Active Networking, QoS and Virtual Routers

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Introduction

The points of interest for the mapping of resource reservations are the borders of regions. Different regions may support different reservation protocols. This is not necessarily the entire network of an ISP. Even within an ISP it might make sense to provide several areas with different supported reservation methods. Because of this we will not refer to an ISP's network but to a so called Reservation Domain (RD), representing a certain topology regarding reservation protocols or administration.
At the border of a RD several mappings may be necessary. Obviously the RSVP to DiffServ mapping is the most probable case [BBBG00]. Because of scalability issues an ISP will be interested in mapping RSVP reservation to Differentiated Services decreasing the load of his backbone routers. On the other hand even the mapping of different Differentiated Service (DS) classes may be necessary, as it is finally left to the an ISP, which Differentiated Service Code Points (DSCP) are used for which type of traffic.

Mobile Agents and Service Mapping

Because of the dynamic behaviour of such RDs and the overhead of a central instance, an approach of using Mobile Code to translate the different resource reservation schemes is favoured. After the injection of capsules, agents occupy the borders of a homogeneous reservation domain, supervising incoming reservations. In the case of DS mapping the agent will determine an appropriate mapping for the packet, reconfigure the border router to do the proper mapping and traffic conditioning and forwards a capsule along the packet's path through the reservation domain in order to configure appropriate scheduling mechanisms in each router.
A more complex task than the support of different DSCPs is the RSVP-based QoS support. RSVP is based on an end to end scheme, so the RSVP messages used for the setup of an reservation have to be transported through the RD. We propose an approach to dynamically negotiate tunnels between the ingress and egress points of an RD as well as the setup of tunnels spanning multiple RDs (see figure 1 left) requiring an interaction of different agents. The tunnels are setup using mobile code to establish the tunnel endpoints.
Beneath the general flexibilty of the approach using active elements, this has the advantage, that a capsule being sent by a border router to the final destination of the data stream passes automatically those routers, which have to be configured. So no knowledge about the the network within an RD is necessary, while a more central approach would require some kind of topology database.

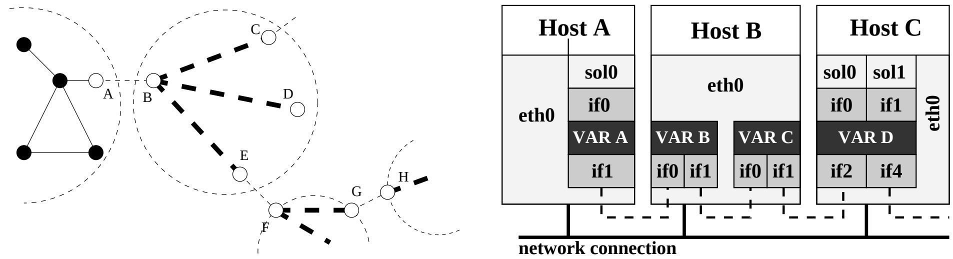

Figure 1: left: Reservation Domains with Agents located at the RD borders and tunnels setup by Agents at ingress and egress points; right: multiple hosts running Virtual Active Routers for emulation purposes

Concept Evaluation by Virtual Active Routers

To evaluate these concepts, to encounter the problem of combining IP forwarding technologies and Active Networking and to be able to provide a testbed of sufficient size we developed an approach to emulate complete active routers including the appropriate IP forwarding [BB00a]. This allows the combination of real hardware and routers with large emulated topologies using several so called Virtual Active Routers (VAR) running on the same host. This basic idea of combining real hardware with an emulated topology is shown on figure 1 (right). The concept simplifies the setup of big topologies on only an couple of real hosts and allows to integrate real hosts and applications with these emulated topologies. A real host cannot distinguish between real and emulated network. Being equipped with capable queueing systems [BB00b] and routing mechanisms the VARs provide a great platform for the easy implementation of new components and concepts. A Capsule Interpreter running on each VAR is used to evaluate the resource reservation mappings.

References

[BB00a] Florian Baumgartner and Torsten Braun. Quality of service and active networking on virtual router topologies. *The Second International Working Conference on Active Networks*, October 2000.

[BB00b] Florian Baumgartner and Torsten Braun. Virtual routers: A novel approach for qos performance evaluation. *Quality of future Internet services, QofIS'2000*, September 2000.

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