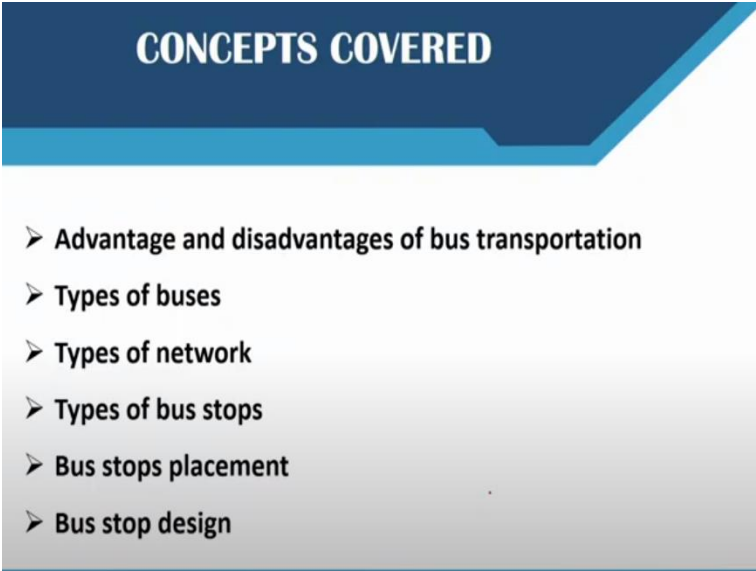


**Introduction to Multimodal Urban Transportation System**  
**Prof. Arkopal Kishore Goswami**  
**Department of Ranbir and Chitra Gupta School of Infrastructure Design and management**  
**Indian Institute of Technology - Kharagpur**

**Module No # 02**  
**Lecture No # 09**  
**Public Transportation: Bus Transportation**

Hello friends. Welcome back to the next lecture on public transportation. So far in the previous lectures you have been introduced to the basics in public transportation and now we are going to look specifically at one of the modes of transportation which is bus transportation.

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**CONCEPTS COVERED**

- Advantage and disadvantages of bus transportation
- Types of buses
- Types of network
- Types of bus stops
- Bus stops placement
- Bus stop design

So in this lecture what we are going to cover are the different advantage and disadvantages of bus transportation, then we are going to look at different types of buses, different types of bus networks, types of bus stops, where they should be placed, and how they should be designed. So all of this put together would be very helpful in understanding how bus stop system should be planned. So let us get started.

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Now, there are some inherent advantage of bus transportation based on previous experience in different cities of the world and as well as India. The greatest advantage with bus transportation is that they can operate on existing road systems. So you do not need to build new infrastructure or you do not need to put in any new facilities in order to start a bus system. In order to operate a new bus system or to expand a bus system do not need to put in new roads, new rails, no overhead electric wires, nothing like that sort, which is which may be needed for other types of public transportation.

That is a very big advantage that bus transportation has. Now there are other advantages as well - - the routes can be easily modified, it could be re-routed based on newer development that is coming up. So for example you have an existing bus route line or a bus route, but a new residential development comes up, you can easily extend that line to the new residential area. It would not need a lot of infrastructure to put it in order to extend it.

The next advantage is the schedule; it can be varied. So you can have multiple schedules that you can run during the day, during the month, during the year, etc., and you can have varied schedules as well. Then the other advantage is when the fleet is not required to run on a bus route or a bus network, you can charter those buses. So you can utilize your fleet in different manners. so that they are not laying unutilized and they are not generating any revenues so they can use for charter services. And relatively less demand, or relatively a lower amount of demand usually suffices dispatching a new bus service. For example, only 20 to 25 number of passengers is

sufficient per hour in order to justify a new bus route. Whereas the other larger public transportation systems require a higher demand or a greater demand just in order to justify a new system. So bus transportation has these advantages.

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**Bus Transportation**

**Disadvantages**

- Lower capacity in high volume corridors
- Limited ability to reduce labor cost in high volume corridors
- Susceptibility of delays from other vehicles
- Less visibility of route network
- Less perceived comfort of passengers

The slide features a background with various icons related to technology and transportation, such as a gear, a smartphone, a Wi-Fi symbol, a laptop, and a network diagram. A red circular icon with a white hand pointing up is positioned to the right of the title. In the bottom right corner, there is a small video inset showing a man with glasses and a suit speaking.

At the same time, it has several disadvantages as well. One is because they run on existing roads, they are susceptible to delays. So there are susceptible to delays not for their inherent reasons but for the reasons of other modes of transportation that are running on the roads. Then, it is also less visible route network. Because it runs on existing infrastructure or on an existing roads it gets hidden amongst the all other traffics and usually it is not very conspicuous.

So you will see many cities painting their buses a certain color so as to make them stand out in the traffic. Otherwise they can blend in and then you cannot easily spot the bus that you want to get on. The other big disadvantage is more to do with the perception of people -- people feel that bus transportation is less comfortable. So they always have this feeling in their mind that it will be crowded, you would not find a seat, etc.

The infrastructure may not be of highest quality. So this perception is something that is associated with the bus transportation. And also for standard buses sometimes what happens is that if you do not have high capacity buses then they do tend to get over crowded and capacity usually cannot be easily added on because you need additional fleet which is almost many times constant.

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The slide features a title 'Bus Transportation' in blue. Below it, the text 'Types of buses' is followed by a bullet point: '•The type of buses used in urban transportation are:'. A list of five bus types follows: '• Conventional bus', '• Articulated bus', '• Bi-articulated bus', '• Mini bus', and '• Double deck bus'. To the right of the text is a diagram of a network with a central purple circle and six red rectangular nodes connected by lines. The background is light blue with various icons like a gear, a smartphone, a Wi-Fi symbol, and a person. A small inset photo of a man with glasses is in the bottom right corner.

So those were the advantages and some disadvantages of bus transportation. Now you need to know what the different types of the buses are, because for a particular route or for a particular network you need to run only those type of buses that will cater to the demand on that route. So you do not need to run high volume, high capacity buses on route where they have a very few people who use them.

Similarly, or alternately, you should not have a low capacity buses such as mini buses on routes that are in high demand. So once you are aware of what are the different types of buses this will help you plan accordingly. Usually you will see there are conventional buses, i.e. 40 foot buses, then there are what are called articulated buses or bi articulated buses, mini busses, and double decker buses, which are now limited in some number of cities in India and also across the world.

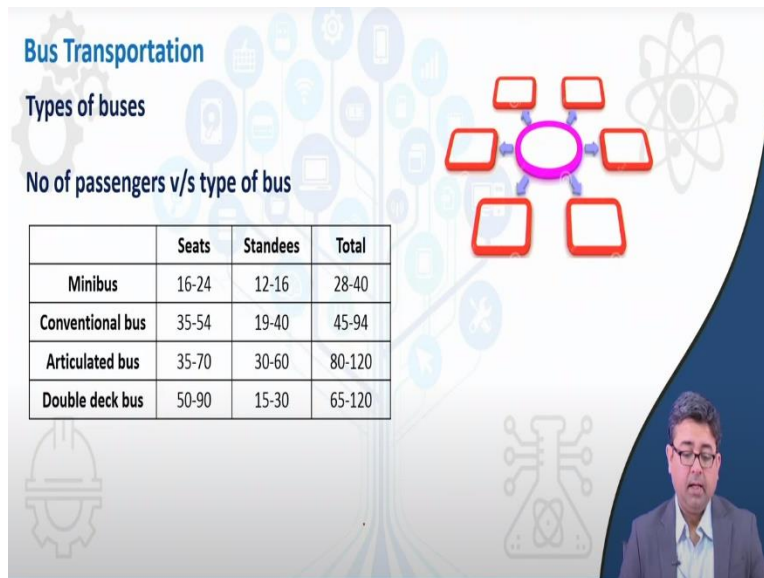
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**Bus Transportation**

Types of buses

No of passengers v/s type of bus

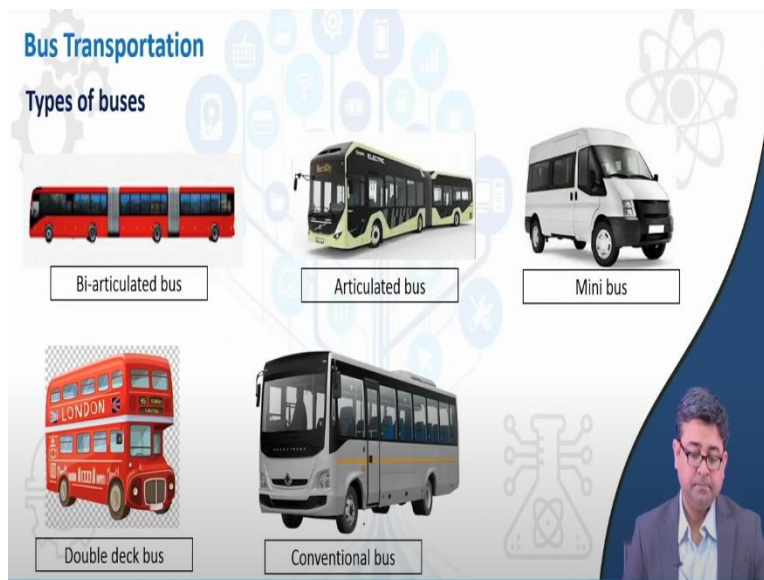
	Seats	Standeers	Total
Minibus	16-24	12-16	28-40
Conventional bus	35-54	19-40	45-94
Articulated bus	35-70	30-60	80-120
Double deck bus	50-90	15-30	65-120



This gives you kind of example of how many passengers can travel sitting and standing in each of these buses. So you would see a conventional bus has anywhere between, 35 to 54 seats can accommodate or it should accommodate 19 to 40 people. So a total of 45 to 94 people can be accommodated in a standard bus. So this is the general practice that should be followed. Now it is not to say that any of buses in India carrying more than this or less than this or this is what we generally recommend or is generally noted when it comes to different capacity for different buses.

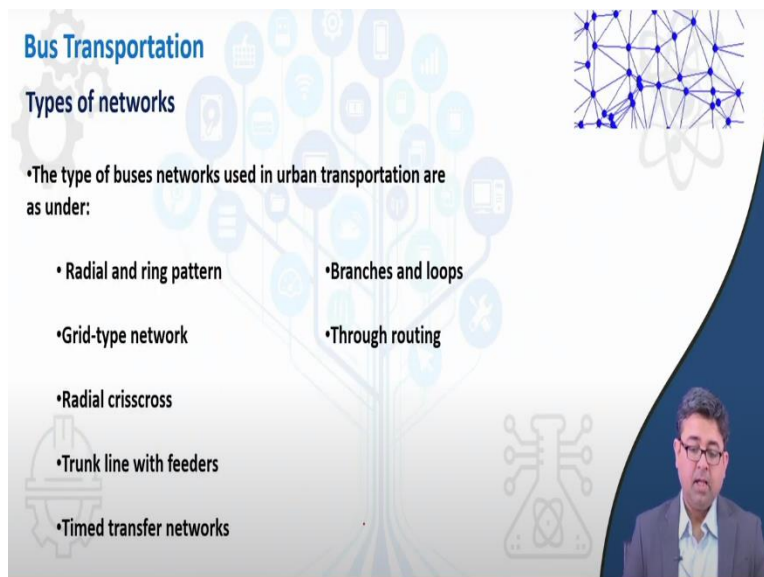
This takes into account the revenues that are generated and this takes into account comfort of the people that are riding those buses and some other factors. So this is general guideline. Now you see articulated buses can take many more people similarly double decker bus can take accommodate more people, but they have their own issue such as articulated buses requires a very large turning radius. So it may not be able to get into the narrower streets, urban streets in your residential areas, so on so forth.

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Here are some pictures of a different types of buses that we are discussing. A conventional bus, double decker bus, articulated and bi-articulated bus which is something new that is coming up in some of the cities which are heavily investing in improving their bus transportation system.

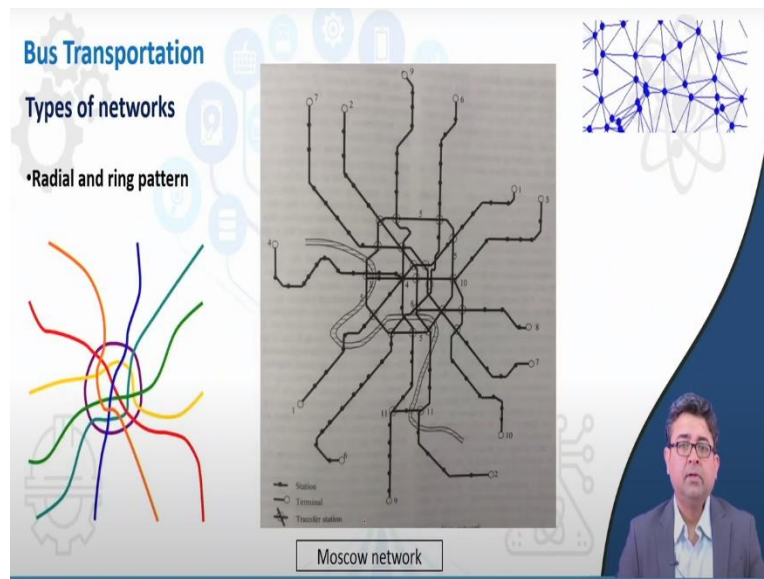
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After you are aware of types of buses now you should be learning more about different types of bus networks. So when you visit a different or a new city the next time, try to get hold of a public transportation bus network map or may be even look up on the internet to see how the bus network is or the transport network is, i.e. public transportation network is. You would see that there are different network patterns of these transportation systems or bus transportation systems.

Listed here are few of them that are mostly used worldwide -- radial and ring patterns, grid type network, radial crisscross, trunk line with feeders, timed transfer networks, branches and loops and through route. And so there is enough material in the text books available that tell you about these routes, i.e. different types of route network. The most common ones are the trunk and line feeder, branches and loops, and the grid network. Radial and ring pattern is also fairly popular across the different cities.

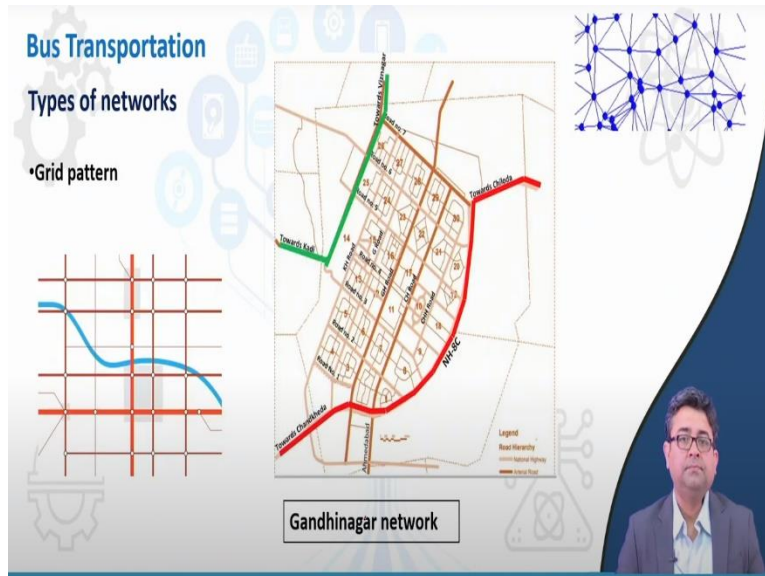
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So if we look at some of them in detail so you would see the radial and the ring pattern somehow looks like this -- so it has a radial pattern which radiates how of the central business district ok. So, all of the different routes radiate out of the central business district into the different suburban areas but at the same time it is overlaid by a ring network as well. So why is this usually done because now if you want to travel from central business district on the blue route and then your destination is eventually on green route you do not want to be this, usually no connection.

If there is no ring route, there is no connection between the blue route and the green route, except for going all the way in to the CBD and then taking the green route again. So the radial pattern kind of allows you to now transfer between these different types of routes or different types of lines. So that is a pattern that is observed in many of these cities. An example here is shown is the Moscow city network.

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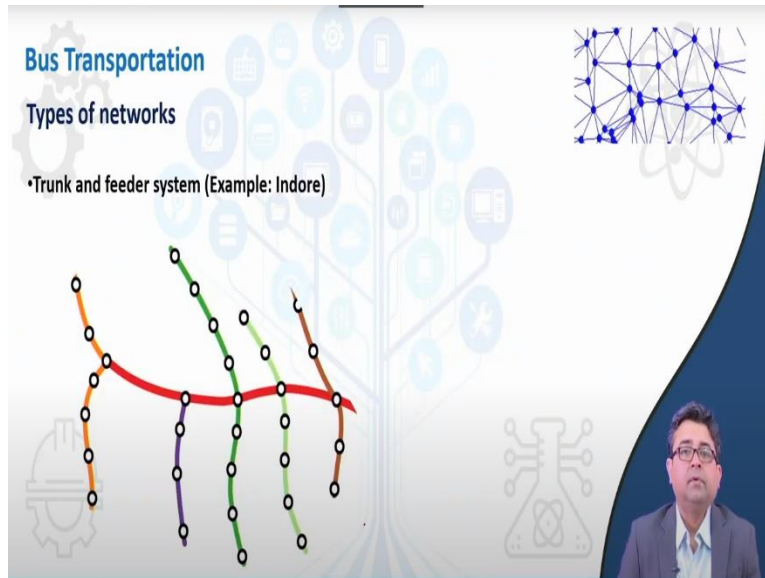


Grid network is something that many of you would also notice in some of the cities that have well planned road networks, i.e. road networks that are square or rectangular in pattern. So if you have such grid patterns it is very easy to reach your destination. The block sizes are usually very small. So once you get off of your bus your destination is not very far or your origin is very close to your bus stop at the home and office.

So these are however mostly restricted around the CBD areas of the most of the cities now. So the CBD areas tend to have this kind of grid road pattern and hence the bus routes in the CBD areas also tend to have a very grid pattern of network. Shown here are the example is the Gandhinagar network.

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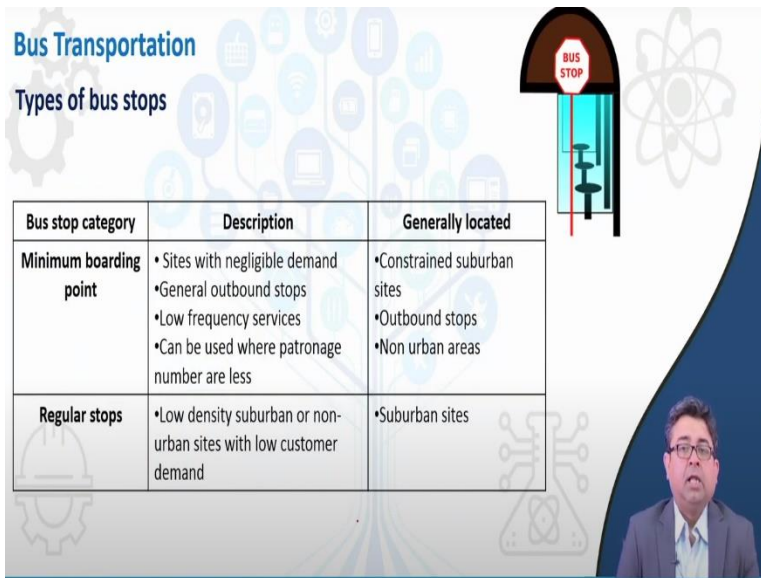
Moving ahead this is something that is becoming popular worldwide also, but it is now catching up in India specially when there are BRTS corridors, i.e. bus rapid transit system corridors. So an example is the Indore city bus rapid transit corridor. So the red line, that is the trunk line, is the trunk or the main line that runs either east west in this case, it is shown east west but can run north south as well. So that is the main route that runs.

And then there are different feeder routes to that main or trunk route that feed into this main line. So there are here you would see the different green orange brown lines that are feeding to the trunk line. So this this type of network usually is seen when there is a main BRTS system and then there are different feeder routes that feeds in to that systems.

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## Bus Transportation

### Types of bus stops



Bus stop category	Description	Generally located
<b>Minimum boarding point</b>	<ul style="list-style-type: none"> <li>• Sites with negligible demand</li> <li>• General outbound stops</li> <li>• Low frequency services</li> <li>• Can be used where patronage number are less</li> </ul>	<ul style="list-style-type: none"> <li>• Constrained suburban sites</li> <li>• Outbound stops</li> <li>• Non urban areas</li> </ul>
<b>Regular stops</b>	<ul style="list-style-type: none"> <li>• Low density suburban or non-urban sites with low customer demand</li> </ul>	<ul style="list-style-type: none"> <li>• Suburban sites</li> </ul>

The next theme to understand is the type of bus stops. So now we have already looked at what are the different types of buses and what are the different type of bus networks. So the next categories is the bus stop. So you think why you want to categorize different bus stops. You want to categories them based on how many people get on board or get off the bus at different types of stops.

So once you know that a particular stop has very heavy boarding during the morning time and a very heavy de-boarding during the evening times then you would know that is be a major residential area were people in the morning go to work and in the evening they are coming back. So you would have them as regular stops or sometimes priority stops even. So you would see that the bus stop categories are divided into different categories and are generally based on the location where they are.

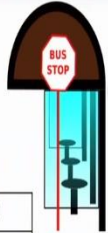

So the first one are called minimum boarding points, which are where very little demand may be present, they are maybe suburban locations, which during day time has a very low demand but may have a little bit demand during peak and off peak times. So those are minimum boarding points, and why you want to classify them, we will get to it a little bit later. Regular stops are regular suburban sites that we discussed just now as morning peak and evening peaks and usually where a little demand is there in the midday.

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## Bus Transportation

### Types of bus stops

Bus stop category	Description	Generally located
Intermediate stops	•Suburban sites and near some attraction	•Main passenger transport corridor
Premium stops	•Sites near major attractors with high customer demand	•Major attraction •Interchanges •Major passenger transport corridor

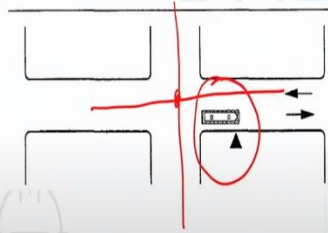
Intermediate points are maybe suburban sites near some attraction. So maybe there is park and ride lot or there is some kind of a large shopping center in the suburban areas those are classified as intermediate stops. Whereas finally premium stops are the sites where the stops near major attractors big office complexes, big entertainment places, so on and so forth.

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## Bus Transportation

### Bus stop placements

•Far side



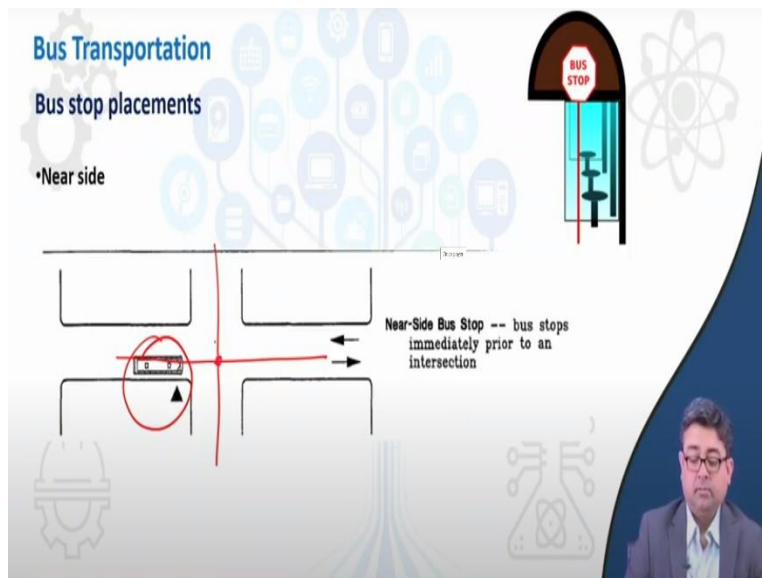
Far-Side Bus Stop -- bus stops immediately after passing through an intersection



Now after knowing what are the different categories of the bus stops, one also has to know where to place these bus stops on the road network. That plays a very important role because these are the locations along the road network where the bus is going to stop to pick up and drop of passengers. So the location has to be very ideal otherwise it may not be able to serve the community.

At the same time location should not cause much delay to the traffic, i.e. to the other traffic modes that are plying on the street. So here is an example of where a bus stop can be placed. If you look at this street network this is an intersection and it is shown here that the bus stop is on the far side of this intersection. So if that is the intersection and the bust stop is after the intersection then it is called far side bus stop, i.e. immediately after passing through an intersection. So this is called a far side bus stop.

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Whereas a near side bus stop is just the opposite. So if this is the intersection and if the bus stop is before the intersection then it is called a near side bus stop.

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**Bus Transportation**  
**Bus stop placements**

- Mid block

Midblock Bus Stop -- bus stops within the block

And the third category is a midblock bus stop. So midblock bus stop is neither close to any of the 2 intersection; neither close to this intersection nor to this intersection. It is somewhere in the middle of this block. Now that we have these 3 different types of bus stops locations. One also has to understand when to locate these bus stops at these 3 different block.

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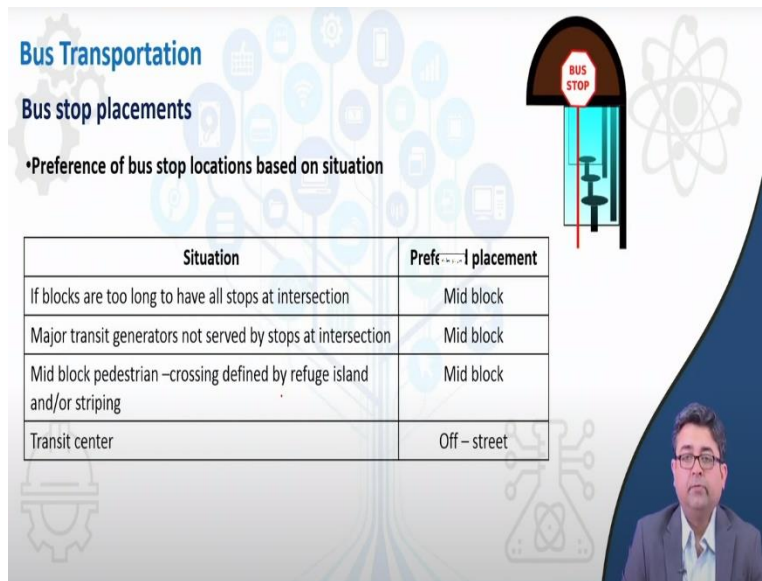
**Bus Transportation**  
**Bus stop placements**

- Preference of bus stop locations based on situation

Situation	Preferred placement
Any signalized intersection where bus can stop on travel lane	Far side
If bus turns an intersection	Far side
Intersection with many left turns	Far side
Complex intersections with multi-phase signals or dual turn lanes	Far side

So usually you would see that the preferred location of any bus stop is the far side. So there are different situations when bus stops are preferred to be placed on the far side. Such as any signalized intersection where bus can stop is on the travel lane. So as you would see here in the previous slides, the bus is on the travel lane and stopping on the travel lanes. So there are other traffic that is going on the same lane and the bus is also stopped on the same lane.

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**Bus Transportation**

**Bus stop placements**

•Preference of bus stop locations based on situation

Situation	Preferred placement
If blocks are too long to have all stops at intersection	Mid block
Major transit generators not served by stops at intersection	Mid block
Mid block pedestrian –crossing defined by refuge island and/or striping	Mid block
Transit center	Off – street

The slide features a background with various icons related to transportation and technology. On the right side, there is a graphic of a bus stop shelter with a 'BUS STOP' sign. In the bottom right corner, there is a small video overlay of a man speaking.

Another situation is given here -- you would very rarely want to place a bus stop in the midblock, unless if the blocks are too long. So if the distance between successive intersections is too long then what you would really ideally want to do is not have those bus stops at the intersection but somewhere in a middle of the intersection. So that you are capturing all the possible rider that are in the middle of the block.

Otherwise it may be too long a distance for them walk from their origin to this intersection. Also the other last item listed here is the transit center, which is off street, meaning that it should not be on the travel lanes, it should have a different structure associated with it. So that is the terminal stations or transit centers, where there are multi modular transit centers involved where you would change from the bus to maybe your train or from a urban bus to the regional bus network. So those are called transit centers and those usually have their own structure, which are off the street.

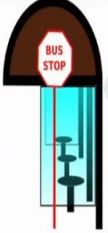

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## Bus Transportation

### Bus stop spacing

•Preference of bus stop spacing based on environment

Environment	Spacing Range	Typical spacing
Central core areas of CBD	300 to 1000 feet	600 feet
Urban areas	500 to 1200 feet	750 feet
Suburban area	600 to 2500 feet	1000 feet
Rural areas	650 to 2640 feet	1250 feet

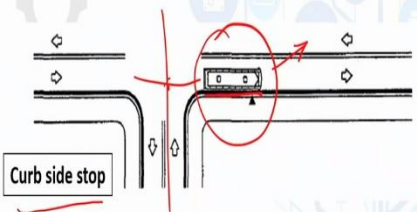
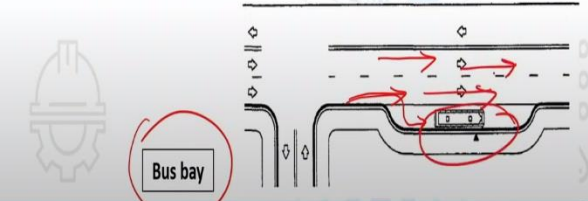

Now here is the typical bus stop spacing scenario. So now you know where the bus stops physically can be located. Either far side, near side, or midblock. And now it is important to also know what the spacing between 2 bus stops is. Now you could see the central core area, the CBD, the spacing is usually very less because there are lot of attraction points and people may want to get up and get off at several locations.

So your bus stops are usually spaced very close to each other when compared to suburban or rural areas, where you can have bus stops spaced very far from each other, i.e. very distantly spaced from each other.

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## Bus Transportation

### Bus stop design

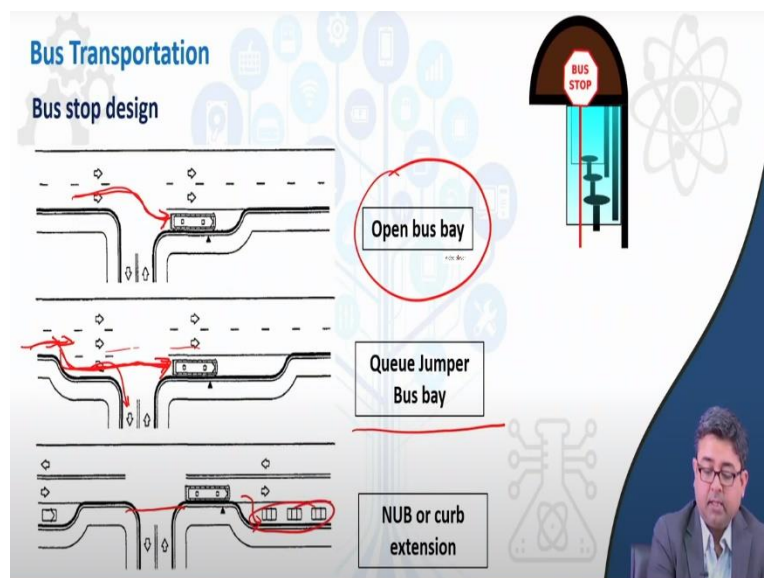




Next we come to the different types of bus stop designs. So now that you know where they can be located, it is also essential to understand how they have to be designed. So let us look at the most common type of bus stop design, that we have also looked at while looking at the bus stop locations, which is the curbside stops. So a curbside stop, so this is the far side if you remember this is the far side bus stop which is there after the intersection,

And it is also curbside, meaning it is the right next to the curb on the road. So it does not have any special infrastructure requirement, buses just stops right next to the curb and people get on and get off from the bus. Whereas in certain other situations you may have something called as bus bay. So here are your regular traffic lanes but then the bus would get into this special lane which is called the bus bay and the bus stop is located in this bus bay.

So this is ideally done or required when there is a location that has a large number of boarding and alighting. So when the bus has to really stop for a long time, or a dwell time of the bus is very high, you do not want it to be obstructing other kind of traffic which it would do if it was on a curbside, i.e. if it was a stop on a curbside. Now it has its own special bus bay and so there is no obstruction to the ongoing traffic.

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The next one, we usually call, is another variety of the bus bay lane, this is called an open bus bay. So you would see that actually right after the intersection the bus bay arrives. So the buses arriving, directly gets into the open bus bay. If you look at a typical one here the bus is passing



the intersection in the travel lane, then the bus bay is the little bit later on. Whereas in an open bus-bay, the bus can directly get in to the bus bay. There are different advantages and disadvantage of this and when they should be designed is all available in the text book.

But first let us at least look into what are the different types? Then another design -- that is called a queue jumper bus bay. So what happens here is if there is a dedicated right turn lane here, I mean these are the diagrams shown here keeping in mind the western driving conditions where driving on the right hand side and they have free right turn lanes. So in our cases it is left turn lanes.

If there is a free right turn lane what usually is allowed is the buses are allowed to take the right turn lane, jump the queue, and go straight. So otherwise they would be queued up here in the travel lanes and waiting for this queue to be dissipated before they could go ahead. So in order to avoid them to be queued up on the travel lanes they are allow to take this right turn only lane, jump the queue, and come directly into the open bus stop that is the example of the queue jumper bus bay.

Similarly, the last one is the NUB or a curb extension. What happens here is that usually the curb is supposed to be here, however it is kind of extended so that the parked vehicles can be on this side, i.e. the parking can be on this side, and the bus stop can be here. So these are pretty well illustrated and easy to understand and explained in your textbook.

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## CONCLUSION

- Advantage and disadvantage of bus transportation in terms of its flexibility, cost, capacity, etc.
- Different types of buses: Mini, standard, articulated, etc
- Types of bus stops
- Placement of bus stops: Mid block, far side, near side
- Design of bus stop



So in conclusion what we looked at today was all the advantages and disadvantages of bus transportation in terms of flexibility, cost and capacity. We introduced you to different types of buses, different types of bus stop, the placements of bus stops, as well as the design of bus stops. So all of these 4 or 5 elements together is going to help you to plan for a bus network in your city and make it more efficient. Thank you so much for your time, looking forward to have you in next lecture.