Urban Transportation Planning
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Module No. # 06
Lecture No. # 30
Route Assignment Contd.

This is lecture 30 on urban transportation planning. The discussion on route assignment will be continued and completed in this class; you may recall in the previous class at the end, we tried to list the different techniques available for route assignment. We know now that are three techniques available for route assignment, they are, number one all or nothing assignment technique, number two multipath assignment technique and number three capacity restrained assignment technique, and we have also seen a numerical example, to understand all or nothing assignment technique.

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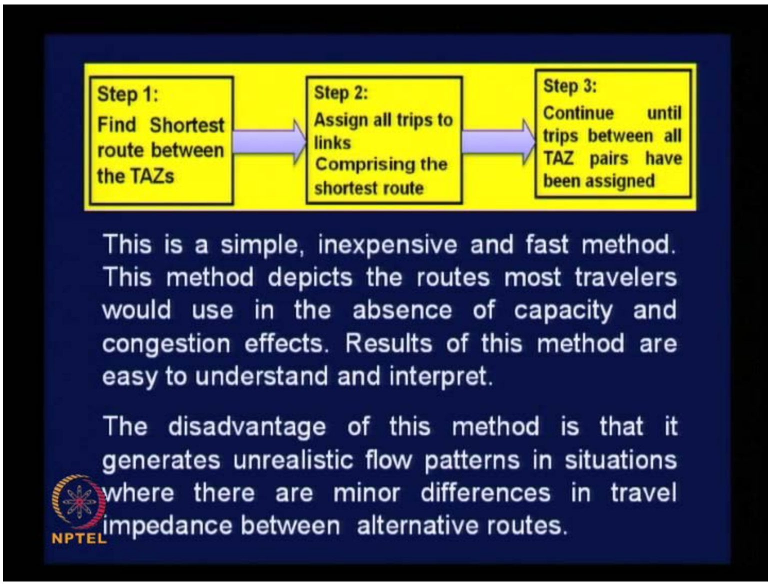

Look at the principle involved in all or nothing assignment technique, you can just follow the three steps illustrated here; step 1 is just to find shortest route between the TAZs, TAZ is nothing, but traffic analysis zone or simply traffic zones. Step 1 is finding the shortest route between traffic analysis zones; because our interest of movement or mobility is between zone centroids. So, find out the shortest path, between the centers of traffic analysis zones. Step 2, assign all trips to links comprising shortest routes, and nothing to other routes that is why, it is all or nothing assignment technique. Assign all trips to links comprising shortest route, represented in the form of minimum path , and step 3 continue until trips between all traffic analysis zone pads have been assigned, continue the process until you cover all the zonal pads.

This is a simple, inexpensive and fast method of route assignment, because we just developed minimum path tree and assigned the whole of traffic to the minimum path that is how it is very fast and simple. This method depicts the routes most travelers would use in the absence of capacity and congestion effects, basically we assume that there are no problems related to capacity of any link or congestion developed on any particular link, we assume and uncongested free flow condition in all the links based on that assumption we assign traffic on all the links comprising minimum path. Results of this method are easy to understand and interpret, interpretation is quite simple and understanding is also relatively easier. Despite these advantages this method has got one serious problem, the disadvantage of this method is that, it generates unrealistic flow, unrealistic traffic assignment in situations where there are minor differences, minor differences in travel impedance between alternative routes.

Let us say we have two alternative routes between zones one and two, if the travel time between or if the travel time along route one is eleven minutes for example, and the travel time along route two, eleven point five minutes, so the difference is minor in practice do not matter much, people might use either route one or route two, but as per the algorithm that we use for all or nothing assignment technique, the whole of the traffic will be assigned to route one, which has got a travel time of just eleven minutes, leaving the other alternative routes which has say travel time of eleven point five minutes empty, which is not realistic so that is the problem with this type of assignment.

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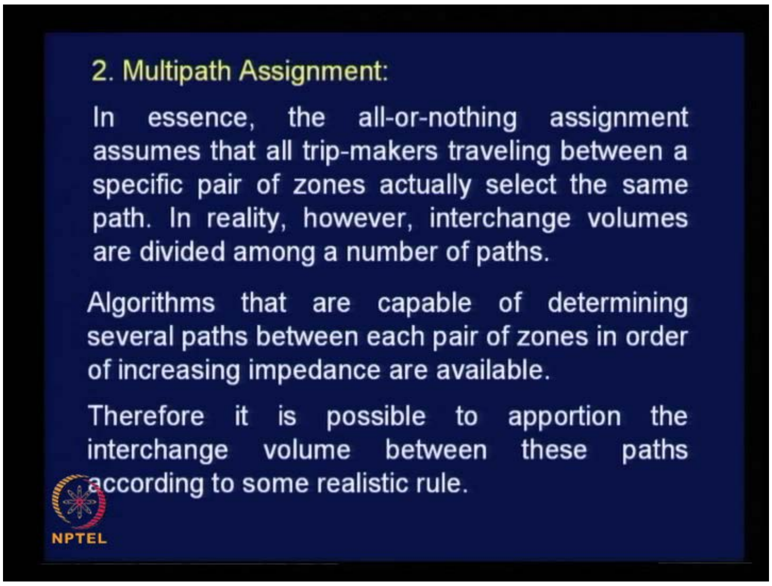

The second method of assignment is multi path assignment, as the name implies this technique assigns traffic on multiple paths, in essence, of course the all or nothing assignment assumes that all trip makers travelling between a specific pair of zones, actually select the same path that is the basic assumption. There is no alternative path as far as the previous technique is concerned. In reality however interchange volumes are divided among a number of alternative paths. So that real aspect or reality is captured in multipath assignment technique. Algorithms that are capable of determining several paths between each pair of zones, in order or increasing impedance are available. So we need to have some algorithm to assign traffic in some order, we cannot equally divide the traffic among the alternatives, the choice of route will depend on the travel time implication, lesser the travel time more is the likely traffic that might use a shorter route compared to relatively longer route. So we need to have some kind of algorithm, to apportion the traffic among various alternative routes.

Therefore, it is possible to apportion the interchange volume between these paths according to realistic rule. Can anyone think of some rule to apportion traffic among alternative paths with different travel times; ten minutes, eleven minutes, twelve minutes like that, let us say three alternatives, how to apportion the traffic, but one reality is that twelve minutes path will have relatively lesser traffic compared to the ten minutes path, because the ten minutes path is shorter compared to twelve minutes path. Shall we say that the traffic taking different routes might be directly proportional to the inverse of the travel times, inverse of travel times that is one suggestion given.

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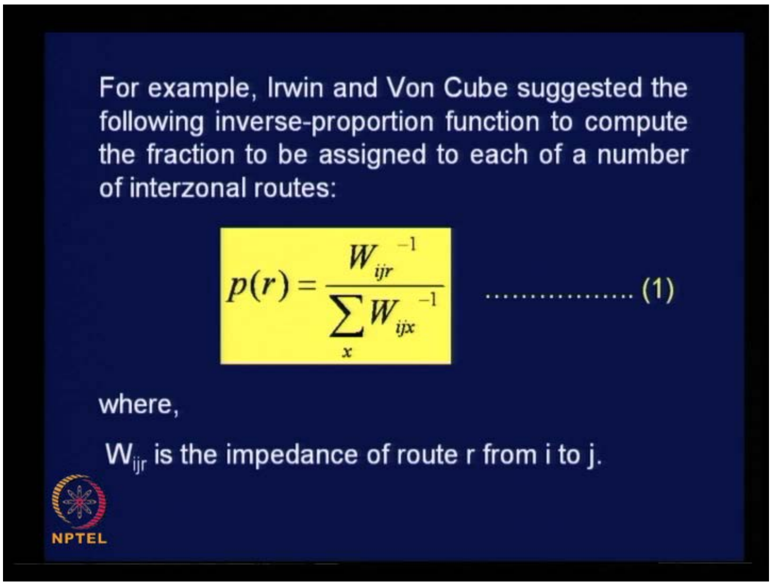

Irwin and Von Cube suggested the following inverse proportional function, to compute the fraction to be assigned to each of a number of interzonal routes, this is the formulas suggested by Irwin and Von cube. P r is equal to W i j r raised to the power of minus 1 whole divided by sigma x equal to 1 to n W i j x raised to the power minus 1, W i j r here is the impedance of route r from i to j or from travel from i to j, p r is nothing, but the proportion of trip assigned to route r. You can see the same information here, the inverse of travel impedance of the concerned route is taken in numerator, and the sum of the inverse of the impedances of all the routes are taken in the denominator.

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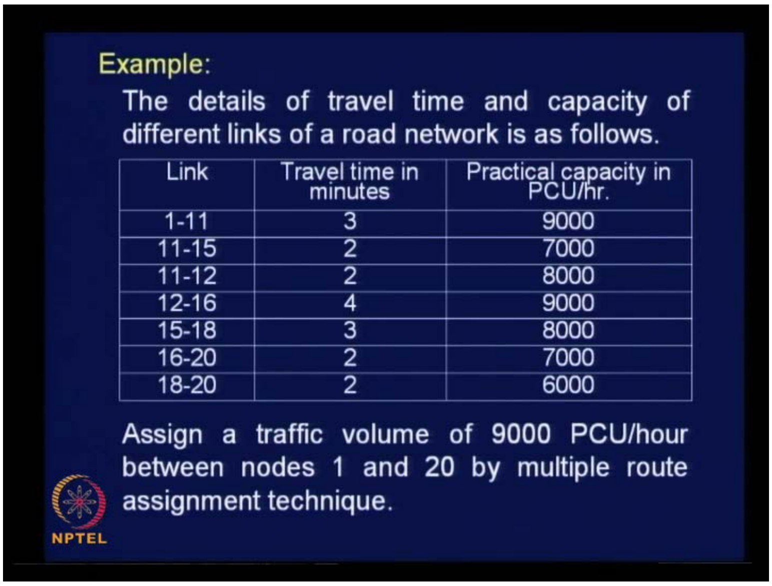

Let's take a small numerical example and try to understand, the multipath method of traffic assignment. This is the information related to a small network, link designations are given in column 1 and travel time in minutes is given in column 2, and practical capacity of each link is also given to us as additional information, even though it may not be very essential at this stage. So you can see some numbers, node numbers used to designate the links, and the question is this. Assign a traffic volume of nine thousand PCU per hour between nodes 1 and 20 by multiple route assignment technique. You have to assign a traffic of nine thousand PCU per hour for movement from node 1 to node 20. Since, we have just node numbers and used to designate links, it will be convenient for us to make a sketch of the given information to understand the problem better. You sketch out the rule net work based on the information given in column 1, link information.

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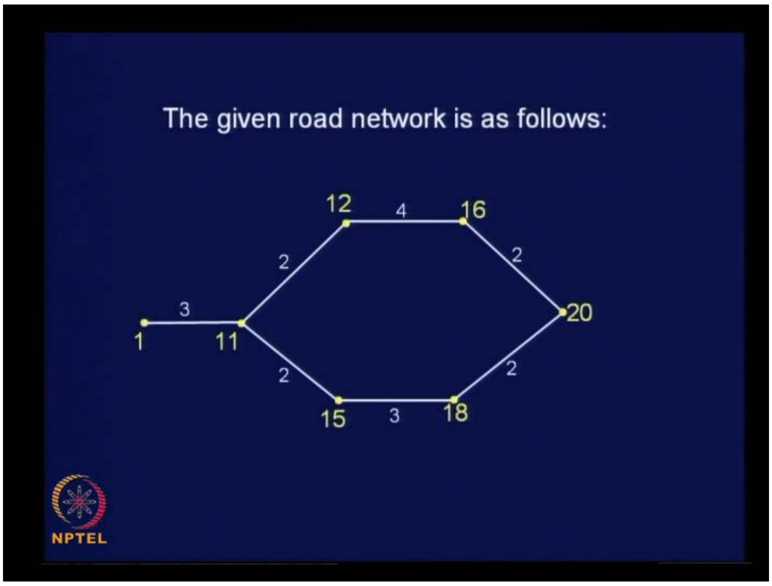

If you do that, you will get this figure. The link designations you may recall 1 11, 11 12, 12 16, 16 20 then 11 15, 15 18 and 18 20. Our interest is to find out the travel time from 1 to 20 along the two alternative routes, and then assign traffic based on the algorithm, and what is the travel time along 1, 11, 12, 16, 20 travel times are indicated with white colored numbers. So 3 plus 2, 5 plus 4, 9 plus 2; 11 minutes, and the travel time along the other alternative path namely 1, 11, 15, 18 and 20 is equal to 3 plus 2, 5 plus 3, 8 plus 2, 10 minutes. So, there are 2 alternative paths involving travel times of 10 minutes and 11 minutes.

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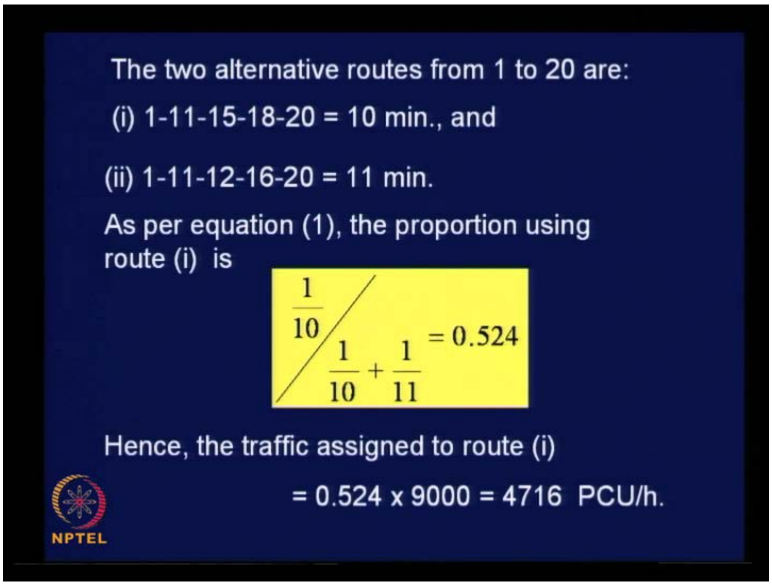

So, the paths are 1, 11, 15, 18, 20 involving a travel time of 10 minutes, and then 1, 11, 12, 16, 20 involving a travel time of 11 minutes. Simply use the algorithm and get the proportion of traffic to be assigned to the two alternative routes. As per the equation one, that we have seen, a proportion using route one is 1 by 10 inverse of the travel time implication, divided by 1 by 10 plus, 1 by 11 that is equal to 0.524, and the actual volume will be the traffic assigned to route one is 0.524 into the total traffic is 9000 and this works out to 4716 PCU per hour, that's the traffic volume assigned to route one with travel time of 10 minutes.

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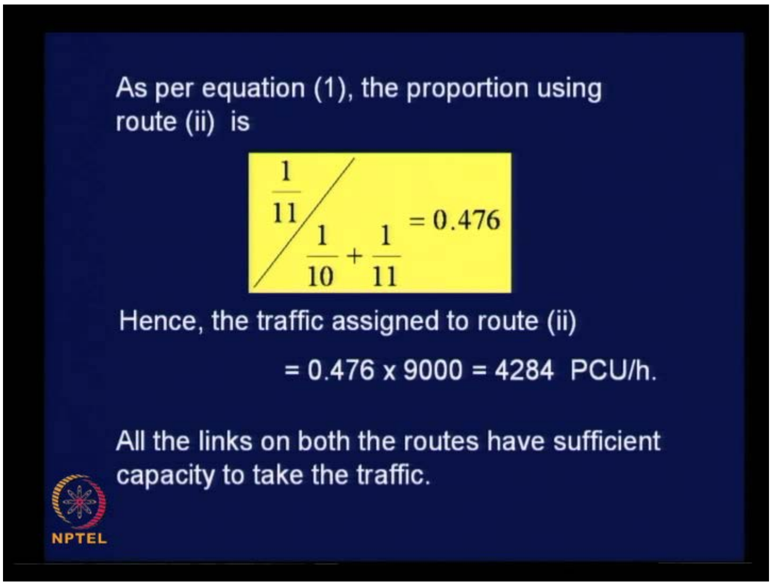

And, as per the same equation, the proportion using route two will be 1 by 11, divided by 1 by 10 plus 1 by 11 that is equal to point 476 and the actual traffic volume is going to be point 476 into 9000, that works out to 4284 PCU per hour. It is a very simple example and in practice you may have more number of links involving these alternative routes, and sometimes the number of alternative routes available may be also usually more than two. All the links on both the routes have sufficient capacity to take the traffic, why we are making this statement, because link capacity is given to us as additional information, you would have seen the third column of the table link capacity was given. Suppose the assigned traffic of 4000 plus in this case, the earlier case slightly higher, if the assigned traffic is more than a link capacity on a particular route, then what to do, you are apportioning traffic along two alternative routes.

Let us say in one alternative route, one of the links may not be able to take the assigned traffic volume, let us say assigned volume in this case as shown here is 4284, and if the capacity of 1 of the links is only 3500 PCU per hour, what do you do under such conditions. It is obvious that you can assign only 3500 PCU per hour along that of the native route, and the balance has to be pushed to the other alternative route, provided the other alternative is able to take this additional traffic. So, that is how in practice you must manage assignment along various alternative rules. If you are given the information about capacity constraint, then you should be very careful and check whether the capacity is exceeded. If capacity is exceeded try to distribute the traffic to other alternative routes.

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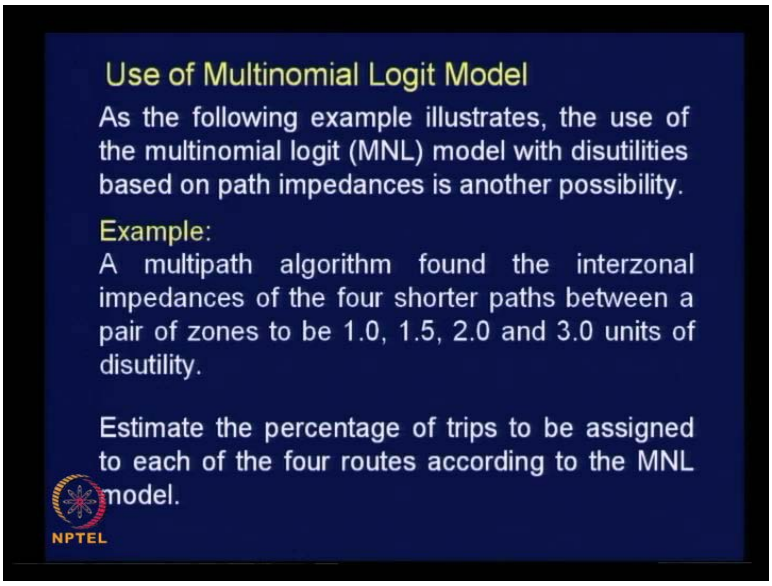

And use of multinomial logit model, how use of multinomial logic mode is relevant at this junction. All of you are familiar that multinomial logit model can be used for mode choice analysis; we have used the model for mode choice analysis, and is it possible to use the model for route choice analysis. You may recall that I told you about the scope of application of the logit model. Logit model can be applied for any choice situation where randomness is increased, it could be choice between two three just consume items or two three modes of transportation or several alternative routes available for choice, for making trips. Basically it is a question of choosing a particular route, knowing the travel time implication or total travel impedance related to each of the alternative routes.

So, we have a set of alternatives, and we try to understand the way people choose a particular alternative. So, that is how instead of using the earlier equation that we have seen, involving the inverse of the travel times. You can also use multinomial logit model to explain route choice, to do route assignment. Why should we use multinomial logit model or what difference it is going to make compared to the earlier method. You may recall multinomial logit model incorporates the randomness related to individuals in choice of a particular alternative among the set of alternative available. The random part is incorporated in the choice process when you use multinomial logit model, and the choice of route also need not be strictly based on only travel time implication, in practice people might look at the overall generalized cost implication or overall travel impedance related to each of the alternative routes.

So, when they try to create a bundle of various utilities or disutilities, related to each of the alternative routes, the randomness comes into the picture, it depends upon the way individuals look at utility or disutility of a particular alternative route, so that is what happens in practice. So, that is how use of multinomial logic model is also appropriate in route choice analysis. It’s very simple, it is not going to be difficult, because the basic model structure is familiar to you, and as the following example illustrates the use of multinomial logit model with disutility’s based on path impedances is another possibility. Let us take a small example, a multipath algorithm found the interzonal impedances in general, not travel plan total impedances of the four shorter paths, why four shorter paths, see the alternative should be comparable.

There could be several alternative paths if you consider the entire road network, you can go to the next station by traveling along a circuitous route it is also possible. So, that cannot be reasonably considered as an alternative route, alternative should be reasonably real alternatives, there should be basically shorter paths, that is where you need to understand the reason for putting the word shorter here, between a pair of zones to be 1, 1.5, 2 and 3 units of the disutility, just units, it is not travel time, the bundle together is given some number as 1, 1.5, 2 and 3 units of disutility. So, you can name it as travel impedance, the total travel impedance along each of the alternative routes. Now, the problem is this, estimate percentage of trips to be assigned to each of the four routes according to the MNL model, Multinomial Logit Model.

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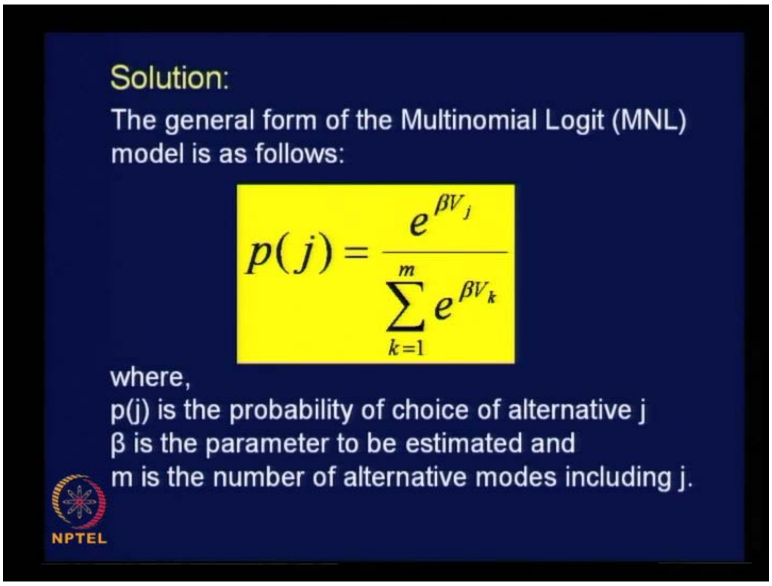

The MNL model structure is given here; it is a same structure as we have seen earlier the only difference is, a symbol beta is introduced here, this is nothing different, this is just to indicate that the utility functions p j involves estimation of the parameters of the involved variable. It is an indicator, otherwise it has got no different meaning compared to what we have seen earlier, where p j is the probability of choice of alternative j, and beta is the parameter to be estimated for the utility function, which is obvious, and the m is the number of alternative modes including j.

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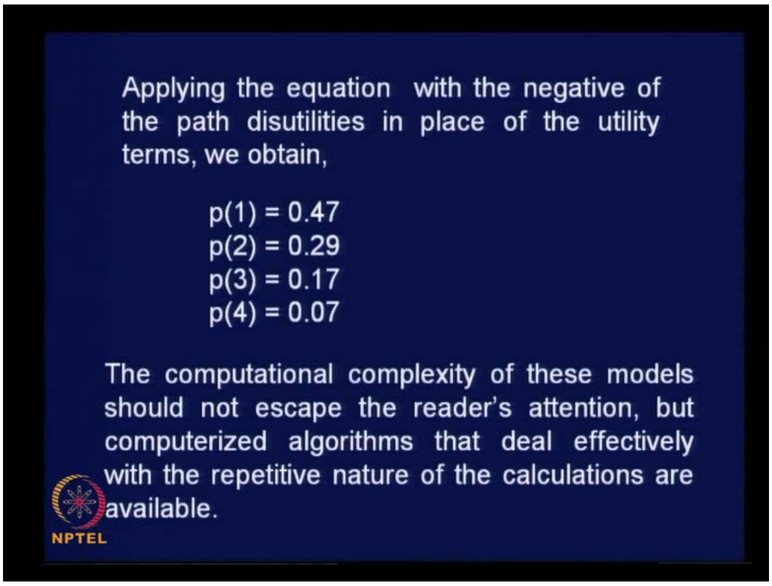

Now, applying this equation with the negative of the path disutility's, disutilities are given as some numbers 11.5 etcetera, and we must take negative of those values for application the model. E power minus of something, in place of the utility terms we obtain these results, I am just giving you the probabilities directly, because of the simple substitution of the numbers in the equation. Probabilities of choice in route 1 is 0.47 probability of choice in route 2 is 0.29 and route 3 point 17 route 4 point 07, it is in the descending order. You may remember the corresponding disutilities associated with route 1, 2, 3, 4 it was 1, 1.5, 2, 3. So, when the disutility increases you find the probability of choice decreases; we substitute those numbers in the previous equation. The computational complexities of these models should not escape the reader's attention. Of course, computationally this is little complex compared to the previous thing, where we simply considered inverse of the travel times, but computerized algorithms that deal effectively with these repeated nature of calculation are available so nothing to worry. Whatever, may be the complexity associated with analytical process, can be managed with available compute program packages.

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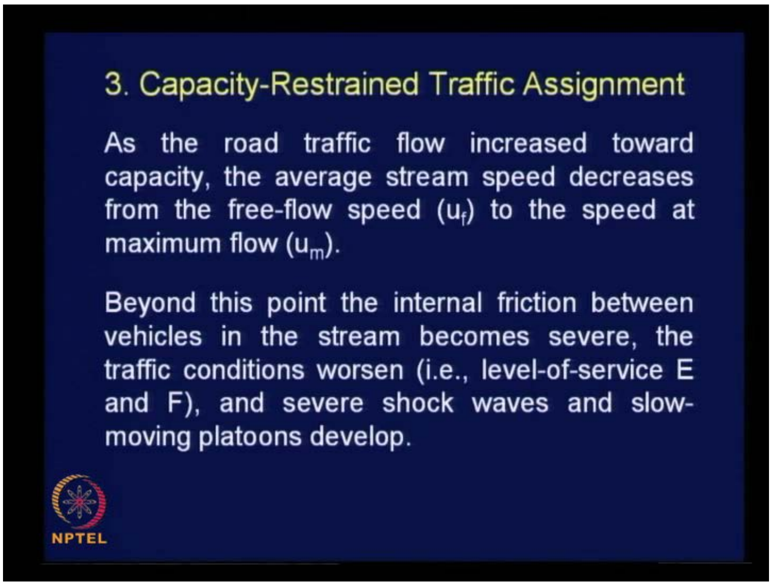

Then the third method of route assignment, namely capacitive restrained traffic assignment, and this is the basic concept to be kept in mind in reality. As the road traffic flow increase towards capacity, the average stream speed decreases from the free flow speed to the speed at maximum flow. It changes from u F to u m; m standing for maximum flow, beyond this point the internal friction between the vehicles in the stream becomes severe, because of reduced headway. The traffic conditions worsen to give you a level of service of E or F, which is the lowest, and severe chock waves and slow moving platoons develop, when the traffic flow increases to reach capacity level.

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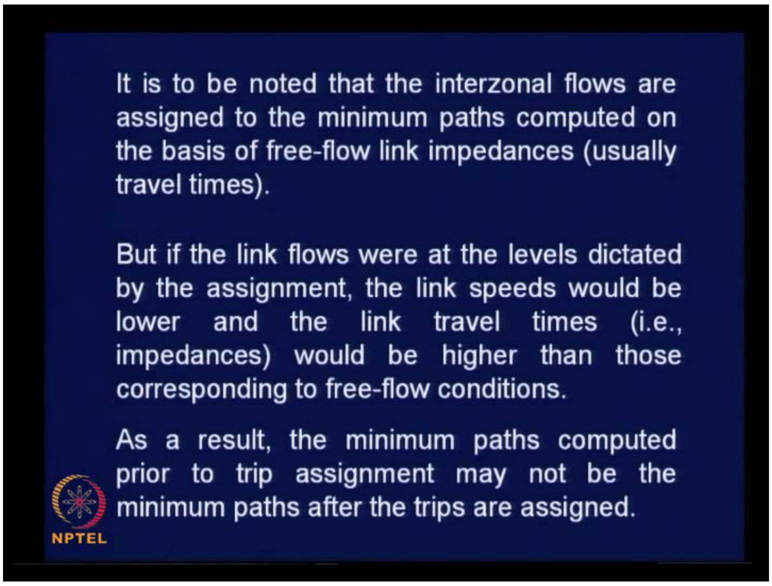
It is to be noted that the interzonal flows are assigned to the minimum paths computed on the basis of free-flow link impedances (usually travel times).

But if the link flows were at the levels dictated by the assignment, the link speeds would be lower and the link travel times (i.e., impedances) would be higher than those corresponding to free-flow conditions.

As a result, the minimum paths computed prior to trip assignment may not be the minimum paths after the trips are assigned.

And it is to be noted that the interzonal flow are assigned to be minimum paths, computed on the basis of free flow link impedances, usually travel time. So, whatever travel time we have been talking about so far are free flow travel times, but in practice when you think of taking different alternative routes during morning peak hour, you do not perceive only the free flow travel time, you simultaneously perceive the possible traffic condition at that point of time along each alternative routes, and then involved travel time under that travel condition. That is how, we perceive the possibility of taking an alternative route when we try to take a decision on practice, so unless this aspect is taking care of our route assignment may not be that realistic.

But if the link flows were at the levels dictated by the assignment, during the assignment process the link speeds would be lower and the link travel times, that is impedances would be higher than those corresponding to free flow condition. This implies that travel times in practice may not be equal to free flow travel time that we normally consider for assignment under all or nothing assignment technique or multipath assignment technique. As a result, the minimum paths computed prior to trip assignment may not be the minimum path after the trips are assigned. You just consider a zonal pair, identify the minimum path trips assign traffic; it's based on all or nothing assignment technique. Once you assign traffic a set of links are loaded with traffic volume, and when you take another zonal pair and assign traffic, some of the already loaded links will also come into the minimum path of the other pair also its likely, in that case if we do not consider the effect of traffic volume existing traffic volume on the travel time, you will not be doing the exercise accurately. So, the point made here is, when you assign traffic in steps, you must realize that the travel time along the link increases, that increase should also be taken into account simultaneously while you are doing assignment, so that ultimately at the end of the process the travel time that you take will be reflective of the reality.

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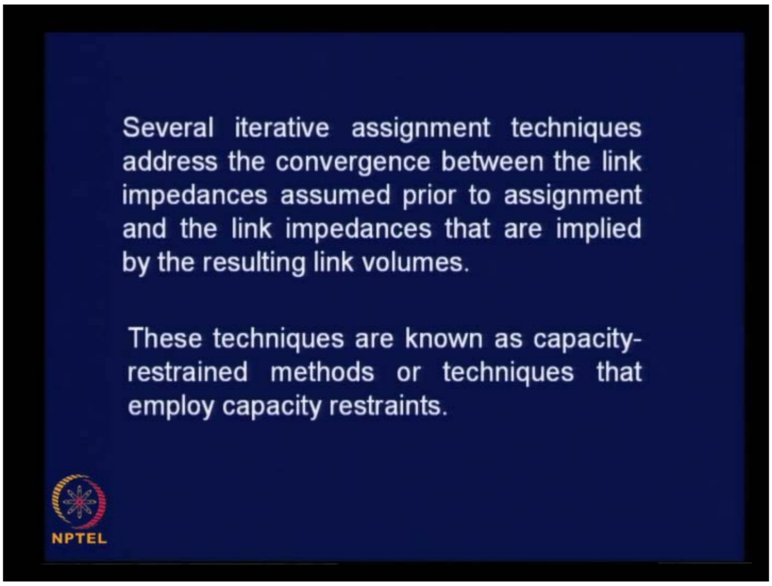

And for this purpose several iterative techniques address this particular convergence between link impedances, assumed prior assignment and the link impedances that are implied by the resulting link volumes, and these techniques are known as capacitive restraints method. There are minor variations, there are several approaches under capacitive restraints techniques, we just talk about the general principle implied or involved in capacitive restraints method of traffic assignment, which basically involves the consideration to the assigned traffic volumes while estimating the travel time resulting minimum path tree, that imply capacity restrains.

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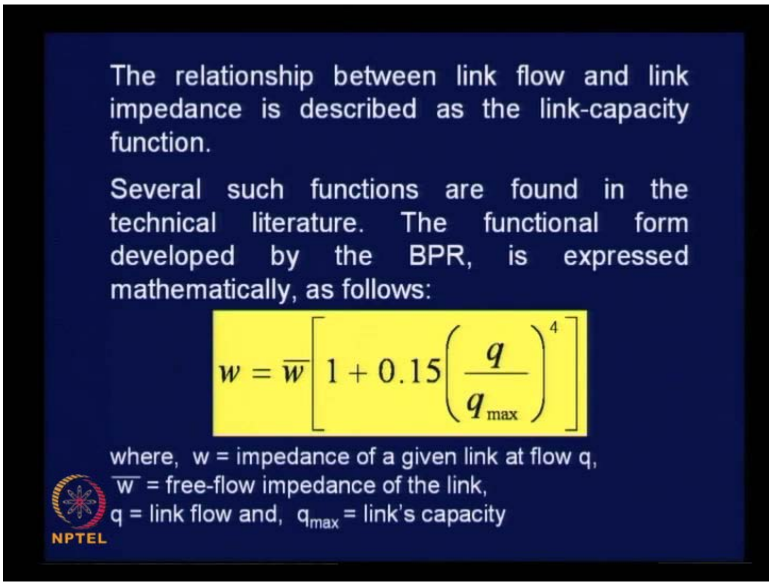

The relationship between link flow and link impedance is described as a link capacitive function, the key to this process is the understanding of the relationship between link flows or link volume and link speed. So, when you assign some traffic flow onto a link, subsequently the speed is going to be less and the involved travel time is going to be more. So, you should know what is the relationship between traffic volume an traffic speed. The assigned say traffic volume to an extent of twenty percent of capacity of a link, what will the extent of reduction of speed from free flow speed, that question has to be answered if you want to effectively apply the capacity restrained method of traffic assignment, that is a pre requisite.

And several such functions are found in the technical literature, number of researchers have come out with some functions relating traffic volume and traffic speed. The functional form developed by BPR; Bureau of Public Roads USA is expressed mathematically as follows, which is more commonly used by different agencies as well as countries. So, this is the BPR equation which is very simply; W is the impedance of a given link at flow q, we are interested to know the impedance on a link at a given flow level, that is given her as W, and W bar is the free flow impedance of the link, under free flow condition we should know what is the impedance or travel time implication that is given here as W bar, and q is the link flow the actual flow at any point of time, and q max is the link’s capacity, and you can see W is given in terms of W bar. W you are estimating in terms of free flow impedance, W bar multiplied by some factor, and if you look at the factor or multiplying part of it, you get some numbers 0.15 and an exponent 4. These numbers are the result of calibration of this equation, based on field observed data in the united stated obviously. So, we can call this equation an empirical equation, which relates the travel impedance on a link at a given volume, traffic volume to the free flow impedance condition which is W bar.

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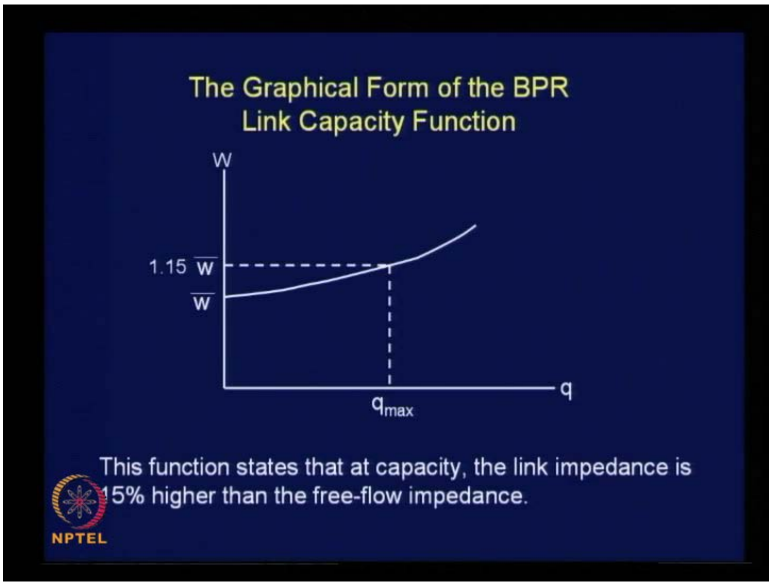

And this equation, when represented pictorially gives you this kind of picture; this is how the travel impedance increases with increase in volume of traffic, under free flow condition as you have seen the impedance is less W bar only, as the volume increases to maximum capacity level, the impedance increases to 1.15 W bar. So, this function stated obviously that at capacity the link impedance is 15 percent higher than the free flow impedance. Please remember this is for the condition prevailing in the USA. But, if you perceive the difference between free flow condition and capacitive flow condition on Indian roads, the percentage is going to be less or more. What is the free flow speed for a motorcycle or car on urban roads in Indian cities, when you are allowed to drive freely as you desire, what speed you will maintain on urban roads, still you cannot drive very fast blindly, you have to be careful, may be let us say the free flow speed is 70 kilometers per hour.

And when the traffic is near capacity on the same road, can you imagine the speed that you will be able to maintain; roughly about 20 kilometers per hour or even less than that, there will be drastic reduction. So, obviously this number is not going to be valid for Indian condition that is to be remembered very carefully, so we should not simply assume to take this 15 percent very seriously, and try to apply for conditions prevailing here.

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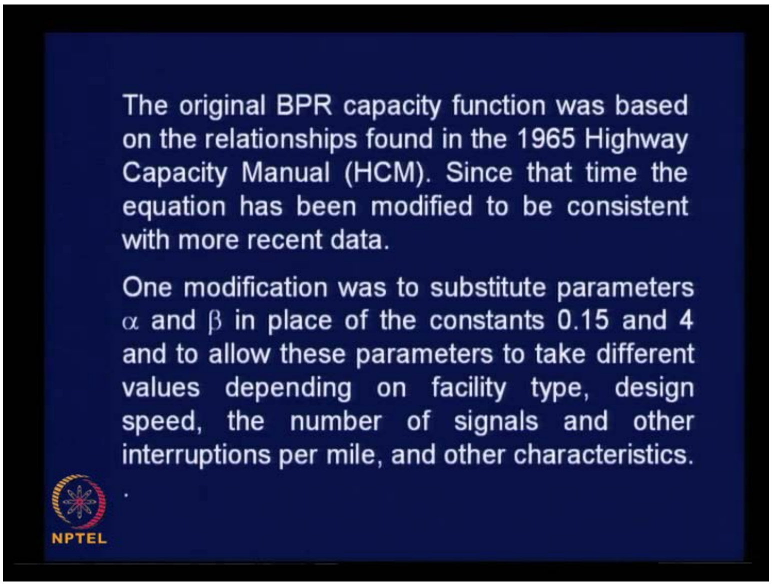

Even in the US there were some questions about these calibrated values and subsequently they have made some changes. The original BPR capacity function was based on the relationships found in the 1965 highway capacity manual, the equation that we see pertains to the traffic condition, road lane traffic conditions that prevailed in the 1960’s, since that time the equation has been modified, to be consistent with mode rules and data. One modification was to substitute parameters alpha and beta in place of the constant values of 0.15 and 4, and to allow these parameters to take different values, depending on facility time, desired speed, the number of signals and other interruptions per mile and few other roadway and traffic characteristics, and they have just given the values in a tabular form.

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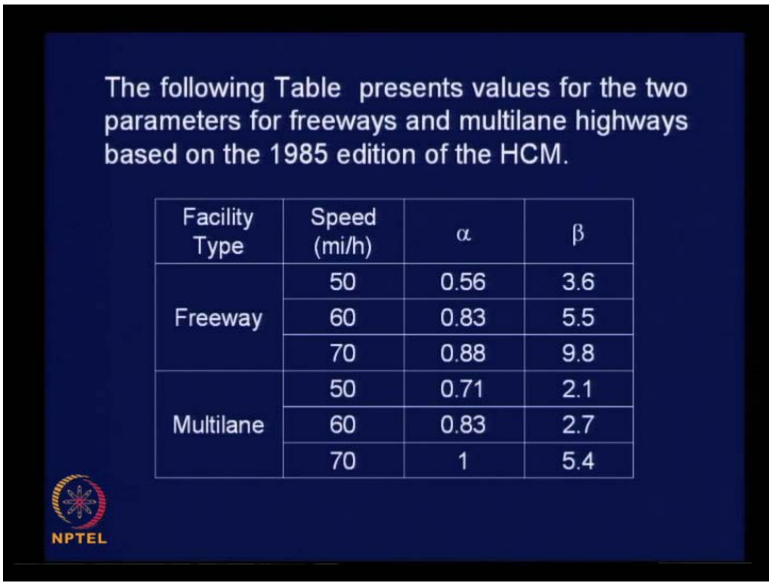

Facility Type	Speed (mi/h)	α	β
Freeway	50	0.56	3.6
	60	0.83	5.5
	70	0.88	9.8
Multilane	50	0.71	2.1
	60	0.83	2.7
	70	1	5.4

In the year 1985, in the 1985 edition of HCM you find this information. They have classified the roads into two types; freeway and multilane roads, freeways are roadways with unrestricted traffic flow condition, and multi end roads will have frequent interruptions for the traffic flow, constraint traffic flow condition prevail on multi roads and freeways will have unconstrained traffic flow condition. And even there the designed speeds have been given three; values 50 miles per hour 60 miles per hour and 70 miles per hour for both these two categories of roads, and the values of alpha and beta are given separately for each category.

In general you can find that the values of alpha compared to the corresponding values, in the case of multilane roads are relatively more, alpha is more in the case of multilane roads compared to freeways, and when you look at beta it is less. This implies what, you can look back and look at the equation that you have seen, and then try to perceive the difference, the effect of traffic volume and speed. Normally on inferior type of facility, the effect will be more significant compared to superior type of facility that is the general understanding, that is what is meant by this relative changes in the alpha and beta values.

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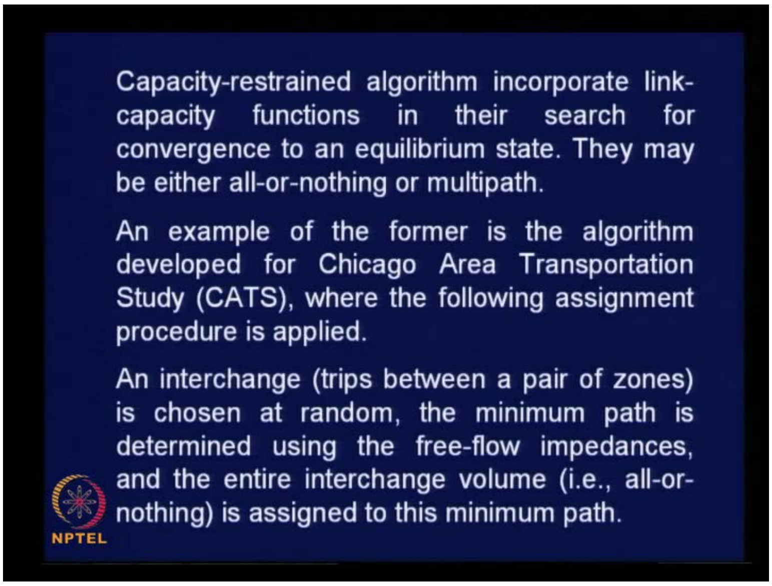

And the capacitive restrained algorithm incorporate, link capacity functions in their search for convergence to an equilibrium state. They may be either all or nothing or multi path, this statement is very important, I will repeat again capacitive restrained algorithm, incorporate link capacity functions in their search for convergence to an equilibrium state that is the only part of this method. This is a component of the general method of route assignment, this capacitive restrain technique helps us to bring in a kind of equilibrium in traffic flow in the road network, with due consideration to change in the travel time because of change in the traffic volume in the assignment process, but the actual assignment technique adopted will be, again either all or nothing or multipath assignment only.

Actually we follow only first two basic methods of assignment, this capacitive restrained assignment is only part, which enables better application of all or nothing or multipath assignment techniques. An example of the former that is all or nothing assignment technique is the algorithm developed for Chicago area transportation study, CATS study, where the following assignment procedure is applied. Now, we are going to see, how to apply all or nothing assignment technique with incorporation of the principle of capacitive restrain. Now, what we do to start with this, an interchange is nothing, but drift between a pair of zones is considered, is chosen at random, you may have a large network; you can just chose any interchange.

The minimum path is determined using the free flow impedances; first you build the minimum path trip, taking free flow impedance as the basis first to start with, and the entire interchange volume, because it is all or nothing procedure is applying to this minimum path. You may have thousands of links or nodes, when you consider one interchange, one zonal pair the number of links or nodes applied may be very small compared to the total number, in that case nothing wrong in just assigning or assuming free flow condition on assigning traffic, that is not going to be the end of it, it is only beginning. So, that is what is being done as step 1.

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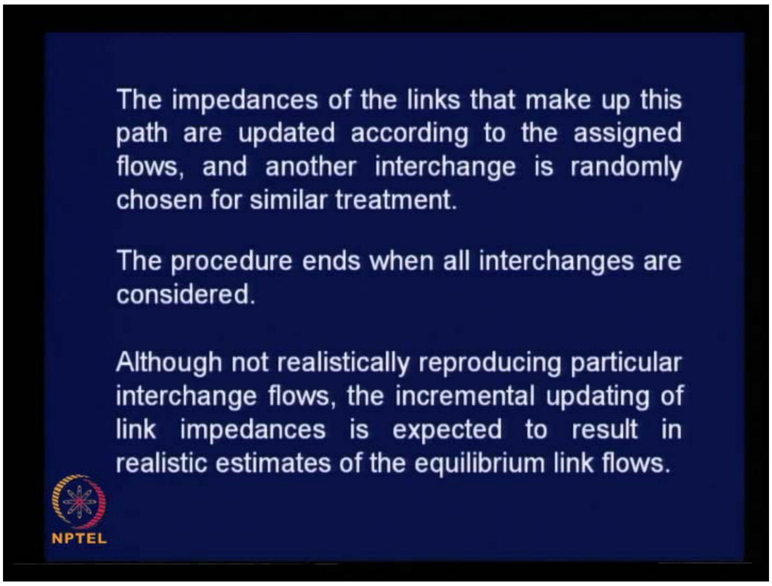

Then the impedances of the links that makeup this path, this minimum path in step 1 are updated according to the assigned flows and another interchange is randomly chosen for similar treatment. So, after assigning traffic, we change the impedances or travel times for all the involved links, is it possible or not. We take one pair of traffic zones and assign traffic from one zone to another, and after identifying the minimum path tree, a set of links will be loaded with some traffic, because we assigned some traffic for subsequent assignment on the same link, when we consider some other zonal pair, we need to know what is the exact travel time, it would not be equal to the free flow travel time, because we already have some traffic assigned on these links.

So, we must have some increased travel impedance, travel time would have increased for subsequent assignments. Since, we have a relationship between traffic volume and speed after having known the assigned traffic you can find out what will be the consequent of the resultant speed on each of these links after the first stage of assignment. So, knowing the speed you just find out the travel time implication and take that as the revised impedance for those links, which were involved in the first step. So, that is what is traded here, the impedances of the links that make up this path are updated, according to the assigned flows obviously, and another interchange is randomly chosen for similar treatment, then choose another zonal pair, assigned traffic after assignment update the travel impedance based on the travel traffic volume. The procedure ends when all interchanges are considered.

So when you do this mechanically, you will find that simultaneously you are changing the travel impedance for concerned links, and this process will enable you to realistically assess the travel impedance and assign the traffic, this is what was done in cats study. Although, not realistically reproducing particular interchange flows, you consider a specific zonal pair, it may not be very realistically interchanging I mean reflecting the actual interchange. The incremental update of link impedances is expected to result in realistic estimates of the equilibrium in link flows, ultimately at the end of the exercise you will find that there is some equilibrium maintained in the whole of the transport system network that is the idea.

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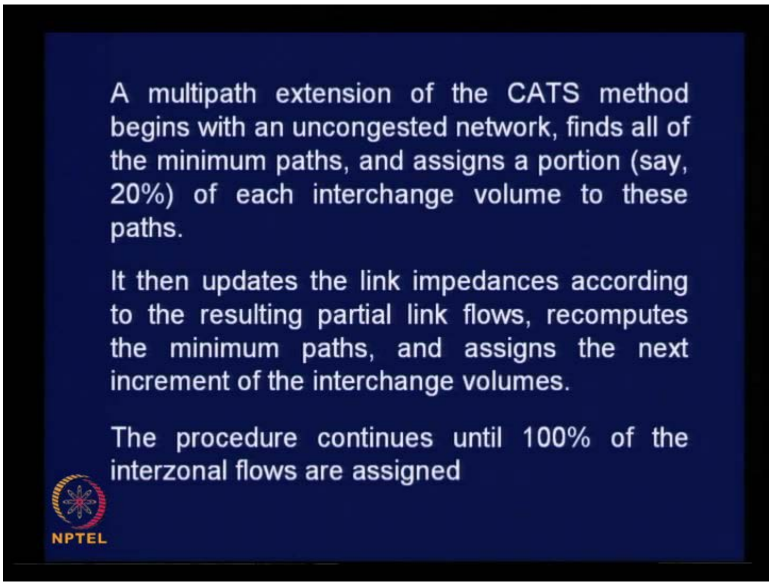

Now, let us see how to go about doing this same exercise by multipath assignment technique, or incorporating capacitor restrain in multipath assignment procedure. A multipath extension of same cat study, begins with an uncongested network or network under free flow condition, finds all of the minimum paths and assigns a portion; say twenty percent of each interchange volume to these paths, are you able to follow this statement, what we do is we consider all these zonal pairs to start with, and identify the minimum path for zonal pair travel, that means the minimum path for any travel, for any movement form 1 zone centroid to the another zone centroid, for the whole of the urban area, or whole of road network is first determined, minimum path for all cases is first found, then you just assign a portion of the total traffic volume between zonal pairs initially to start with, do this for all the zonal pairs again. For example, you take twenty percent of the total traffic volume, and do the assignment for all the zonal pairs covering the entire whole network, that means the whole network will be loaded to an extent of twenty percent.

Now, you revise the travel impedance based on the assigned traffic volume, once you put twenty percent of traffic your travel time is not going to remain the same, it is going to increase, and you have the relationship between traffic volume and traffic speed. So, get the speed for each of the links after assigning twenty percent of traffic, and then work out the corresponding traffic impedance in terms of travel time, so that is the new travel time for you. Once you have changes in travel time then you will find the minimum path tree also changed. Again before you start the next assignment process, you must determine the minimum path tree again for all the zonal pairs, covering the whole of the network, once you complete that you assign another twenty percent say for example.

So, like that you do assignments in stages and complete the process covering the whole of the traffic volume, maybe in 2, 3, and 4 of 5 stages. Please remember at every stage you have to work out new minimum path trees for zonal pairs before assigning subsequent traffic volume. It then updates the link impedances according to the resulting partial link flows, because we assign only some percentage, re-computed the minimum paths and assigns the next increment of the interchange volume, after re-computing minimum paths. The procedure is continued, it continues until 100 percent of the interzonal flows are assigned.

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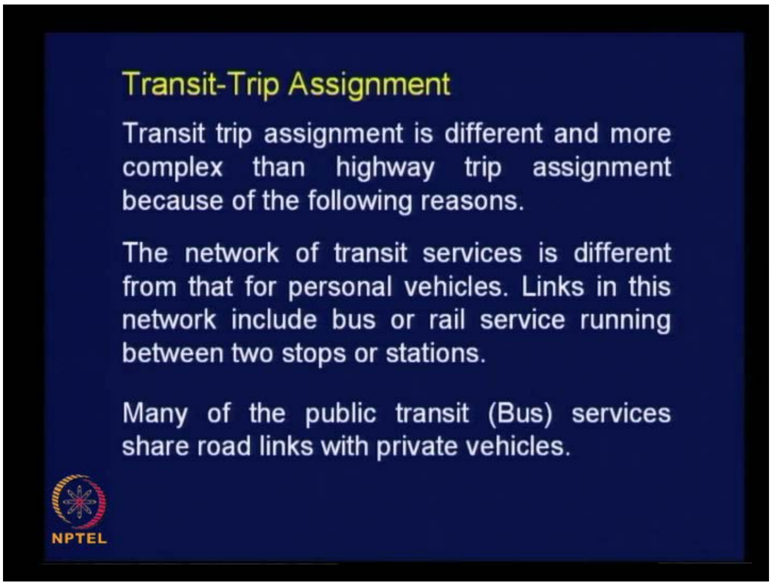

So, that is about the three methods of route assignment, all these discussions are relevent for assigning traffic, when private or personal transport modes are used, then how to assign traffic when the travelers use transit service. In the case of private transport modes we easily convert person rips into equivalent vehicular trips, and then just assign traffic in terms of number of vehicles, but in the case of transit, they are plying on fixed routes, and you cannot just convert the person trips into equivalent number of transit vehicles, even from a traffic zone if you convert all the person trips into equivalent vehicular trips, you may end up with say one and a half wagons of train service, that is not the realistic way, that should be some other procedure to be followed for assigning transit trips.

Transit trip assignment is different and more complex than highway trip assignment, because of the following reasons; the first is this, the network of transit services is different from that of personal vehicles that is one thing, network is totally different. Links in this network include bus or rail service running between two stops or stations. The definition of links and nodes are not relevant for transit trips, as far as transit trips are concerned, say for example the transit service that you consider is a bus service each bus stop is a node not the intersections, each bus stop will be considered as a node in a transit network. Similarly, each railway station will be node in your rail transit network that is the major difference. Many of your public transit services share road links with private vehicles, so there speeds will be changing from link to link, you cannot have a generalized free flow speed etcetera, this complexity has to be tackled by some means, I am just listing the differences between transit assignment and previous case.

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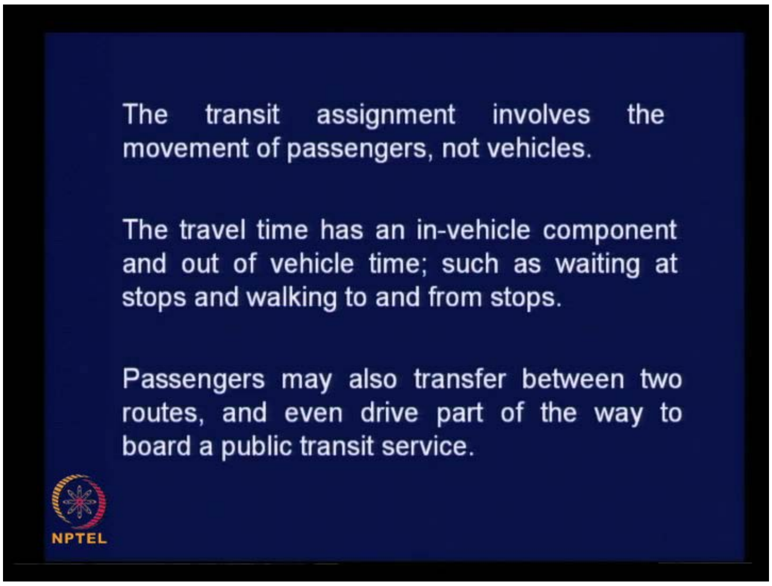

The, transit assignment involves the movement of passengers and not vehicles, so we must consider only passengers to be moved using the available transit service. If there are 100 people taking bus during morning peak from a zone, you just push them into the available transit vehicles in batches. Let us say there are the frequency of bus in one hour is about five on a particular route, then divide this particular number into five batches and push them into the buses. So, we are assigning only person trips as far as transit assignment is concerned that is the major difference. The travel time has an in vehicle component and outer vehicle time; such as waiting at stops and walking to and from stops and so on. So when you think of travel time components, you should not just think of only in vehicle travel time when you estimate travel times in the case of transit trips, and passengers may also transfer between two routes, and even drive part of the way to board a public transit vehicle, use a bicycle to go to railway station, park the bicycle and take the train, or use a motorized two wheeler, so it becomes multimode transportation. So, all these effects are to be brought into your analysis process, I am just listing the complexities only.

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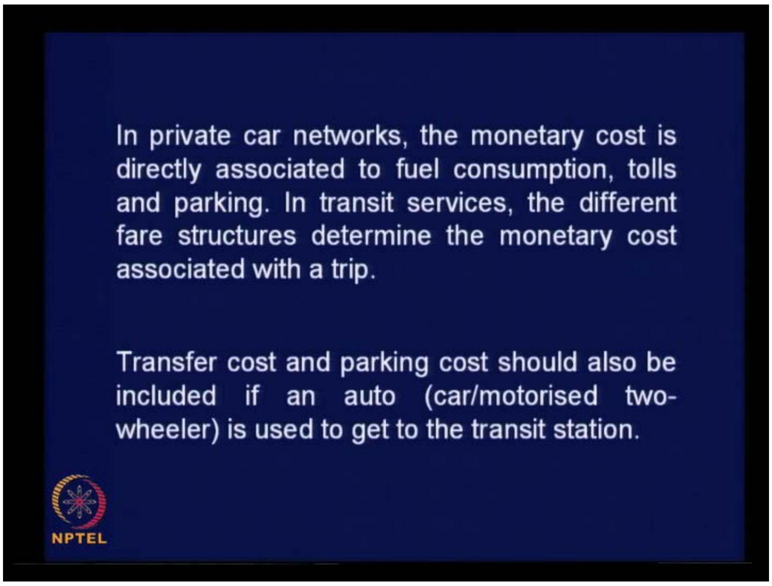

In private car networks, the monitory cost of directly associated with fuel consumption, tolls and parking fees. In transit services the different fare structures determine the monitory cost associated with a trip. If you are including cost component in your travel resistance then this difference has to be understood very clearly. Transfer cost and parking cost should also be included if an auto, may be car motorized two wheeler is used to get to the transit station, as I mentioned earlier. So, these are the differences between transit assignment and route assignment in the case of personal transport vehicles.

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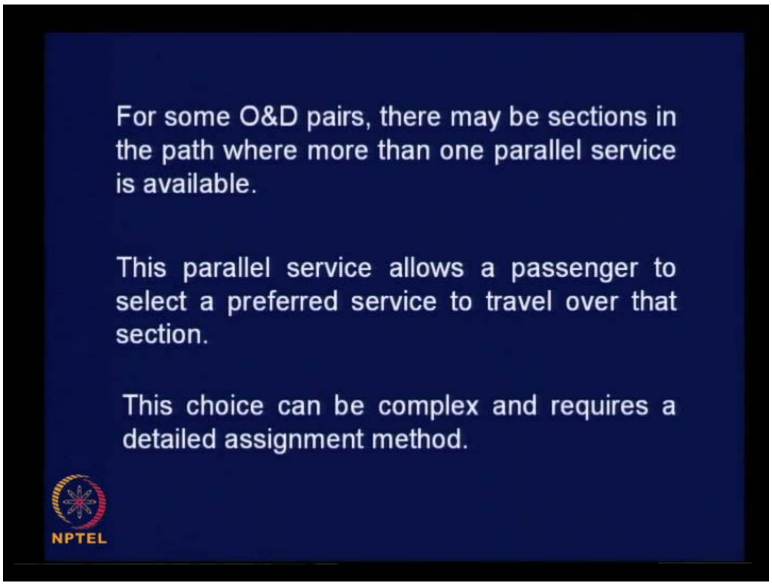

For some O & D pairs, there may be sections in the path where more than 1 parallel service is available. Let's say the travel distance or travel time implication is 50 minutes, for first 10 minutes the person may have only one transit service available, and later on for next 30 minutes of travel there may be train service as well as no service available in parallel, some might switch over to the other transit mode, because its someway more convenient or comfortable compared to the other one. So, this kind of changes, availability of mode choices should also be taken into account when you assign traffic. This parallel service allows a passenger to select a preferred service to travel over that particular section. This choice can be complex and requires a detailed assignment methodology to be followed, that is about the complexity related to the transit assignment.

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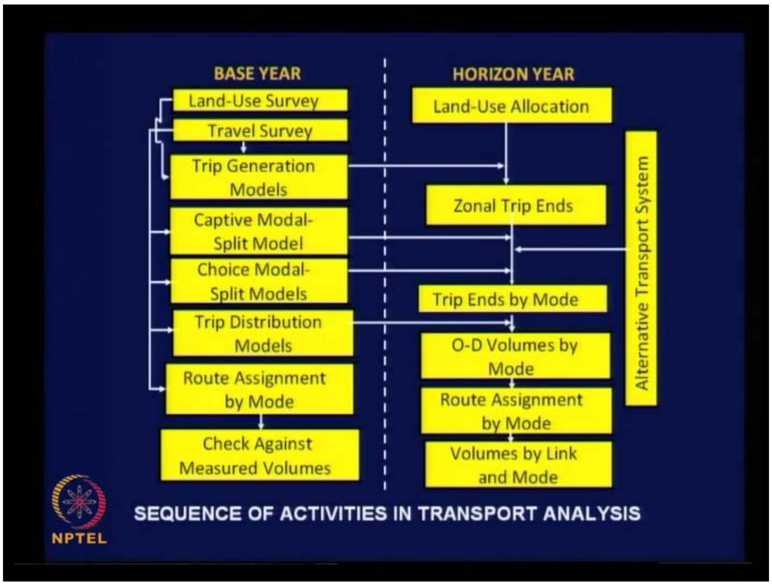

Now, look at the master flow chart and find out where we are. We are almost at a box last box, but one box on the left hand side. The final step is check against measured volumes, once you assign traffic it is possible for us to actually check the traffic volume link by link, because we theoretically assign traffic and create traffic volume. You can actually measure the same traffic in the same field, and its possible for us you compare the field observed traffic volume with your assigned traffic volume, that is the method of checking the correctness of your result.

There is no distinct calibration procedure for assignment models, please understand. Its only comparison of the actual field observed data with your result that you get through the assignment process. Compare both and if they are matching satisfactorily you stop, otherwise there is something wrong somewhere and you go backwards and check every step each of the four steps, and identify the errors redo the exercise and come back to the assignment stage, and again compare with the actual field of your traffic volume, repeat the process until there is a reasonable match between your assigned traffic and actual field observed traffic.

So with this we complete our discussion on route assignment, all the 4 analytical steps are completed at this stage. To summarize what we have done today, we discussed about the three assignment techniques, namely all or nothing assignment technique, multipath assignment technique and capacitive restraint assignment technique. We have seen numerical examples to understand all or nothing assignment technique as well as multipath assignment technique clearly, and we also know now the capacitor restrained procedure is an input for actually assigning traffic either by all or nothing assignment technique or multipath assignment technique, and taking case study as example we have seen, how capacity restrain technique can be incorporated in all or nothing assignment procedure as well as multipath assignment procedure. And finally we tried to understand the difference, between assignment of personal vehicle involved traffic and assignment of transit trips. In the case of transit its again assignment of person trips into transit service and other associated problems are related to accurate estimation of travel time and possibility of choices between transit service, all those things are to be considered while assigning transit trips. We will stop here and continue with the next topic in the next class.