

The role of BB in Traffic Engineering

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February 2000

Talk Overview

- Differentiated Services and the Two-Tier Architecture
- UCLA's BB implementation
 - Simple Policy Database, Web Interface
 - Forwarding Path Mechanisms
 - Management of edge routers using COPS
- Remaining Research Challenges
- Proposed Solutions

The Challenge : providing QoS in Internet wide scale!

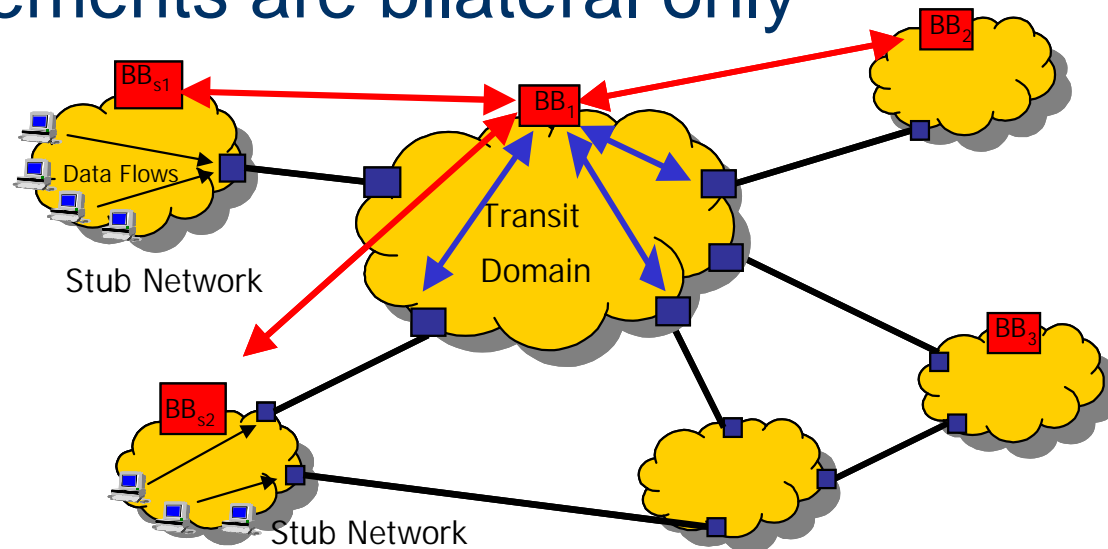
- Internet2 QBone was formed to meet this challenge
- Diffserv has made a first step forward
 - Fundamental division:
 - Forwarding Path
 - Management Plane
 - developed build blocks for forwarding path
- Remaining challenge: management plane

The Two Tier Resource Management Architecture

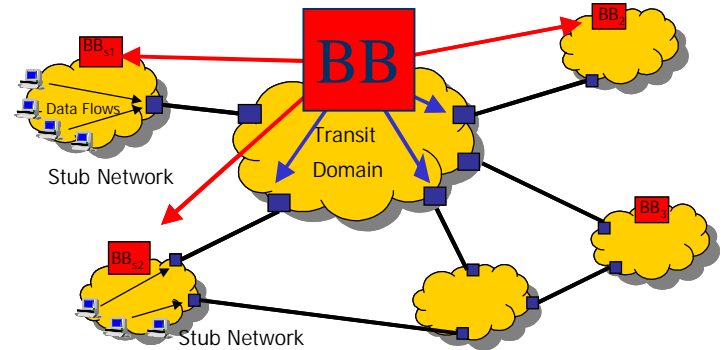
- Follows Routing Architecture
- Resource Management is performed at two levels:
 - Inside administrative domains (Intra-domain)
 - Between neighboring domains (Inter-domain)
- Inter-domain: pre-negotiated bilateral relations
- Concatenation of bilateral agreements leads to end-to-end QoS delivery paths

The Two-tier Architecture (cont.)

- Allocations between domains are for traffic aggregates
- Agreements are bilateral only

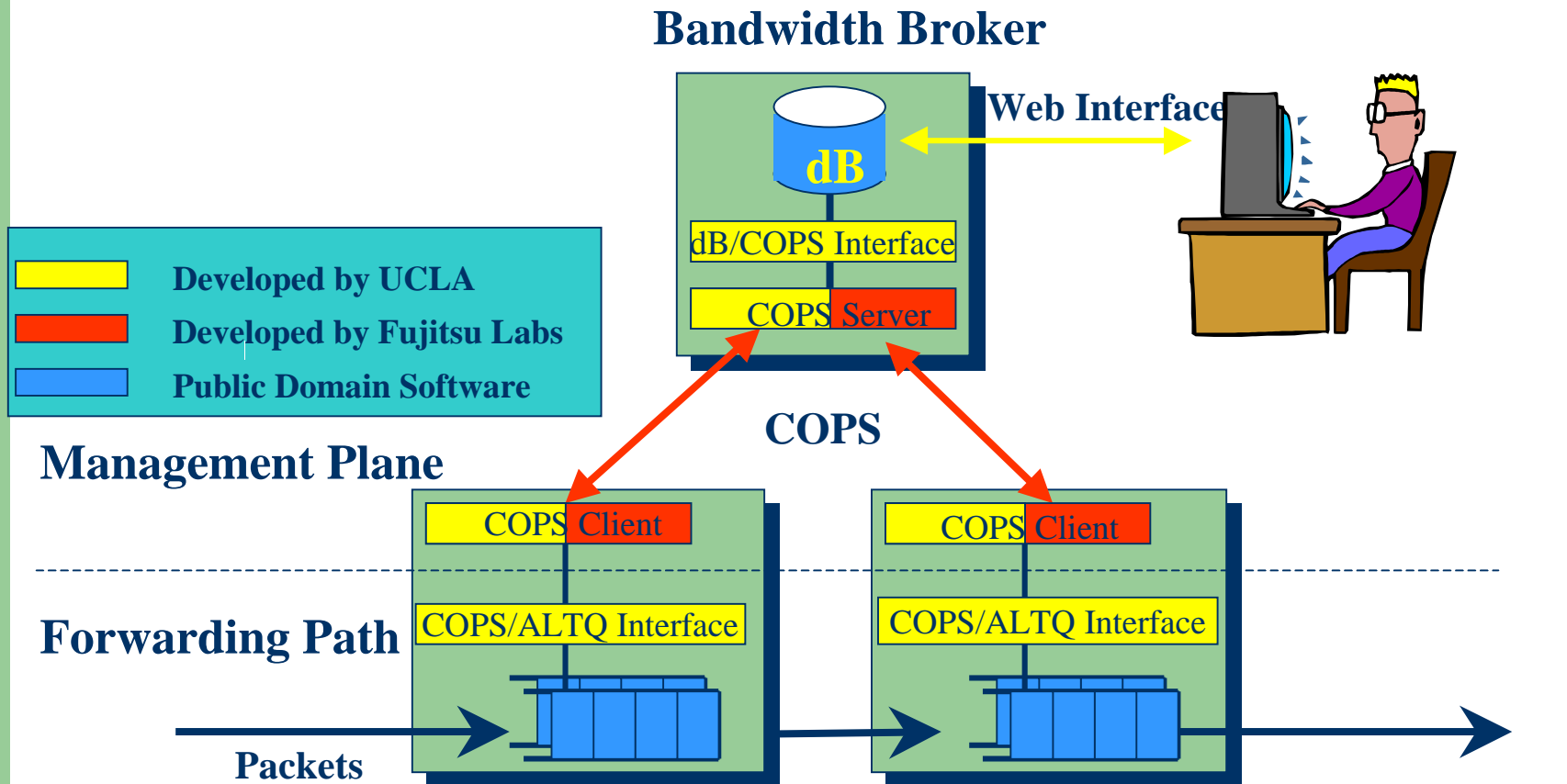


Bandwidth Broker

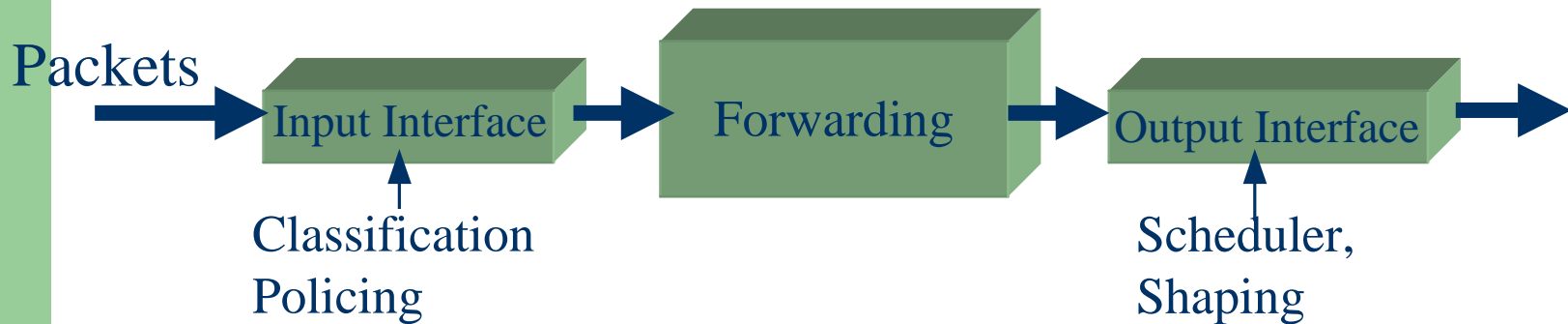


- Logical entity responsible for resource allocation in an administrative domain
 - Centralized vs. Distributed Implementation
- Coordinates Inter-domain and Intra-domain resource allocations
- Policy repository

Implementation Overview



Forwarding Path



- Classification based on DS Value in IP header
 - EF PHB (Expedited Forwarding per-hop forwarding behaviors)
- Policing is performed using a token bucket meter (tuned by Bandwidth Broker)
- Shaping at Output queue: CBQ

Policy Database

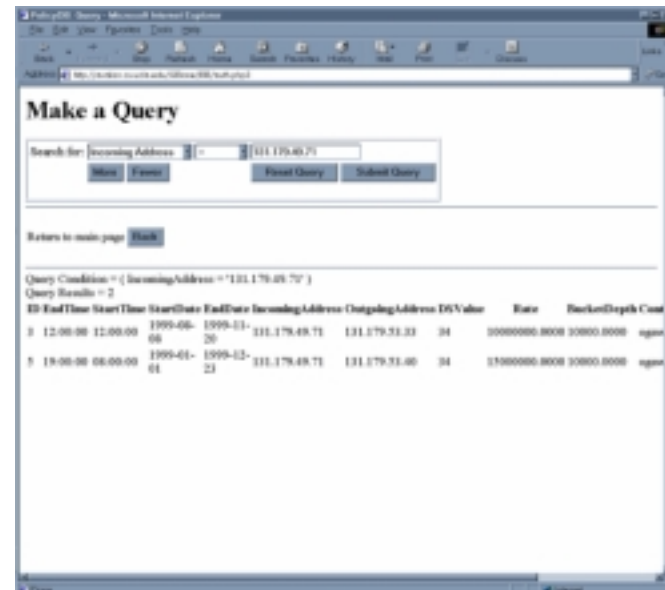
- Using freely available MySQL RDBMS
- Web-based front end for easier access to the policy database
 - PHP3 scripting language
 - Supported by Apache server
- Network administrator : get info of existing flows, add or delete flows easily

Screenshots

- Login Screen



- Query Results



Challenge

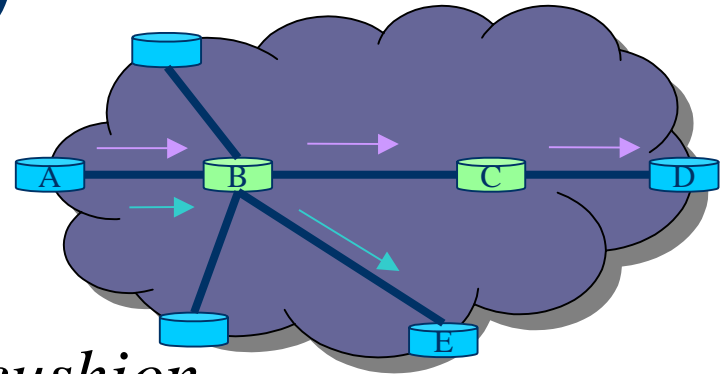
- Provide effective tools for supporting aggregate QoS traffic without per-flow state
 - within each domain: Resource Allocations for Traffic Aggregates
 - Domain receiving traffic has to *predict* to where traffic flows
 - Adapt to traffic variations
 - Notify upstream domains, in the event of failure
 - between domains: Protocol Constraints
 - Change at time scales (much) larger than individual applications' time scale
 - Stability

Proposed Solutions

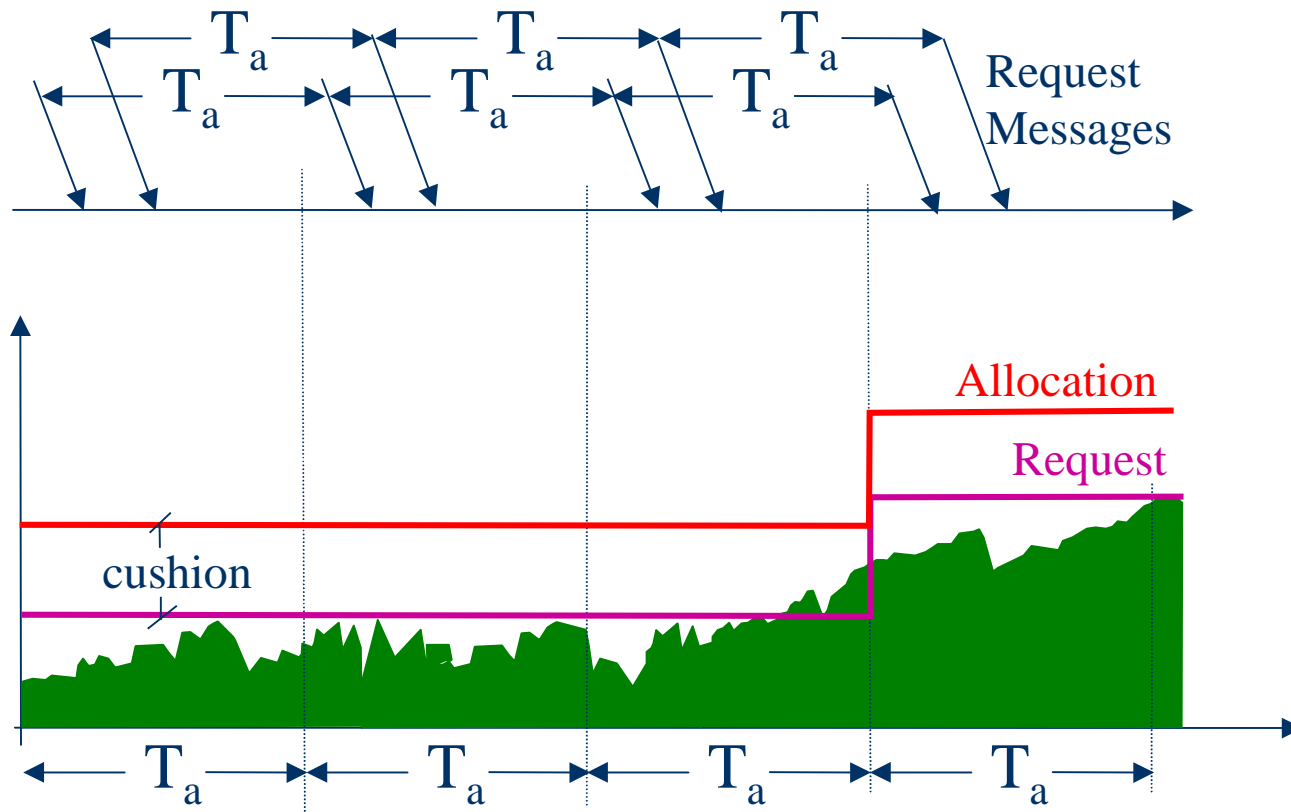
- Use measurements to estimate traffic directions
- Use MBAC to admit new requests
- Apply *cushions* to protect against
 - Estimation errors
 - Traffic shifts
 - Cascaded readjustments

Intra-Domain Protocol

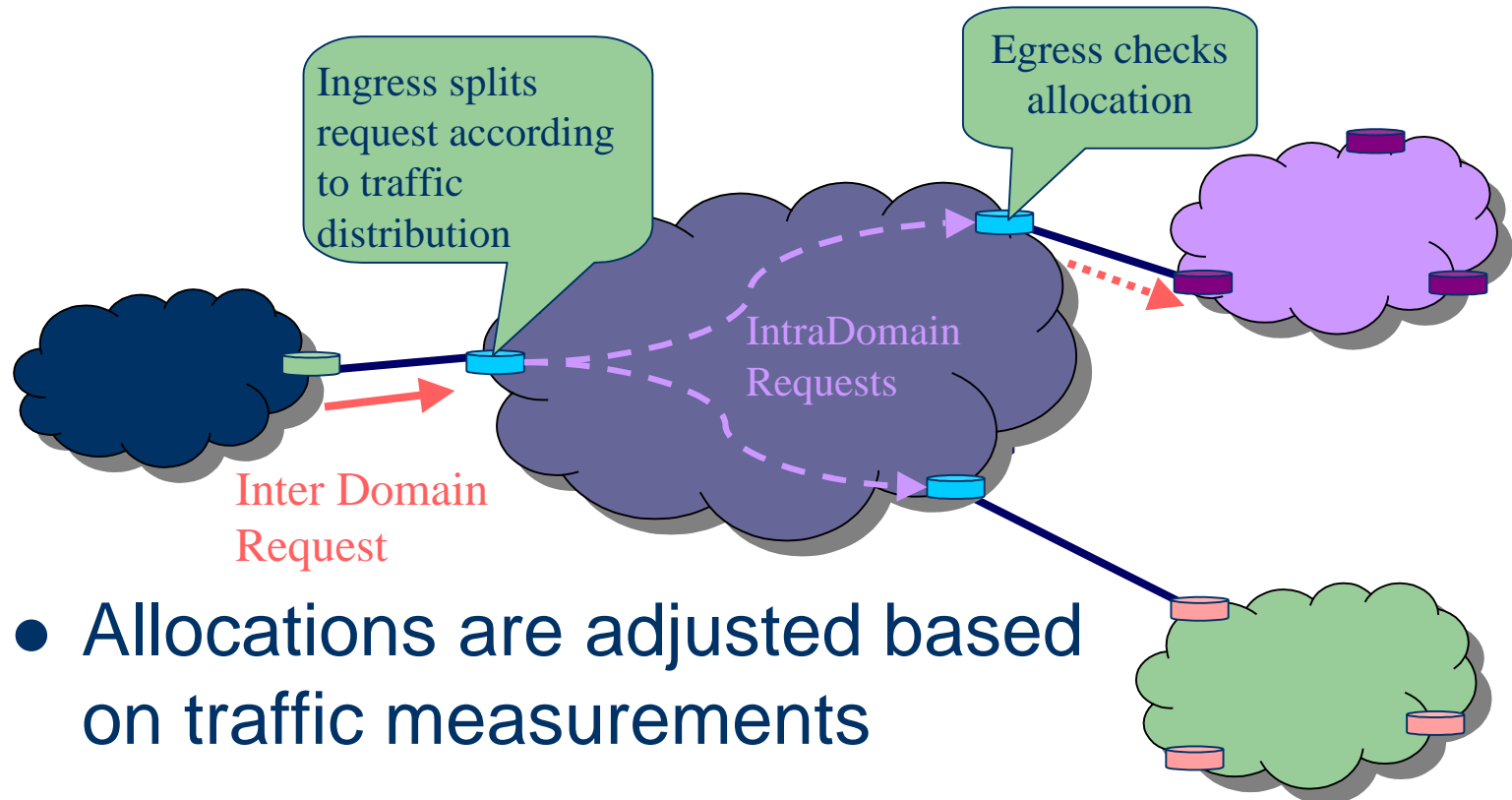
- Ingress routers periodically send request messages
- Interior routers collect request messages
- Allocation = $\sum requests + cushion$
 - cushion calculated from locally observed traffic conditions
- Allocation intervals can be adaptive
- State requirements



Intra-Domain Protocol (cont.)



Inter-Domain Protocol



- Allocations are adjusted based on traffic measurements

Dilemma in Request Dynamics

- The larger the system, the more clients & applications, the higher frequency of total individual changes
- The larger the system, the lower the viable frequency of changes to keep the system stable

Damping request dynamics between domains

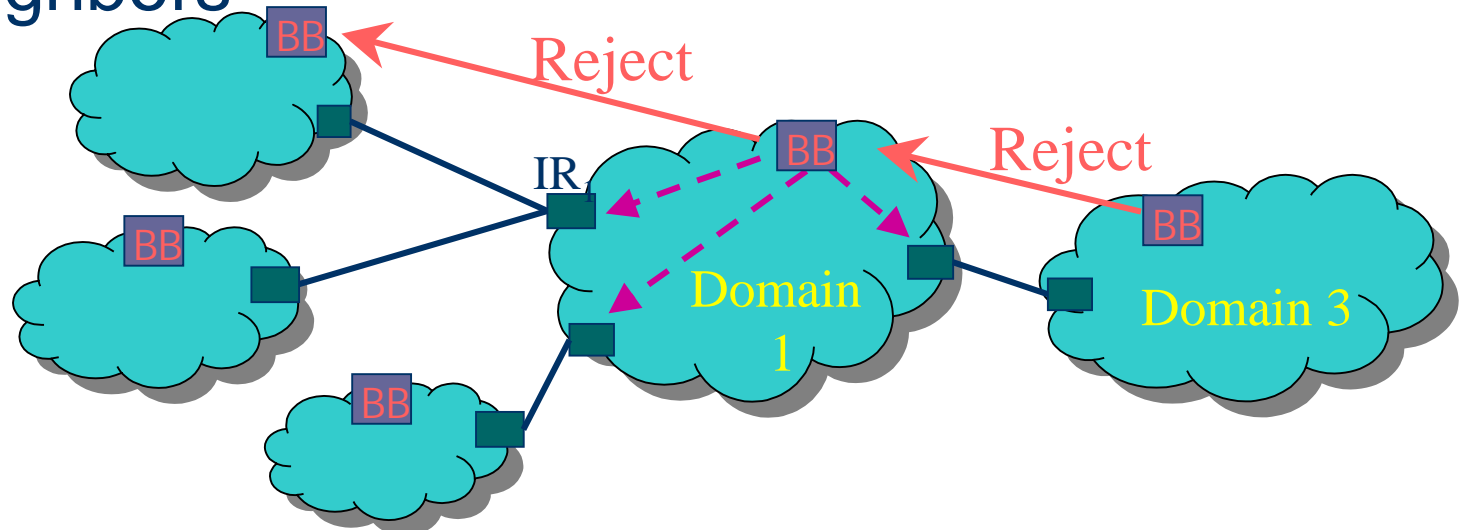
- Statistical multiplexing: gamble in handling large numbers
 - here the "large number" is number of requests
- Muxing requests means time damping
 - aggregate request changes over time, some go up, some go down
 - adjust the aggregate at much longer time scale than individual dynamics
 - have cushions
 - randomize request timing to avoid global dynamics

Reject Behavior

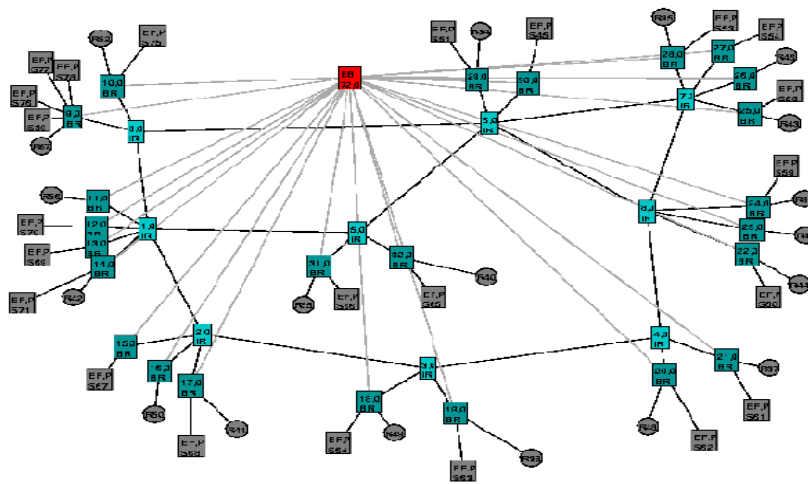
- What to do when resources are exhausted
 - Resources at Domain Boundaries
 - Internal resources
- Goals
 - Notify upstream neighbors
 - Protect domains that should not be affected
 - Apply policy decisions

Reject Behavior (cont)

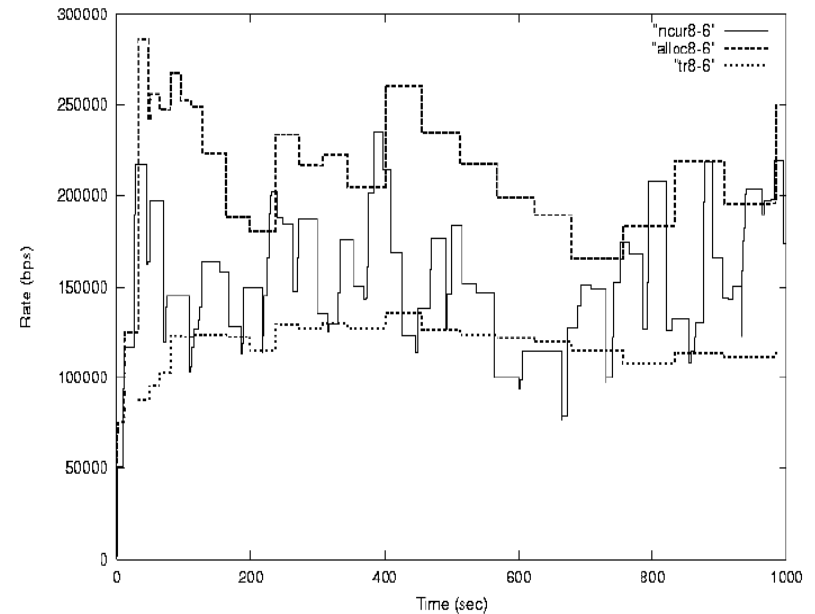
- BB inquires border routers to learn which sends traffic towards failure point
- Apply policy decision to notify upstream neighbors



Intra Domain Simulation Results

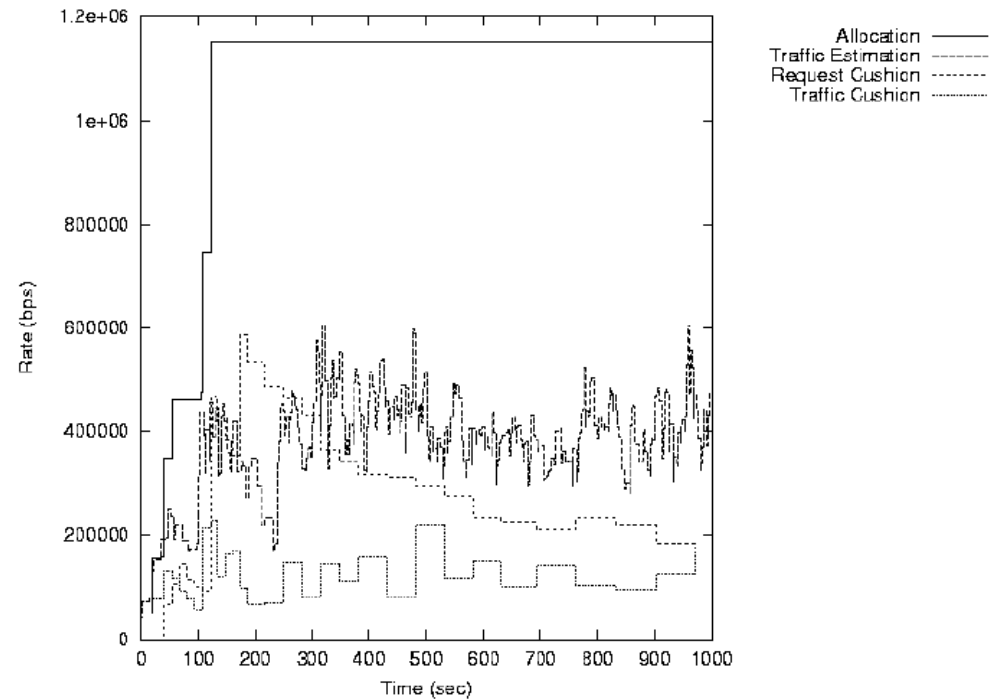
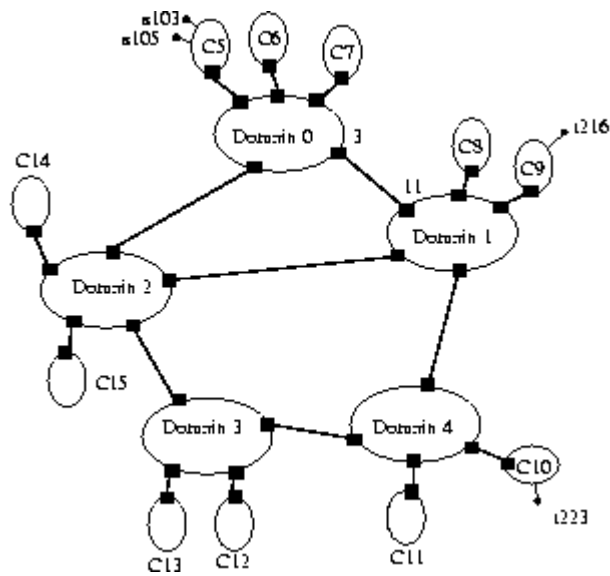


BBN Topology



Allocation

Inter-Domain Simulation Results



Summary

- Two-Tier Resource Management Architecture
 - Allocation is done in two levels
 - Concatenation of Intra- and Inter-Domain allocations create end-to-end QoS
- Partial prototype available at <http://irl.cs.ucla.edu/twotier/>
- Current work on the design of Intra- and Inter-domain protocols