

Deterministic (“Timetable”) Transit Assignment

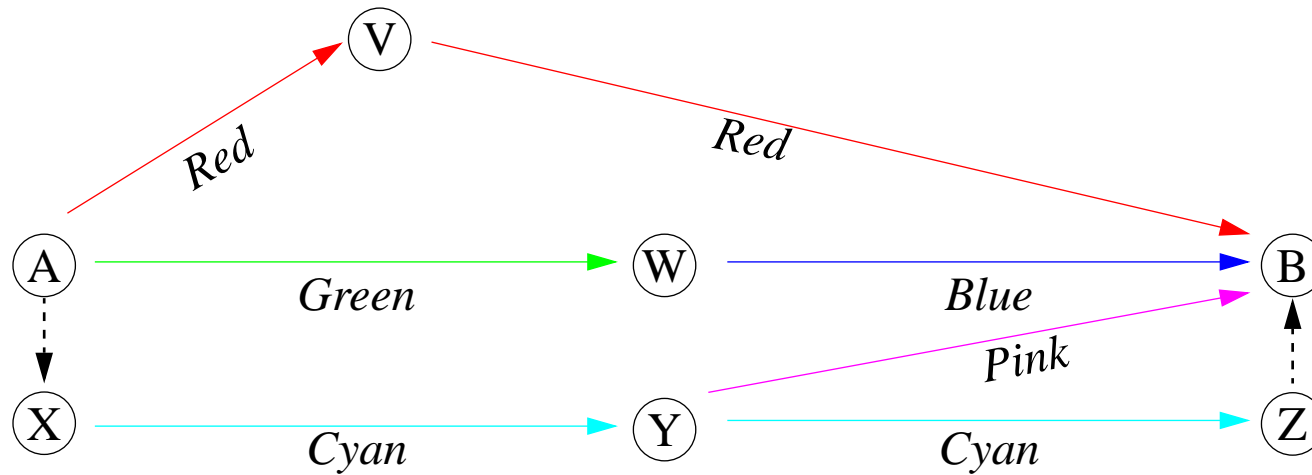
Presented by

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EMME/2 Standard Transit Assignment

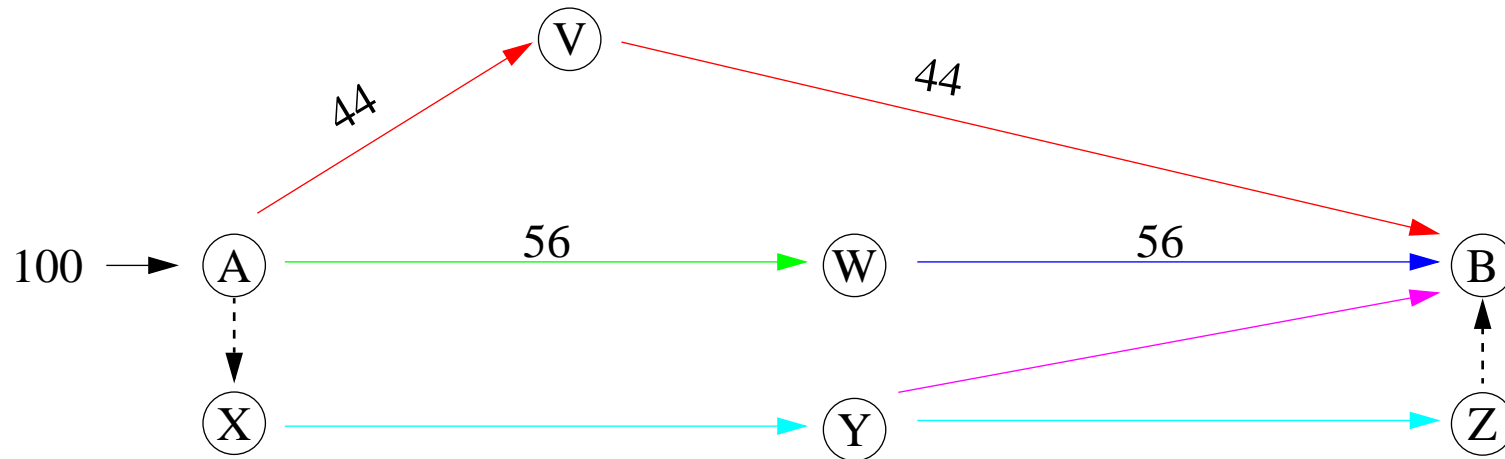
- Based only on **frequencies** (headways) and the following **assumptions**:
 - exponential distribution of inter-vehicle times
 - uniform passenger arrival distribution at stops
 - steady-state
- Trips defined by their origin and destination centroids
- Requires relatively little data
- Easily applied for future years
- Finds the optimal **strategy** (minimizing the expected total cost)
- Well suited for most urban applications (high frequencies)
- Does not consider complete timetable information

Network Data Required for Standard Assignment



Line	Travel Times		Headway
<i>Red</i>	A → V: 11	V → B: 19	15
<i>Green</i>	A → W: 10		12
<i>Blue</i>	W → B: 12		10
<i>Cyan</i>	X → Y: 10	Y → Z: 13	30
<i>Pink</i>	Y → B: 17		60

Standard Assignment: 100 Trips from A to B

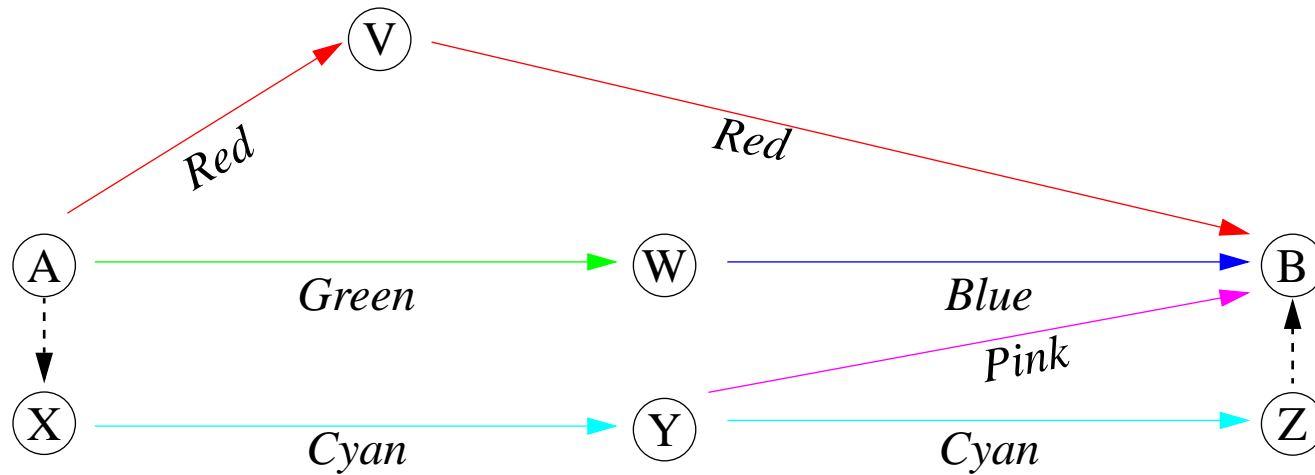


- Assignment parameters:
 - wait time factor: 0.5
 - boarding penalty: 5 minutes
 - all weights: 1
- Optimal strategy:
 - at A, board the *Red* or the *Green* line, whichever comes first
 - if the *Red* line was taken, alight at B
 - if the *Green* line was taken, alight at W; then take the *Blue* line and alight at B.
- Expected transit “time”: 39.44 minutes

Deterministic (“Timetable”) Transit Assignment

- Considers **complete timetable** information (\Rightarrow no longer steady-state)
- Trips defined by their origin and destination nodes **and** their **desired time** for **departure** or **arrival**
- Requires coding the complete timetable
- Can be applied for future years only if complete timetable information available
- Finds the optimal **path** (minimizing the total cost)
- Best suited for intercity or regional applications (irregular service, low frequencies)
- Not a replacement for the standard assignment

Timetable Information



Red

A: 8h10 8h25 8h40
 V: 8h21 8h36 8h51
 B: 8h40 8h55 9h10

Green

A: 8h08 8h20 8h32 ...
 W: 8h18 8h30 8h42 ...

Cyan

X: 8h29 8h59
 Y: 8h39 9h09
 Z: 8h52 9h22

Blue

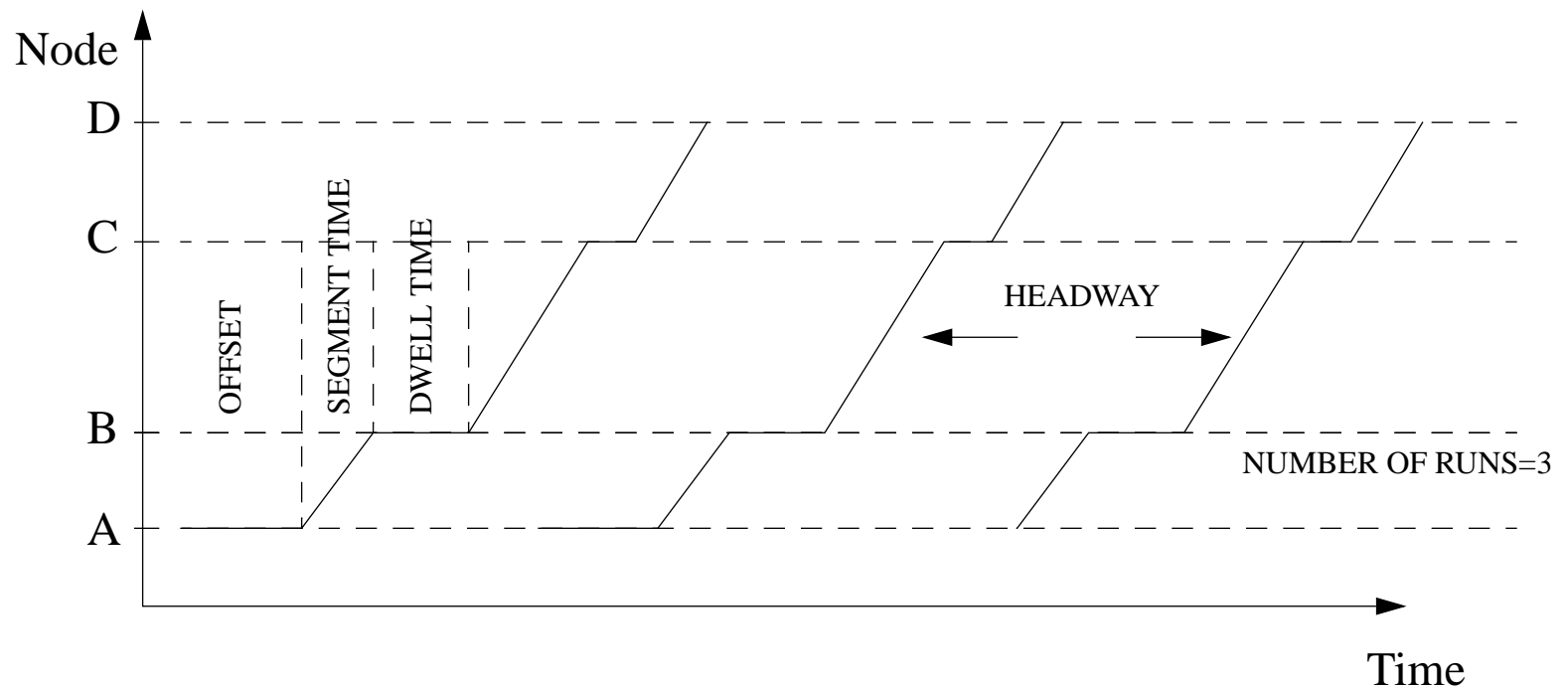
W: 8h33 8h43 8h53 ...
 B: 8h45 8h55 9h05 ...

Pink

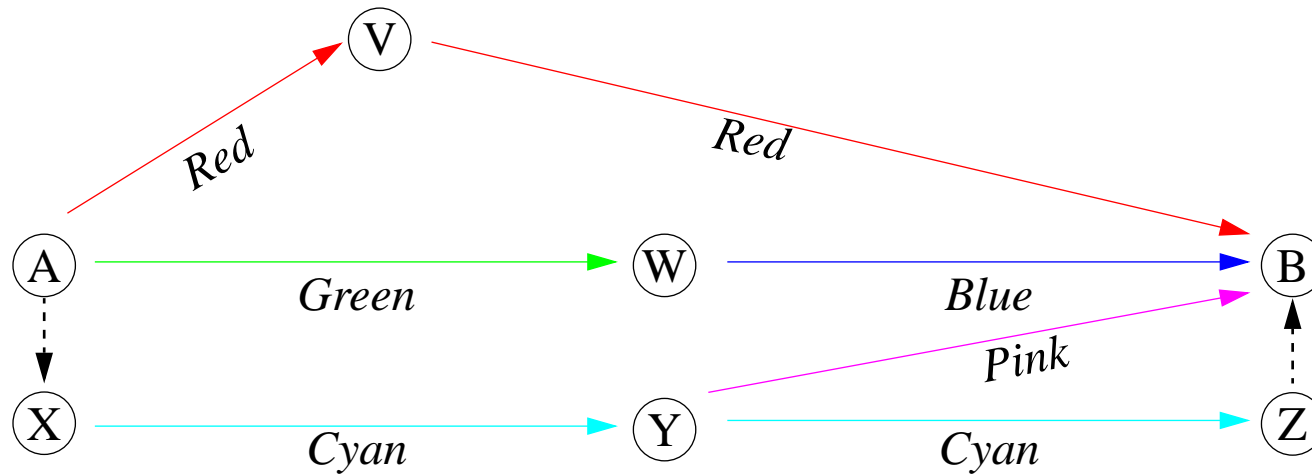
Y: 8h44
 B: 9h01

EMME/2 Timetable Information

- Already available
 - headway: time between 2 runs of the same line
 - segment time: travel time on transit segments
 - dwell time: time spent at nodes
- New timetable information
 - line offset: departure time of first run of line
 - number of runs: number of runs during the assignment period



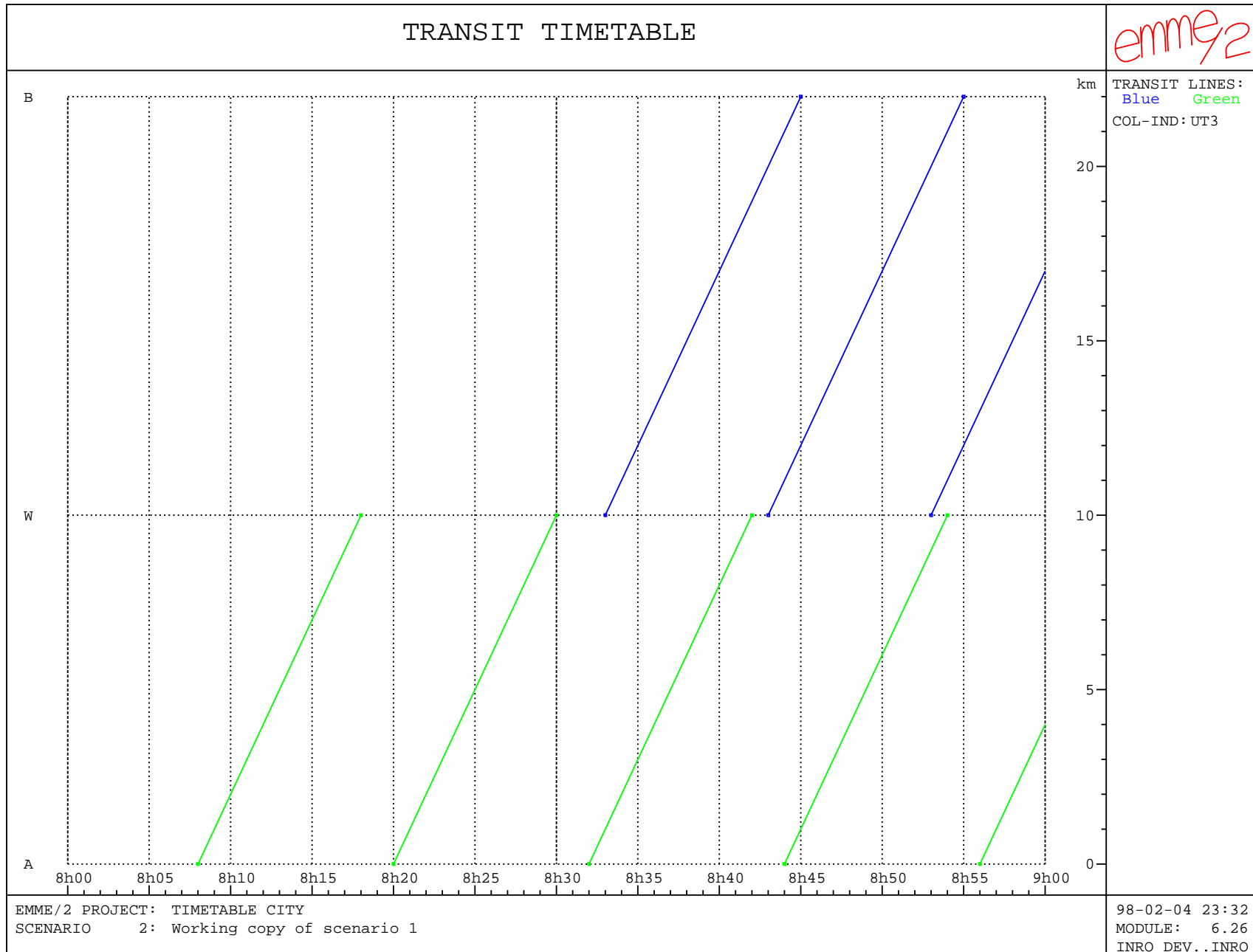
Network Data Required for Deterministic Assignment



Beginning of assignment period: 8h

Line	Travel Times	Headway	Offset	No of runs
<i>Red</i>	A → V: 11 V → B: 19	15	10	3
<i>Green</i>	A → W: 10	12	8	999
<i>Blue</i>	W → B: 12	10	33	999
<i>Cyan</i>	X → Y: 10 Y → Z: 13	30	29	2
<i>Pink</i>	Y → B: 17	60	44	1

Timetable Plot (New Module 6.26)



Desired Departure or Arrival Time Specification

- General format:

target_time[-*max_early*[\$*early_pen*]] [+*max_late*[\$*late_pen*]] [@*granularity*]

- target time 14h25
- maximum earliness and lateness -30, +15
- cost/minute earliness and lateness \$2.5
- time granularity @5

- Examples of **departure** times

13h30

target time is 13h30

13h30-15+30

possible times between 13h15 and 14h

13h30-15+30@5

possible times: 13h15, 13h20, 13h25 ... 13h55, 14h

13h30-15\$1.2@5

earliness is penalized

- Examples of **arrival** times

+2h00-60+60@15

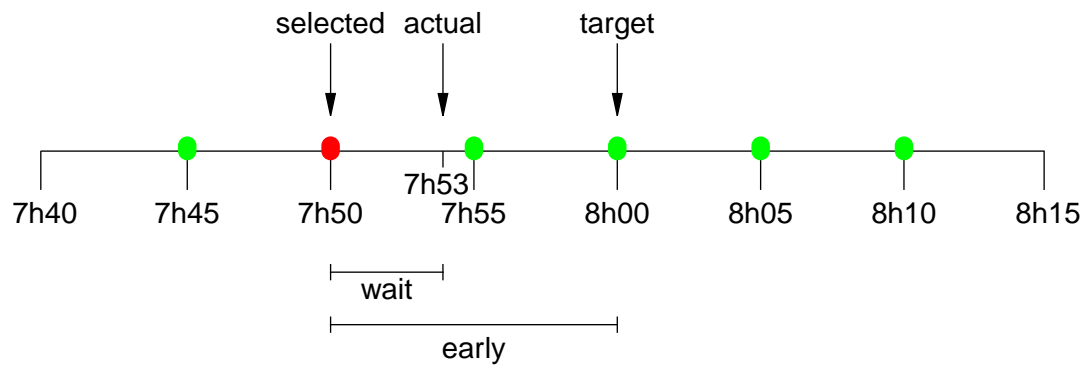
possible times: 1h, 1h15, ... 2h45, 3h the next day

8h25+30\$1.4@10

lateness is penalized

Earliness

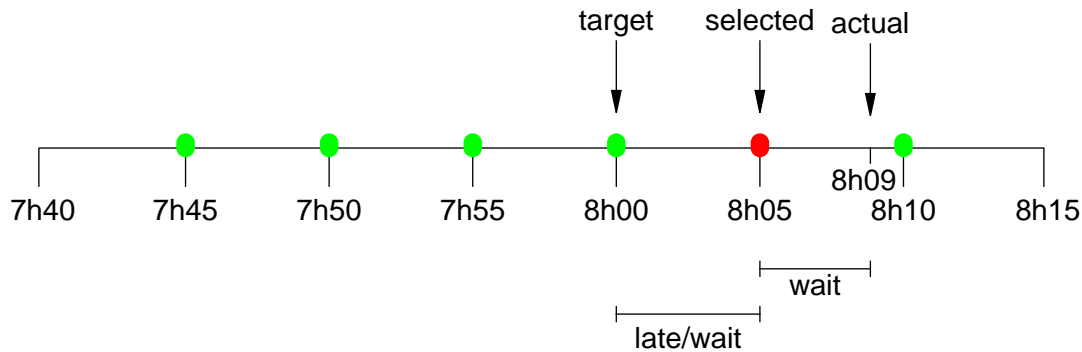
- Desired departure time: **8h00-15+10@5**
- Actual departure time: 7h53
- Possible departure times: 7h45, 7h50, 7h55, 8h00, 8h05, 8h10.



- Earliness: 10 minutes
- Wait: 3 minutes
- If early penalty is 1.5 \Rightarrow **early cost** will be 18 ($=1.5*10+1*3$)

Lateness

- Desired departure time: **8h00-15+10@5**
- Actual departure time: 8h09
- Possible departure times: 7h45, 7h50, 7h55, 8h00, 8h05, 8h10



- Time between 8h00 and 8h05 is considered as
 - **lateness**, if late penalty < 1
 - **wait**, if late penalty > 1
- If late penalty is 0.25 \Rightarrow **late cost** will be 5.25 ($=0.25*5+1*4$)
if late penalty is 1.1 \Rightarrow **late cost** will be 9 ($=1*5+1*4$)

Trip Data Specification

- Trip data may be contained in batch input file, such as:

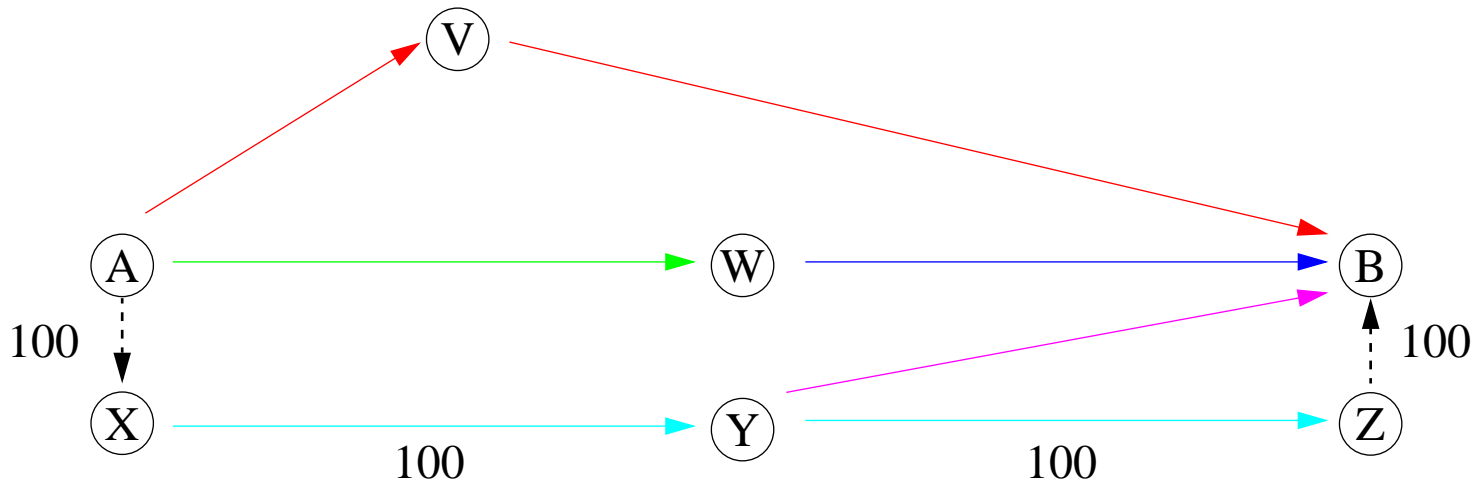
```
t dta
  13  107  arr=18h00+30$1.1@15
  27   30  dep=8h30-15+15 vol=3
```

- Trip data may be entered interactively (via a dialog)
- A demand matrix may be specified:
 - entire matrix is assigned using the same desired departure/arrival time
 - demand “slices” can be assigned consecutively:
 - slice 1 - demand 6h00 to 6h29
 - slice 2 - demand 6h30 to 6h59
 - ...

Assignment Parameters

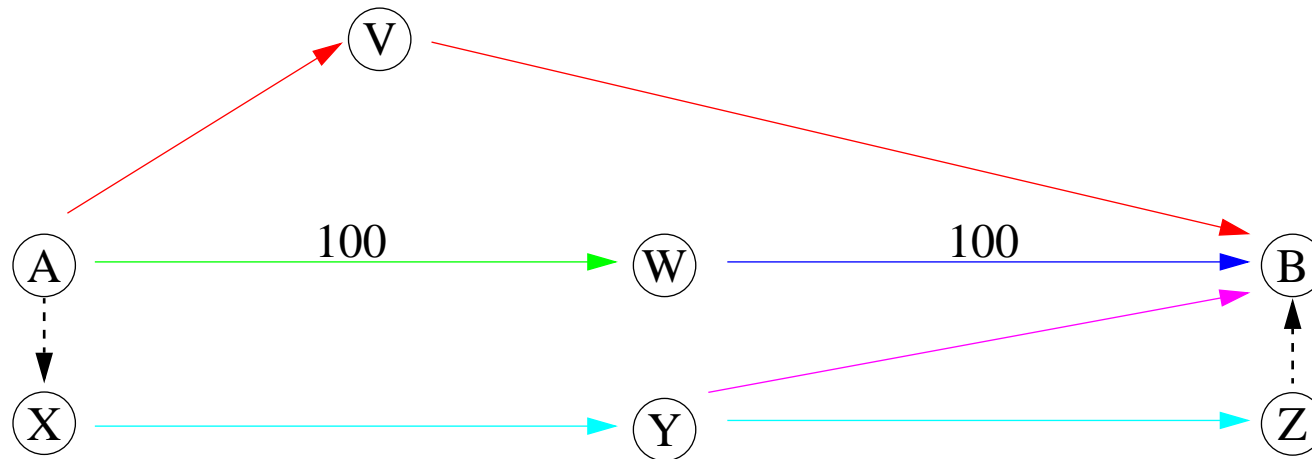
- Active modes
- Minimum waiting time
 - used to determine the feasibility of a path
 - may be constant, or node/line specific
- Boarding penalty
 - used to determine the cost of a path
 - may be constant, or node/line specific
- Weight factors
 - used to determine the cost of a path
 - may be specified for auxiliary transit, boarding and in-vehicle time

Deterministic Assignment (A → B arr=9h00)



- Assignment parameters:
 - minimum waiting time: 2 minutes
 - boarding penalty: 5 minutes
 - all weights: 1
- Optimal path:
 - leave A at 8h25 and walk to X (arriving at 8h27)
 - leave X at 8h29 with the *Cyan* line and alight at Z
 - upon alighting at Z, walk to B (arriving at 8h55 ⇒ 5 minutes early)
- Total travel cost: 40 minutes

Deterministic Assignment (A → B arr=8h45)



- Parameters:
 - minimum waiting time: 2 minutes
 - boarding penalty: 5 minutes
 - all weights: 1
- Optimal path:
 - be at A for 8h18 in order to board the *Green* line at 8h20
 - alight at W at 8h30
 - leave W at 8h33 with the *Blue* line
 - arrive at B a 8h45 (neither early nor late)
- Total travel cost: 37 minutes

Assignment Results

- Network results (may be saved or not in the data bank)
 - transit times
 - transit volumes (may be added to existing volumes)
- Result matrices (when assigning a demand matrix):
 - travel time components
 - total travel time
 - transit cost components
 - total transit cost
 - number of boardings
 - distance travelled

Output Formats

- Assignment summary including
 - assignment parameters
 - network statistics)
- Detailed trip descriptions

```

from 178 to 744 desired departure:13h30-15$1.2+30$.3 trips: 1

at   arr   dep   with   --time(late 3.50)--   --cost(late 3.50)--   -distance-
node time  time  line/mode aux  wait  inv cumul  aux  wait  inv cumul  (mi) cumul
 178 13h33 13h35 15e-SW      2.00 14.72 16.72      7.00 17.67 28.17  4.07  4.07
1046 13h50 13h50      p    1.00      17.72 1.50      29.67  .05  4.12
1047 13h51 13h51      p    1.00      18.72 1.50      31.17  .05  4.17
1050 13h52 13h52      p    1.40      20.12 2.10      33.27  .07  4.24
 996 13h54 14h00 31-SW      6.38 12.36 38.86      11.38 14.83 59.48  2.11  6.35
 744 14h12      total: 3.40  8.38 27.08 38.86  5.10 18.38 32.50 59.48      6.35

```

- Trip summaries (report or punch)

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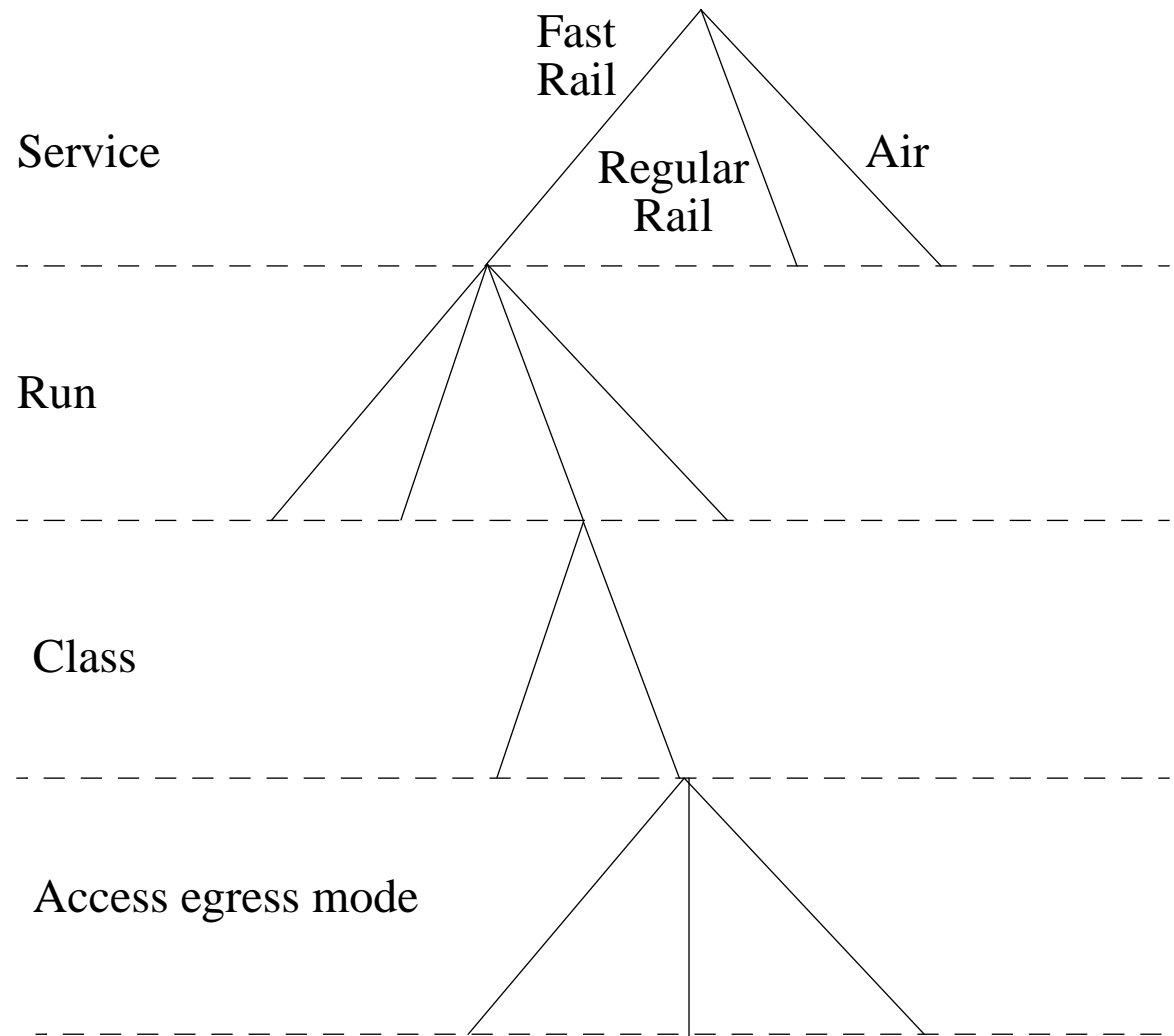
from to trips  dep  arr tela taux twai tinv  time cela caux cwai cinv  cost nb dist
 178 744     1 13h30 15h28  .0 118.  .0  .0 118.4  .0 178.  .0  .0 177.6  0 5.92
 178 744     1 14h00 15h58  .0 118.  .0  .0 118.4  .0 178.  .0  .0 177.6  0 5.92
   68  80     2 16h49 18h00  .0 70.8  .0  .0  70.8  .0 106.  .0  .0 106.2  0 3.54
   13 107     1 16h47 18h00  .0 73.2  .0  .0  73.2  .0 110.  .0  .0 109.8  0 3.66
   27  30     1 08h10 08h26 10.0  9.4  2.0  4.8  16.2  6.3 14.1  7.0  5.8  33.1  1 2.67
   27  30     3 08h50 09h06 20.0  9.4  2.0  4.8  16.2  8.8 14.1  7.0  5.8  35.6  1 2.67

```

Choosing the Appropriate Assignment Model

Service Characteristics	Domain of Application	Behavioral Hypothesis	Route Choice Model	Assignment Model
Low frequency high reliability Completely informed traveller	Intercity transit systems	Pre-trips choices Regular arrival at stops	Schedule delay	To runs (low frequency services) Time/space network
High frequency Not completely informed traveller	Urban transit systems	Attractive set generation Random arrival at stops Adaptive run choice (at stops)	Attractive line set Minimum expected travel and wait time Indifferent adaptive behavior	Optimal strategies
High frequency High reliability Completely informed traveller	Urban transit systems (ITS)	Pre-trips choice at stops and run (at origin) Regular arrival at stops	Scheduled travel time	To runs (high frequency services) Time/space urban network

A Possible Choice Model



Conclusion

- The timetable transit assignment opens **many new** possibilities for EMME/2 applications, but
 - the exact timetable must be known
 - the appropriate demand data must be available.
- The demand models calibrated and used should be based on paths obtained from the timetable assignment.
- The timetable assignment is unlikely to replace the standard assignment due to:
 - lack of **time information on demand**
 - lack of **timetable information** for future years.It will complement it for intercity and regional applications.