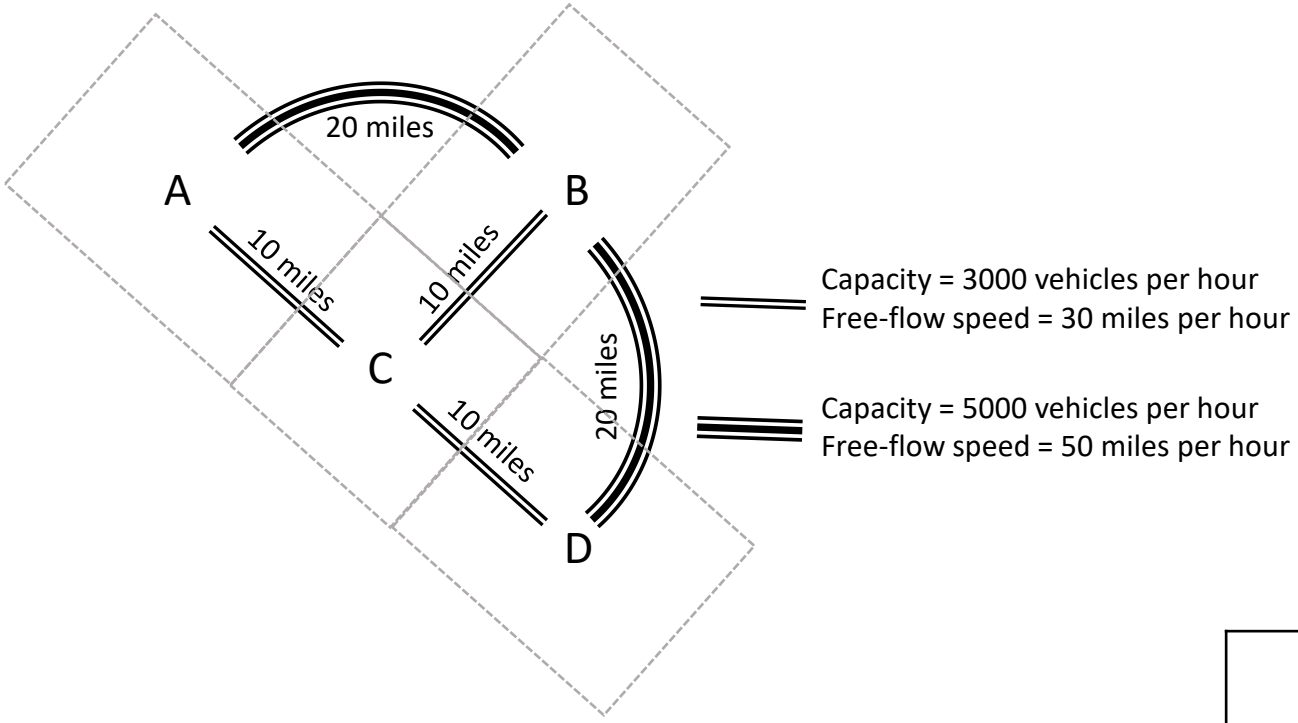


Capacity = 3000 vehicles per hour
Free-flow speed = 30 miles per hour

Capacity = 5000 vehicles per hour
Free-flow speed = 50 miles per hour

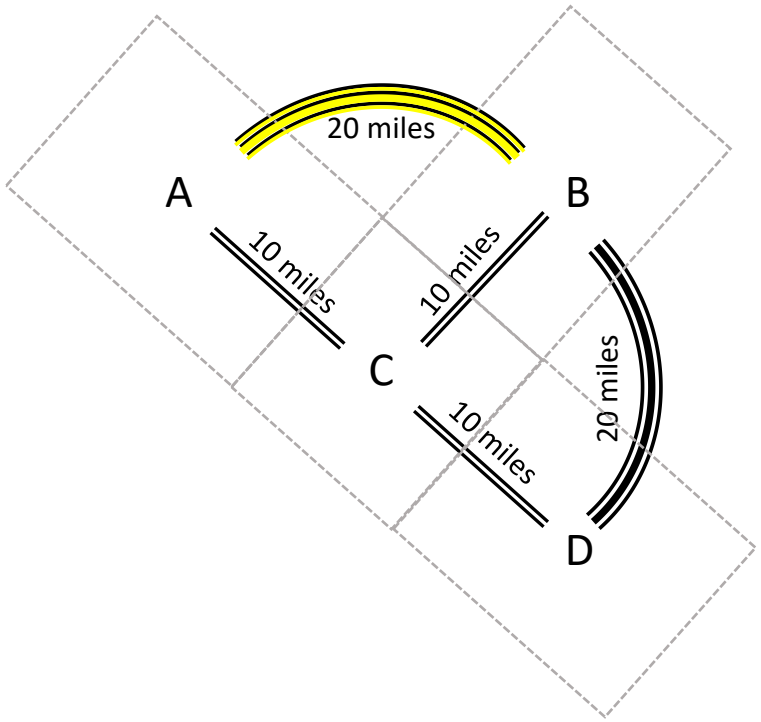
Demand (vehicles per hour)

	A	B	C	D
A	0	3,800	2,000	6,000
B	500	0	2,000	4,000
C	200	100	0	300
D	600	700	3,000	0

A to B

Tree-building: Possible routes

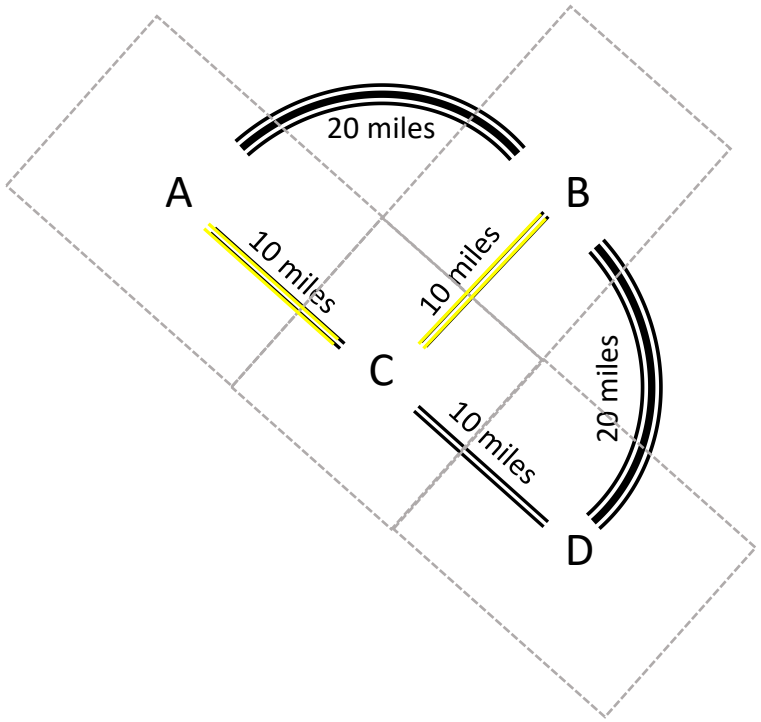
- A-B



A to B

Tree-building: Possible routes

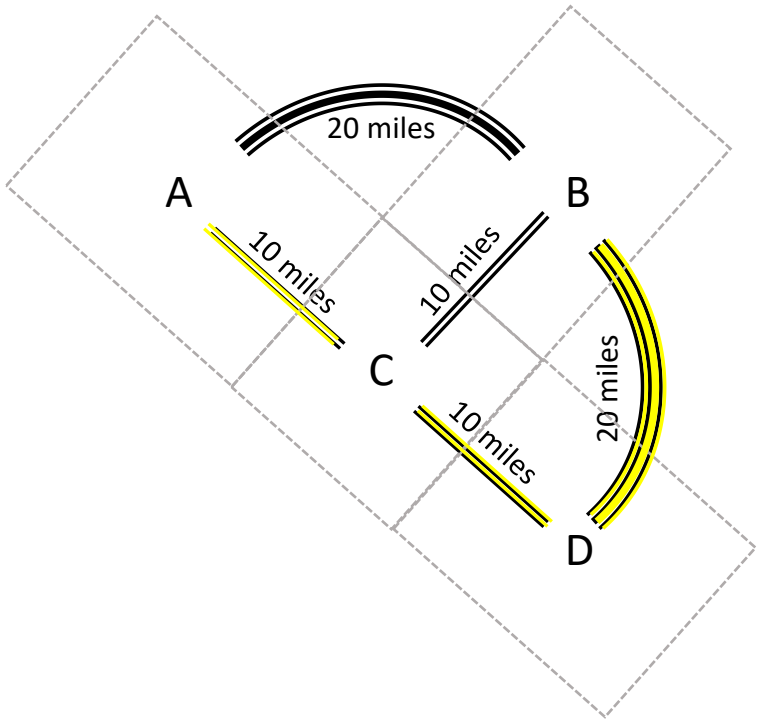
- A-B
- A-C-B



A to B

Tree-building: Possible routes

- A-B
- A-C-B
- A-C-D-B



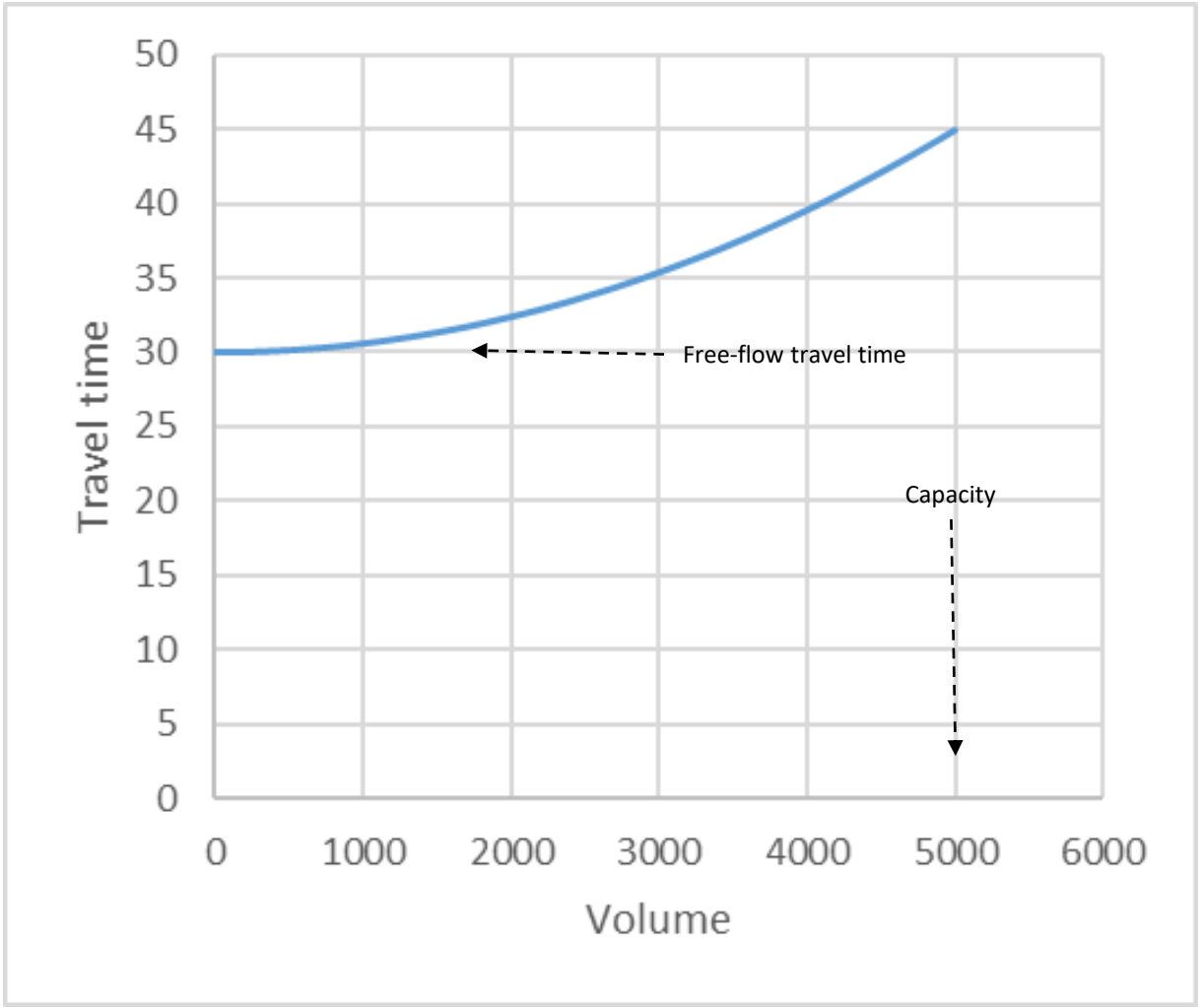
Wardrop’s equlibrium

- Any two used routes will have an equal travel time, so no traveler can improve her travel time (cost) by switching to a different route.

Effects of congestion

Travel time $= t_0 \left[1 + \alpha \left(\frac{V}{C}\right)^{\beta}\right]$

Use $\alpha = 0.5$, $\beta = 2$

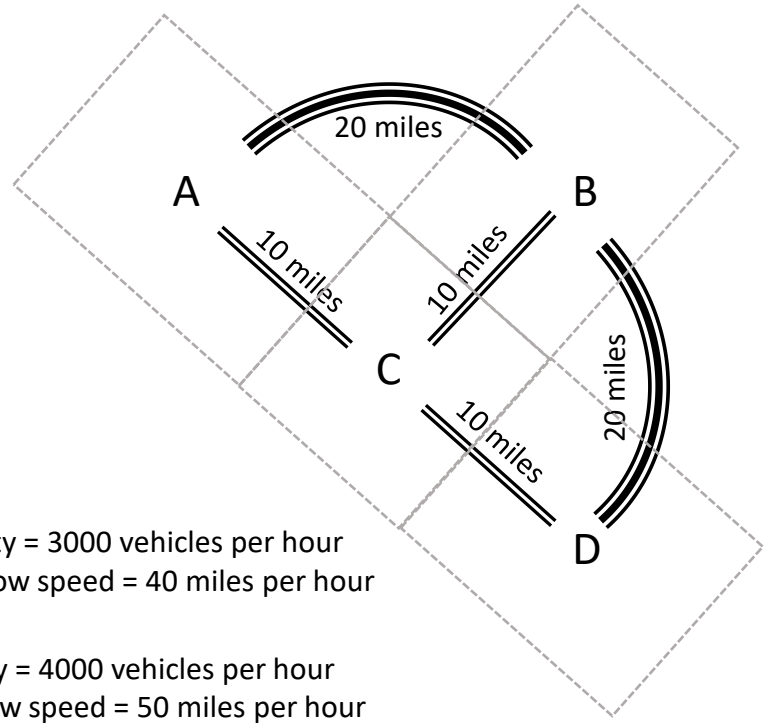


All-or-nothing assignment

	A-B	A-C-B	A-C-D-B
Free-flow time (min)	24	30	54
Volume	3,800	0	0
Capacity	4,000	3,000	3,000
V/C	0.95	0	0
Travel time	35	30	54

Demand (vehicles per hour)

	A	B	C	D
A	0	3,800	2,000	6,000
B	500	0	2,000	4,000
C	200	100	0	300
D	600	700	3,000	0



Congested assignment

$$24\left[1+0.5\left(\frac{V_{AB}}{4{,}000}\right)^2\right]=30\left[1+0.5\left(\frac{V_{ACB}}{3{,}000}\right)^2\right]$$

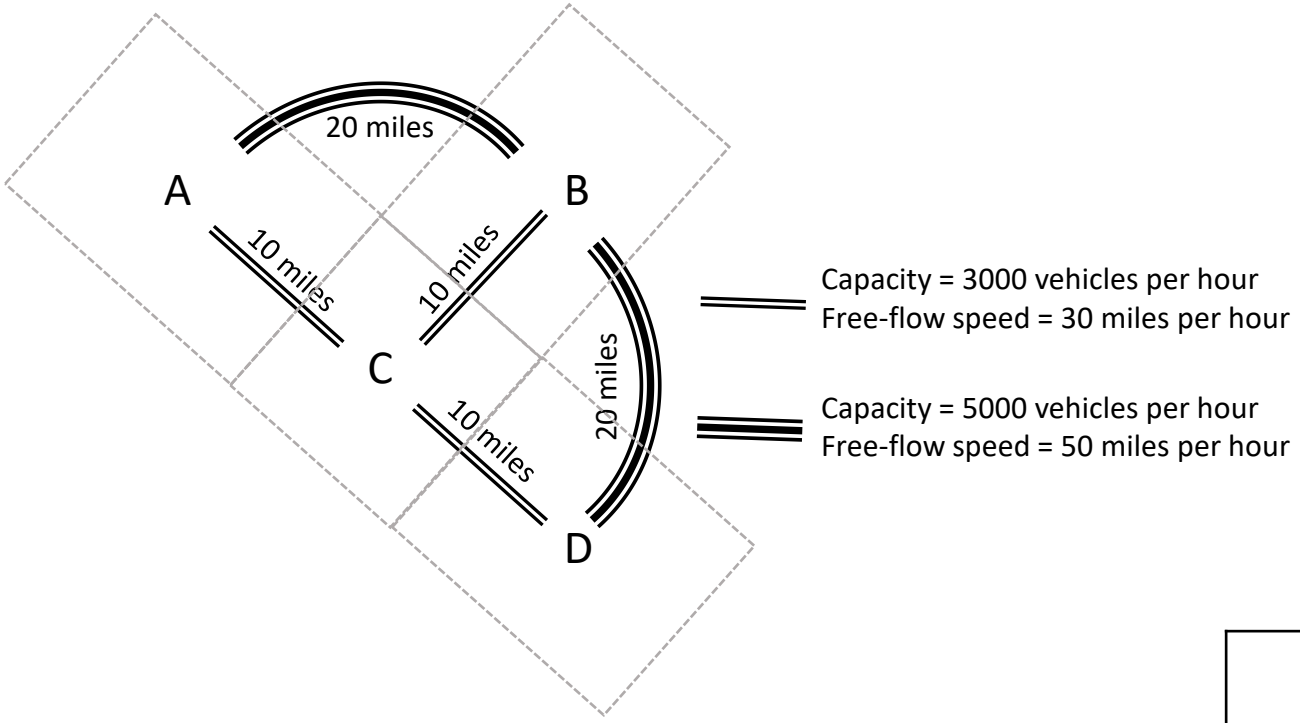
$$V_{AB}+V_{ACB}=3{,}800$$

$$24\left[1+0.5\left(\frac{V_{AB}}{4{,}000}\right)^2\right]=30\left[1+0.5\left(\frac{3{,}800-V_{AB}}{3{,}000}\right)^2\right]$$

$$V_{AB}=3044$$

$$V_{ACB}=756$$

	A-B	A-C-B	A-C-D-B
Free-flow time (min)	24	30	54
Volume	3,044	756	0
Capacity	4,000	3,000	3,000
V/C	0.76	0.25	0
Travel time	31	31	54



Travel time $= t_0 \left[1 + \alpha \left(\frac{V}{C}\right)^{\beta}\right]$

Use $\alpha = 0.5$, $\beta = 2$

Demand (vehicles per hour)

	A	B	C	D
A	0	3,800	2,000	6,000
B	500	0	2,000	4,000
C	200	100	0	300
D	600	700	3,000	0

Incremental assignment

- Divide total volume into equal portions and assign then one at a time.