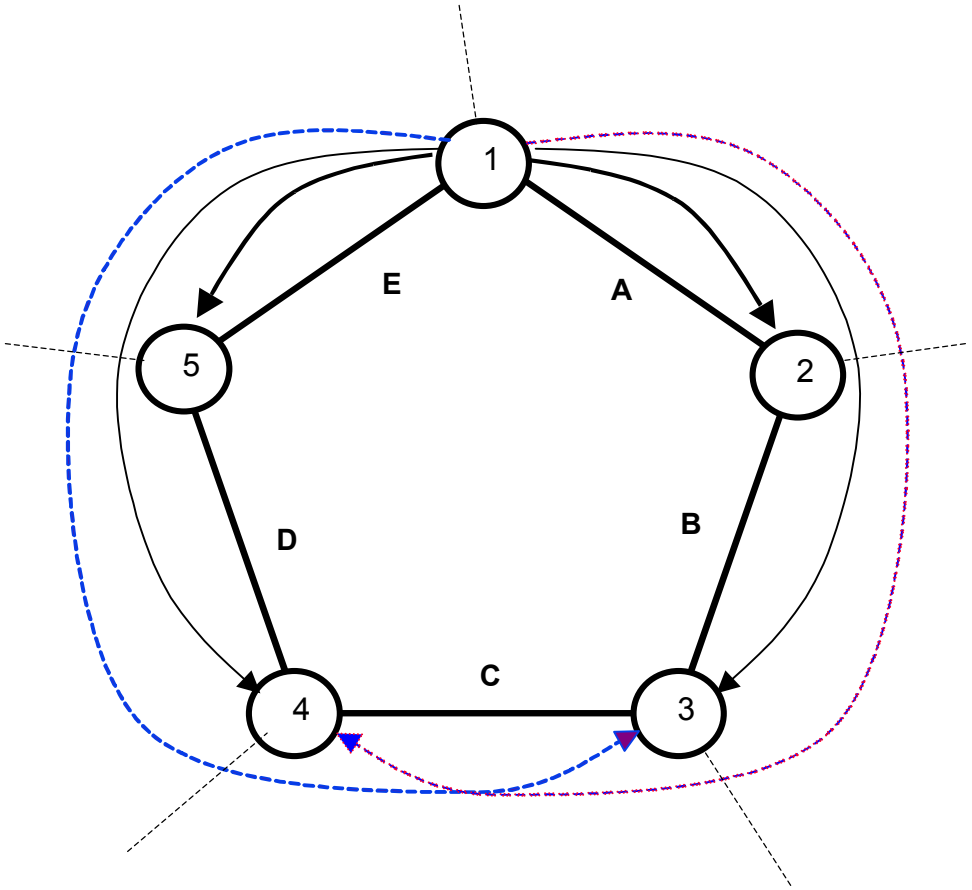
About MPLS

- "It is expected that MPLS will be a crucial strategic element in addressing the ever-present scaling issues faced by the Internet as it continues to grow."
  - this is from a MPLS conference advertisement
- "Until MPLS is fully supported it brings nothing new to our customers," said [Mika] Uusitalo [Sonera]. "We will not implement it until it really brings us value,"he said, confirming a growing Scandinavian trend against MPLS
  - http://www.totaltele.com/view.asp?ArticleID=32975&Pub=CWI&CategoryID=705

(MPLS for) Load balancing

- Ability to forward IP packets over arbitrary non-shortest paths
  - makes it possible to apply load balancing
- Still, there is the question, Why?
  - for improved utility
    - through better throughput
  - for reduced cost
    - through smaller capacity requirement - but is this valid statement?

Load balancing - a case study



OSPF

vs.

Load balancing

Evaluated issue:

should, e.g., part of the traffic from 1 to 3 transferred via 5 and 4

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Assumptions

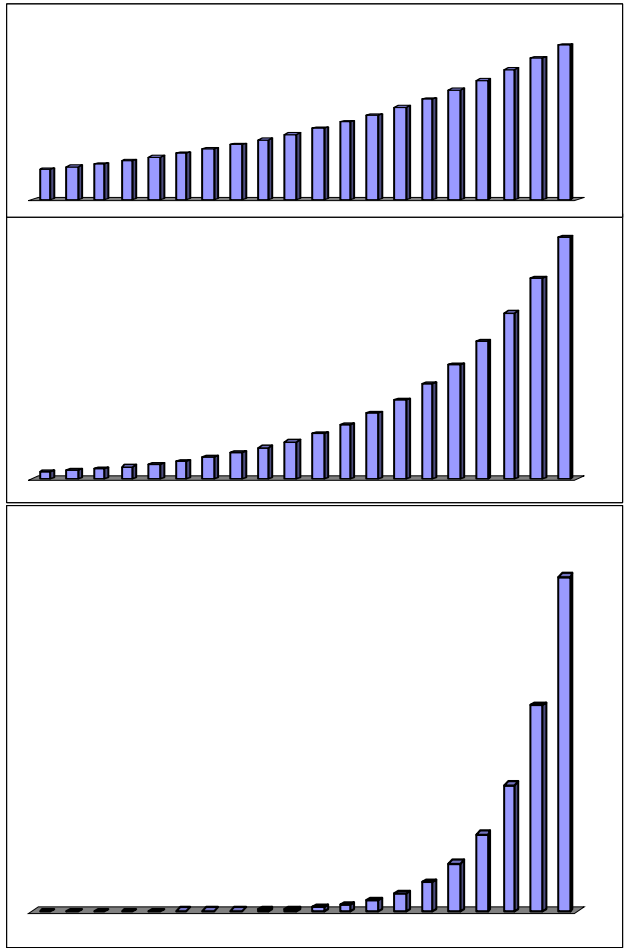
- Average traffic per each node pair = 10
- Variations of these traffic components, $\rho/A = 0.2 \ldots 2$
  - log-normal distribution + random number generator used to select a number of cases
  - after the case has been determined, the average traffic is fixed
    - in addition, it is assumed that the real traffic varies according to (another) log-normal distribution ($\rho/A = 0.25$)
- Dimensioning criteria
  - (approximately) the probability that a packet encounters a link that is overloaded = P_{loss}

Evaluation method

- Comparision of required capacity
  - find the capacity for OSPF and Load Balancing in a way that P_{loss} is the same for both
  - gain of LB = $(C_{OSPF} - C_{LB})/C_{OSPF}$
- Tool used for optimizíng
  - Excels Solver
    - 10 variables (limited between 0 and 1)
    - seem to work
    - result not guaranteed - but anyway that is realistic situation
- Main issue to be evaluated
  - gain as a function of unevenness of traffic distribution (ρ/A)

Unevenness examples

- $\rho/A \approx 0.5$
  - 19 * 10 + 1 * 35.2
  - 2 + 3 + 4 + … 20 + 21
  - 1.09^i , i = 1 … 20
- $\rho/A \approx 1.0$
  - 19 * 10 + 1 * 67.6
  - 7 * 0 + 2 + 4 + 6 … 24 + 26
  - 1.21^i , i = 1 … 20
- $\rho/A \approx 2.0$
  - 19 * 10 + 1 * 171.8
  - 15 * 0 + 10 + 20 + 30 + 40 + 50
  - 1.63^i , i = 1 … 20



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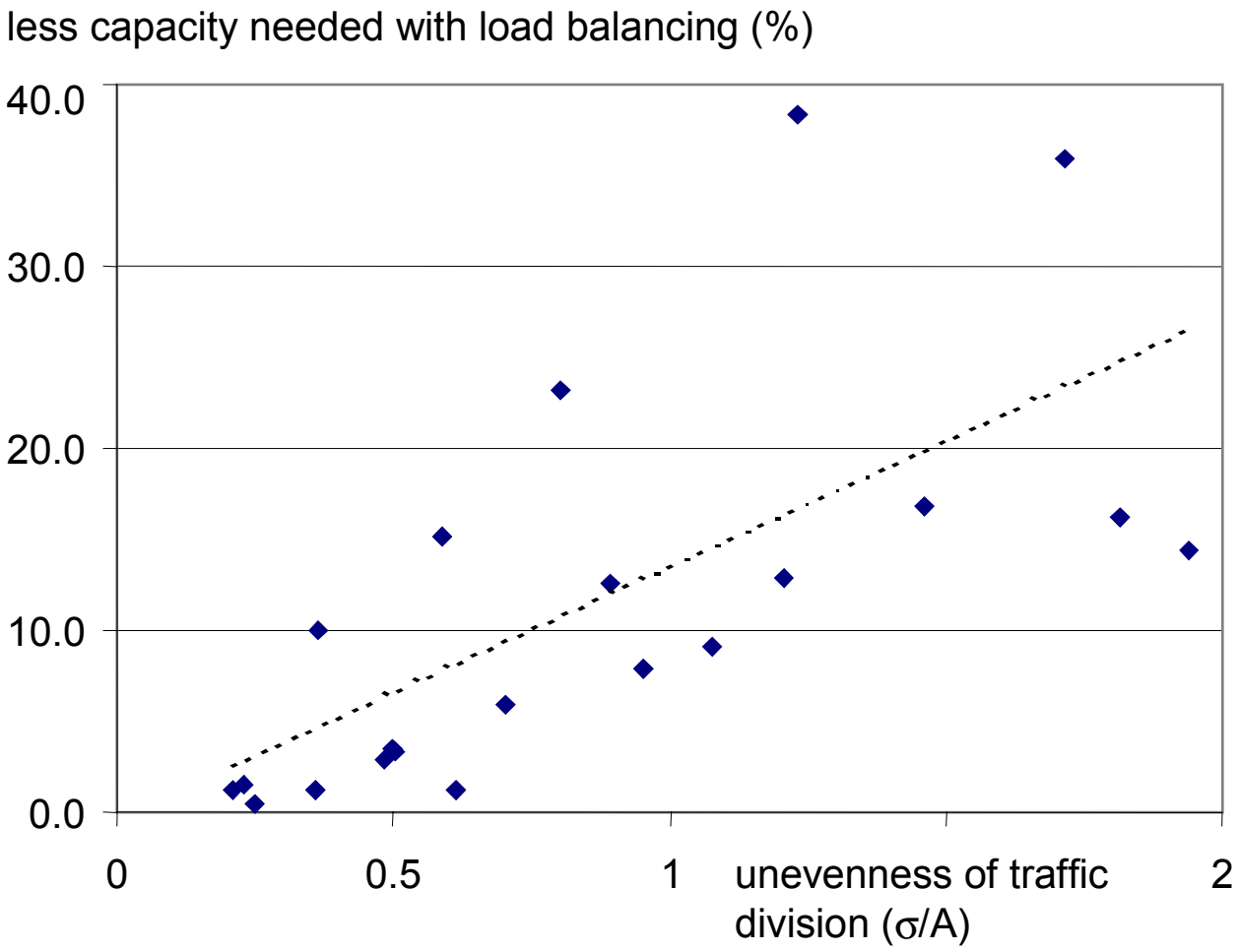
Results



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Conclusions

- Gain measured in capacity saving 10 … 20%
  - depending on evenness of traffic distribution
  - maybe even 30% with very uneven load distribution
- But
  - traffic is not as static as supposed here
  - it is not always possible to divide traffic infinitesimally
  - implementation and management cost can be significant
  - if one link is permanently overloaded, its capacity should be updated rather than use permanently another route
- Real question
  - is, e.g., 10% capacity saving more valuable than the extra cost related to the introduction of a new technology

About DiffServ

- diffserv architecture and phb definitions made router vendors aware that they need to implement various classification/policing/marking/queuing/dropping mechanisms in their boxes and that is all there is to it. when i shop for a router, i never ask anything about ef, af, or even diffserv. i only ask about the mechanisms to make sure that they allow me to implement the services that i have in my network.
  - -- juha [Heinänen, Telia]

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About AF

- The question is what is the use of AF? What problem we can solve or what service we can implement by
  - by classifying packets into 4 classes
  - by reserving a share of capacity for each class
  - by marking each packet into one of three drop precedences (within the class)
- From the viewpoint of
  - utility
    - individual user
    - group of users
  - isolation (but is this a relevant viewpoint)
  - something else

AF implementation