UNIT III

SCHEDULING AND FARE STRUCTURE

Route planning. Scheduling of transport vehicles. Preparation of timetable, costs, and fare structure. Methods of fare collection. Preparation of fare table.

Route planning

- Logistics firms that operate their own fleets tend to use a route plan that has the vehicles starting and ending at the same location. This ensures the minimum repositioning of vehicles and personnel. However, to develop routes that cover all deliveries and pickups to and from numerous customers is extremely complex and to develop the routes that are most efficient is becoming increasingly difficult.
- Many route planners can develop efficient routes but find that – due to rules on how many hours a driver can operate a vehicle,

Scheduling of transport vehicles

- Once the timetable is determined, the number of vehicles required to be in revenue service can also be identified. When the vehicle schedule is determined, the total mileage and hours for the vehicle fleet are defined. Finally, when the crew schedule is determined, the total cost of labor (operators) is defined.

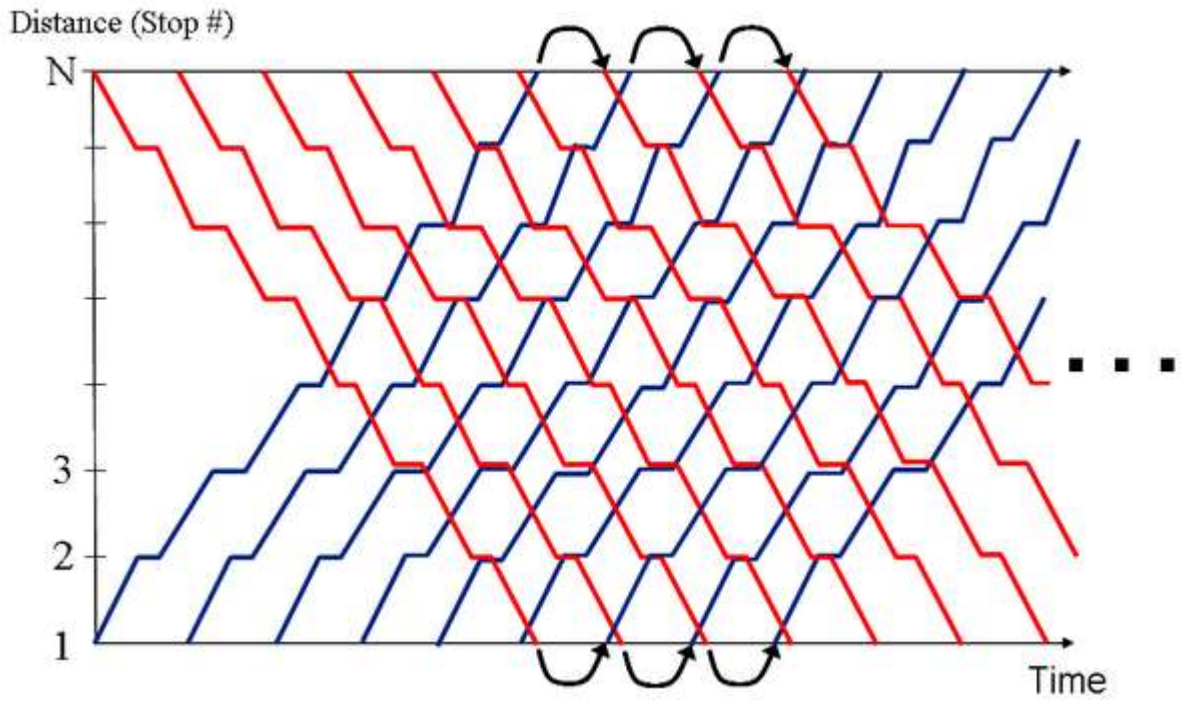
Timetabling

- Let *h* be the selected headway for a route, perhaps for a specific time period of the day.
- Let t_{ij} be the time between stop *i* and stop *j* along the route, where *i* and *j* are adjacent stops. The travel times between stops, t_{ij}, can vary by time of day, particularly as they may be affected by traffic conditions. They may also reflect any slack time built into the schedule between stops, to allow for possible variability in travel times.
- Finally, let t_0 be the dispatch time (departure time) of the first vehicle from a terminal.
- Then, the timetable can be created simply using the following structure, with *n* stops on the route and *k+1* vehicles to dispatch:

Stop 1 (Terminal)	Stop 2	Stop 3	Stop 4	…	Stop n (Terminal)
t_0	t_0+t_{12}	$t_0+t_{12}+t_{23}$	$t_0+t_{12}+t_{23}+t_{34}$	…	$t_0+\sum_{i=1}^{n-1} t_{i,i+1}$
t_0+h	t_0+h+t_{12}	$t_0+h+t_{12}+t_{23}$	$t_0+h+t_{12}+t_{23}+t_{34}$	…	$t_0+h+\sum_{i=1}^{n-1} t_{i,i+1}$
t_0+2h	t_0+2h+t_{12}	$t_0+2h+t_{12}+t_{23}$	$t_0+2h+t_{12}+t_{23}+t_{34}$	…	$t_0+2h+\sum_{i=1}^{n-1} t_{i,i+1}$
t_0+3h	t_0+3h+t_{12}	$t_0+3h+t_{12}+t_{23}$	$t_0+3h+t_{12}+t_{23}+t_{34}$	…	$t_0+3h+\sum_{i=1}^{n-1} t_{i,i+1}$
…	…	…	…	…	…
$t_0+k\cdot h$	$t_0+k\cdot h+t_{12}$	$t_0+k\cdot h+t_{12}+t_{23}$	$t_0+k\cdot h+t_{12}+t_{23}+t_{34}$		$t_0+k\cdot h+\sum_{i=1}^{n-1} t_{i,i+1}$

The primary decision variable here is the initial dispatch time, t_0. Different operating conditions might lead to a number of possible choices for t_0:
"Clockface" values. Passengers may remember the schedule more clearly if the dispatch times fall at easily recognized times on the clock. For example, with 15-minute headways, there may be value to passengers in dispatching a vehicle on the :00, :15, :30, and :45 of each hour.

“string diagram,”



Vehicle scheduling

- Vehicle scheduling, also called “blocking”, involves assigning vehicles to cover the trips associated with the timetable. A vehicle “block” is the schedule of travel of a vehicle for a given day, including: (1) a pull-out from the depot, (2) a sequence of trips from the timetable, (3) any dead-head trips, and (4) a pull-in back to the depot.

- Constraints on this process include the following:
  - Each trip in the timetable must be made by a vehicle.
  - A vehicle cannot be assigned more than one trip at any point in time.
  - If a vehicle must be re-positioned for a trip, the associated travel time and distance from its current position to the new position must be observed.

- To solve for the vehicle schedule, one might consider a simple “first-in-first-out” rule. In this case, a vehicle stays on the same route throughout the whole period, and is always assigned to the next trip after a layover. The string diagram above gives just such an arrangement.
- As a simple example, suppose we have a route that runs from terminal A to terminal B and then back to terminal A. Travel time from A to B and from B to A, including running and dwell time, is 30 minutes, and a minimum 5 minute layover is needed at each terminal. Headways are 15 minutes.
- Below is a timetable for this situation, for trips between 6:00 am and after 9:00 am. The left-hand side of the timetable shows vehicle trips from A to B, while the right-hand side shows vehicle trips from B to A.

Depart A	Arrive B		Depart B	Arrive A
6:00	6:30		6:10	6:40
6:15	6:45		6:25	6:55
6:30	7:00		6:40	7:10
6:45	7:15		6:55	7:25
7:00	7:30		7:10	7:40
7:15	7:45		7:25	7:55
7:30	8:00		7:40	8:10
7:45	8:15		7:55	8:25
8:00	8:30		8:10	8:40
8:15	8:45		8:25	8:55
8:30	9:00		8:40	9:10
8:45	9:15		8:55	9:25
9:00	9:30		9:10	9:40

The colors correspond to different vehicles used on the route. The gray color corresponds to the first vehicle of the day, leaving A at 6:00 am and continuing with the trip from B at 6:40, the trip from A at 7:15, etc. A total of five vehicles are required to cover all the trips in this timetable.

In addition to the trips from the timetable, the vehicle block also includes a pull-out and pull-in, so that the final block for the first vehicle (gray) could look like the following.

Activity	Start time	Starting location	Ending location
Pull-out	5:40 am	Depot	A
Trip	6:00 am	A	B
Trip	6:40 am	B	A
Trip	7:15 am	A	B
Trip	7:55 am	B	A
Trip	8:30 am	A	B
Trip	9:10 am	B	A
...	...	...	...
Trip	7:10 pm	B	A
Pull-in	7:40 pm	A	Depot

fare structure

- **Fare structure** is the system set up to determine how much is to be paid by various passengers using a transit vehicle at any given time. A linked trip is a trip from the origin to the destination on the transit system.

Methods of fare collection

- Manual fare collection
  - **Manual fare collection** is the practice of collecting fares manually (without the aid of an automated machine).
  - Equipment
    - **Cash bag**
    - **Coin dispenser**
    - **Tender tray**

Automated fare collection

- An **automated fare collection (AFC) system** is the collection of components that automate the ticketing system of a public transportation network - an automated version of manual fare collection. An AFC system is usually the basis for integrated ticketing.

- AFC systems often consist of the following components
- Tier 0 - Fare media
- Tier 1 - Devices to read/write media
- Tier 2 - Depot/station computers
- Tier 3 - Back office systems
- Tier 4 - Central clearing house

Preparation of fare table