Performance evaluation of hose bandwidth allocation method using feedback control and class-based queueing for VPNs

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Outline

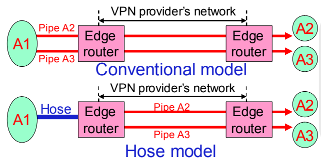
- Background
- Our objective
- Hose bandwidth allocation method
  - Feedback control
  - Class-Based Queueing
- Simulation model and results
- Conclusion

Background : VPNs

- Virtual Private Networks for geographically separated organizations
  - Many global companies have strong interest in constructing large-scale VPNs
- Two major requirements:
  - Security
  - Quality of Service (QoS) assurance
- Deployment barrier of current QoS assurance model
  - If the number of sites increases,
    - Required resources drastically increase
    - Configuration complexity increases

Background: Hose model

- Conventional model versus hose model



Subscriber
A geographically separated organization who wants to subscribe QoS-enabled VPN Service
Site
A VPN endpoint in a subscriber

- Components of VPN hose model
  - Provisioning method
    - To allocate long term bandwidth to meet customer requirements with the minimum bandwidth consumption
  - Bandwidth allocation method
    - To control bandwidth allocation parameters in response to the traffic changes

Our objective

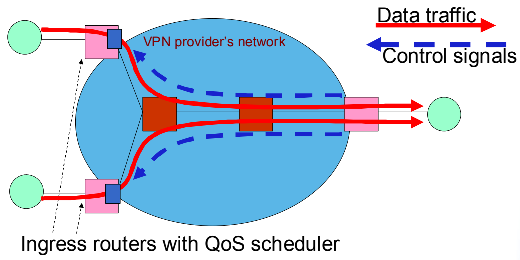
- To produce a hose bandwidth allocation method
  - Without this method, instantaneous changing traffic cannot be accommodated.
- Our requirements in terms of QoS assurance
  - Proportional fair bandwidth allocation among subscribers
  - Fair bandwidth allocation among active sites within the allocated bandwidth for the subscriber
  - High utilization

An example of fair bandwidth allocation (%)

Time		0	1	2	3
Subscriber X	Site X1	0	100	50	25
	Site X2	0	0	0	25
Subscriber Y	Site Y1	0	0	50	50

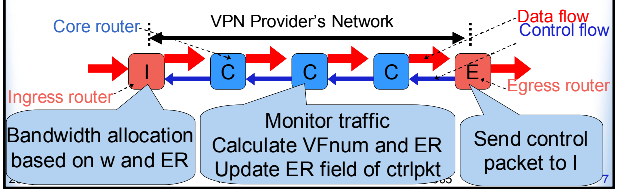
Hose bandwidth allocation method

- Key idea
  - Integration of feedback-driven traffic control and QoS scheduler installation at ingress router



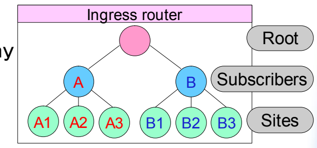
Hose bandwidth allocation method: Feedback-driven bandwidth control

- Weighted proportional fair rate allocation (WPFRA)
  - Feedback-driven bandwidth allocation method
- Definition
  - *w* : weight for sites
  - *VF* : the amount of traffic for a weight one
  - *ER* : available rate for VF



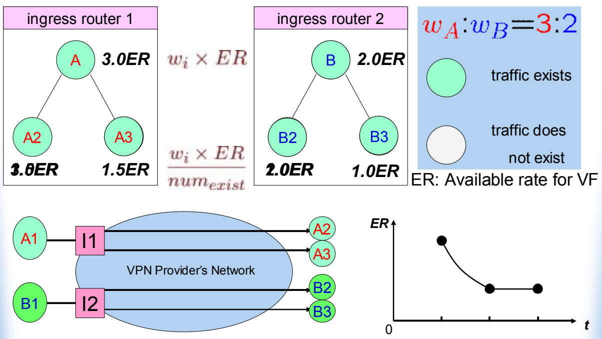
Hose bandwidth allocation method: QoS scheduler at ingress router

- Basic scheduler we employ is
  - Class-Based Queueing (CBQ)
    - Can allocate bandwidth in hierarchical classes
  - Two levels of hierarchy
    - Subscriber
    - Sites

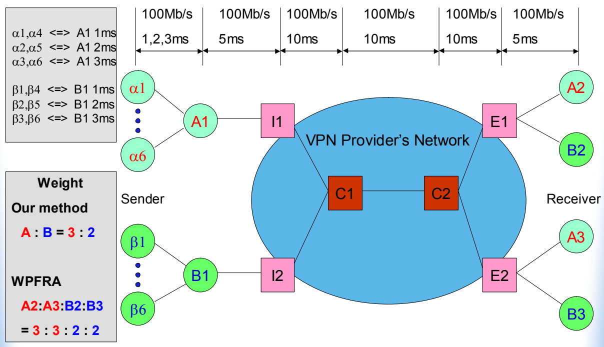


  - We add traffic measurement and weight change functions
    - If the traffic to a destination becomes empty, then the corresponding weight should be zero.

Hose bandwidth allocation method: Example



Simulation: Model



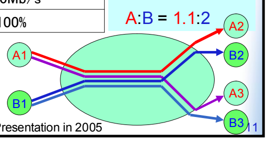
Simulation: Steady state

		Our method	Original WPFRA
A	A2	31.6Mb/s	41.2Mb/s
A	A3	31.6Mb/s	41.2Mb/s
B	B2	36.8Mb/s	17.6Mb/s
Util.		100%	100%

Ideal ratio 3:2
Our method
A:B = 3.4:2
Original WPFRA
A:B = 9.4:2

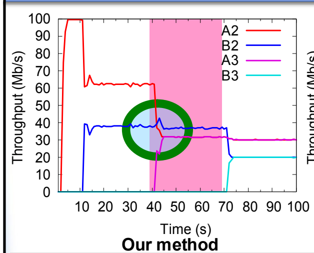
		Our method	Original WPFRA
A	A2	59.3Mb/s	35.9Mb/s
B	B2	20.3Mb/s	32.0Mb/s
B	B3	20.3Mb/s	32.0Mb/s
Util.		100%	100%

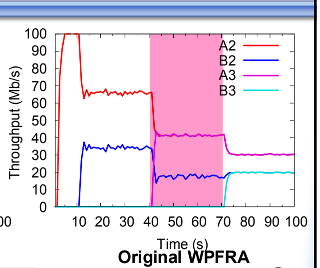
Our method
A:B = 2.9:2
Original WPFRA
A:B = 1.1:2



Utilization and bandwidth allocation requirements are satisfied

Simulation: Transitional state

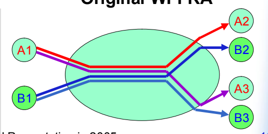




40 to 70s after run simulation

Throughput to B2 is not much affected when traffic to A3 is started.

=>Requirements about fair allocation are satisfied even when another flow arrives.



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Conclusion

- We proposed a hose bandwidth allocation method for QoS-enabled VPN services which meets three requirements
  - Proportional fair bandwidth allocation among subscribers
  - Fair bandwidth allocation among active sites
  - High utilization
- Our method is integration of
  - Feedback-based traffic control
  - Modified QoS scheduler at ingress router
- Simulation results showed
  - Our method achieves all three requirements in both steady and transitional scenarios
- Future work
  - Stability evaluations in large scale scenario

Fin.