With Min Cut Max Traffic Flow at Junctions using Graph Theory

By

Rohitkumar Reddy Challa

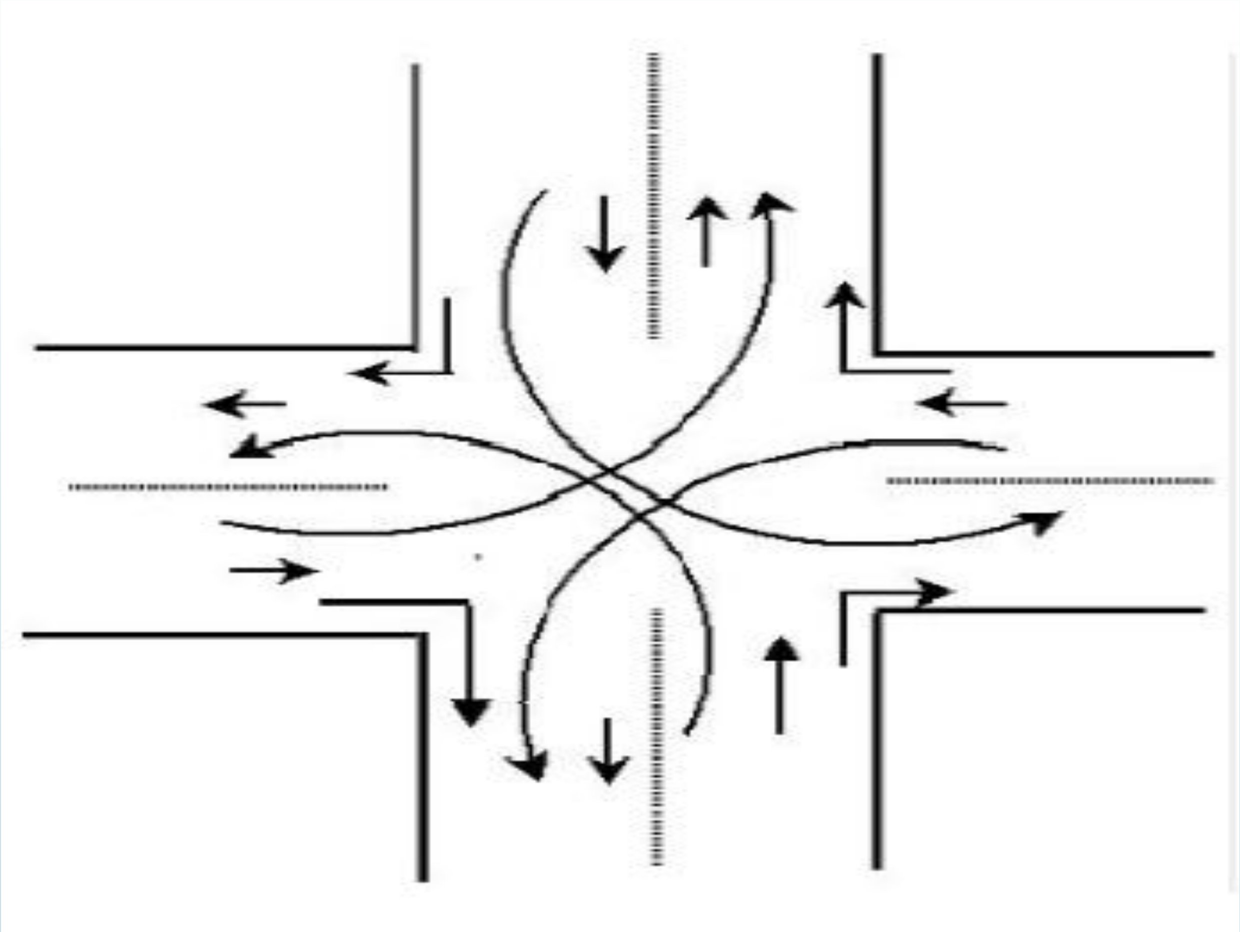
Content:

- Real World Problem
- Construct a graph From Problem
- Graph Properties
- Solution to the Problem
- Conclusion
- References

A Real World Problem?

- Due to the permanent growth of population new roads and highways has been built in most of the modern cities to harmonize the increasing number of vehicles.
- The growing number of vehicles has led to the accidents, noise pollution and waste of time. These problems are managed by signal control.

Construct a graph From Problem



Graph Properties

- **Graph Coloring, Chromatic number, Star Coloring, Star Chromatic number and Four Color theorem.**
- **CUT**

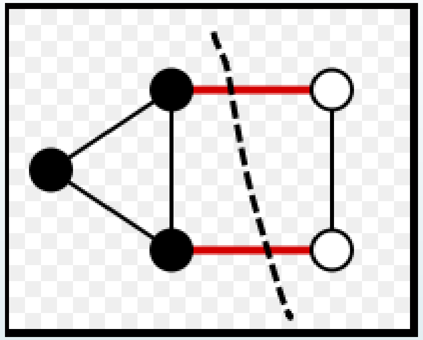
Cut is a partition of the vertices of a graph into two disjoint subsets. Any cut determines a cut-set, the set of edges that have one endpoint in each subset of the partition. These edges are said to cross the cut.

- **Cut Set**

A cut C=(S,T) is a partition of V of a graph G=(V,E) into two subsets S and T. The cut-set of a cut C=(S,T) is the set $\{(u,v) \in E | u \in S, v \in T\}$ of edges that have one endpoint in S and the other endpoint in T. If s and t are specified vertices of the graph G, then an s–t cut is a cut in which s belongs to the set S and t belongs to the set T.

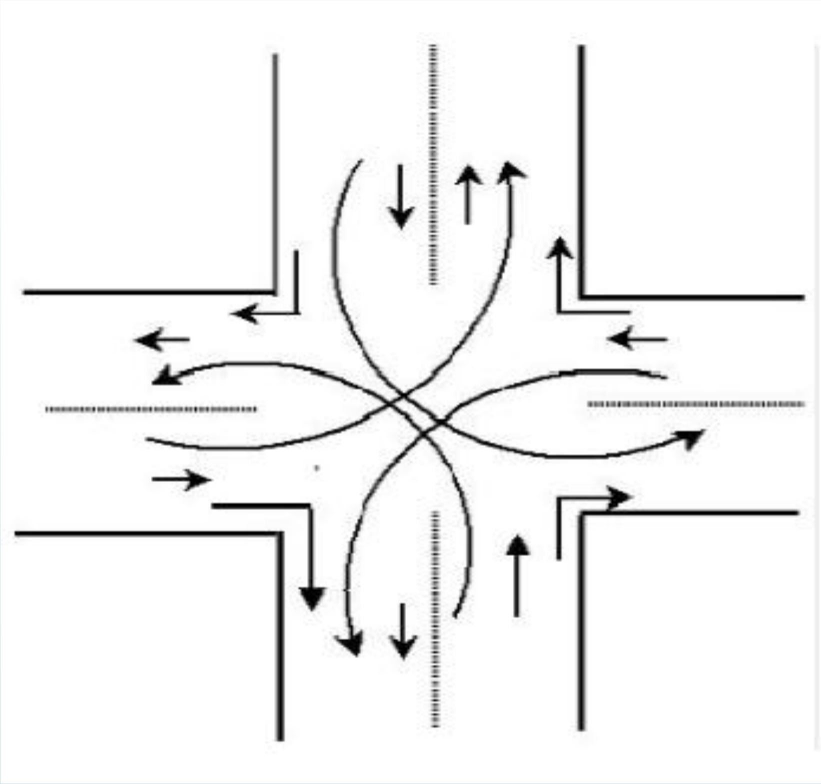
- **Weighted Graph:** In an weighted graph and undirected graph, the size or weight of a cut is the number of edges crossing the cut. In a weighted graph, the value or weight is defined by sum of the weights of the edges crossing the cut.
- In this case, the capacity of a traffic intersection is defined as the maximum hourly rate at which the traffic participants or vehicles can be expected to traverse the intersection during a given time period under prevailing roadway, traffic and control conditions. The time period normally used for expressing capacity is hour.
- **Edge-Connectivity:** The edge connectivity of a graph is the largest , that is, the minimum k such that it is possible to disconnect the graph by removing k edges.
- In graphs that represent communication or transportation networks, the edge-Connectivity is an important measure of reliability.

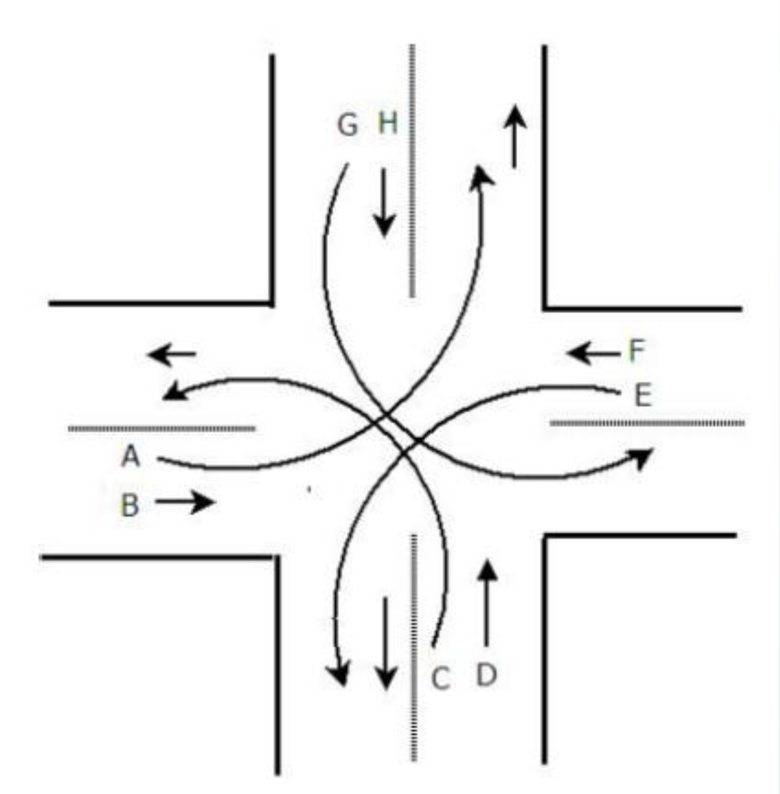
- **Minimum Cut**: A cut is minimum if the size or weight of the cut is not larger than the size of any other cut.
- The illustration on the below graph shows a minimum cut: the size of this cut is 2, and there is no cut of size 1 because the graph is bridgeless.



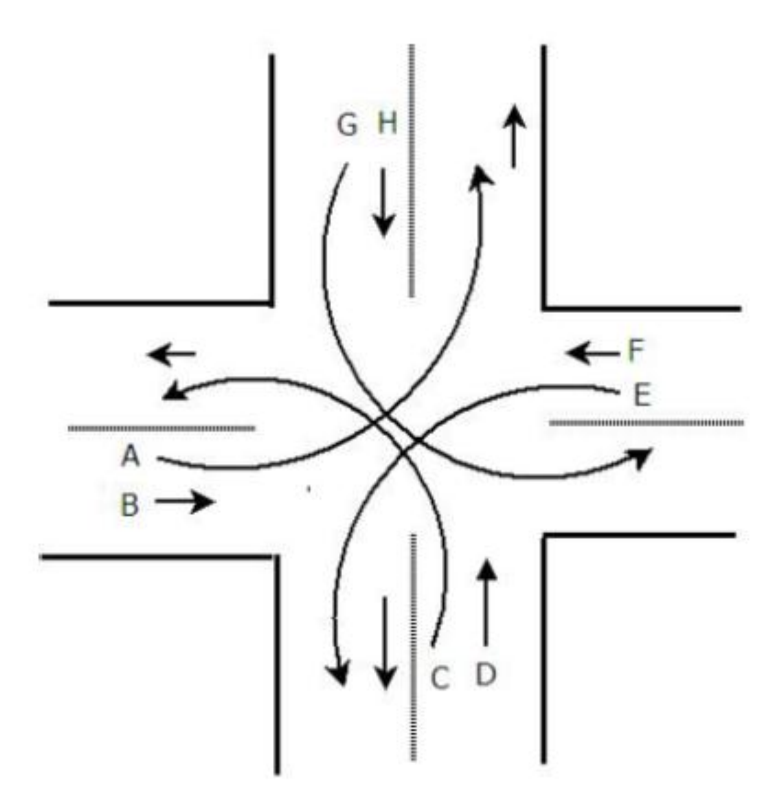
Theorem: The Max-flow min-cut theorem proves that the maximum network flow and the sum of the cut-edge weights of any minimum cut that separates the source and the sink are equal.

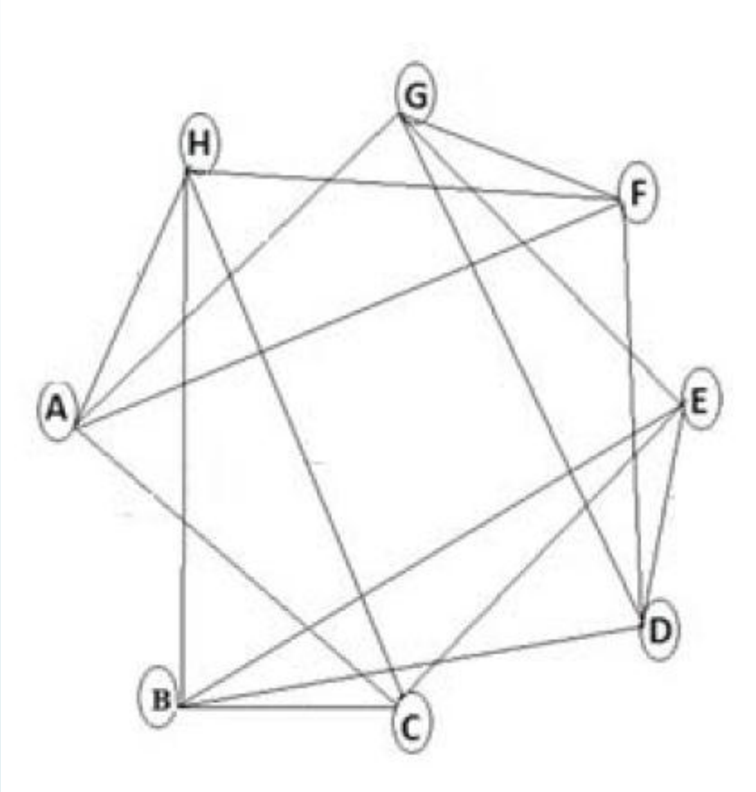
Solution to the Problem



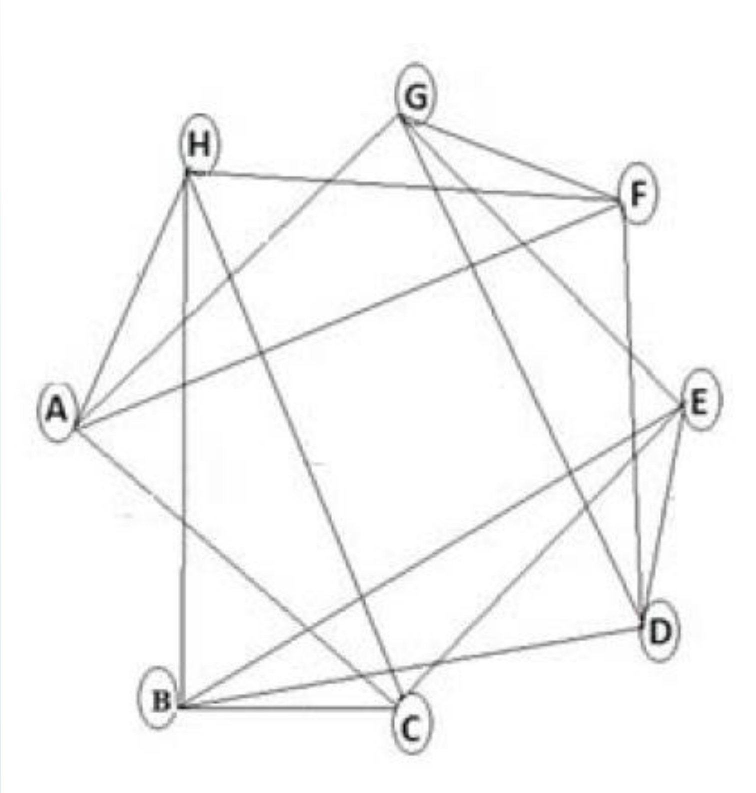


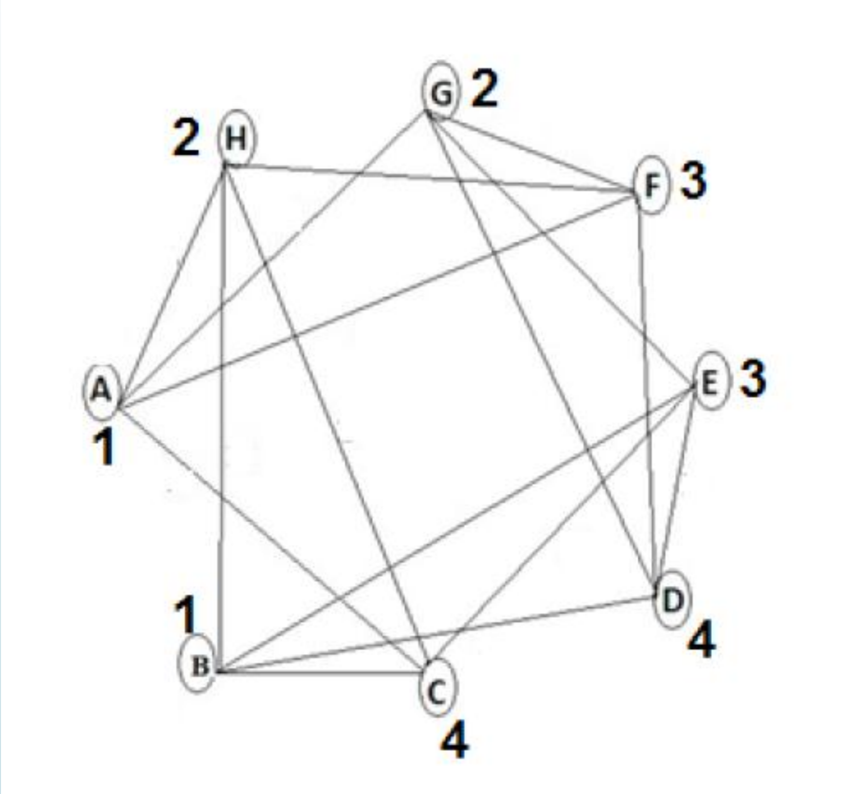
Solution to the Problem



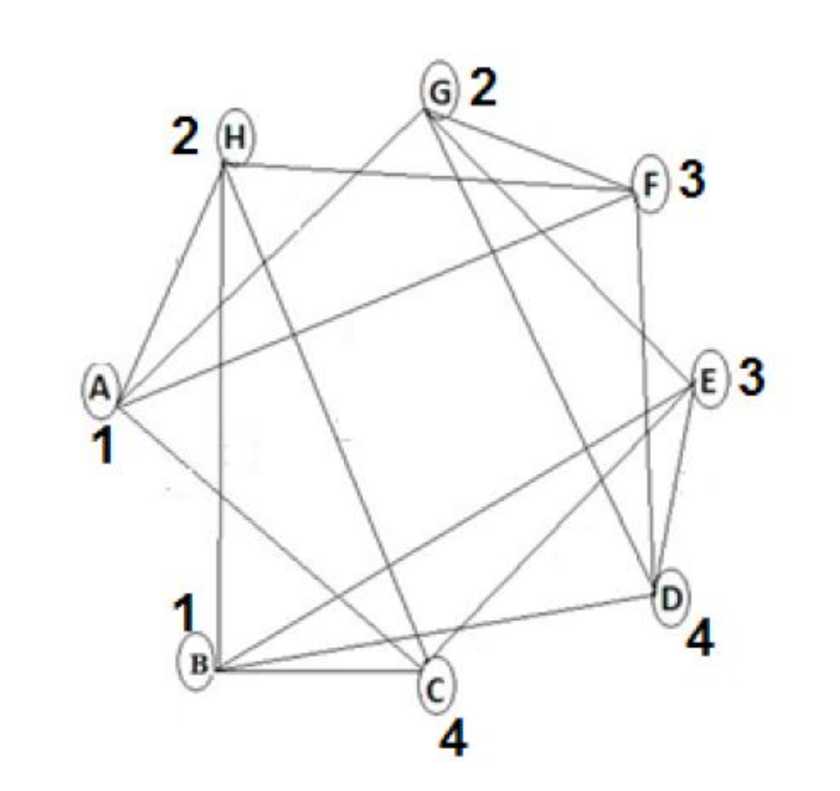


Solution to the Problem





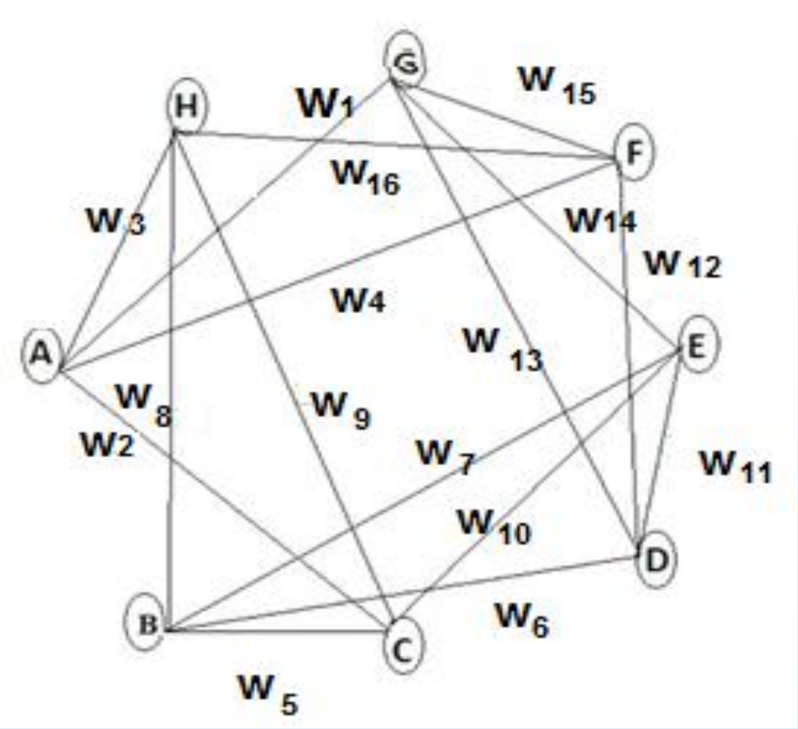
Solution to the Problem



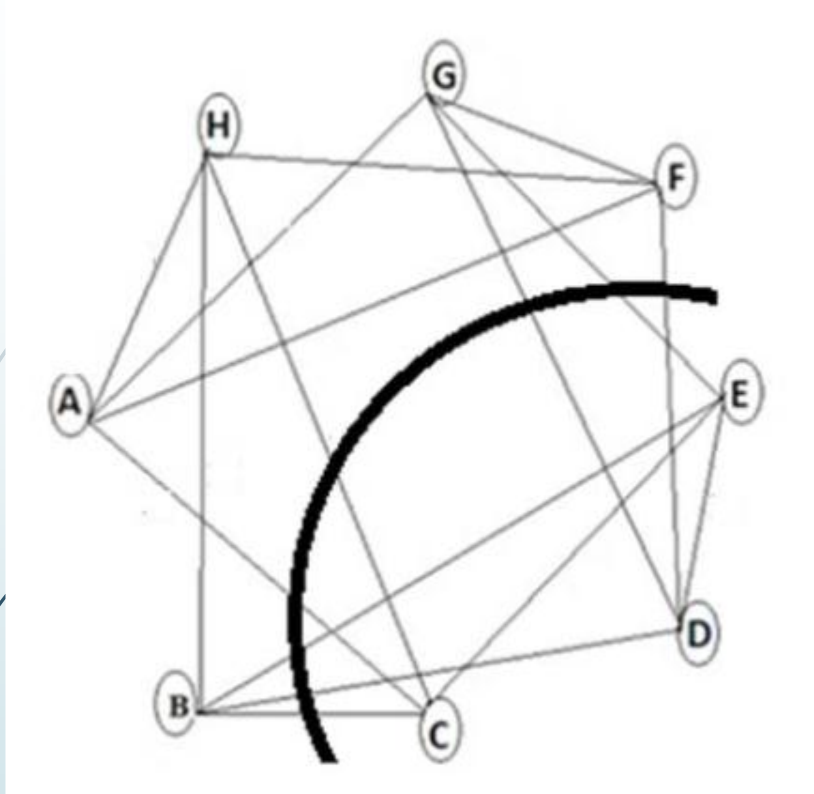
	colors	vertices
Color 1	green	A & B
Color 2	blue	H & G
Color 3	red	F & E
Color 4	yellow	C&D

Traffic light pattern			
Phase 1	Phase 2	Phase 3	Phase 4
Only A and B proceed	Only C and D proceed	Only E and F proceed	Only G and H proceed

Minimization of waiting time of vehicles in Traffic signal:



VERTICES	EDGES	WEIGHTS
A	AG,AC,AH,AF	W_1,W_2,W_3,W_4
B	BC,BD,BE,BH	W_5,W_6,W_7,W_8
C	CA,CB,CH,CE	W_2,W_5,W_9,W_{10}
D	DB,DE,DF,DG	W_6,W_{11},W_{12},W_{13}
E	ED,EC,EB,EG	W_{11},W_{10},W_7,W_{14}
F	FA,FD,FG,FH	W_4,W_{12},W_{15},W_{16}
G	GA,GF,GE,GD	W1,W15,W14,W13
H	HA,HB,HC,HF	W3,W8,W9,W16



VERTICES	EDGES	WEIGHTS
C	CA,CB,CH,CE	W2,W5,W9,W10
D	DB,DE,DF,DG	W6,W11,W12,W13
E	ED,EC,EB,EG	W11,W10,W7,W14

Traffic light pattern			
Phase 1	Phase 2	Phase 3	Phase 4
Only A and B proceed	Only C and D proceed	Only E and F proceed	Only G and H proceed

- The minimum number of vehicle which can be permitted through the edges is the capacity of the cut in the traffic network which means the right of way without any distraction for a smooth, safe, and better control of traffic. As the amount of the cut is obtained by the weights of the edges of the cut which is the sum of their weights.
- Here the sum of the weights W9+W10+W4+W7+W11+W12+W8+W13+W14+W15 of the edges must be less than or equal to 30000passenger vehicle per unit(PCU) as each has a maximum limit of 3000 passenger vehicle per unit per hour.
- Finally, Maximum cut value can obtained from minimum cut maximum flow theorem.

Conclusion:

- Many of the traffic real world problems can be solved by graph theory.
- During solving the problem we have to use the graph properties.
- While dealing with the R-W problems, the data what you're getting must be accurate it helpful for efficient solution to the problem.
- Recent days technology came on to the hands and getting efficient solutions to the traffic problems. Those are executing in real life.
- Finally, every one have the safer journey, cheaper journey and saving the time.

References:

- www.Wikipedia.org
- GRAPH COLORING ANDEDGE CONNECTIVITY INTRAFFIC SIGNAL PROBLEM R.Nagarathinam, Dr. N.Parvathi.
- Class lectures.

Questions ???