Strategies for Sustainable, Efficient, and Economic Integration of Public Transportation Systems

Challa Prathyusha, Sandeep Singh, and P. Shivananda

Abstract In India, the city and intercity State Road Transport Undertakings (SRTUs) cater 6.8 million passengers/day over a length of 1.48 billion passenger-km/day during 2015–2016. The average occupancy ratio of 47 SRTUs has decreased by 1.56%, from 70.74 in 2014–2015 to 69.65 in 2015–2016. The traditionally followed operational plan for the public transportation system in urban areas results in a financial loss of 7% in SRTUs; from Rs. 10,587.98 crore in 2014–2015 to Rs. 11,349.78 crore in 2015–2016. In order to achieve the equalization of public service, there is a necessity for operational integration of the public transportation system to reduce the financial losses to public buses. The public transportation system productivity and efficiency could be maximized through the components of the Intelligent Transportation System (ITS) like Electronic Ticketing Machines (ETMs) and Global Positioning System (GPS) equipped with Vehicle Tracking Unit (VTU), which helps in the collection of data for a network. In this paper, the bus transit frequency is evaluated for one route with even headway by point check method. The bus service frequency software (Visual Basic-VB6) is developed to estimate user and operator costs for economic analysis. The results show that the waiting time cost of the passenger and the fleet size is minimized using deficit function as the solution for timetable synchronization and vehicle scheduling.

Keywords Operational integration · Frequency · Intelligent transportation system (ITS) · Electronic ticketing machines (ETMs) · And vehicle tracking unit (VTU)
1 Introduction

In the context of Indian cities, the dependence of the urban trips on public transport is based on numerous parameters like the city size, geographical considerations, land use, and functional segregation of activities over the city. The Multiple Criteria Decision-Making (MCDM) method enhances the traveling behavior, and the provision of better transit service is challenging in the cities [1]. In India, the city and intercity State Road Transport Undertakings (SRTUs) cater 6.8 million passengers/day over a length of 1.48 billion passenger-km/day during 2015–2016. The average occupancy ratio of 47 SRTUs has decreased by 1.56%, from 70.74 in 2014–2015 to 69.65 in 2015–2016. The traditionally followed operational plan for the public transportation system in urban areas results in the financial loss of 7% in SRTUs, from Rs. 10,587.98 crore in 2014–2015 to Rs. 11,349.78 crore in 2015–2016 [2]. In urban areas, public transit remains to be a challenge due to an increase and variation in travel demand [3]. There is a necessity for public transport transit integration: organizational, physical, and operational, which can be achieved through push and pull measures [4]. If the demand for public transportation is less, then flexible service is desirable and conventional service method during high demand. The integration of these two methods develops a variable-type service [5]. In order to achieve the equalization of public service, there is a necessity for operational integration of the public transportation system to reduce the financial losses to public buses.

2 Literature Review

The public transportation system productivity and efficiency could be maximized through the components of the Intelligent Transportation System (ITS) like Electronic Ticketing Machines (ETMs) and Global Positioning System (GPS) equipped with Vehicle Tracking Unit (VTU) which helps in the collection of data for a network [6]. Public transportation performance is checked through various service level benchmarks: headway, service coverage area, transit-accessible area, average waiting time, high-frequency accessible area, boarding, % transit ridership, organized Public Transportation (PT), peak hour, and availability of PT. The modified indicator was operating ratio, which is defined as the ratio between cost/km and earning/km [7]. According to [8], the SRTU performance indicators in the Indian context were (1) Capacity-fleet size and vehicle seat capacity; (2) Serviceability-revenue per km, passengers per km, load factor, passengers carried, and number of routes; (3) Safety-number of accidents, fatalities, and injuries; (4) Productivity-operating cost, cost per km, maintenance cost, traffic revenue, non-traffic revenue, operating ratio, and cost recovery; (5) Reliability-trip scheduled, regularity, actual trips operated, departure and arrival timings, number of breakdowns, and rate of breakdown; and (6) Comfort-average age fleet were considered in the frequency and time table scheduling of the
bus. The various factors influencing the efficiency of a bus operating system are reliability of service, frequency, route coverage, excessive transfers, fare and low profit [9]. Reliability of travel time is one of the concerned aspects for both user and operator and the bus arrival time will be influenced by various factors such as boarding and alighting of passengers, weather, and congestion [10]. However, to predict the travel time, weekly, daily, and hourly patterns need to be analyzed. The different arrival time prediction models are time series, regression, Kalman filtering, artificial neural networks, and super vector machines [11]. The time series model is used for the travel time of the bus at the stops. The bus service reliability is evaluated to improve the operational efficiency in two stages: strategic and tactical planning [12]. The 12 cities have been surveyed to know the satisfaction and dissatisfaction levels of the user from the bus service (primary mode-53.6%), and overcrowding is the most critical aspect of dissatisfaction; this can be improved through higher frequency [13]. The strategic-network design and the tactical-frequency setting and timetabling are given more importance in public transportation planning. The objective function, constraints, and decision variables of user and operator are used to optimize public transportation [14].

3 Aims and Objectives

In Indian context, the public transport system productivity and efficiency could be maximized through the basic operational planning process. In this paper, the bus transit frequency is evaluated for one route with even headway by point check method. The bus service frequency software (Visual Basic-VB6) is used to estimate user and operator costs for economic analysis. The main objectives are as follows:

- To develop a model for frequency setting for a route.
- To develop a model for scheduling of bus for a particular route.

4 Model Formulation

The four basic operational planning processes include network route design, setting timetables, scheduling vehicles to trip, and assignment of drivers [15]. A cost-effective frequency setting is one of the most complicated strategic planning for public transportation due to variations in travel patterns along the routes. The major service attributes route, operation, vehicle, user-level, and cost are considered with transit operators. The optimal frequency for different time periods of a single route for a single time period is determined considering user and operator attributes and parameters in “Bus Service Frequency Setting Software,” which is mathematical programming in Visual Basic (VB6). The service efficiency constraints in the transit assignment such as cost per passenger, passenger per vehicle-kilometer, cost recovery
ratio, number of trips per vehicle, number of passengers per trip per vehicle, operation cost per trip per passenger per vehicle with the objective to minimize the fleet size, and maximize the patronage. The regional bus scheduling problem (RBSP) is a network problem (NP), which is solved in this paper using a bi-level programming model [16] and which helps in integrating the frequency and timetable of a single route [14].

4.1 Assumptions

1. In frequency setting for a bus, any size of the time period for a single day (service period ≤ 24 h), stop to stop operation cost, for each stop minimum dwell time, for every passenger lost-penalty cost, passengers in-vehicle travel time and waiting time, seat availability, and standing cost are considered.
2. Different bus sizes and capacity, access, and egress time are not considered.
3. In the sequence of bus departures, bus bunching considered were short turning, overtaking, and stop skipping not allowed.

The simulation executed under the following conditions:

1. Buses dispatched for a given headway.
2. The constraints of the user and operator are followed while assigning the passengers for each bus.
3. Historical boarding and alighting of passengers are applied for each bus.

Let on route \( k, i = 1, 2, 3 \ldots V \) denotes a set of vehicles dispatched from the stops \( j = 1, 2, 3 \ldots S \), vehicle type \( Z \) with a seating capacity \( Q^Z_i \). The arrival, departure, and dwell time are denoted as \( t_{ij}^{arr}, t_{ij}^{dep} \) and \( t_{ij}^{dwell} \), respectively, for a given period \( h = 1, 2, 3 \ldots H \). To set vehicle frequency, boarding and alighting of passenger count, passenger arrival rate, and stop to stop travel time are necessary from the operator’s point of view [17].

4.2 Cost Minimization

The user and operator cost attributes influence the bus operating system. The overall cost is minimized considering two objective functions, minimum user and operator cost for a given route. The cost function is estimated using the handbook on feasible service delivery ranges for bus transit in the Indian Context part 2-operator perspective, chapter-4 for a given service period [17] as follows:

\[
\text{Overall Cost } (C_S) = \text{User Cost } (C_U) + \text{Operator Cost } (C_O)
\]
User Cost \( (C_U) = \) Waiting Time Cost \( (C_W) + \) In-vehicle Seating Time Cost \( (C_{Tseat}) + \) In-vehicle Standing Time Cost \( (C_{Tstand}) + \) Passenger Inconvenience Cost \( (C_P) \) \( (2) \)

Operator Cost \( (C_O) = \) Fuel cost \( (C_F) + \) Depreciation Cost \( (C_D) + \) Crew Cost \( (C_{crew}) + \) Maintenance Cost \( (C_M) + \) Operator Penalty Cost \( (C_P') \) \( (3) \)

4.3 Frequency

Frequency is defined as the minimum number of vehicles requires for a given period \cite{18}. In this work, the frequency is estimated for the baseline scenario using an hourly load point.

\[
F_{hk} = \max [P_{mh}/\gamma_h Q, F_{mhk}] \quad (4)
\]

\(F_{hk}\) Frequency (Number of vehicles for a given period on route \(k\)).
\(P_{mh}\) Total number of passengers at maximum load point.
\(\gamma_h\) Load Factor.
\(Q\) Capacity of bus.
\(F_{mhk}\) Minimum required frequency.

The constraint is formulated on route \(k\) subject to the minimum objective function \(C_S\) for departures:

1. \(\alpha_k^{max} < \alpha_k^{route} < \alpha_k^{min}\) \( (5)\)

2. \(h_{w_k}^{max} < h_{w_k}^{route} < h_{w_k}^{min}\) \( (6)\)

where \(\alpha\) = Crowding level, \(h\) = Headway.

5 Solution Method

5.1 Theorem 1

The set of all trips arrives and departs within a scheduling horizon and does not consider Dead Heading (DH); the minimum number of vehicles required to serve all
the trips is equal to the sum of all deficits. This is known as the fleet size theorem.

\[
\text{Minimum } V = \sum_{j=1}^{S} D(S) = \sum_{j=1}^{S} \text{Maximum}(j, h) | h = 1, 2, 3, \ldots H | \quad (7)
\]

5.2 Deficit Function

Deficit function (DF) is defined as the necessity of a minimum number of vehicles required to complete \( N \) trips in the scheduling. In the scheduling, the change of the departure timings reduces the fleet size and waiting cost of the passenger. The failure of this method results in unbalanced loads, overcrowding, empty, and bus bunching problems, so DF is studied carefully while assigning vehicles to the trips.

If the precedence relation \( R \) is satisfied, then vehicle is serviced sequentially as follows:

\[
R: i < (i - 1) \rightarrow t_{ij}^{arr} \leq t_{(i-1)j}^{dep} \text{ and } j_{i}^{arr} = j_{i-1}^{dep} \quad (8)
\]

A deficit function is also known as step function changes by \(-1\) and \(+1\) for every arrival and departure times of each trip during the service period.

\[
\text{Minimum } V = \sum_{j=1}^{S} \text{Maximum}(\text{DF}(j, h) | h = 1, 2, 3 \ldots H | \quad (9)
\]

5.3 Maximum Flow Fleet Theorem

\[
\min \, N = V - \max \, C_O \quad (10)
\]

\( N \) Chain of the trip.

\( V_z \) Number of vehicles of size \( Z \).

**Proof** Given \( i = 1, 2, 3, 4 \ldots V \), each trip is assigned to \( i \) vehicles for Up and Down by the vehicle \( i \), the required fleet size can be reduced where the flow \( C_O \) can be saved by linking the trips together. Therefore, the minimum fleet size is required to perform all the trips.
5.4 Passenger Boarding and Alighting Prediction Algorithm

The historic data of passengers and capacity of the bus is considered to predict the passengers boarding and alighting.

The predicted number of boarding passengers:

\[
Pb_{i+1}^{j+1} = a_{j+1}(PT_{j+1,A}^{i+1} - t_{j+1,A}^{i}) + R_{j+1}^{i}
\]  

(11)

\(Pb_{i+1}^{j+1}\) Number of boarding passengers for bus \((i + 1)\) at stop \((j + 1)\).

\(\lambda_{j+1}\) Number of passenger arrival rate at stop \((j + 1)\).

\(PT_{j+1,A}^{i+1}\) Arrival time of bus \((i + 1)\) is predicted at stop \((j + 1)\).

\(t_{j+1,A}^{i}\) Arrival time of bus \((i)\) at stop \((j + 1)\).

\(PT_{j+1,A}^{i+1} - t_{j+1,A}^{i}\) Headway for the bus \((i)\) is predicted at the stop \((j + 1)\).

\(R_{j+1}^{i}\) After the departure of the bus \((i)\), remain passengers from stop \((j + 1)\).

The number of passenger’s in-vehicle:

\[
N_{j+1}^{i} = N_{j}^{i} + b_{j+1}^{i} - a_{j+1}^{i}
\]  

(12)

\(N_{j+1}^{i}\) In-vehicle passengers for bus \((i)\) after departure from stop \((j + 1)\).

\(N_{j}^{i}\) In-vehicle passengers for the bus \((i)\) after departure from the stop \((j)\).

\(b_{j+1}^{i}\) Boarding passengers for bus \((i)\) at stop \((j + 1)\).

\(a_{j+1}^{i}\) Alighting passengers for bus \((i)\) at stop \((j + 1)\).

Check for bus capacity:

\[
C_{j+1}^{i} = P_i - N_{j+1}^{i}
\]  

(13)

\(C_{j+1}^{i}\) saturation of capacity for bus \((i)\) after departure from stop \((j + 1)\).

If \(C_{j+1}^{i} \leq 0\) it presented that the number of passengers in the bus \(i\) reached the capacity.

\(C_{j+1}^{i}\) After departure from stop \((j + 1)\), in-vehicle passengers for bus \((i)\).

\(P_i\) Maximum number of passengers can be in the bus \(i\).

If the vehicle capacity of the bus is exceeded, then the remaining passengers are supposed to wait for the next bus. The remaining number of passengers can be calculated as

\[
R_{(j+1)}^{i} = Pb_{(j+1)}^{i} - b_{(j+1)}^{i}, C_{(j+1)}^{i} \leq 0
\]

\[
0, C_{j+1}^{i} > 0
\]  

(14)

where
After the departure of the bus \((i)\) from the stop \((j + 1)\) remaining passengers.

- \(P_{b_{j+1}}^i\): Passengers boarding for bus \((i + 1)\) at stop \((j + 1)\).
- \(b_{j+1}^i\): Passengers boarding for bus \((i)\) at stop \((j + 1)\).
- \(C_{j+1}^i\): After departure from the stop \((j + 1)\), a saturation of capacity for the bus \((i)\).

The number of alighting passengers can be estimated by passenger’s in-vehicle:

\[
p_{a_{j+1}^{i+1}} = \sigma_{j+1} C_{j+1}^{i+1}
\]  

where

- \(p_{a_{j+1}^{i+1}}\): predicting alighting passengers for bus \((i + 1)\) at stop \((j + 1)\).
- \(C_{j+1}^{i+1}\): In-vehicle passengers for bus \((i)\) after departure from stop \((j + 1)\).
- \(\sigma_{j+1}\): % passengers alights at stop \((j + 1)\).

6 Case Study

Bengaluru Metropolitan Transportation Corporation (BMTC) is one of the most dominant modes with a fleet size of about 6165 buses, including feeder services to metro covering 53,984 km catering 45 lakh commuters per day along 2194 routes with 43 depots during 2016–2017 [19]. The fleet utilization of BMTC buses is decreased by 7.1% from 2013–2014 (91.2%) to 2018–2019 (84.1%). The revenue of BMTC for the non-air conditioned bus is Rs. 41.48/km, whereas the operating cost is Rs. 57.88/km [20]. Hence, there is a necessity for operational integration to reduce the loss of BMTC buses.

The selected bus route-290E goes along the route Yelhanka to Shivajinagar, located in the northern part of Bangalore city. It has a route length of around 20.1 km with 13 major bus stops. The input details for morning peak hour 08:00:00 a.m. to 08:59:00 a.m. in the software are given in the tables as follows (Tables 1, 2, 3 and 4):

The model and software developed balances the bus service operation for different service periods considering upper and lower constraints. Figures 1 and 2 illustrates the developed time table for up and down directions, respectively and for a given service duration, the performance details are listed below:

- Total Number of buses Yelahanka Old Town to Shivajinagar (UP) = 5.
- Total Number of buses Shivajinagar to Yelahanka Old Town (Down) = 5.
- Crowd = 1.5, Departures from A \(-12\), Departures from B = 12.
- Minimum Fleet Size = 12, Maximum Fleet size = 15.
- Vehicle-Kilometer = 482.4, Fuel Consumption = 96.95 L.
- Fuel Cost = Rs. 5817.18, Vehicle Depreciation Cost = Rs. 31963.47.
- Crew Cost = Rs. 1,44,000.00, Maintenance Cost = Rs. 2412.00.
- User Cost = Rs. 192,313, Operator Cost = Rs. 29660.08.
### Table 1  Distance and travel time between stops

| Origin                | Destination          | Distance (kms) | Travel time (min) (Up) | Travel time (min) (Down) |
|-----------------------|----------------------|----------------|------------------------|--------------------------|
| Yelahanka             | Maruthinagar         | 2.2            | 4.9                    | 4.5                      |
| Maruthinagar          | Kogilu               | 1.5            | 4.5                    | 4.1                      |
| Kogilu                | Ittige Factory       | 1.3            | 6.1                    | 5.7                      |
| Ittige Factory        | R.K. Hedge Nagar     | 3.7            | 17.55                  | 16.2                     |
| R.K. Hedge Nagar      | Thenisandra          | 1.8            | 5.7                    | 5.3                      |
| Thenisandra           | Nagavara             | 2.3            | 10.6                   | 9.8                      |
| Nagavara              | Arabic College       | 1.0            | 6.9                    | 6.4                      |
| Arabic College        | Kodugondanahalli     | 1.3            | 12.2                   | 11.31                    |
| Kodugondanahalli      | Periyar Nagar        | 1.3            | 2.0                    | 1.9                      |
| Periyar Nagar Circle  | Coles Park           | 1.5            | 4.1                    | 3.8                      |
| Coles Park            | CSI Park             | 1.5            | 10.6                   | 9.8                      |
| CSI Park              | Shivajinagar         | 0.7            | 5.3                    | 4.9                      |

### Table 2  Boarding and alighting of passengers up and down

| Place                  | Passenger arrival rate (Pass/min) (Up) | Passenger arrival rate (Pass/min) (Down) | Boarding Up | Boarding Down | Alighting Up | Alighting Down |
|------------------------|----------------------------------------|-----------------------------------------|-------------|---------------|--------------|----------------|
| Yelahanka              | 6.5                                    | 0.0                                     | 44          | 0.0           | 0.0          | 23             |
| Maruthinagar           | 4.5                                    | 1.9                                     | 2           | 5             | 12           | 11             |
| Kogilu                 | 3.9                                    | 4.5                                     | 7           | 4             | 13           | 16             |
| Ittige Factory         | 11.0                                   | 4.1                                     | 16          | 5             | 24           | 18             |
| R.K Hedge Nagar        | 5.4                                    | 3.5                                     | 9           | 18            | 3            | 14             |
| Thenisandra            | 5.7                                    | 4.9                                     | 24          | 5             | 18           | 17             |
| Nagavara               | 4.2                                    | 3.8                                     | 4           | 4             | 19           | 5              |
| Arabic College         | 3.9                                    | 5.1                                     | 9           | 18            | 7            | 11             |
| Kodugondanahalli       | 3.1                                    | 4.9                                     | 30          | 10            | 15           | 2              |
| Periyar Nagar Circle   | 4.5                                    | 10.0                                    | 14          | 6             | 8            | 6              |
| Coles Park             | 3.9                                    | 3.5                                     | 3           | 5             | 8            | 4              |
| CSI Park               | 2.1                                    | 4.1                                     | 8           | 8             | 13           | 3              |
| Shivajinagar           | 0.0                                    | 5.9                                     | 0           | 42            | 30           | 0              |
Table 3  Service level constraints

| Service level constraints | Vehicle specifications |
|---------------------------|------------------------|
| 1. Headway range: minimum—2 and maximum—5 | 1. Bus seat capacity (C): 65 |
| 2. Crowding level range: minimum—1.2 and maximum—1.5 | 2. Vehicle life span: 15 years |
| 3. Increment factor: 1 min | 3. Vehicle life span: 800,000 vehicle-km |
| 4. Maximum waiting time: 25 min | 4. Vehicle fuel consumption: running-5 kmpl, engine idle-2 L/h |
| 5. Maximum number of unserved buses: 4 | 5. Number of doors: 2 |

| Operation specifications | Operation cost specifications |
|--------------------------|-------------------------------|
| 1. Minimum layover time: 0 min | 1. Cost of vehicle: 7,000,000 INR |
| 2. Average boarding time: 5 s | 2. Fuel cost: 60 INR/Lit |
| 3. Average alighting time: 3 s | 3. Vehicle maintenance cost: 5INR/km |
| 4. Minimum dwell time: 0 s | 4. Crew cost: 300,000 INR/Month |
| 5. Number of crew on board: 2 | 5. Operator penalty: 10 INR/Lost-Passenger |
| 6. Bus bunching threshold: 1 min | |
| 7. Minimum bus holding time: 1 min | |

| User cost specifications | |
|--------------------------|-------------------------------|
| 1. Waiting time cost: 0.8 INR/Min | |
| 2. Travel time cost: seating—0 INR/min and standing—0.4 INR/min | |
| 3. User inconvenience cost: 0 INR/Pass | |

Table 4  Route fare chart

| Stops | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|
| 1     | 0 | 5 | 10| 15| 19| 20| 20| 22| 22| 22| 23| 23| 24|
| 2     | 5 | 0 | 5 | 10| 15| 19| 20| 20| 22| 22| 22| 23| 23|
| 3     | 10| 5 | 0 | 5 | 10| 15| 19| 20| 20| 22| 22| 22| 23|
| 4     | 15| 10| 5 | 0 | 5 | 10| 15| 19| 20| 22| 22| 22| 23|
| 5     | 19| 15| 10| 5 | 0 | 5 | 10| 15| 19| 20| 22| 22| 23|
| 6     | 20| 19| 15| 10| 5 | 0 | 5 | 10| 15| 19| 20| 22| 23|
| 7     | 20| 20| 19| 15| 10| 5 | 0 | 5 | 10| 15| 19| 20| 23|
| 8     | 22| 20| 20| 19| 15| 10| 5 | 0 | 5 | 10| 15| 19| 20|
| 9     | 22| 22| 20| 20| 19| 15| 10| 5 | 0 | 5 | 10| 15| 19|
| 10    | 22| 22| 20| 20| 19| 15| 10| 5 | 0 | 5 | 10| 15| 19|
| 11    | 23| 23| 22| 22| 22| 20| 20| 19| 10| 5 | 0 | 5 | 10|
| 12    | 23| 23| 22| 22| 22| 20| 20| 19| 15| 10| 5 | 0 | 5 |
| 13    | 24| 23| 23| 22| 22| 20| 20| 20| 20| 15| 10| 5 | 0 |

7 Conclusion

The study results point out the frequency of a single route for a single time period considering user and operator costs. The simulation-based frequency through mathematical programming considering operator and user service constraints caters to
the sustainable, efficient, and economical public transportation system, which saves resources and provides an environment-friendly transportation system in urban areas. The waiting time cost of the passenger and the fleet size is minimized using the Deficit function as the solution for timetable synchronization and vehicle scheduling. The objective function is the same for pre- and post-COVID-19. However, the desired occupancy constraint values vary under social distancing, frequency, and timetable synchronization of a particular route that can be evaluated using this model based on demand variation. Thus, the routes are rationalized based on the variation in boarding and alighting of the passengers between the origin and destination.

Appendix

| Terminal A |
|------------|

| Dep. | Pool | Dep_bus | Dep_time | Arr_bus | Arr_time |
|------|------|---------|----------|---------|----------|
| 1    | 0    | A 1     | 08:00:00 | ---     | ---      |
| 2    | 0    | A 2     | 08:05:00 | ---     | ---      |
| 3    | 0    | A 3     | 08:10:00 | ---     | ---      |
| 4    | 0    | A 4     | 08:15:00 | ---     | ---      |
| 5    | 0    | A 5     | 08:20:00 | ---     | ---      |
| 6    | 0    | A 6     | 08:25:00 | ---     | ---      |
| 7    | 0    | A 7     | 08:30:00 | ---     | ---      |
| 8    | 0    | A 8     | 08:35:00 | ---     | ---      |
| 9    | 0    | A 9     | 08:40:00 | ---     | ---      |
| 10   | 0    | A 10    | 08:45:00 | ---     | ---      |
| 11   | 0    | A 11    | 08:50:00 | ---     | ---      |
|     | 1    | ---     | ---      | B 1     | 09:38:09 |
|     | 2    | ---     | ---      | B 2     | 09:43:06 |
|     | 3    | ---     | ---      | B 3     | 09:48:06 |
|     | 4    | ---     | ---      | B 4     | 10:04:06 |
|     | 5    | ---     | ---      | B 5     | 10:02:09 |
|     | 6    | ---     | ---      | B 6     | 10:04:58 |
|     | 7    | ---     | ---      | B 7     | 10:08:02 |
|     | 8    | ---     | ---      | B 8     | 10:09:38 |
|     | 9    | ---     | ---      | B 9     | 10:11:38 |
|     | 10   | ---     | ---      | B 10    | 10:13:38 |
|     | 11   | ---     | ---      | B 11    | 10:15:38 |

Fig. 1 Time table for up direction
Fig. 2 Time table for down direction

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