IPTE
IP Traffic Engineering with QoS support

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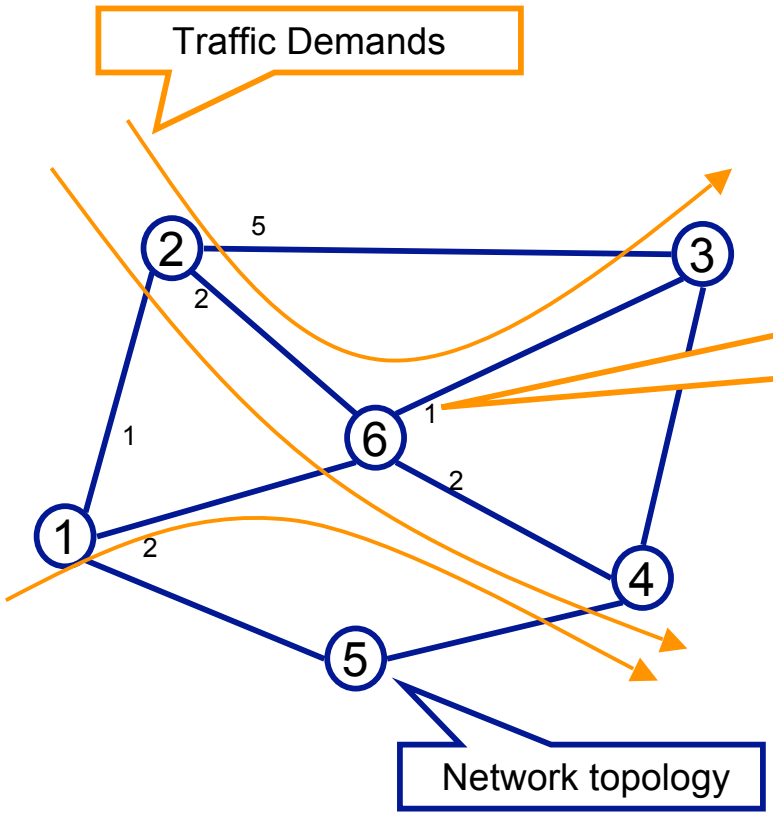
Topics…

- Basic idea
- Requirements
- Outline of Operation
- Some Results

The Idea - TE Using Weight Manipulation



OSPF link weights determine the routes taken by traffic Demands.

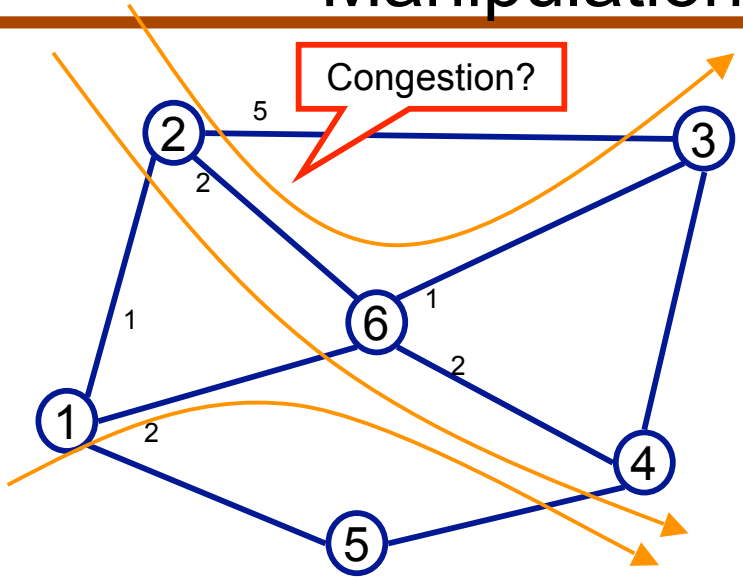
Method for optimisation:
Change link weights to better Balance load.

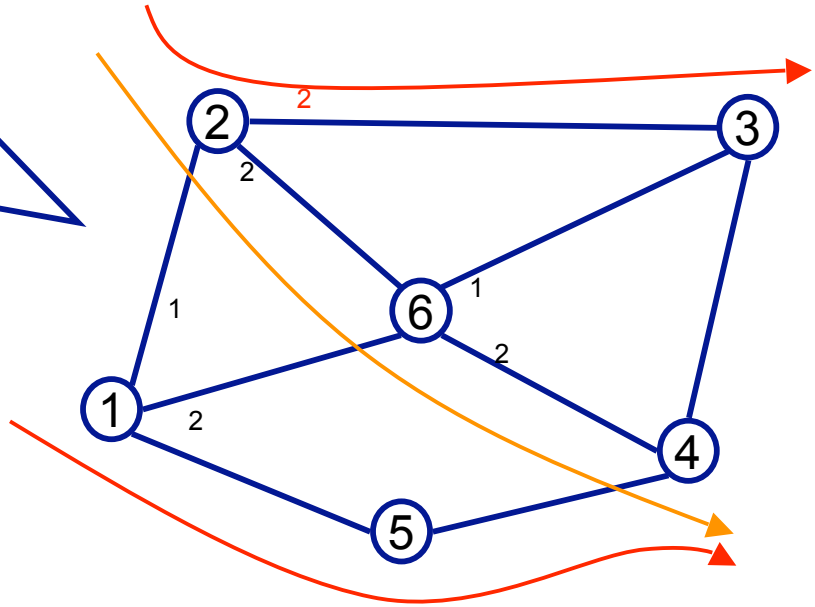
The Idea - TE Through Weight Manipulation

Result:
Flows are better distributed across network.
Largely done already.

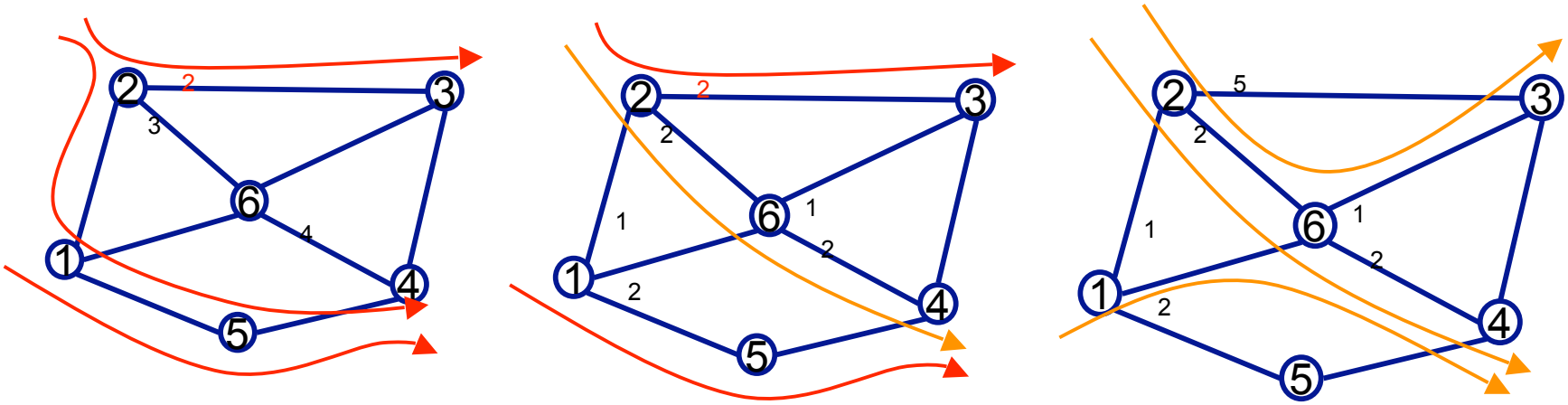
Problems:
Have to watch for QoS constraints on the demands.

DSCP based QoS classes help…





Routing Planes



Tag traffic with similar QoS constraints with same DSCP:
DSCP tagged traffic classes provide the means for routing on DSCP + link weight set for each DSCP

…hence allowing 64 independent “routing planes”.

Problems:
Complexity increased though traffic of different QoS Classes sharing the same physical link.

“Why do such a thing?”

Advantage:
QoS traffic engineering without the need for MPLS alike,
little change to existing technology.
Management plane QoS,
no network layer awareness needed.

Disadvantage:
Not as flexible as MPLS-TE?
Also, need:

QoS Demand Matrix:
Projected demands or past measured demands,
Bandwidth, delay constraint

Network topology:
The topology of the network
to be optimised.

Optimisation Principle

Principle:

Simulates traffic on network for given set of link weights.

Optimisation is based on heuristics and

many iterations.

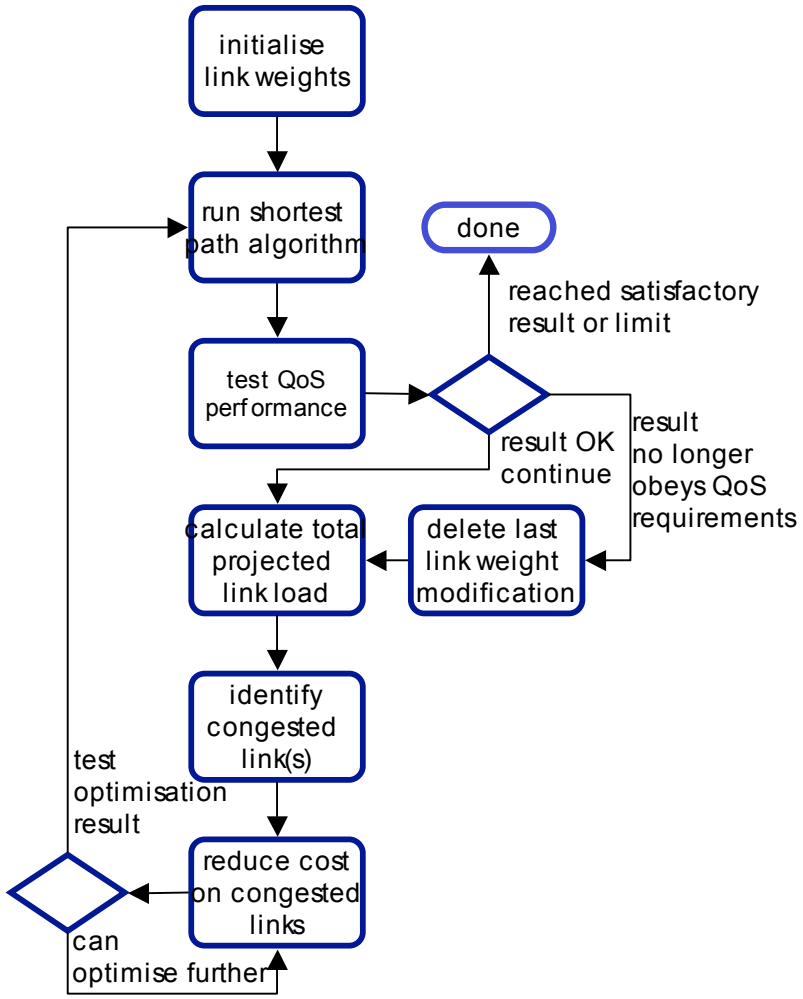
Primary Goal:

For a given topology and traffic demand matrix, find a set of link weights that balance the load across the network, while honouring the QoS constraints of the traffic demands.

Secondary Goal:

Additionally, balance the load evenly across all links, so that future demands

may be accommodated.



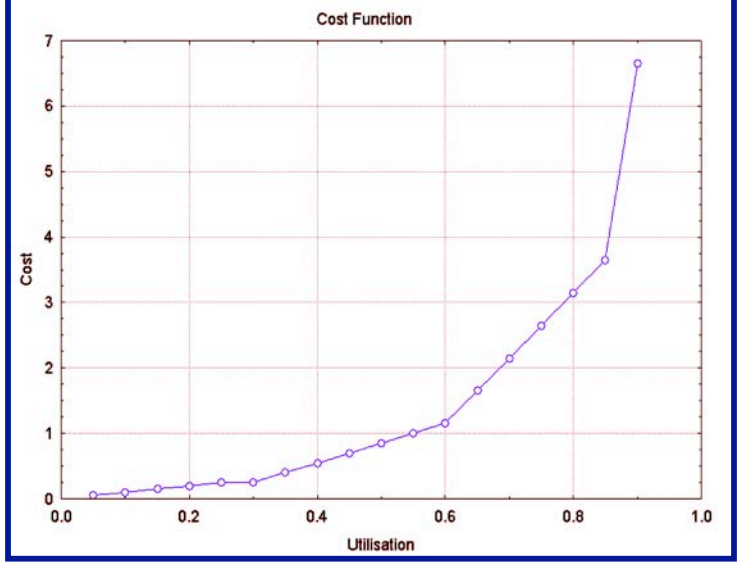
The Cost Function - Identify High Cost Links

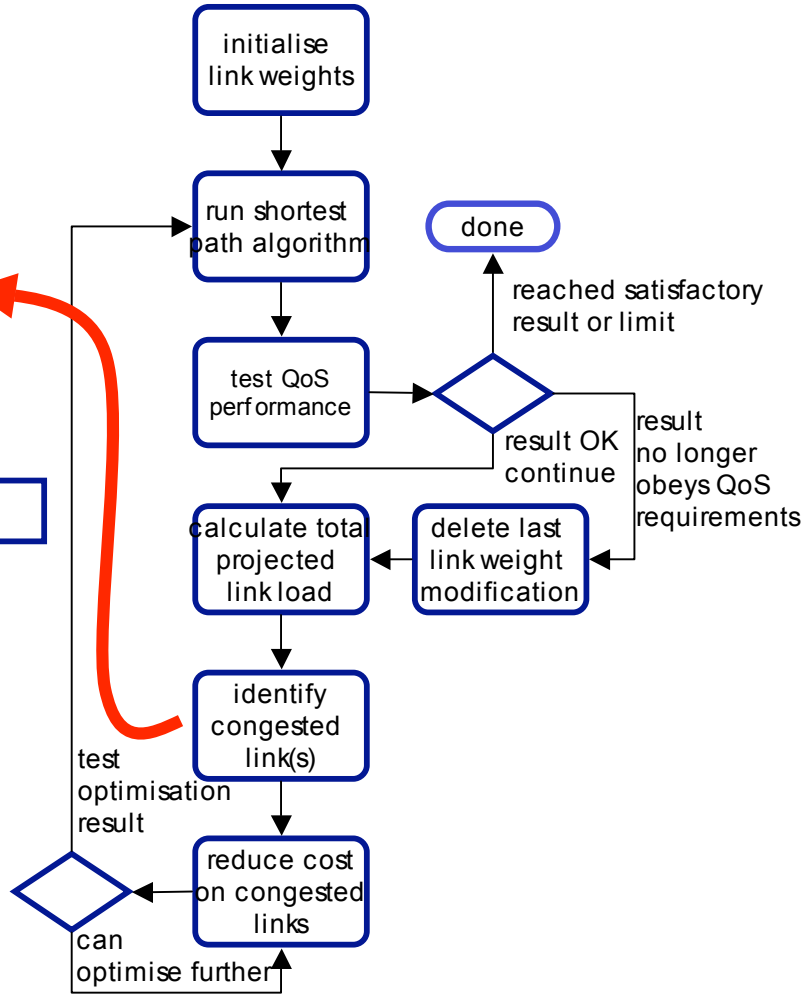
Equivalent b/w to account for traffic from different classes.
All classes are optimised at the same time!

Sum of cost from all links

$$\Phi = \sum_{l \in E} \Phi_l(L_e) = \sum_{l \in E} \Phi_l \left(\frac{\sum_{h \in H_l} (f_{l,h}(x_{l,h}))}{c(l)} \right)$$

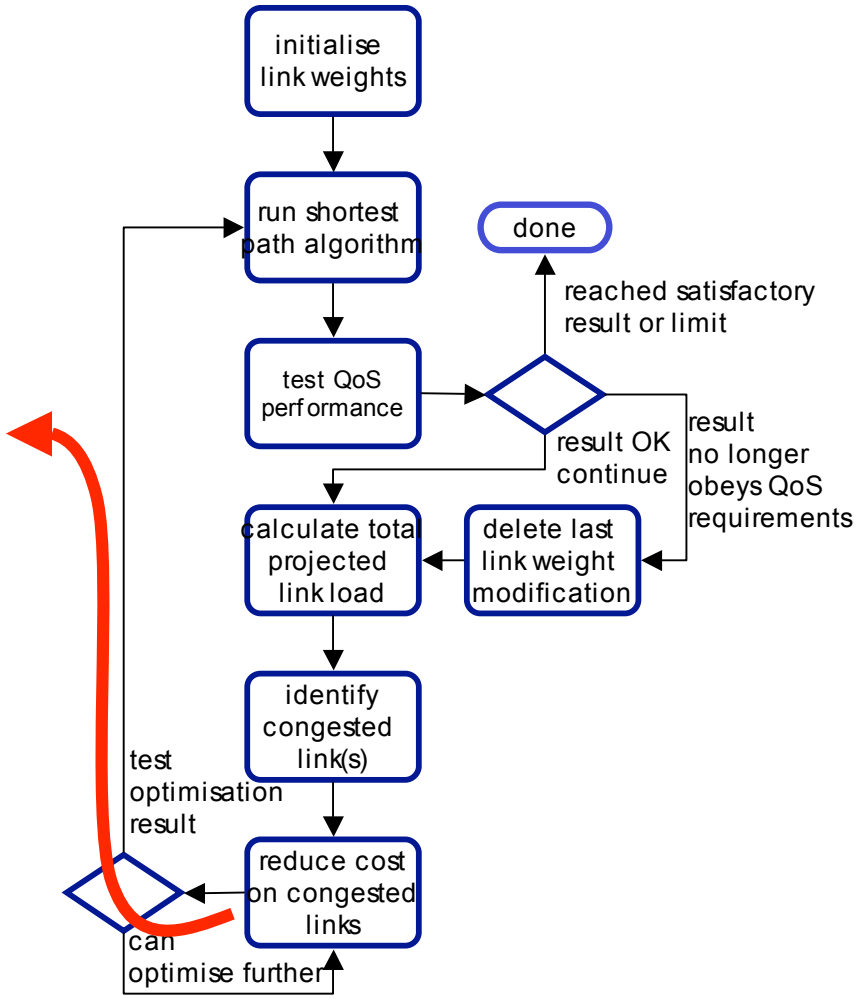
Sum of DSCP's cost



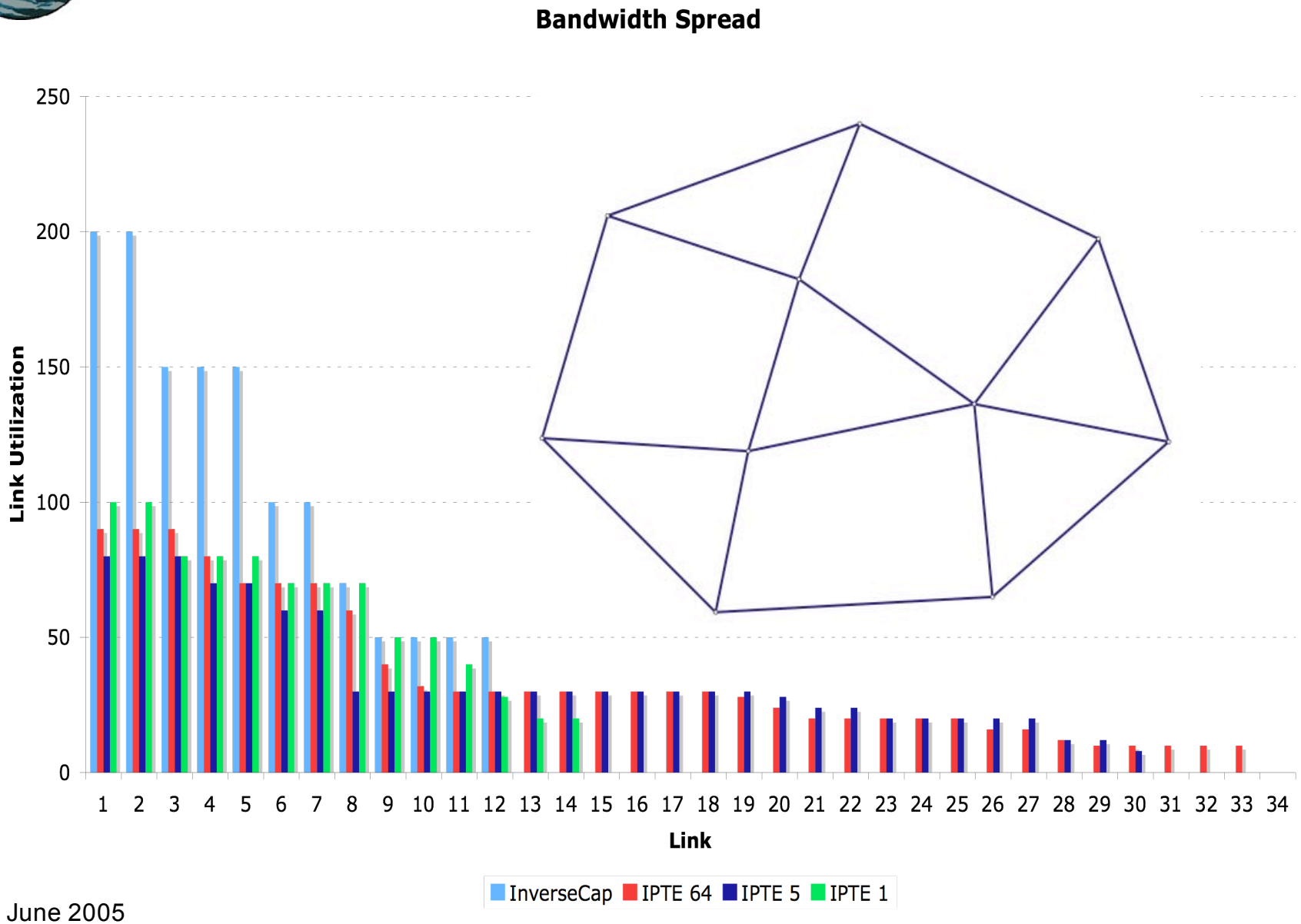


Methodology for Cost Reduction

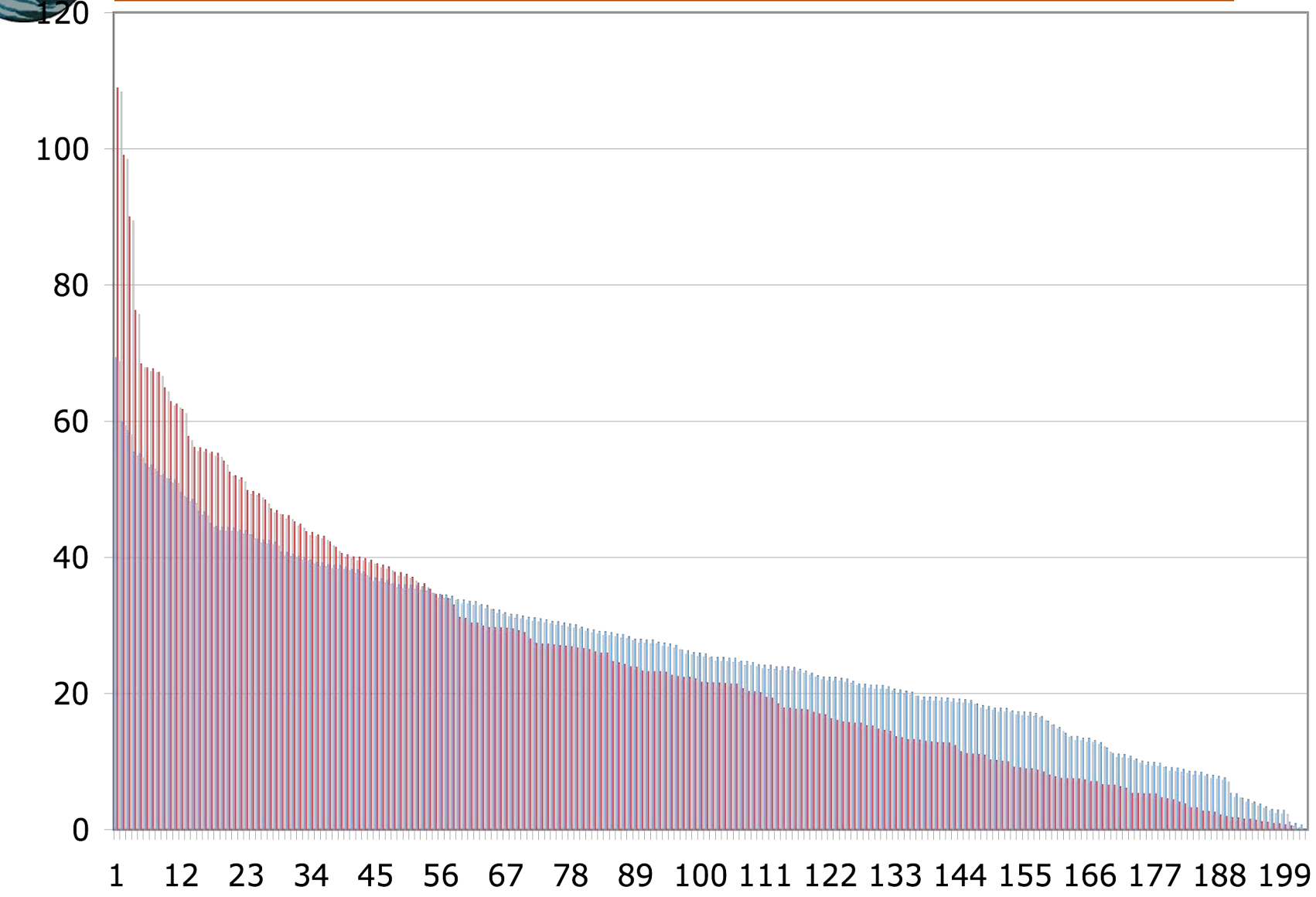
- High cost link cost reduction
  - Find highest cost link and reduce the load on this link by increasing its link weight
- Random link cost reduction
  - Randomly select from a number of high cost links and increase link weight.
  - Avoids cycling problem of the first approach
- Advanced guided cost reduction
  - Record past iterations in hash table
  - Use Random reduction method



Bandwidth Distribution Results



50 Node Network Bandwidth Distribution



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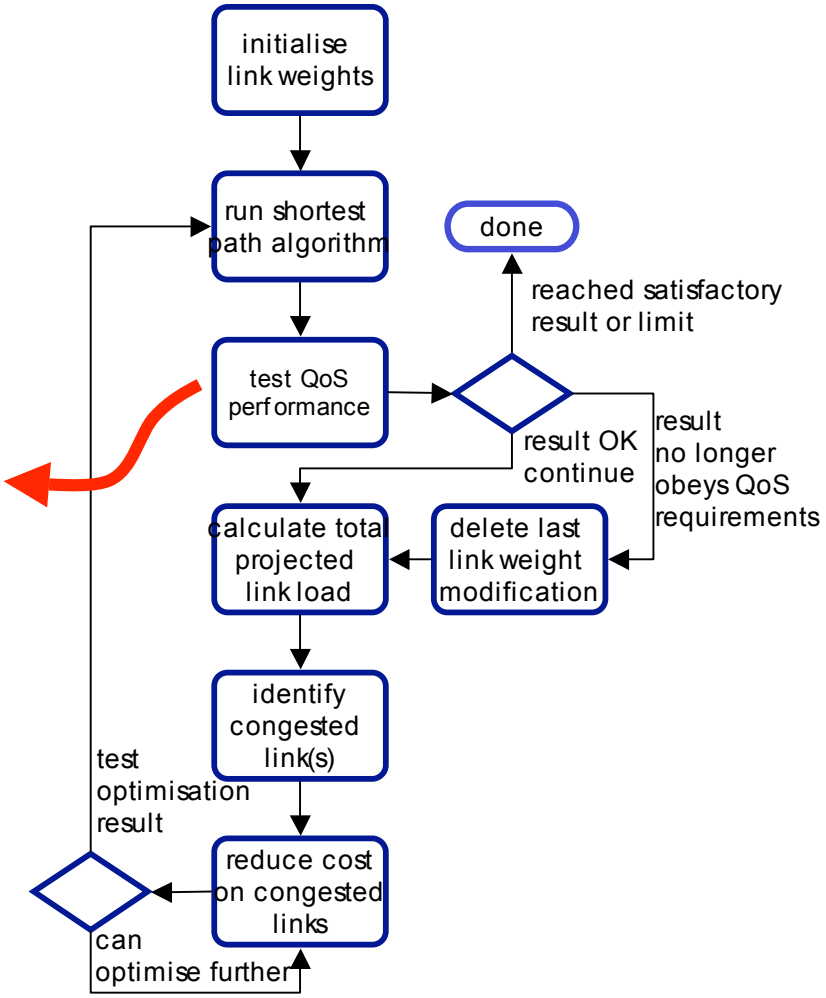
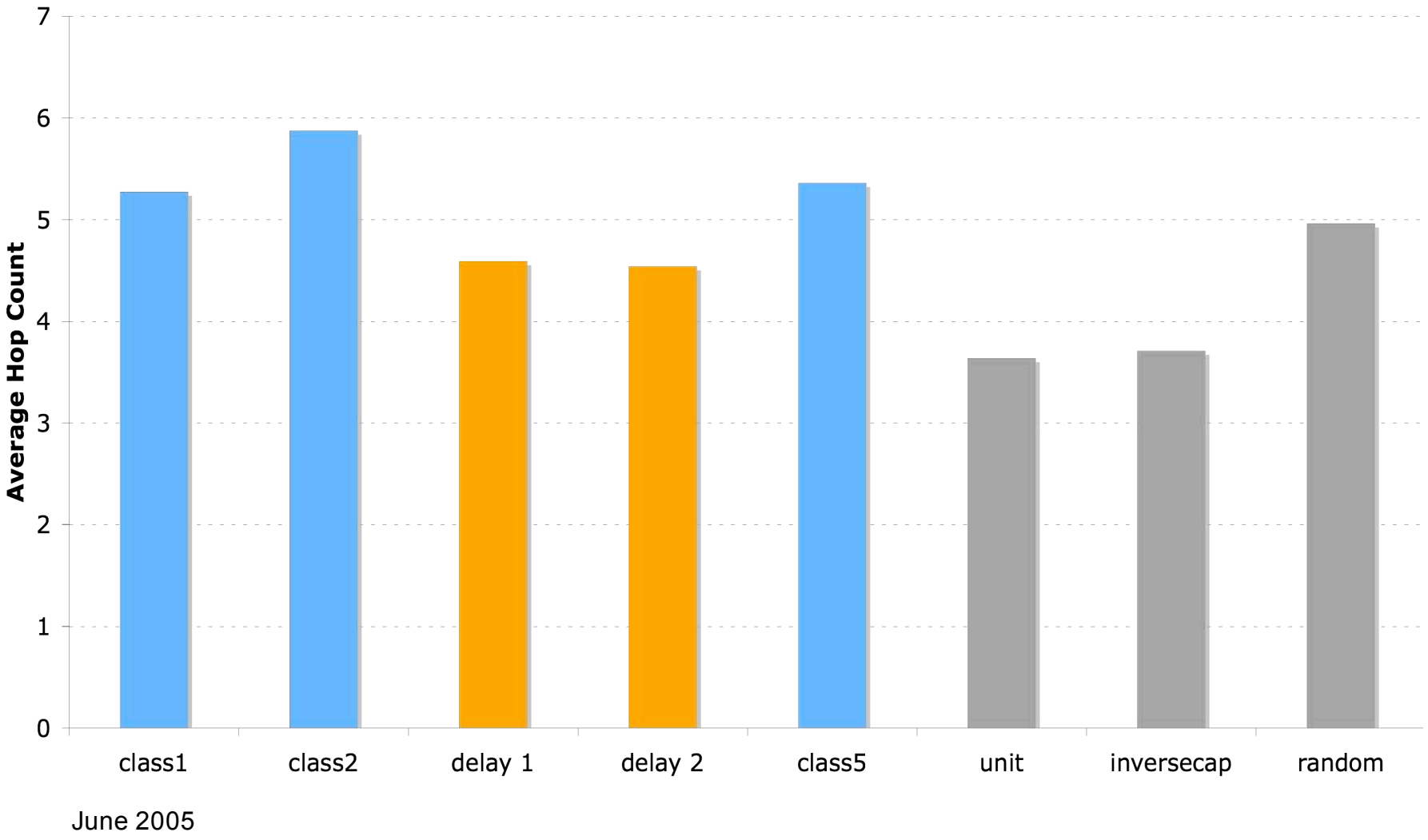
QoS Performance

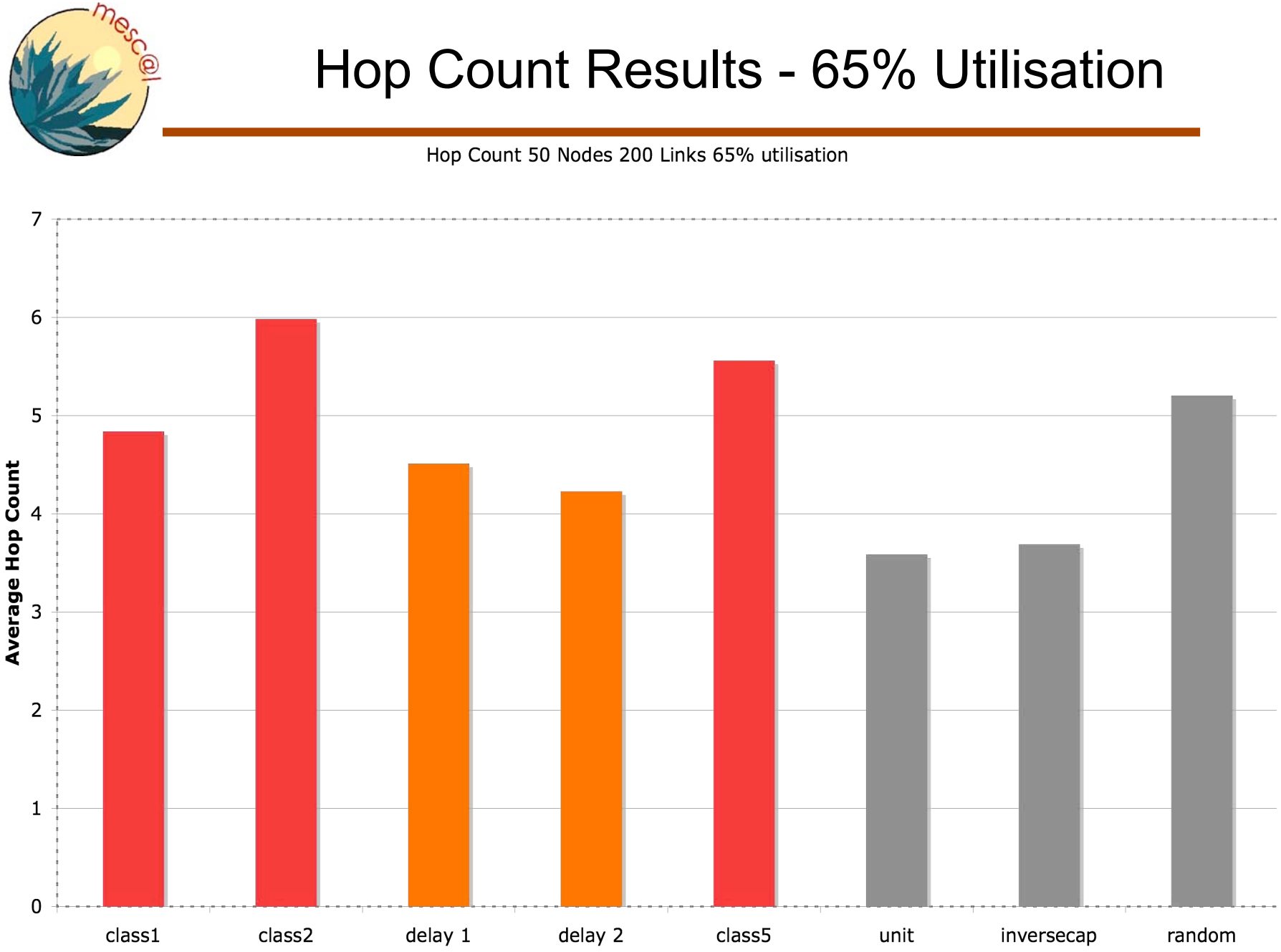
- Problem
  - Modification to a link weight potentially has impact on routing on the whole plane
  - Resulting changes in traffic flows have impact on all planes
- Solution
  - Each modification requires re-computation of projected load on network as well as checking of QoS constraints for planes



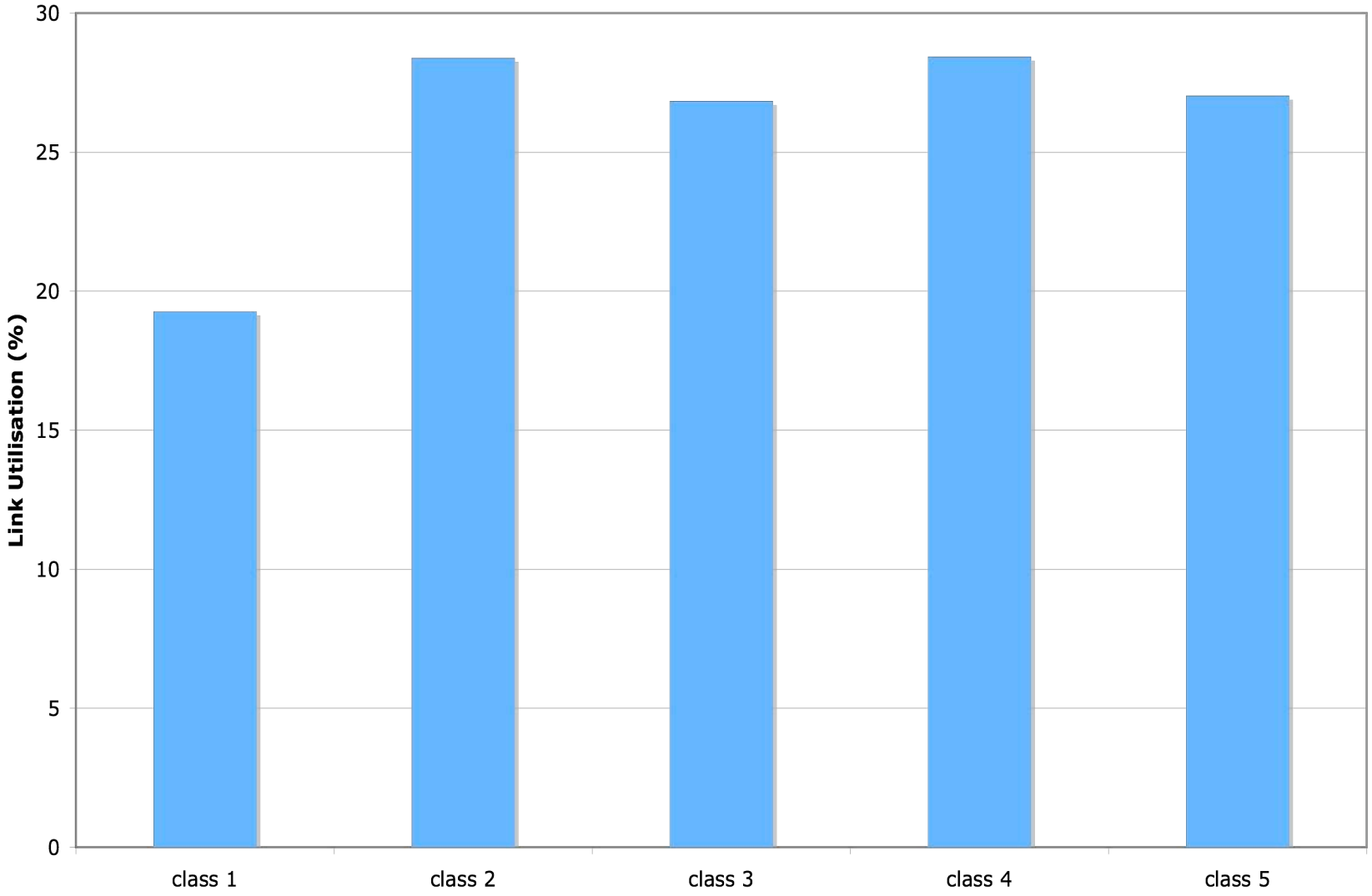
Hop Count Results - 40% Utilisation



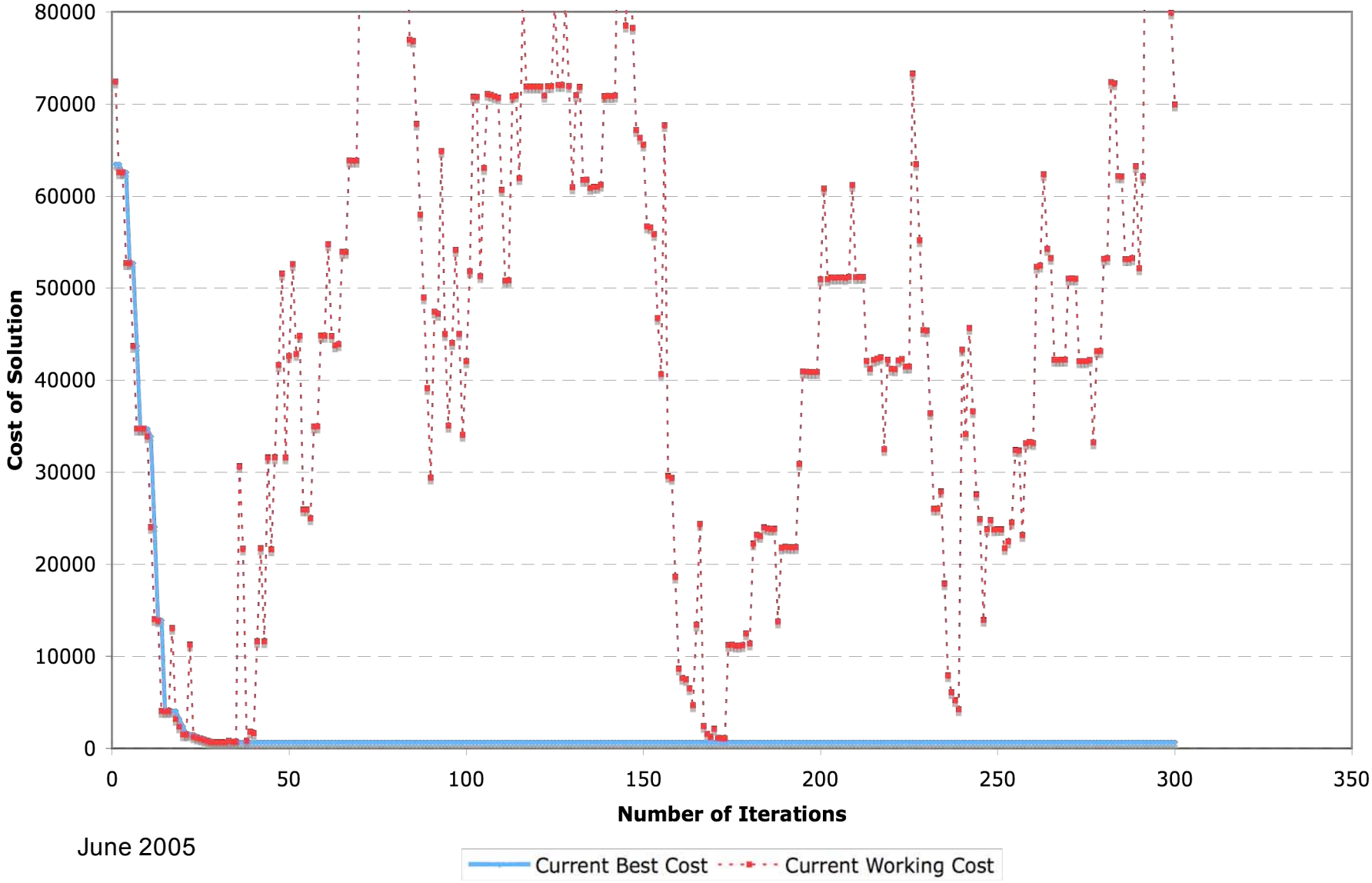
Hop Count Results - 65% Utilisation



Link Utilisation Results



Convergence



IP Traffic Engineering with QoS support

- Cost function issues to be resolved to better “decouple” the different classes’ optimisation goals
- Multi-purpose optimisation of network to many different needs
- Based on “traditional” routing