QoS routing in a DiffServ network

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Content

- QOSPF
- General optimal routing (GOR)
- Optimizing OSPF weights
- Multi-class optimal routing (MCOR)
- Test-bed in IRoNet
- Useful links

QOSPF

- It is described in RFC2676 (Informational), Aug 1999.
- Shortest path algorithms (e.g., BF) are adapted to compute paths of maximum available bandwidth for all hop counts.
- Integrated into Gated, but not widely deployed yet…
- Problem: Available bandwidth as QoS metric may be opportunistic too? BTW, how to determine it in the networks without resource reservation?
- Extending QOSPF?
  - Using link-state concept
  - TE metric instead of available bandwidth?

General optimal routing (GOR)

- Assumption: Best effort routing, i.e., shortest path routing is not optimal, or not near-optimal.
- Problem definition (loose)

  Given G(V,E), minimize $\Sigma_{(i,j)} D_{ij}(F_{ij})$
- Optimal routing achieves optimization through load balancing, i.e., by directing traffic along any paths in any proportions.
- In practice, GOR requires more flexible routing architecture, e.g., MPLS that supports explicit routes (Route pinning)!!!
- More importantly, lacking distributed and efficient GOR algorithms…
- GOR protocol for MPLS?

Optimizing OSPF weights

- Achieves near-optimal routes by optimizing OSPF weights
- Optimizing OSPF weights for a given set of demand is NP-hard again :-(
- How?
  - Route computation algorithms:
    - Local search heuristic
    - Genetic algorithm (GA)
- It leverages the use of OSPF but requires the interaction with control plane to set weights.
- It is a hop-by-hop routing, so no need of MPLS support.
- But, it may be inflexible against traffic congestion!!!
- Also, we want to see more results about cost, stability…

Multi-Class Optimal routing (MCOR)

- DiffServ and inter-class effect
  - Intuitively, high priority traffic affects the performance of low priority traffic.
  - Traffic can be characterized, e.g., delay-sensitive traffic and throughput-sensitive traffic
- MCOR dates back to type-Of-Service (TOS) routing.
- MCOR selects routes for each class, for example,

  If a packet belongs to class-1,

  find next hop in routing table 1;

  else

  find next hop in routing table 2.

Our current work on MCOR

- We proposed Per-class QoS routing (we call it PERD)
- Extend QOSPF to support PERD
- Requires MPLS support to reach maximum near-optimization
- In comparison with Shortest path, Widest-Shortest path algorithm, our simulation results proved that
  - PERD improves the throughput and delay performance of whole network, as well as that of each class, especially low-priority class.
- Next step is
  - To model the PERD mathematically, and
  - To get rid of the need of MPLS support → MCOR in general.

Test-bed side view (Draft)

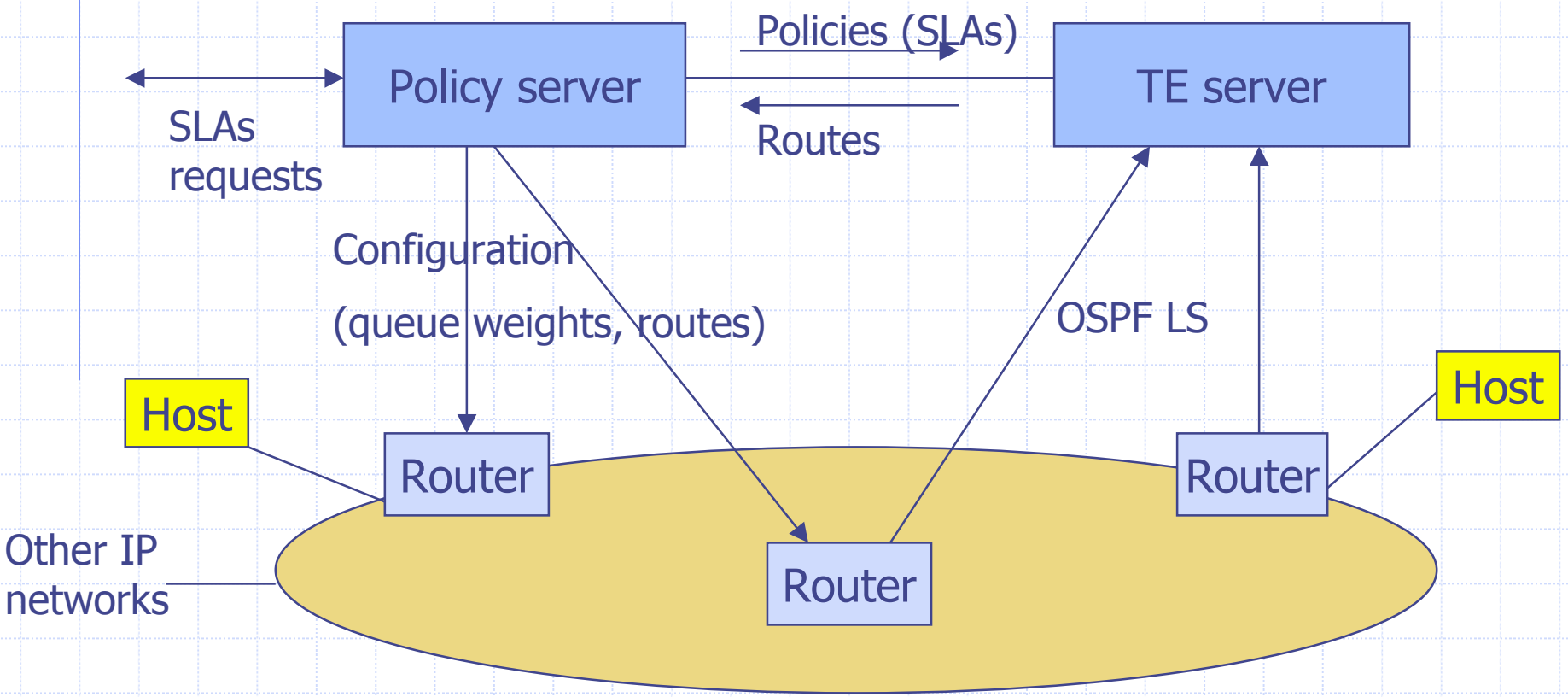

Figure 1: Test-bed in IRoNet

Test-bed – TE server

- TE server mainly includes
  - One or more (Q)OSPF listeners that monitor link state changes.
  - A routing core that computes optimal routes.
  - More functions in order to adapt queue weights against congestions (?)
- TE server may compute new routes when
  - Policy server commands so.
  - Policies (e.g., SLAs) change.
  - Network congestion happens somewhere.
- Reuses the core of QoS Routing Simulator – QRS in order to fast verify and deploy routing algorithms?!

Other routing issues

- Select link cost function
  - Unit: 1
  - Available bandwidth
  - Inverse-Capacity: inverse proportional to link capacity
  - …
- Select optimization metric
  - Minimizing cost
  - Minimizing maximum link utilization
  - … (Customer-perspective metrics: e.g., end-to-end delay)

Related links

- IRoNet homepage

http://www.tct.hut.fi/tutkimus/ironet/

- IRoNet QoSR homepage

http://www.tct.hut.fi/tutkimus/ironet/qosr.html

- QRS (QoS routing simulator) homepage

http://www.tct.hut.fi/tutkimus/ironet/QRS/index.html