TRAFFIC NETWORK ANALYSIS

2004 Democratic National Convention in Boston

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SOM 822

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OVERVIEW

- Introduction, Goals, and Assumptions
- Network definition
- User link cost functions
- Redistribution of traffic
  - User optimization flow conditions
  - Different demand levels
- Conclusions and Recommendations

INTRODUCTION

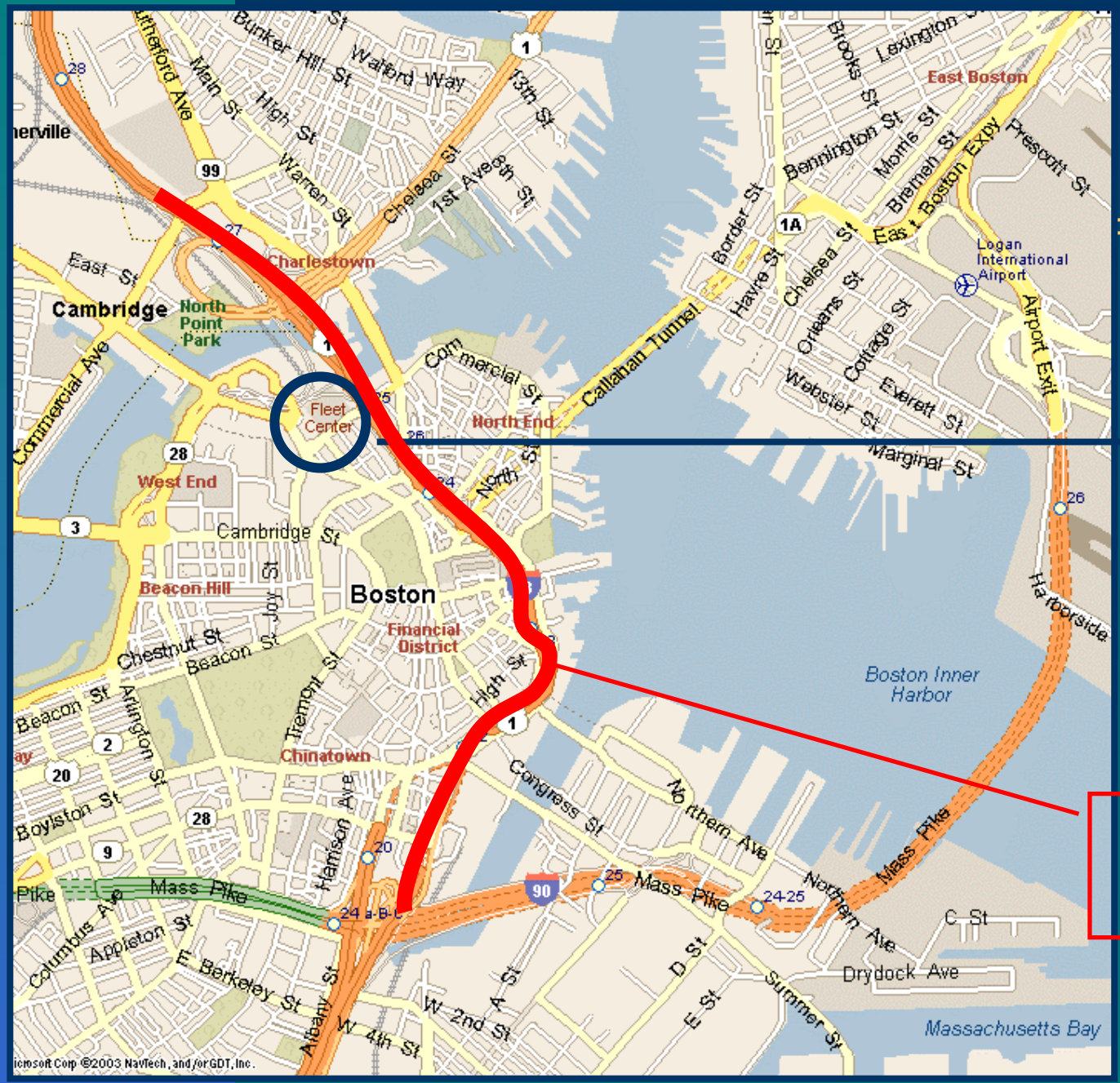
2004 Democratic National Convention
July 26 ~ July 29, 2004, Boston, MA

SECURITY MEASURES:

CLOSURES:

- Interstate 93 nearby the Fleet Center
  - The Zakim Bridge
  - Northern Portals of the Big Dig Tunnel
- North Station

SITUATION



FLEET CENTER

TRAFFIC RESCTRICTIONS

GOALS

- Develop a TNE model for the Boston metro area
- Identify changes in traffic behavior in the Boston metro area due to the restrictions imposed during the Democratic National Convention
- Provide recommendations to mitigate the potential adverse effects on the traffic network

ASSUMPTIONS and LIMITATIONS

- Only North-South traffic considered
  - One O/D pair in the Network
- Most traffic going from north to south drive in major routes
- Once the traffic restriction is imposed, only a small percentage will divert from I-93 to alternative routes
- Travel time is used as a measure of cost on each link

PRELIMINARY NETWORK

- Path 1

I-93 (North to Boston)

- Path 2

Route 1 and Ted Williams Tunnel and connect with I-93 (Boston to South)

- Path 3

Route 128 (I-95)

ALTERNATIVE ROUTES

- Alternative 1

Traffic diverting from I-93 to secondary roads

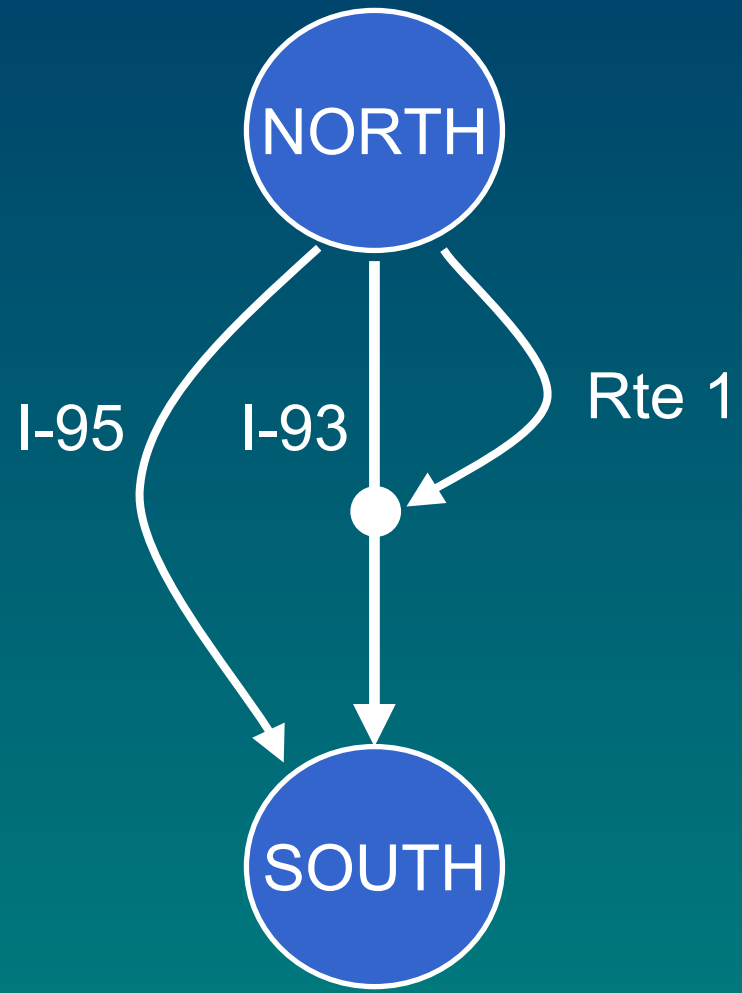
- Alternative 2

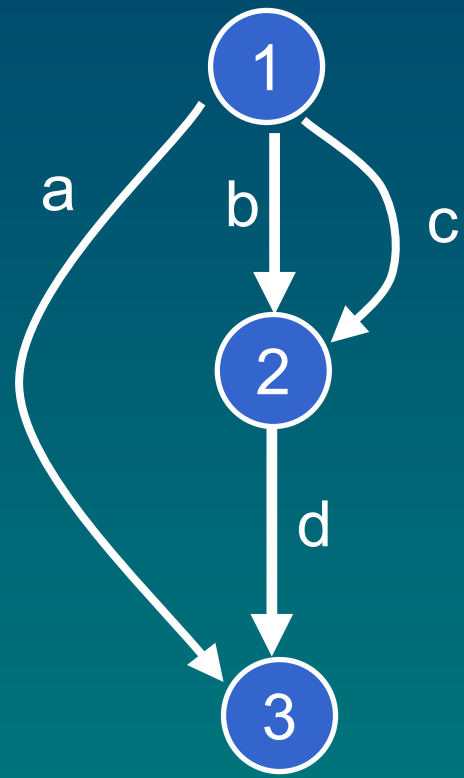
Route 1 and Ted Williams Tunnel and connect with I-93

- Alternative 3

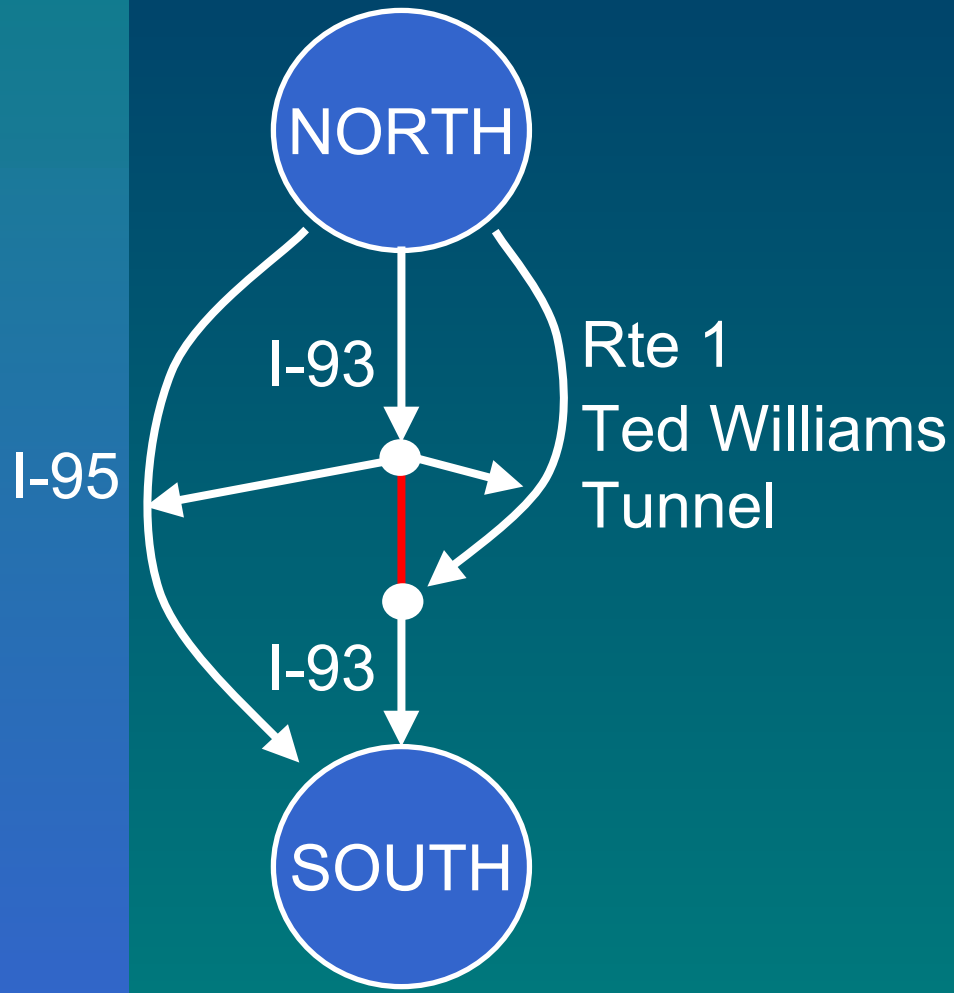
Route 128 (I-95)

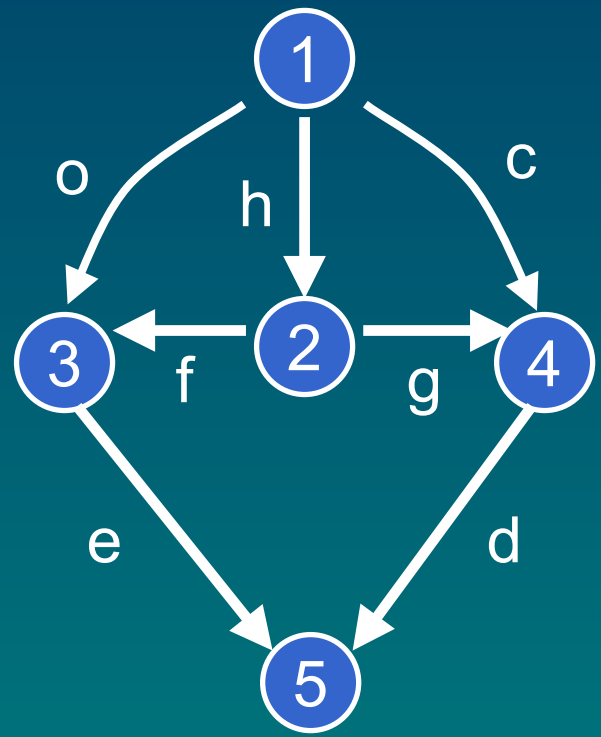
NETWORK 1
NO RESTRICTIONS





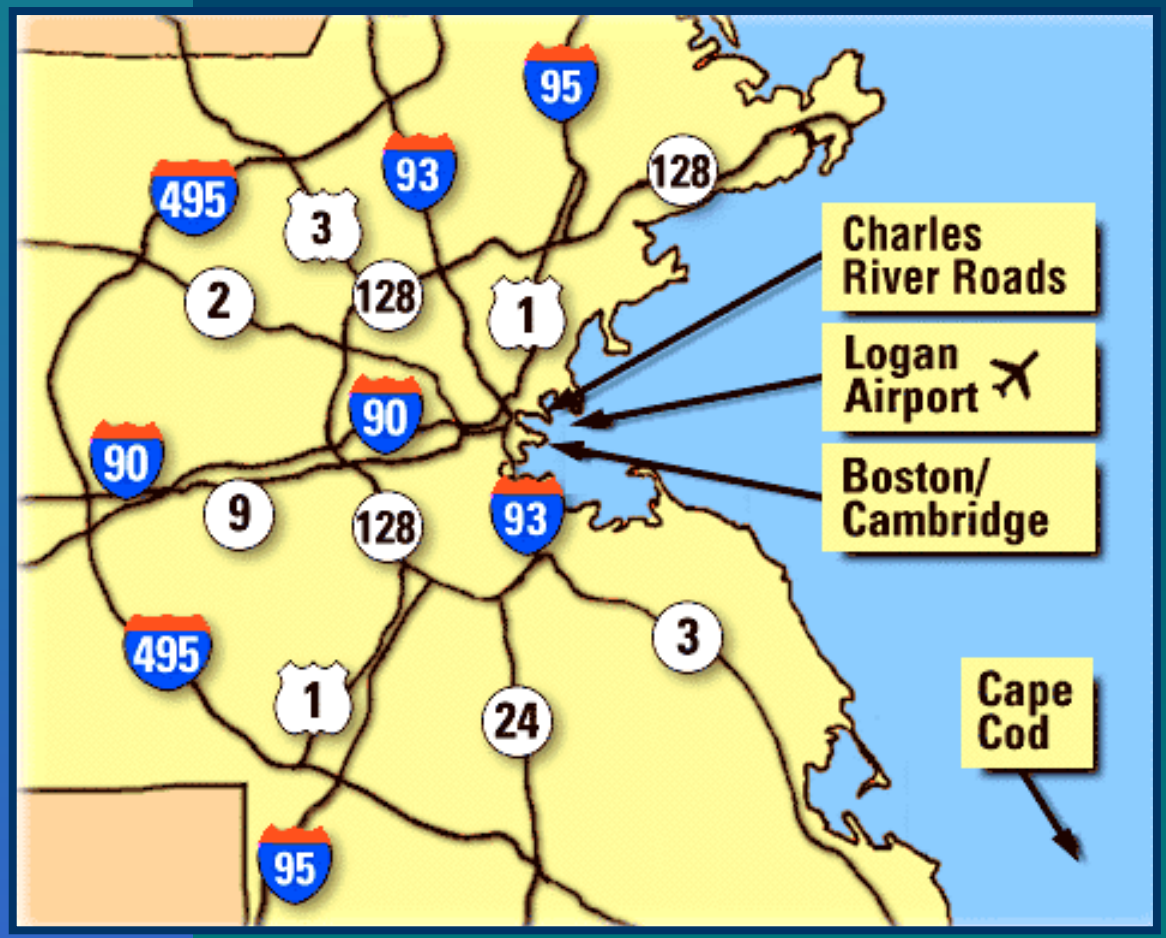
NETWORK 2
RESTRICTIONS IN I-93





TRAVEL TIME

SmarTraveler®

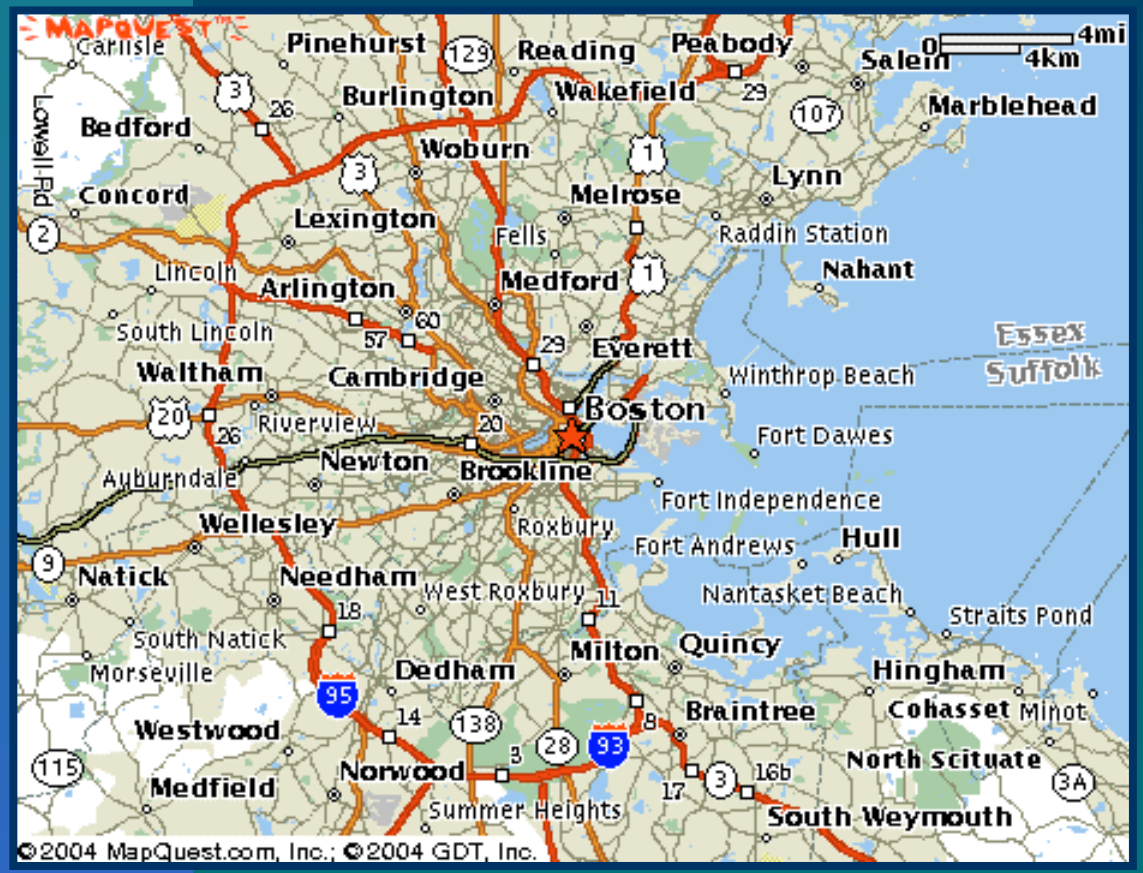


LIVE TRAFFIC REPORTS

Provides real time traffic information using traffic cameras

http://www.smartraveler.com/

TRAVEL TIME



ONLINE MAPPING AND DRIVING DIRECTIONS TOOL

Estimated distance and travel time for non-congested conditions

http://www.mapquest.com/

LINK USER COSTS

- Cost ~ Travel Time
- Linear and separable cost link functions

$$t(f_a) = g_a f_a + h_a \quad \forall a \in L$$

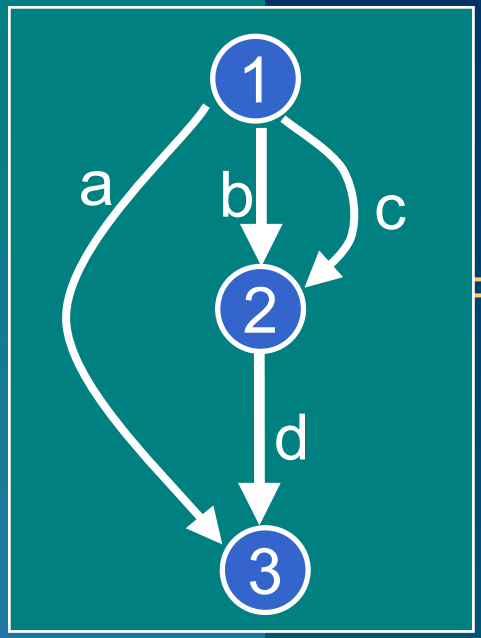
$$g_a > 0 \text{ and } h_a > 0$$

h_a : *fixed travel time free flow conditions (uncongested factor)*

g_a : *Travel delay (congested factor)*

LINK USER COSTS

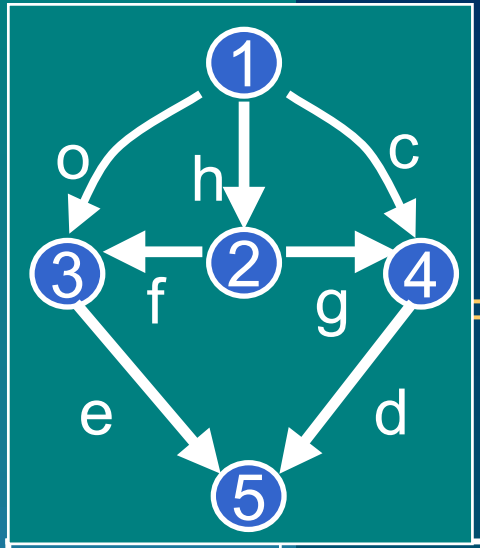
- Estimation of link cost functions:
  - h_a : *Fixed Travel Time*
    - Estimated Travel Time
      - Source: MAPQUEST
      - Time = length / avg. speed
  - g_a : *Travel delay*
    - Travel Delay during afternoon peak hour
      - Source: SMARTRAVELER
    - Peak hourly volumes
      - Source: MassHighway Traffic Volume Counts



h_a Fixed Travel Time

NETWORK 1

	Description	Est. Distance	Est.Time (h_a)
Link a	I-95 (Reading-Braintree)	44 miles	41 minutes
Link b	I-93 North (Reading-Boston)	14.5 miles	14 minutes
Link c	Route 1 (Peabody-Boston)	19 miles	23 minutes
Link d	I-93 South (Boston-Braintree)	12 miles	11 minutes



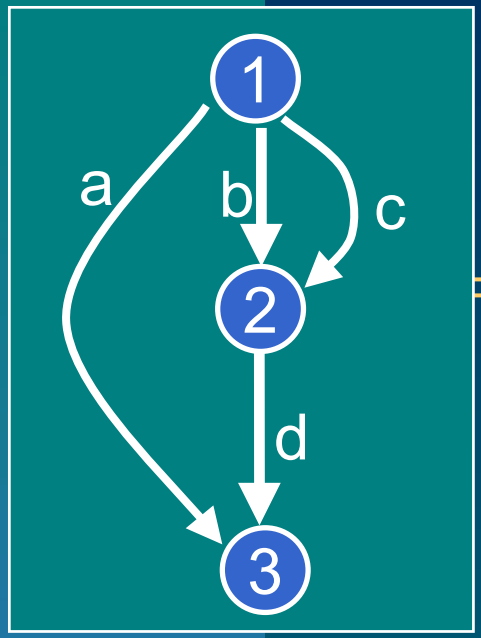
h_a Fixed Travel Time

NETWORK 2

	Description	Est. Distance	Time (h_a)
Link o	I-95 North (Reading-Weston)	19.5 miles	18 minutes
Link h	I-93 North (Reading-Medford)	10 miles	9 minutes
Link c	Route 1 (Peabody-Boston)	19 miles	23 minutes
Link d	I-93 South (Boston-Braintree)	12 miles	18 minutes
Link e	I-95 South (Weston-Braintree)	24.5 miles	23 minutes
Link f	Rte 60 (Medford-Weston)	15 miles	23 minutes
Link g	Rte 99 (Medford-Chelsea)	5.5 miles	11 minutes

$g_a x$ Travel Delay

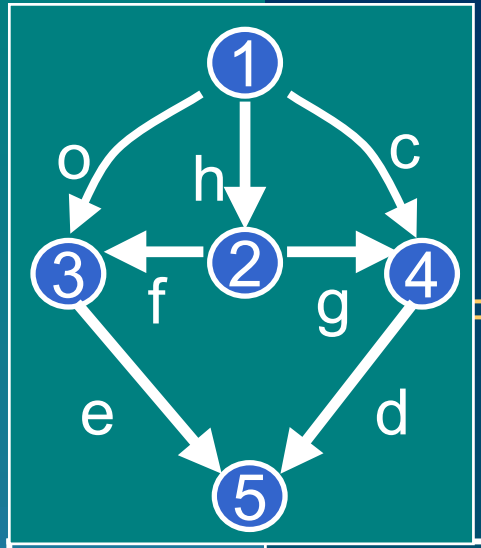
- $DDHV = AADT$ x K x D
  - $DDHV$: Directional Design Hour Volume (vph)
  - $AADT$: Average Annual Daily Traffic (vpd)
  - K: Proportion of daily traffic occurring during peak hour (assumed K = 0.1)
  - D: Proportion of peak-hour traffic traveling in the peak direction (assumed D = 0.6)



$g_a x$ Travel Delay

NETWORK 1

	Travel Delay	AADT	Peak hour Flow	g_a
Link a	40 minutes	200000	12000	1.11E-3
Link b	30 minutes	215000	12900	1.29E-3
Link c	35 minutes	75000	4500	2.71E-3
Link d	25 minutes	190000	11400	1.22E-3



$g_a x$ Travel Delay

NETWORK 2

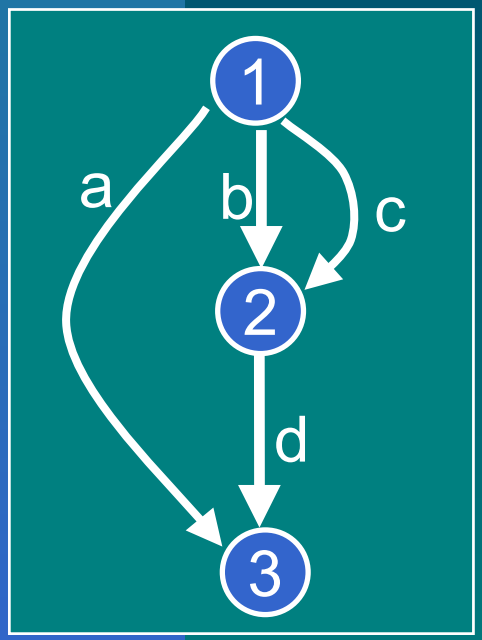
	Travel Delay	AADT	Peak hour Flow	g_a
Link o	24 minutes	200000	12000	4.90E-4
Link h	22 minutes	212000	12720	1.00E-3
Link c	35 minutes	75000	4500	2.71E-3
Link d	25 minutes	190000	11400	1.22E-3
Link e	30 minutes	210000	12600	5.86E-4
Link f	36 minutes	25000	1500	9.00E-3
Link g	22 minutes	50000	3000	3.67E-3

NETWORK 1
GENERAL EQUILIBRATION ALGORITHM

Path 1 = link a

Path 2 = link b + link d

Path 3 = link c + link d

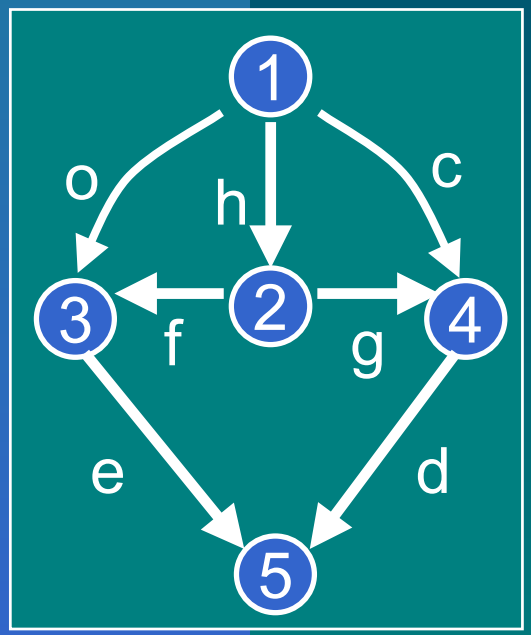


TRAVEL TIMES

	d= 20,000	d= 30,000	d= 40,000
Path 1	51 min	58 min	65 min
Path 2	51 min	58 min	65 min
Path 3	51 min	58 min	65 min

NETWORK 2
GENERAL EQUILIBRATION ALGORITHM

Path 1 = link o + link e
Path 2 = link h + link f + link e
Path 3 = link h + link g + link d
Path 4 = link c + link d



TRAVEL TIMES

	d= 20,000	d= 30,000	d= 40,000
Path 1	54 min	62 min	70 min
Path 2	65 min	70 min	75 min
Path 3	54 min	62 min	70 min
Path 4	54 min	62 min	70 min

NETWORK 1
USER OPTIMIZATION FLOW CONDITIONS

TRAFFIC VOLUMES

	Description	d= 20,000	d= 30,000	d= 40,000
Link a	I-95 North	8,978 vph	15,577 vph	22,152 vph
Link b	I-93 North	9,794 vph	12,132 vph	14,454 vph
Link c	Route 1	1,228 vph	2,291 vph	3,394 vph
Link d	I-93 South	11,022 vph	14,423 vph	17,848 vph

NETWORK 2
USER OPTIMIZATION FLOW CONDITIONS

TRAFFIC VOLUMES

	Description	d= 20,000	d= 30,000	d= 40,000
Link o	I-95 North	12,712 pvh	19,937 vph	27,324 vph
Link h	I-93 North	3,015 vph	3,954 vph	4,973 vph
Link c	Route 1	4,273 vph	6,108 vph	7,703 vph
Link d	I-93 South	7,288 vph	10,063 vph	12,676 vph
Link e	I-95 South	12,712 vph	19,937 vph	27,324 vph
Link f	Rte 60	0	0	0
Link g	Rte 99	3,015 vph	3,954 vph	4,973 vph

CONCLUSIONS and RECOMMENDATIONS (1)

- The increase in delay for the north-south traffic due to the traffic restrictions is minor
- Redistribution of traffic (d=30,000 vph)
  - I-95: 33 % increase
  - I-93 north: 66 % decrease
  - I-93 south: 33% decrease
  - Route 1: 150% increase

CONCLUSIONS and RECOMMENDATIONS (2)

- Further analysis for traffic with destination Boston is needed
- A small scale analysis is needed to model the traffic behavior in the proximity of the restricted area
- A complementary study of the Transit Network is needed to evaluate in the analysis the closure of North Station

THANK YOU

QUESTIONS?