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Issues in modelling ISP networks

Olivier Bonaventure
Pierre François
Bruno Quoitin

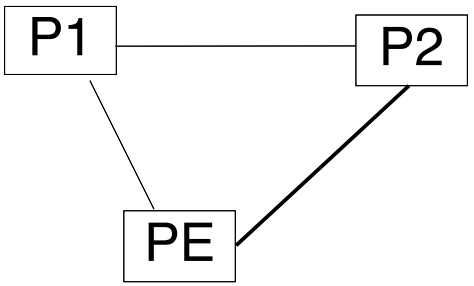
Université catholique de Louvain
Louvain-la-Neuve, Belgium

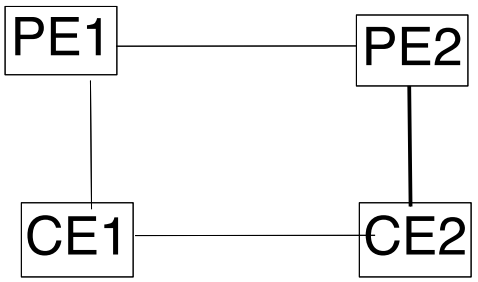
http://inl.info.ucl.ac.be

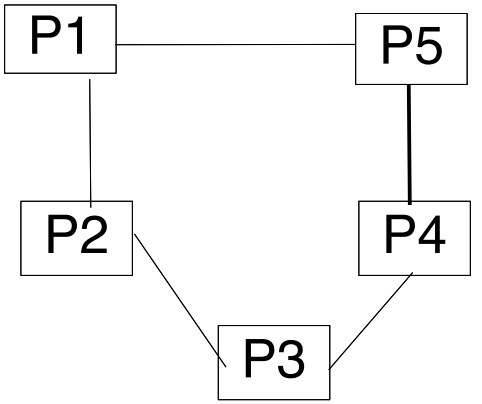
INGI
Département d'ingénierie informatique

The ISP's view of a network

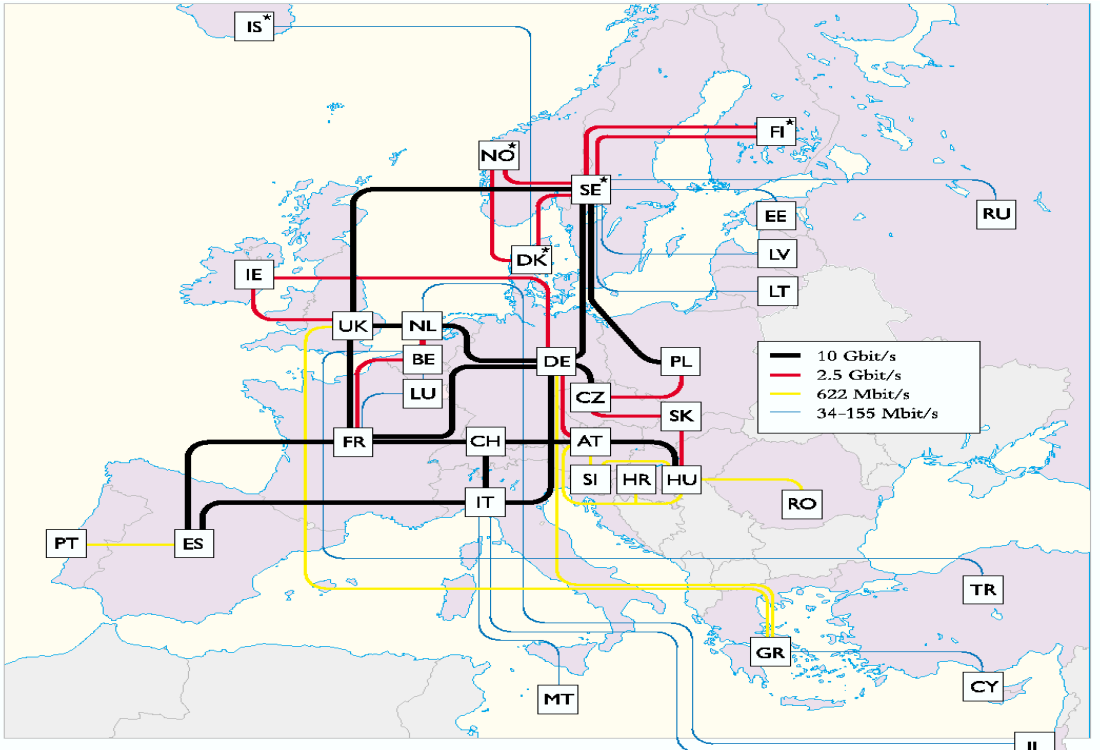
- High-level architecture
  - Star (single or dual)
  - Ring
  - Full mesh
  - Parallel planes
  - ...
- Building blocks
  - Points of Presence
    - Several routers per POP
      - P, PE and CE routers
    - Location is function of clients
  - Common patterns







Research networks

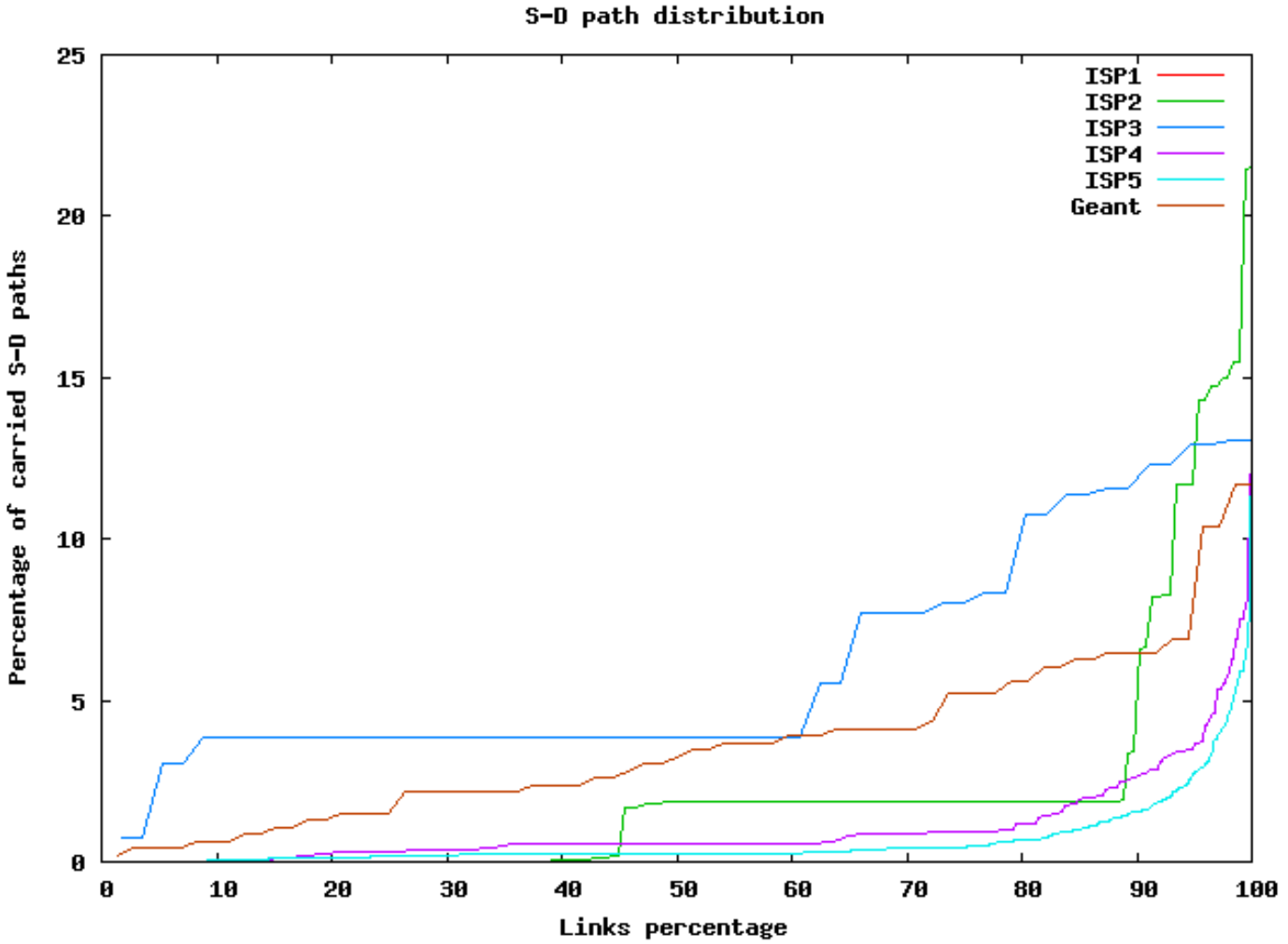


- Are know by researchers, but differ from ISP networks

First difficulty : network topology

- ISP's view
  - Network inventory
  - OSPF/ISIS link-state database
    - Routers
    - Links and LANs
    - link metrics
- Researcher's view
  - Observable part of the ISP network
  - Mainly observed by using `traceroute`
  - Issues with `traceroute`
    - routers can only be inferred
    - alias resolution
    - observed links depend on observation point
    - no information about link weights
    - load balancing was not well handled by `traceroute`

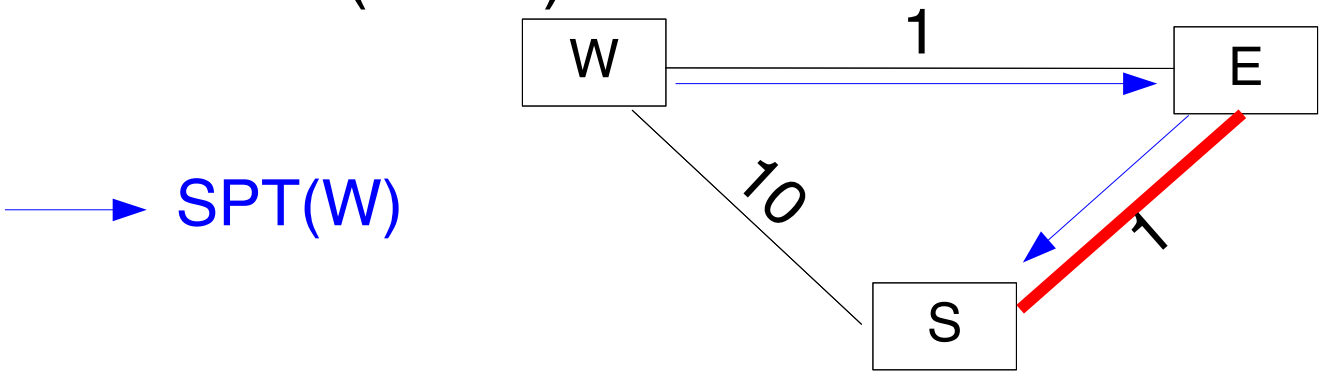
Limits of network observation



- How many links do we really observe when analysing `traceroute` data ?

Importance of link metrics

- Do link metrics really matter ?
- Case study
  - Protection against link failures with loop-free alternates (LFAs)



  - If link S->E fails, S can simply forward all packets towards E via W and they will reach E
    - LFA is one of the IP-based fast reroute techniques being developed within IETF

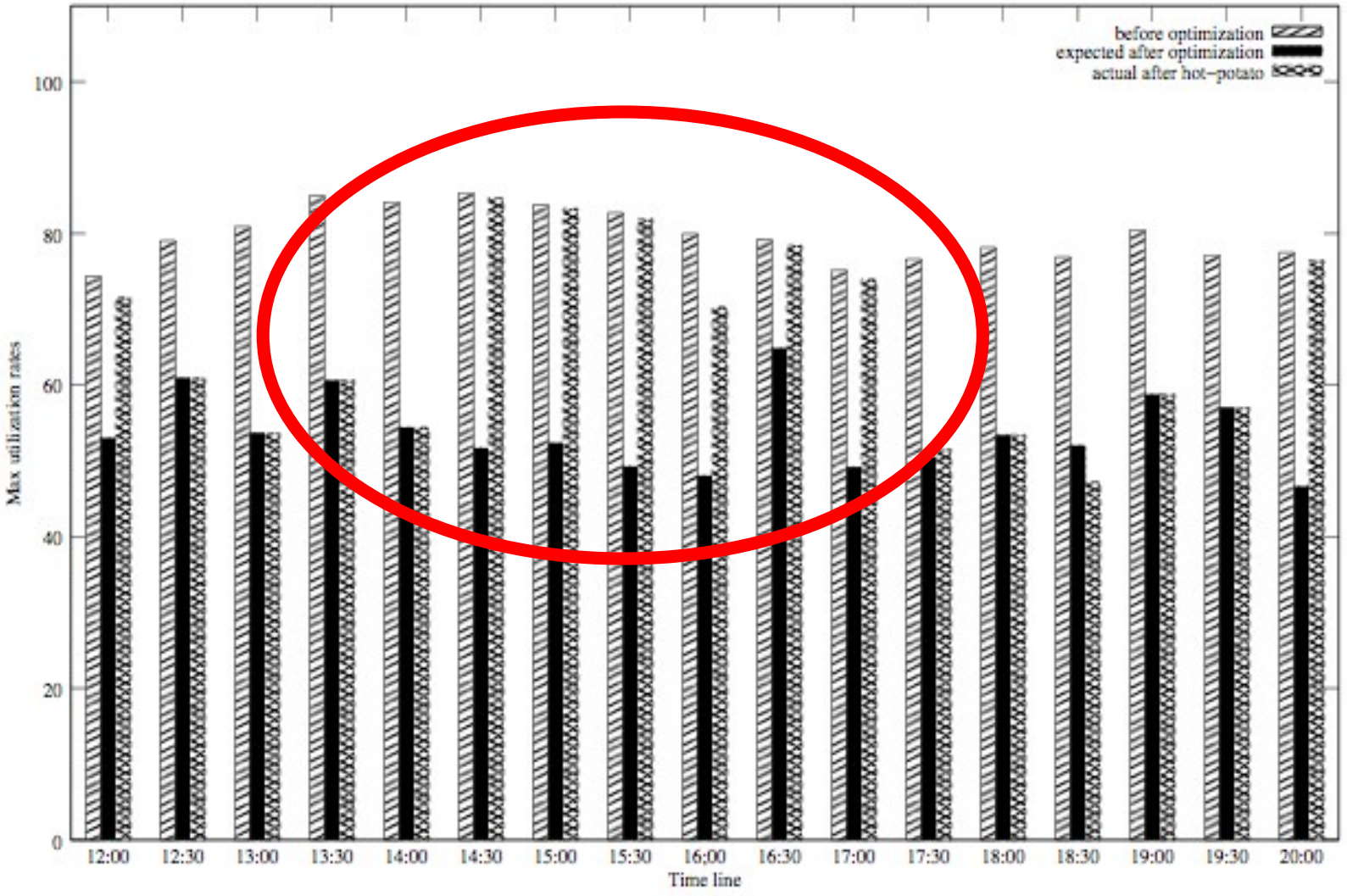
Importance of link metrics (2)

- Coverage of loop-free alternates
  - Real link metrics
    - GEANT : 66%
    - ISPA : 46%
    - ISPB : 50%
    - ISPC : 66%
    - ISPD : 31%
    - ISPE : 7%
  - Hop count metrics
    - GEANT : 22%
    - ISPA : 12%
    - ISPB : 40%
    - ISPC : 46%
    - ISPD : 21%
    - ISPE : 46%

Second case study
Traffic engineering GEANT

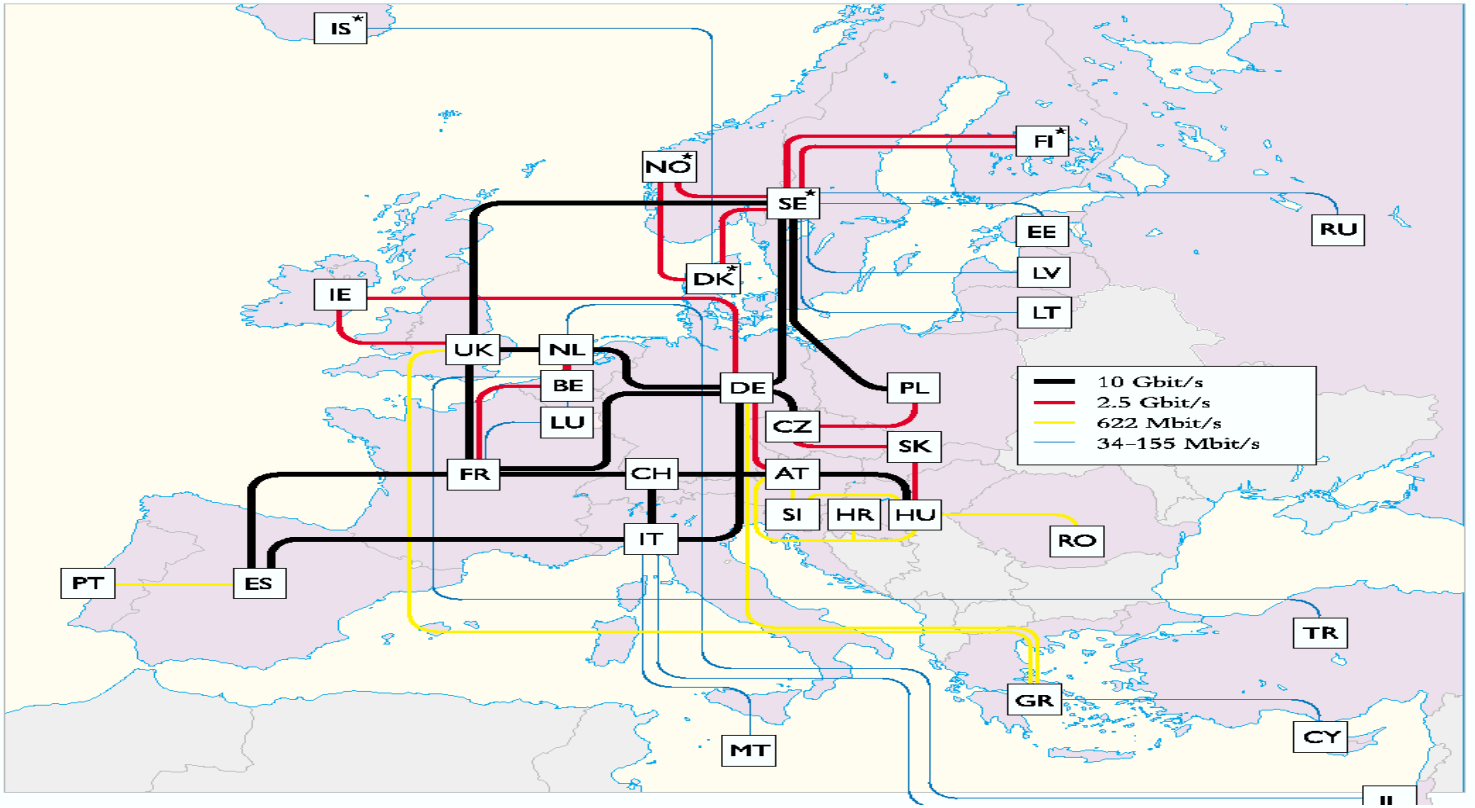
- Input
  - C-BGP model of GEANT network in TOTEM toolbox
  - traffic matrices obtained from Netflow data on all border routers
    - router-router traffic matrices
    - prefix-prefix traffic matrices
- Experiment
  - For each traffic matrix
    - compute maximum intradomain link load
    - run IGP weight optimizer to minimize load
    - recompute with C-BGP model maximum intradomain link load

Traffic engineering GEANT (2)



What did we forgot ?

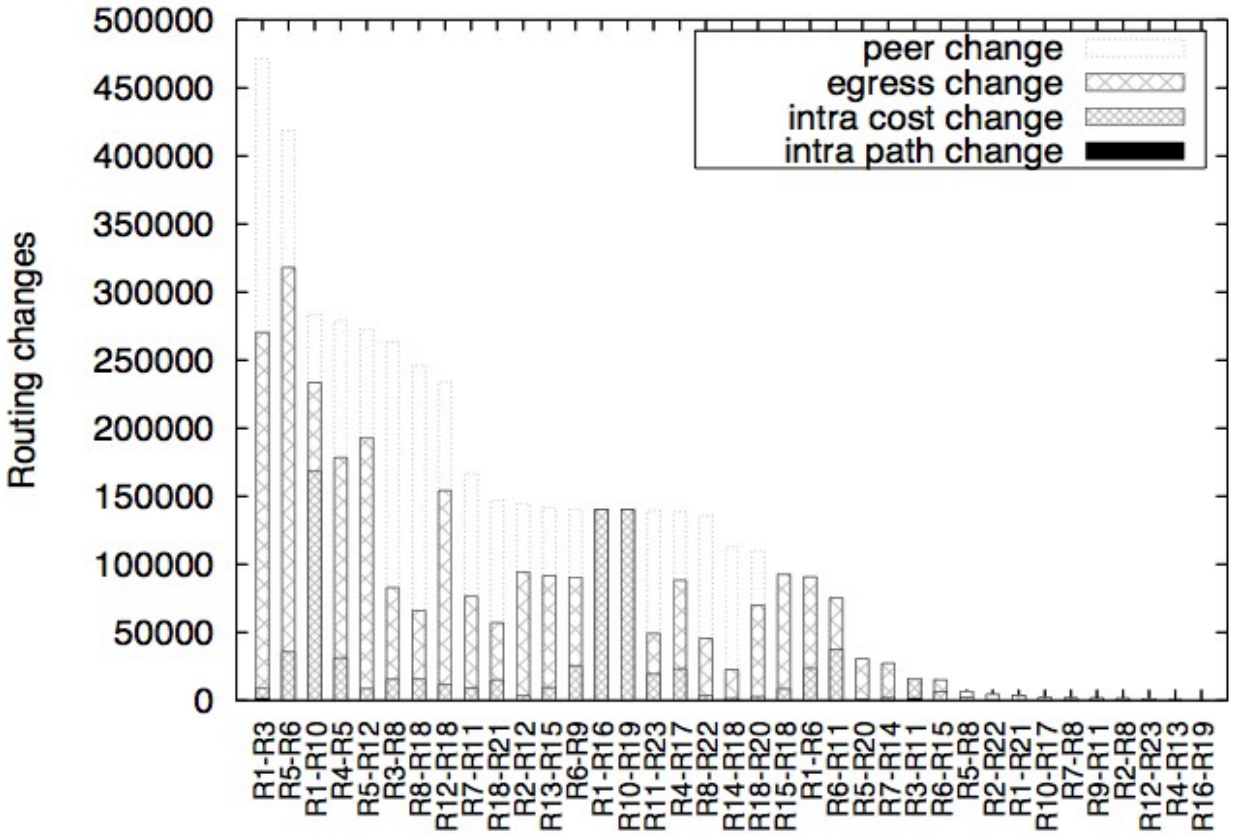
- GEANT is a transit network
  - Most packets are produced and consumed outside



- 6 peering links with transit providers
- 2 peering links with Abilene
- Links (usually two for backup) to each NREN

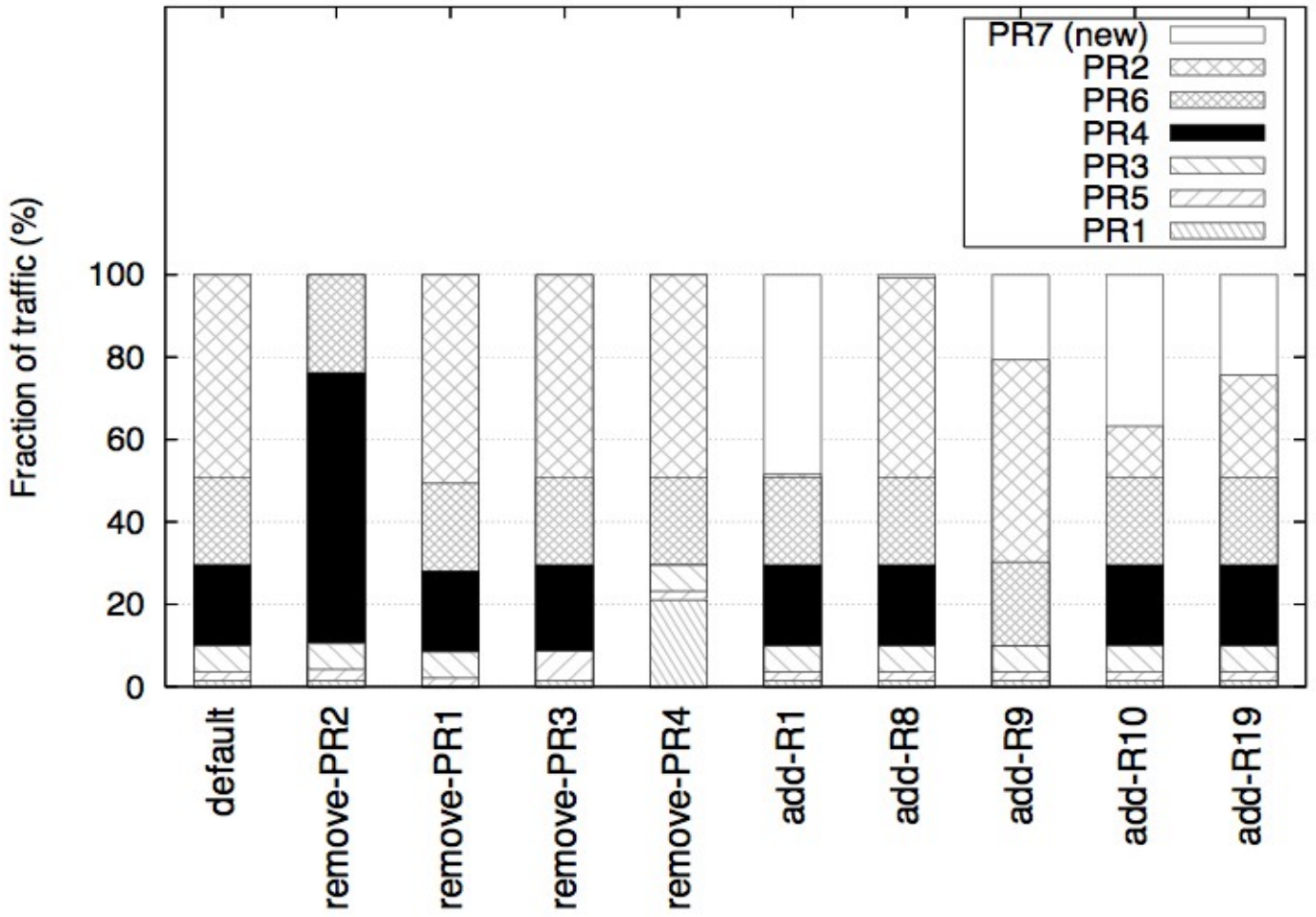
Third case study : failure analysis

- How sensitive is the network to the removal of one intradomain link ?
  - Example with GEANT



Fourth case study : peering change

- How sensitive is the network to changing one peering link ?
  - Example with GEANT



Conclusion

- Accurately modelling an ISP network is possible
  but this requires lots of data that are unfortunately often not available to researchers

  - Network topology (routers and links)
  - Intradomain routing
    - IGP metrics
    - areas
  - Interdomain routing
    - eBGP sessions and BGP filters
    - iBGP sessions and route reflectors
  - Traffic statistics

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