Network Support for Adaptive Multimedia Applications

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Overview

- scalable resource reservation: YESSIR and aggregation
- monetary feedback for adaptation: RNAP
- measurement and feedback
“Classic” Service Classification

- best effort
- guaranteed (delay)
- controlled load ($\approx 0$ loss)
- differentiated service: “where all the flows are above average”
Service Classification

- reserved FSA-DTT
- TCP data transfer "TCP-friendly"
- multimedia
- transaction
Adaptive Interactive Multimedia

- “TCP-friendly” is not good enough
- MM need limited bandwidth-changes: “fading”
- audio only allows step-wise adjustment
- reservation: trade blocking $\leftrightarrow$ loss probability
- need incentive to adapt
- non-interactive multimedia: TCP with buffering?
YESSIR: RSVP Problems

Complexity:
- receiver-initiated
- error handling

Scaling:
- state management per router
- CPU overhead for refresh messages

Reservation restrictions:
- always rejects request fail-and-retry churn
YESSIR

- RTCP sender reports marked with router-alert option
- set up reservations for associated data (RTP) flow
- no additional reservation protocols needed
- router marks if reservation failure
- receiver report reports back failure(s)
- still support sender flow-merging
- without flow spec: byte count\(i\) – byte count\(i-1\)
- measurement-based admission?
Partial Reservations

- stop reserving at first failure vs. reserve what one can get
- at refresh time, pick up new links
- possibly more efficient than try-and-cancel?
- resource fragmentation under high-load
Reservation Aggregation

- reservation aggregation for sink and source trees
- additive aggregation, not flow merging
- hysteresis for merged flows
RNAP: Resource Negotiation and Pricing

- even diff-serv needs admission control
- RNAP: either separate protocol for diff-serv or RSVP+
- just dropping packets doesn’t work well for multimedia
- users need economic incentive to throttle
- constant reservation over bounded immediate or future intervals
RNAP Operation

Query: services, prices for interval
Quotation: time-limited offer
Commit: network admits service
Close: negotiation session
Notes on Pricing

- $p(\text{guaranteed}) > p(\text{CL}) > p(\text{BE})$
- price = holding + usage + congestion
- price = $f(\text{predictability interval})$
- holding = opportunity cost; can only resell as lower grade
- usage = $f(\text{type, burstiness, } \ldots)$
- price capping  reject calls
- temporary price inequalities
- demand $D$, supply $S$: $p_c(n) = p_c(n - 1) + k(D, S) * (D - S)/S$

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RNAP Pricing Example

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RNAP: Centralized

Access Network

RNAP messages

Intra-domain Messages
RNAP: Distributed

Access Network

B1

B2

B3

B4

B5

B6

B7

B8

Access Network

----- => RNAP messages

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Utility Function Learning

- utility function is personal & task-dependent
- learning mechanism: user adjusts quality with price feedback
- value of call decreases with duration of session?
Open Router Architecture

installable code

routing lookup:
\( OIF = f(addr) \)

packet classifier

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## Monitoring

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<tr>
<th></th>
<th>granularity</th>
<th>access</th>
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<tr>
<td>SNMP</td>
<td>pull</td>
<td>interface</td>
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<tr>
<td>mrouted</td>
<td>push</td>
<td>mcast group</td>
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<tr>
<td>RTCP</td>
<td>push</td>
<td>mcast group</td>
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- 3rd party RTCP: forced to receive media + feedback
- no selectivity
Threshold-Based Monitoring

- motivation: lots of small unicast applications (Internet telephony)
- need third-party monitor
- “this conversation may be monitored for quality assurance”
- geographic correlation
- use RTCP feedback with scaling & reconsideration, but …
Threshold-Based Monitoring

Bob - Alice: 10%

multicast

threshold: 5%, 1000 complainers

fault correlation

monitor

Alice

Bob

RTP
Conclusion and Speculation

- need multiple reservation, routing, measurement, ... protocols
- price predictability vs. fairness (INDEX, …)
- currently, hard to add functionality
- efforts like P.1520 or active networks too brittle
- installable code (API) + standard in-band control + standard IP
- need new finger(pointing) protocol: “who’s dropping/delaying my packets?”