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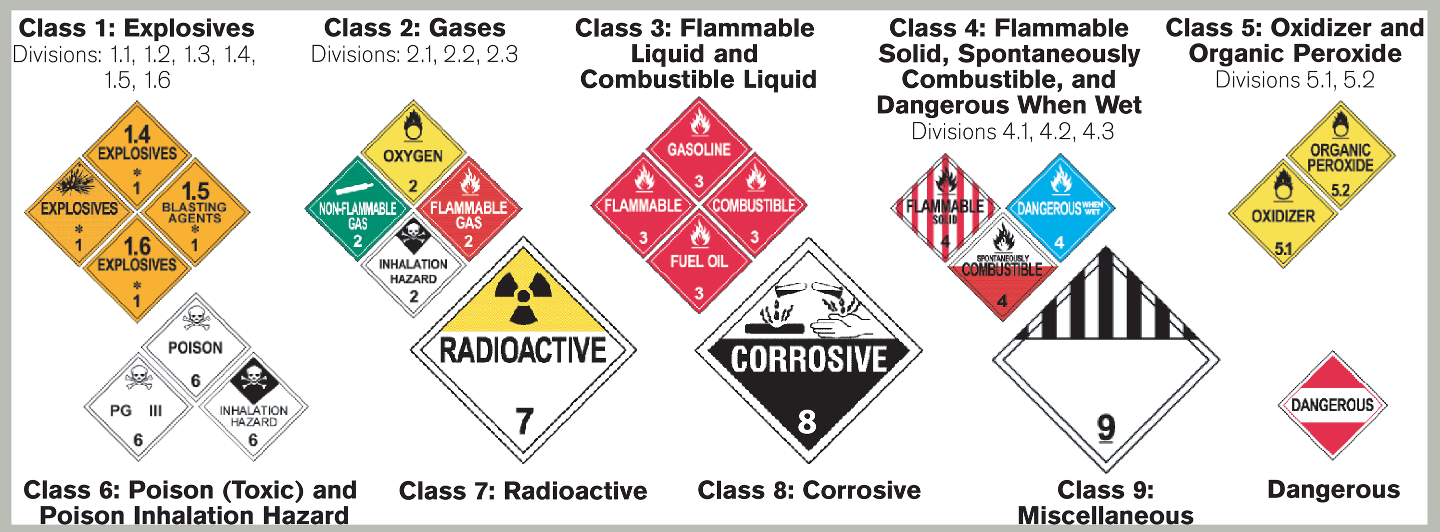
Hazardous Materials (hazmat)



Number of hazmat incidents in 2000-2009

Mode	No. of Incidents	Percentage
Air	13,232	7.89
Highway	146,120	87.09
Rail	7,987	4.76
Water	446	0.27
Total	167,785	100

How to Control Network Flows?

- Network Design Approach
  - Close/Open road segments
  - Increase capacity of road segments
- Toll System Approach
  - Charge tolls to vehicles traveling certain road segments

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Risk Measure and Travel Delay

- We consider a *duration-population-frequency* risk measure:

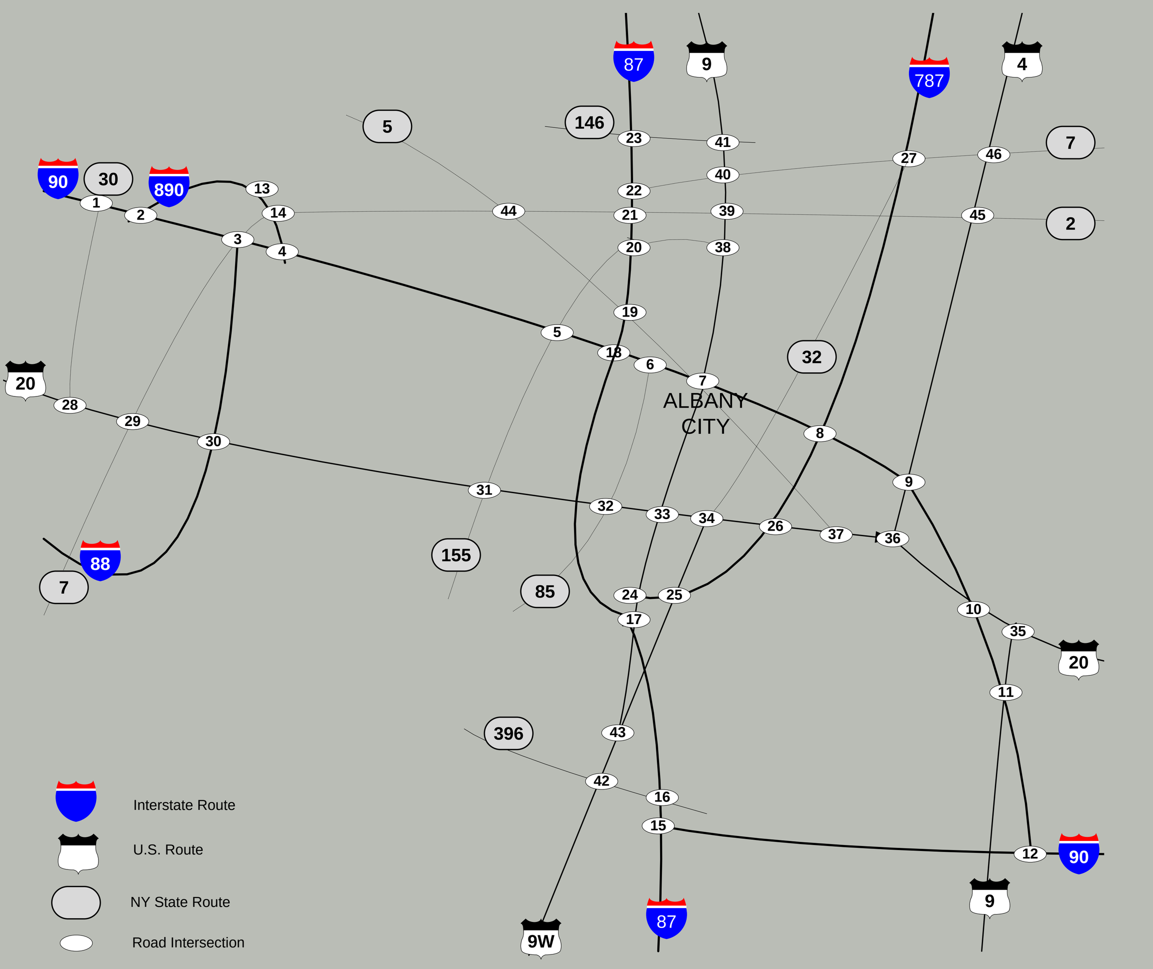
$$R_a(v_a, u_a) = s_a(v_a)\rho_a u_a$$

where ρ_a is the population exposure along the arc.

- The linear travel delay function is:

$$s_a(v_a) = t_a(1 + v_a/C_a)$$

Case Study for Albany, NY (46 nodes and 70 arcs)



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Results

(w_1, w_2, w_3)	Risk	Delay (regular)	Delay (hazmat)	Toll (regular)	Toll (hazmat)
$(10^{-4}, 1, 1)$	-15.09%	3.95%	-0.27%	1.29×10^9	1.66×10^3
$(10^{-3}, 1, 1)$	-22.07%	4.68%	-1.39%	1.31×10^9	1.66×10^3
$(1, 1, 1)$	-24.70%	22.61%	-39.61%	5.29×10^6	0
$(10^2, 1, 1)$	-24.70%	25.99%	-39.52%	0	0
$(10^5, 1, 1)$	-24.70%	25.99%	-39.52%	0	0

Table: Results with various w_1 with given $w_2 = 1$ and $w_3 = 1$

(w_1, w_2, w_3)	Risk	Delay (regular)	Delay (hazmat)	Toll (regular)	Toll (hazmat)
$(1, 1, 1)$	-24.70%	22.61%	-39.61%	5.29×10^6	0
$(1, 10^5, 1)$	-5.23%	2.86%	4.89%	2.87×10^8	0
$(1, 10^8, 1)$	-4.41%	2.81%	5.58%	2.62×10^8	0
$(1, 10^{12}, 1)$	-4.41%	2.81%	5.58%	2.62×10^8	0

Table: Results with various w_2 with given $w_1 = 1$ and $w_3 = 1$

(w_1, w_2, w_3)	Risk	Delay (regular)	Delay (hazmat)	Toll (regular)	Toll (hazmat)
$(10^{-4}, 1, 10^5)$	-22.52%	3.06%	-11.9%	3.30×10^7	0

Table: Results with $(w_1, w_2, w_3) = (10^{-4}, 1, 10^4)$

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