible or engineering practical level. Thus the present transit assignment procedure suffers from two problems. First, trips are assigned to transit lines with disregard to their actual capacity. Second, while some lines are assigned passenger loads beyond capacity, there might be other lines with just slightly longer travel times which are greatly underutilized.

A realistic assignment should take into account and not exceed the actual capacity of every transit line. Furthermore, it should consider lines capacities while rationally simulating people's travel behavior. In this paper a transit assignment algorithm is presented which takes into account the actual capacity of transit lines and assigns trips to more than a single path when the shortest path reaches its capacity. This procedure produces a practical Multipath Capacity Limited Transit Assignment (McLAT). The procedure was implemented on an IBM mainframe computer using standard UMTA's UTPS package with the addition of only one Fortran program.

1. Introduction

At present most patronage predictions of transit system are performed using UMTA's UTPS package [1] or some adaptation of it. This set of programs is typically applied once in a customary sequence of mode choice and assignment programs to produce ridership predictions for the various components of the transit system during typical periods of the day. The transit assignment produced by a typical UTPS system can be classified as an All-or-Nothing limited equilibrium assignment. The equilibrium achieved by this type of assignment procedure under the usual assumptions of constant travel times and headways has the property that no individual using the system can improve his utility by using a different transit line or switching to a different mode. However passenger loads assigned to a transit line can far exceed the line capacity. In such a case line headway has to be reduced to provide enough capacity to accommodate transit demand. If the increase in frequency is not accounted for by iterating again through the mode choice and assignment models, the equilibrium assumptions are violated. If on the other hand this iteration is performed the new demand will be even higher requiring more transit capacity. This process may or may not converge, even if it does it might occur at an equilibrium point which requires transit capacity much beyond economically feasible level. The equilibrium may even occur at a point which violates engineering constrains such as street capacities or minimum headway separation between vehicles. Thus the presently used transit assignment program suffer from the following two undesirable and unrealistic characteristics:

1. Trips are assigned to transit lines with disregard to their actual capacity. Thus, some lines might be loaded with passengers much beyond their ability to carry those loads.

2. While some lines are assigned passenger loads beyond capacity, there might be other lines serving the same O-D pairs with just slightly longer travel times which are greatly underutilized.

These two problems occur because of the simple All-or-Nothing procedure used for transit assignment, and have very serious practical implications on the validity of the transportation planning process. From the point of view of a transit agency , the amount of service which it can provide at a given future year is dictated by economical considerations and budget limitations. Thus, a clear planning objective of an transit agency is to achieve a realistic transit assignment for a given level of service. In such a context, transit level of service should be treated as predetermined policy decision parameter, if not throughout the whole planning process, than at least in its last stages. Thus a realistic assignment should take into account and not exceed the actual capacity of every transit line. Furthermore, it should consider lines capacity while rationally simulating people's travel behavior. A rational transit assignment model should take into account not only the fastest transit route serving an O-D pair but should consider as well second or even third best transit alternative options. The second or third best transit alternatives should be considered as long as the best is overcrowded and while their travel utility is higher than the non transit alternative.

In this paper we present a transit assignment algorithm which takes into account the actual capacity of transit lines and assigns trips to more than a single path when the shortest path reaches its capacity. This procedure produces a practical Multipath Capacity Limited Transit Assignment (McLAT). This procedure was implemented on an IBM mainframe computer using standard UMTA's UTPS package with the addition of a single Fortran program and a minute modification of one existing program.

In the next chapter the theoretical background of the proposed algorithm in UTPS framework is presented. In chapter 3 the algorithm is formally presented and discussed. Chapter 4 consists of an outline of programming considerations for the implementation of the algorithm in the context of a standard UMTA's UTPS package. Chapter 5 presents a comparison between proposed transit assignment and a standard UTPS procedure applied to the Los - Angles metropolitan area. The paper ends with a short conclusion chapter.

2. THEORETICAL BACKGROUND OF THE PROPOSED PROCEDURE

At present the typical UTPS process performs transit assignment assuming no limits on the capacity of transit lines. Thus the present transit assignment procedure is an All-or-Nothing assignment in the sense that for every O-D pair, all trips are assigned to a single transit path. This will happen even if the assigned passengers volumes far exceed the shortest line capacity and even if an alternative underutilized path exists between the same O-D pairs with only slightly longer travel times. The underlying behavioral assumption of the proposed procedure is that people will chose to use second or third best transit alternative as long as these alternatives possess a higher utility than all other non-transit alternatives. This assignment does not reach equilibrium in the transit network since there are people travailing on transit between the same O-D pairs which could have improved their utility by switching to another transit path. However in spite of the fact that transit equilibrium is not maintained it will be shown next that the equilibrium conditions between total demand for travel and supply exists. It is argued that the proposed procedure is more realistic than the present ones which neglect to realize economical or engineering capacity limits. On moderately crowded transit systems the presently used assignment procedure might produce erroneous results. On very crowded transit systems, which are typical of rush hour periods of large metropolitan areas, the results of existing transit assignment procedures might produce completely unrealistic patronage forecast which by far over estimating actual transit usage. A short discussion of the proposed McLAT algorithm in the context equilibrium in the urban transportation system is presented next.

To begin the discussion we adopt the two basic assumptions which are customary within the framework of UTPS models system:

1. The characteristics of demand and supply are stationary for the simulated time period. This time period can be a whole day or any typical part of it.
2. The total travel demand on all modes for each O-D pair is fixed. Thus the O-D matrix is exogenous to the transportation modeling system.

These two assumptions narrow the equilibrium problem to the distribution of trips between the various modes and routes on the network. The demand function is a standard Logit function while the supply function is determined by the transit and highway characteristics. The supply curve of every single transit line is not influenced by travel volumes while travel time on the highway monotonically increases with volume. In present application of the UTPS system it is assumed that the transit line does not have any capacity limits. However it seems very unrealistic to assume no capacity limits on heavily crowded transit system. If the shortest transit route serving a pair of zones has a specific capacity of passengers per hour, all excess demand has to use the high system or some other transit path. In the proposed McLAT procedure we assume that any transit path which has excess capacity and provides the users with a higher travel utility than the highway system constitutes a feasible transit alternative and will be used for travel between this O-D pair. This hierarchical choice process can be stated as follows: a zone pair is serviced by two or more transit lines with limited capacity. The supply functions of this lines are:

$$TT1 = \begin{cases} A & VT1 <= CT1 \\ 0 & VT1 > CT1 \end{cases} \quad \text{and} \quad TT2 = \begin{cases} B & VT2 <= CT2 \\ 0 & VT2 > CT2 \end{cases}$$

Where: CT1 and CT2 are capacity limits of lines 1 and 2.

VT1 and VT2 are passengers loads of line 1 and 2.

TT1 and TT2 are travel times of line 1 and 2 and TT2>TT1.

The supply function for the highway network can be represented as: $TC = T0 + F(VC)$

Where: T0 is the free flow travel time on the highway path.

F(VC) is an increasing function of highway volume VC.

The equilibrium state for this system is presented in figure 2.1. In the figure The demand function (D-D) is a simple Logit function, and the supply function (S1-S1) is defined as:

$TC - TT1 = T0+F(V-VT)-TT1$

Where: V is the total travel demand between the O-D pair.

Since line 1 is superior to line 2, providing a shorter travel time its travel time TT1 is used in the supply equation. The potential demand for line 1 is VP but its capacity is CT1, and VP > CT1. Thus, the actual number of passengers which can use line 1 is VC1 producing unassigned demand of the magnitude of VP - CT1. This demand can not use line 1 and has to chose between the highway and transit line 2. The leftover demand for travel can now be distributed between these modes using the original Logit function. The unassigned volume: VP - CT1, should be distributed between the highway and transit line 2 as shown in Figure 2.2. The proposed procedure can be expanded to any number of lines serving the same O-D pair. This iterative process produces a Multipath Capacity Limited Transit Assignment by assuming a hierarchical choice process where transit lines are considered consecutively in order of their level of service and compared to the highway alternative. The best line is considered first, then the second best, and so on until all demand is exhausted. In the two transit line example above, the total transit volume will be: VT12 = CT1 + VT2 and the total highway volume will be: VC = V - VT.

The assignment procedure stated above is an extension of the customary UTPS procedure. It was applied in an almost completely automated way using standard UTPS programs and one additional fortran program. The new proposed method is an iterative procedure as defined in the next chapter.

3. GENERAL DESCRIPTION OF THE PROPOSED ALGORITHM

The proposed algorithm was developed and used for transit alternative investigation in Los - Angeles. The need for a capacity limited assignment arose from the fact that the operating costs of the transit system had to be kept below a predetermined level to meet the agency's budget constraints. The McLAT procedure was used in the final stage of the transit planning process after an in depth analysis of various transit alternatives was performed using standard UTPS process. Due to the size of the area and complexity of the transit network the only practical way to implement the McLAT algorithm was to maximize the use of standard UMTA's UTPS package programs in the new procedure. An iterative procedure which consists of standard UTPS programs such as: UPATH, USTOS, UMATRIX, ULOAD(UPRAS) and UMODEL for Logit predictions [2], as well as, a special Fortran program - UOLIM (Overloaded Lines Identification & Network Manipulation [3]) were used. To present the algorithm, first a notation convention is defined. Next the algorithm is formally presented and finally specific issues of the algorithm are discussed.

3.1 Notation

[OD]	Original O-D matrix.
od	a cell in [OD].
[OD]xx	xx% of the original O-D matrix.
[OD]xx(i)	ODxx matrix used in iteration i.
{ST}(i)	A set of all stops which a vehicle passes while it caries passengers at or above capacity at iteration i.

NT0	Original (unmodified) transit network.
{LNovl}(i)	A set of transit lines which contain stops included in {ST}(i).
NT(i)	Modified transit network at iteration i.
[ODovl](i)	A matrix containing all OD pairs who's in vehicle part of their minimum path starts at a stop included in {ST}(i).
[ODfre](i)	A matrix containing all OD pairs who's in vehicle part of their minimum path <u>does not</u> start at a stop included in {ST}(i).
[LD](i)	Passenger loads on the transit network at iteration i.

3.2 Algorithm Steps

1. Take [OD]xx and NT0.
2. Perform a standard UTPS simulation run to produce [LD](i).
3. Apply UOLIM to perform the following:

   a. Identify overloaded stops - {ST}(i).

   b. Identify overloaded lines - {LNovl}(i).

   c. Create a new network NT(i+1) = NT0 - {LNovl}(i).
4. Identify [ODovl](i) for all stops in {ST}(i) using USTOS.
5. Using UMATRIX create a new yy fraction of [ODfre]yy(i+1) and [ODovl]yy(i+1) as follows:

   [OD]yy(i+1) = yy*[OD]

   $$[ODovl]yy(i+1) = [OD]yy(i+1)^{*} \begin{cases} 1 & \text{if od E [ODovl](i)} \\ 0 & \text{otherwise} \end{cases}$$

   [ODfre]yy(i+1) = [OD]yy(i+1) - [ODovl]yy(i+1).

6. Perform a full UTPS simulation run using network NT(i+1) and OD matrix [ODovl]yy(i+1) to produce [LDovl](i+1).
7. Perform a full UTPS simulation run using network NT0 and OD matrix [ODfre]yy(i+1) to produce [LDfre](i+1).
8. Using ULOAD(UPRAS) Combine transit loads as follows:
   [LD](i+1) = [LD](i) + [LDfre](i+1) + [LDovl](i+1).
9. Go to step 3 and repeat through step 8 with decreasing increments of the OD matrix until all demand is exhausted.

3.3 REMARKS ON THE ALGORITHM

The basic idea behind the McLAT algorithm is to assign to transit an increment of the total demand and test the transit lines for overcrowding. Then partition the transit network and another increment of demand into two subsets. One subset includes transit lines which did not reach capacity and all the O-D pairs which in the previous iteration boarded transit at stops which were carrying capacity loads and thus not able to carry additional passengers. Using this set of O-D volumes and subset of the original network new transit paths in the system are created. The second subset includes the original network and an increment of all the O-D pairs which boarded the transit system in the previous iteration at stops which had excess capacity thus being able to carry additional passenger loads. More details of the algorithm will be discussed later.

The algorithm presented above consists mainly of iterations of the customary UTPS process and additional simple manipulation of O-D matrices and transit network coding. The O-D matrix is manipulated using standard UTPS programs, while the network is modified by the

UOLIM program. The whole process is automated through special features in the UOLIM program to be discussed in chapter 4. Each iteration except the first one consists of twice applying the full sequence of UTPS programs necessary to generate the customary transit assignment. Practical considerations, and the level of overcrowding of the origin network, define the number of iterations and the fraction size of the OD matrix at each iteration. The fraction size of the OD matrix used in each successive iteration should be no larger than the one used previously. Furthermore, It makes practical sense to start the iterative process with relatively high fraction which can be predetermined by the ratio of unconstrained passenger loads to capacity on the heaviest loaded line. Thus under normal network loads three to four iterations of the proposed algorithm will produce a passenger assignment which will not over load the transit network by a significant amount.

Most of the algorithm steps are straight forward and do not present any computational problem. All steps except step 3 are performed using standard UTPS programs. Step 3 however deserves a special explanation regarding the way it operates. This step which identifies overloaded stops along the transit line can be implemented in two ways. Assume that at a point in the iterative process ZZ% of the total demand were already assigned to the transit network. Then the following two alternatives exist to identify overloaded stops:

1. A stop can be identified as overloaded if the passenger load in the vehicles exceeds the total capacity of the line.
2. A stop can be identified as overloaded if the passenger load in the vehicle exceeds ZZ% of the total capacity of the line.

Assume that the first definition is adopted and the overloaded stops occur somewhere down stream along the line. Then passengers who in the next iteration board the transit line at stops before the overloaded ones and travel through them will cause excess loads on the vehicles beyond their stated capacity. This method of simulation might produce unrealistic transit assignment. Trips originating at zones which board the transit line at overloaded stops are overestimated while trips from zones boarding transit at stops where capacity exists are estimated correctly. On the other hand if the second definition of capacity is adopted the proposed transit assignment might significantly under estimate passenger loads. To remedy this problem step 3 of the algorithm should to be improved. An exact enumeration of all transit paths while testing for stops capacity in their order along the transit route, from first to last, can not be done efficiently given the size of the transit network. A rigors and efficient mathematical method to solve the problem is not available at present. Given the size of the transit network at hand the only practical solution was to modify the heuristic approach presented above. An alternative definition to those presented for testing capacity of lines can be defined as follows: Assume that ZZ% of total demand was already allocated to the transit network. Let CAPzz be a capacity level after a ZZ fraction of total demand was allocated and, let CAPtot be absolute capacity level then define capacity testing level as:

$$CAPzz = CAPtot*[ZZ + 0.5*(1.0 - ZZ)]$$

This definition for capacity level alleviates most of the problems associated with the two capacity definitions stated above. It will mark a transit stop as overloaded when loads inside the vehicle are above the percent fraction of capacity level. However this capacity level is still below total capacity, allowing for additional passengers, in the next iteration, to board the transit line at upstream stops without violating capacity restrictions. The value of CAPzz can not exceed total capacity of the transit line. This definition represents an intermediate value relative to the two capacity definitions stated above. Details of implementation of the proposed algorithm are presented in the next chapter.

4. PROGRAM IMPLEMENTATION AND PROCEDURE AUTOMATION

The main programing effort in the process of implementing the propose McLAT procedure was in the development of UOLIM program -Overloaded Lines Identification and Network Manipulation. All inputs to this program, except for one, exist as standard UTPS files. There was a need to create an additional file which contains all transit lines and passenger loads at stops along their routes. Although such a file is not created by any of the existing UTPS program, printed report no. 3 produced by UPRAS module of ULOAD program [4] contains precisely the necessary data. A very simple modification of this program was implemented so that the necessary file is created optionally by request. This file contains all the line identification information and for each direction and each stop the number of passengers boarding embarking and travelling in the vehicle. This file is created at step 8 of the algorithm and is used as input to UOLIM program.

The UOLIM program was coded in Fortran following UTPS programing conventions and using its service subroutines. Detailed description of the program is presented in UOLIM users manual [3] thus only the main features of the program will be discussed here. The UOLIM program mainly performs the following three tasks:

1. Identification of overloaded stops along transit lines.

2. Generation of a new transit lines file containing only non overloaded line.

3. Automatic updating of the JCL stream and control cards for next iteration of the McLAT procedure.

The last two features of the program require further explanation. The generation or update of the transit network is performed a follows: The original lines file is a standard input to the UOLIM program. Each transit line in this file is tested for overloading in each direction of travel separately. If the line is overloaded in both direction it is completely removed from the network. If it is overloaded in a single direction, only one direction is removed. If the transit line is coded in the correct order of stops only the direction code is changed to indicate a single directional line. If the line is overloaded in the opposite direction to the order of the coded stops the order of stops is reversed and the directional code is changed to indicate a single directional line. This new lines file is used to perform step number 6 of the algorithm.

The third function of UOLIM program is to automate as much as possible the execution of the proposed McLAT procedure. The program produces very extensive reports of overloaded line and associated stops as well as a very extensive statistical summary. However to run the proposed McLAT procedure many control cards need to be prepared after each iteration to run the necessary USTOS and UMATRIX programs. Preparing manually, after each iteration, control cards from computer printed reports is a lengthy, tedious and error prone task. To overcome this problem UOLIM program accepts as input a JCL file which includes a generic setup of control card to perform all the USTOS and UMATRIX runs defined in steps 4 and 5 of the algorithm. The program updates USTOS

PARAMETER cards contained in the JCL stream with the list of new overloaded stops. The new updated JCL file can be submitted as is to perform the UTPS runs which execute the next iteration of steps 4 and 5 of the McLAT procedure. Steps 6 and 7 of the McLAT procedure are standard transit assignment runs and are executed using a standard JCL setup with very little manual intervention. Step 8 of the McLAT procedure is performed by a simple modification of the standard JCL setup for UPRAS module of ULOAD program. Thus the whole McLAT procedure can be run almost automatically without any appreciable additional manual work relative to the manual tasks necessary to perform a conventional UTPS transit assignment.

The performance of the UOLIM program is extremely flexible. The user can specify to the program capacity of vehicles by mode and line; transit lines to be excluded from capacity checking by line, mode, or transit company. The type of capacity check out of the three defined in paragraph 3.3 can be, as well, specified by the user. Other control parameters of the program dictate various options of network manipulations and the JCL stream updates.

5. COMPARISON OF TRANSIT ASSIGNMENT RESULTS

To test the performance of the McLAT procedure it was applied to the Los - Angles metropolitan area in the final analysis stage of one of the proposed alternatives for the Metro Rail system. The alternative chosen for analysis was first evaluated using a standard UTPS procedure the outline of which is presented in figure 5.1. A very comprehensive description of the standard planning procedure used by SCRTD is presented in "Patronage forecasting procedures at SCRTD " [2]. The size of the transportation planning problem at hand is extremely large consisting of over 1600 zones, 500 transit lines operated by 12 transit companies, a network of 7000 nodes and 14000 links and four trip purposes.

The motivation for the development and use of the McLAT procedure was a policy decision of SCRTD (Southern California Rapid Transit District) to restrict annual operating costs of the SCRTD bus system to $525 M. The operating cost are calculated by the following equation:

OPCOST = K0 + K1*[PK-VEH] + K2*[VHT] + K3*[VMT] + K4*[PSGRS]

Where: K0 through K4 are constants

PK-VEH is the number of peak vehicles necessary to provide the service.

VHT, VMT of the bus fleet and the number of passengers - PSGRS is expressed on annual basis.

When the standard UTPS procedure was applied to the network demand far exceeded the coded bus system capacity. ULOAD and URAP modules (see figure 5.1) adjusts the line frequencies, up and down, to accommodate demand. The operating costs of the SCRTD bus system after its service frequencies were adjusted were about $608 M. annually. This operating costs exceed the stated goal of the agency by $83 M. annually, which is about 15.8%. At the same time the adjusted bus frequencies violate the equilibrium conditions between demand and supply as assumed by the mode choice model.

The McLAT procedure was applied to the same network in the following way:

1. Only the HBW trips were assigned by the McLAT procedure since most of the overcrowding on the network occurred during the morning and evening peak periods which are mainly loaded with HBW trips. The other three trip purposes HBO, OTO (Other To Other), and OTW, (Other To Work) were assigned in one step using the standard UTPS

procedure.

2. Three full iterations of the McLAT procedure were performed assigning successively 40, 30, and 30 percent of total demand.

Comparison between the results of the standard UTPS procedure and the final outcome of the McLAT procedure are presented in table 5.1. The annual operating costs of the McLAT transit assignment are $563 M. saving $45 M. relative to UTPS transit assignment. The reduction in operating costs was mainly by reducing the peak fleet requirements by 270 buses. There is also a small reduction of 56 vehicles during off peak periods. This reduction is caused by the HBW trips which do not occur during the daily peak periods. The smaller amount of peak buses reduced the fleet annual VHT and VMT. The savings in peak buses, VMT and VHT is achieved at the expense of the passenger loads carried. The number of HBW person trips carried by transit is reduced by 7.7% from 650,000 to 600,000. The combined effect of the lower levels of those performance measures caused the $ 45M savings.

The net reduction of 270 peak buses consists of a reduction of 308 buses operating along 78 transit routes and an increase of 38 buses operating along 13 transit routes. The number of transit lines along which the number of peak buses increased in the McLAT assignments is a proxy measure for the amount of multiple paths created by McLAT procedure. In the present simulation this number was not very high only along 13 transit routes this number increased. Of this 13 routes, line capacity was reached on 9 routes indicating that there was not a lot of excess capacity on alternative transit routes. The relatively small increase in the number of peak buses - 38 also points to high crowding on the network.

The number of overloaded transit lines declined from 87 to 76 and overloaded stops from 439 to 320. At first glance this reduction appear to be relative low. However it should be noticed that this figures represent the number of overloaded lines and stops and not the magnitude of overloading. Out of the 76 overloaded bus lines 31 carried loads in excess of 20% of capacity. This figure is much lower, both in number of overloaded lines and loading levels, then the ones which occurred in UTPS assignment. Fine tuning of the McLAT procedure applying four increments of 40, 30, 20 and 10 percent would have significantly reduced overloading.

Given the complexity of the network and the high level of crowding it seems that the McLAT procedure performed the transit assignment very well. The stated goal of the agency to lower operating costs of the bus system to $ 525M. was not reached. Analyzing assignment results it seems that the coded line frequencies and demand patterns were to high. To reach the stated budgetary constraint it is necessary to modify the frequencies of the transit service.

6.0 CONCLUSIONS

The McLAT procedure presented in this paper served the purpose it was developed for, i.e. to perform transit assignment under capacity restrictions. It is believed based on the experienced at hand that it provides a more realistic results than the standard UTPS transit assignment. It was developed as a heuristic procedure in the framework of UTPS and can be easily adopted to similar micro and mainframe transportation planning packages. McLAT is an iterative procedure in which almost all manual, error prone, tasks were eliminated. The whole iterative process can be executed in almost completely automatic way. Each iteration, however, constitutes a relatively lengthy task. For a network of the size of Los-Angles, under best circumstances, the turn around time needed to perform one iteration is one day. Thus to perform the full McLAT procedure, while fine tuning it, might require 4 to 5 days. This time frame is acceptable only when used in the last stages of the transportation planning process and applied to few prescreened alternatives. At present the McLAT procedure seems practical and acceptable method to overcome the deficiencies of standard UTPS and similar transit assignment procedures.

However transit assignment deserves a better faith. From the point of view of software technology and mathematical sophistication all available transit assignment procedures, are at best, slight improvements over procedures which are at least 15 years old. We can not expect to improve much the performance and financial integrity of the transit industry if we are unable to provide it with half decent planning tools. the McLAT procedure is a very modest step in the right direction. If it is nothing more than stimulus for the development of mathematically rigorous multipath capacity limited assignment its contribution will not ever be understated.

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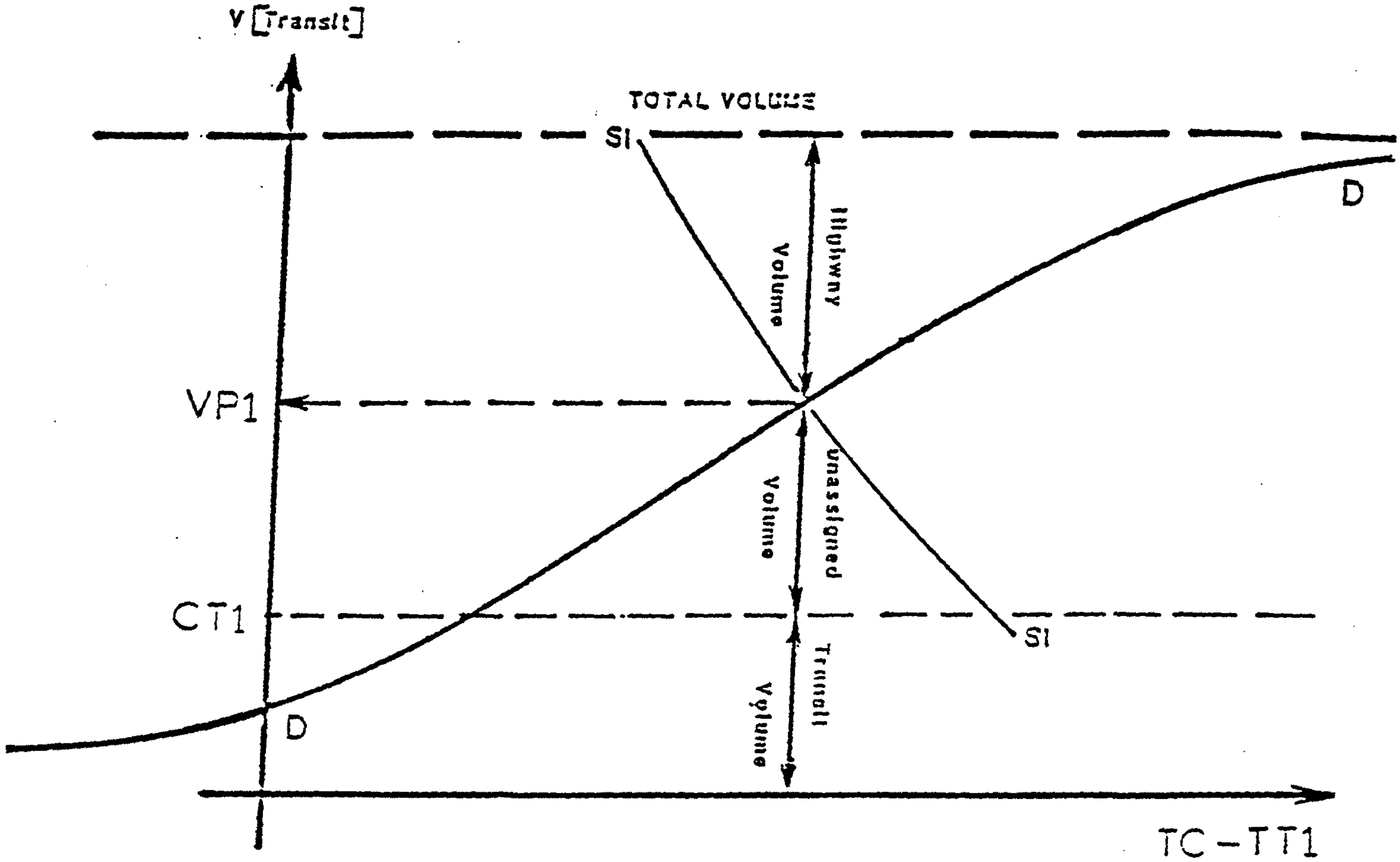

FIGURE 2.1

EQUILIBRIUM BETWEEN DEMAND and LIMITED CAPACITY TRANSIT LINE

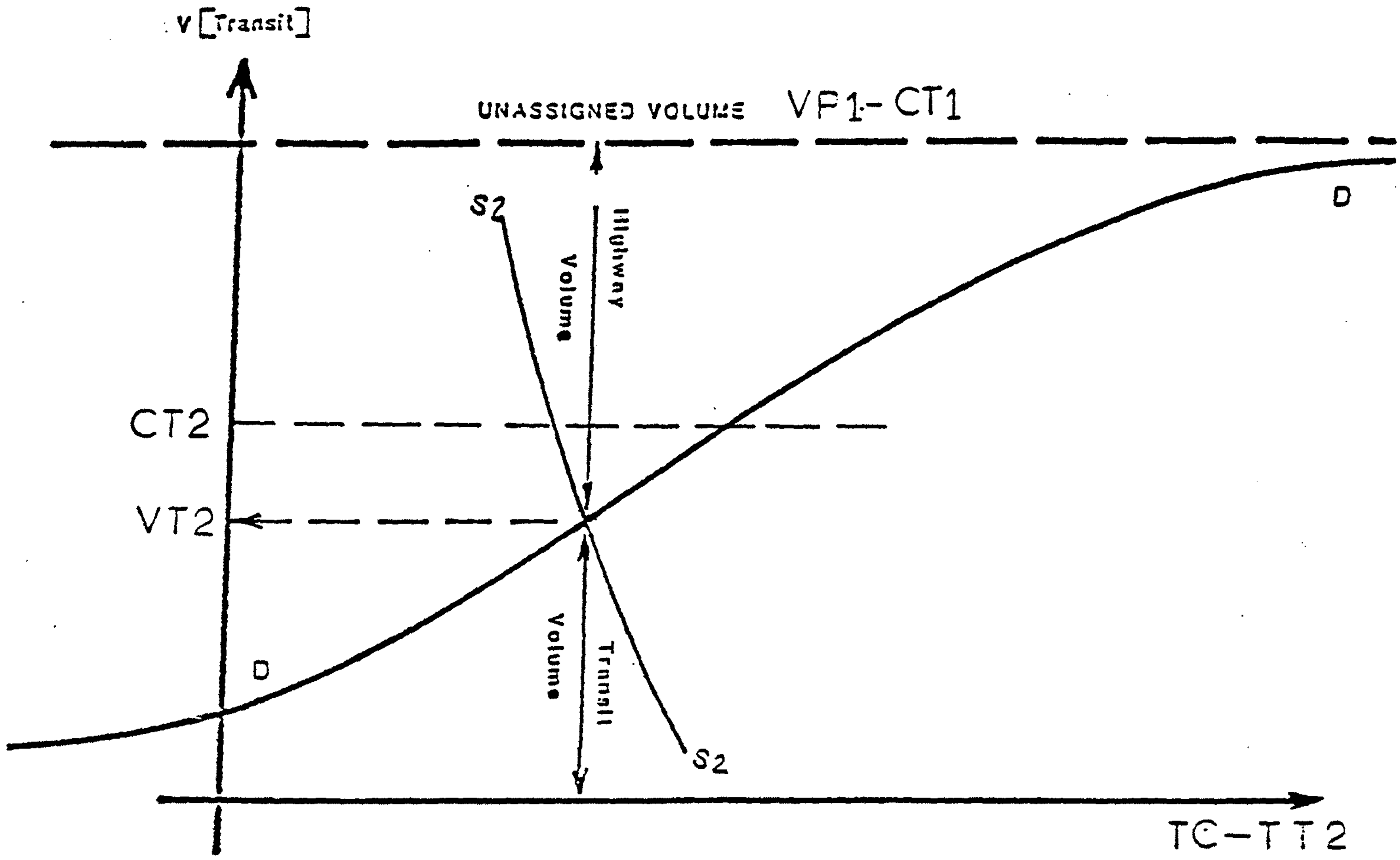

FIGURE 2.2

EQUILIBRIUM BETWEEN UNASSIGNED DEMAND and LINE 2

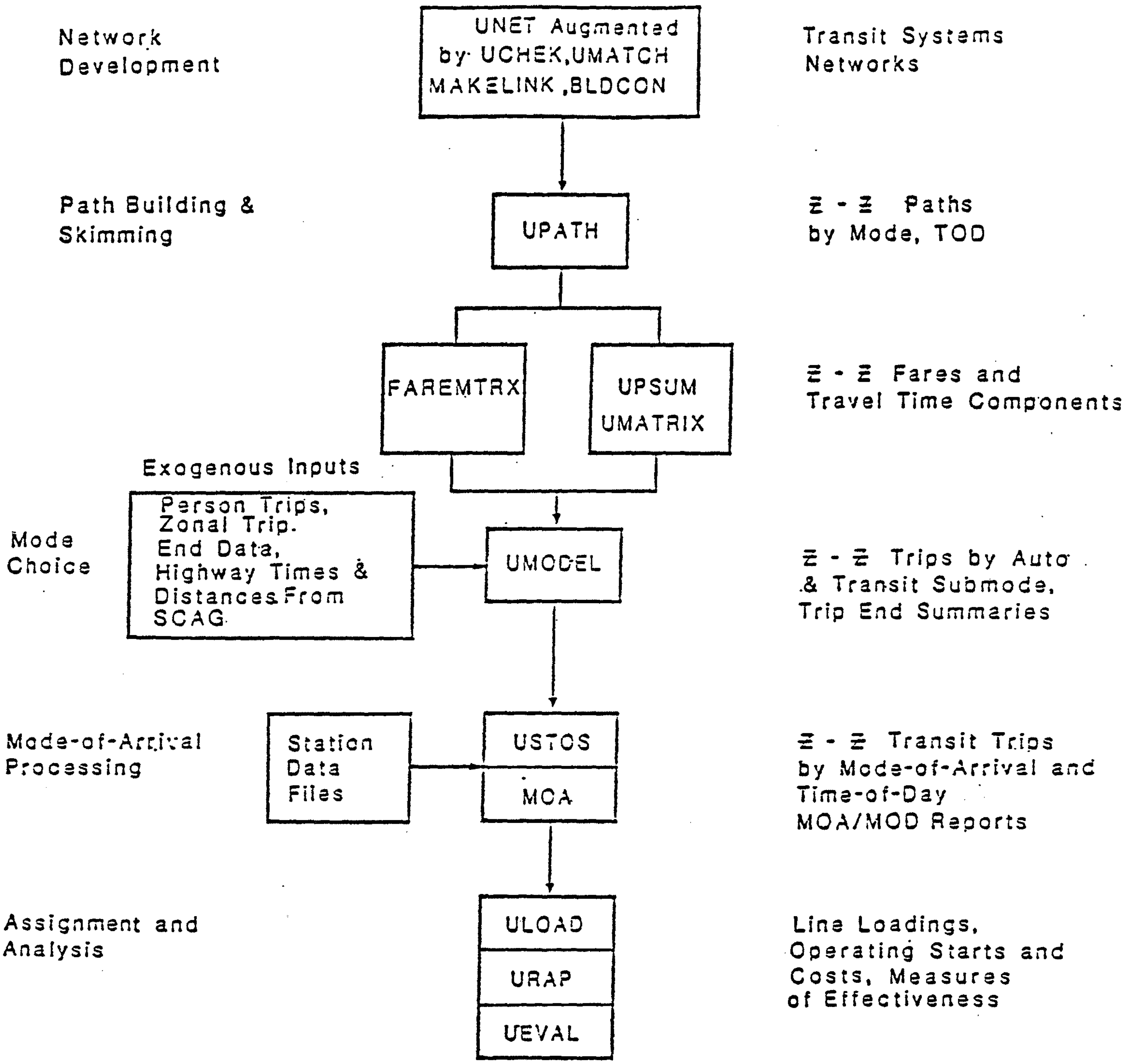

FIGURE 5.1

SCRTD PATRONAGE FORCASTING PROCESS

TABLE 5.1 RESULTS OF STANDARD UTPS AND McLAT PROCEDURE

SYSTEM CHARACTERISTICS	STANDARD UTPS		McLAT PROCEDURE
SCRTD bus lines	287		287
Other bus lines	224		224
Heavy rail	1		1
Light rail	4		4
SCRTD overloaded lines			
Both directions	21		18
One direction	66		58
Overloaded stops	439		320
Daily HBW modal split (persons)			
Auto modes	8,600,000		8,650,000
Transit	650,000		600,000
Transit share (%)	7.0		6.5
Daily non HBW modal split (persons)			
Auto mode	39,000,000		39,000,000
Transit	1,100,000		1,100,000
Transit share (%)	2.7		2.7
SCRTD daily vehicles requirements			
coded pk veh	2,234		2,234
op veh	1,034		1,034
Modified pk veh	2,382		2,112
op veh	1,248		1,192
SCRTD Peak vehicles changes McLAT vs. UTPS			
Reduced pk veh requirements		308	
Increased pk veh requirements		38	
Net savings			270
SCRTD line changes McLAT vs. UTPS			
Reduced pk veh requirements		78	
Increased pk veh requirements		13	
SCRTD annual (1986 $)			
Bus operating costs	608,000,000		563,000,000
Net savings			45,000,000