

Network Support for Adaptive Multimedia Applications

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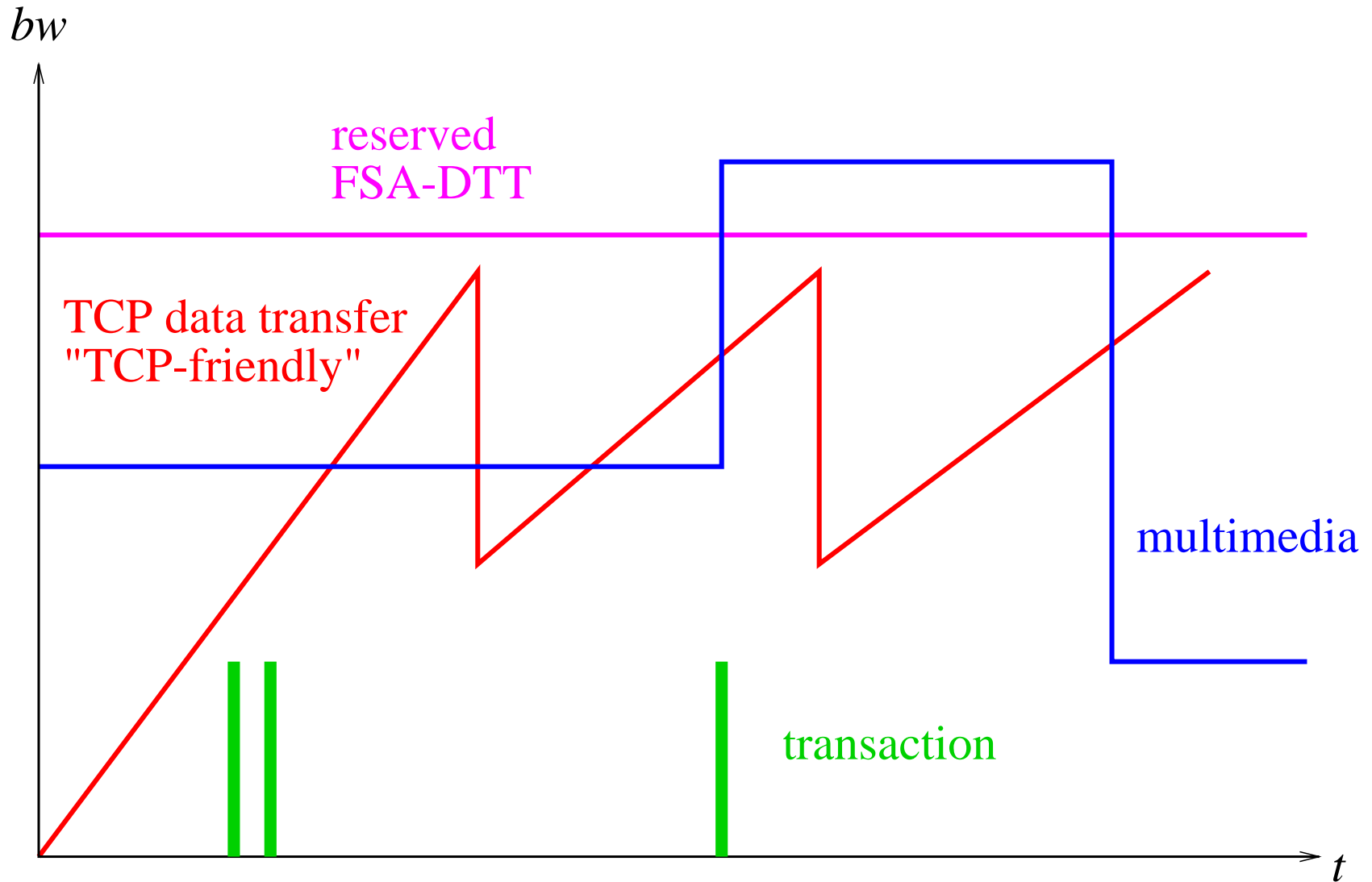
Overview

- scalable resource reservation: YESSIR and aggregation
- monetary feedback for adaptation: RNAP
- measurement and feedback

“Classic” Service Classification

- best effort
- guaranteed (delay)
- controlled load (≈ 0 loss)
- differentiated service: “where all the flows are above average”

Service Classification



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: $\text{byte count}_i - \text{byte count}_{i-1}$
- 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

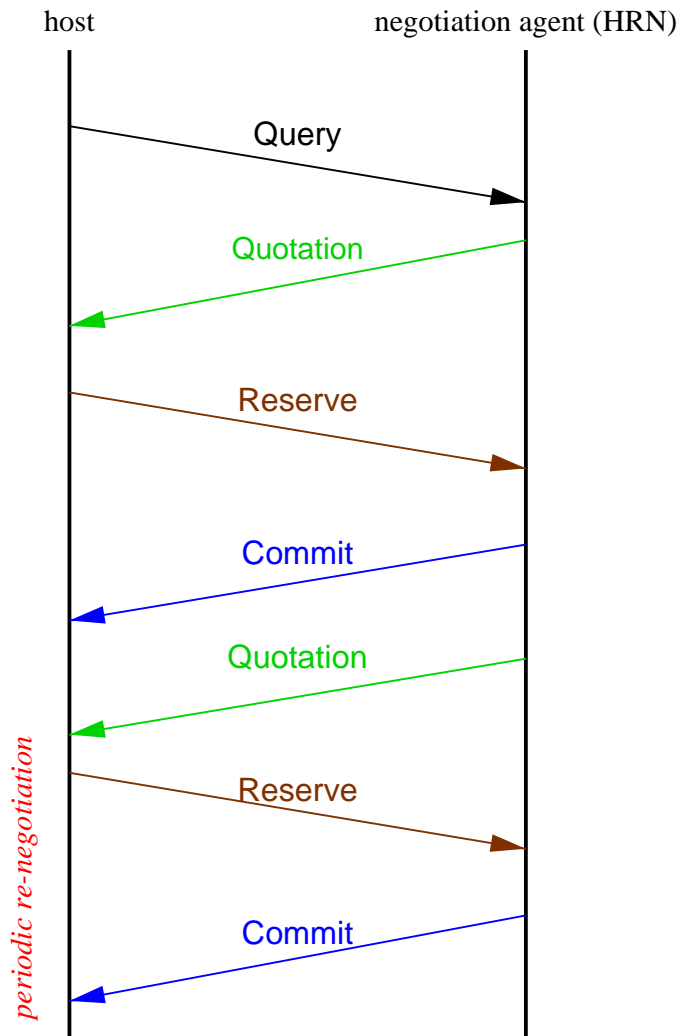
Reservation Aggregation

- 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

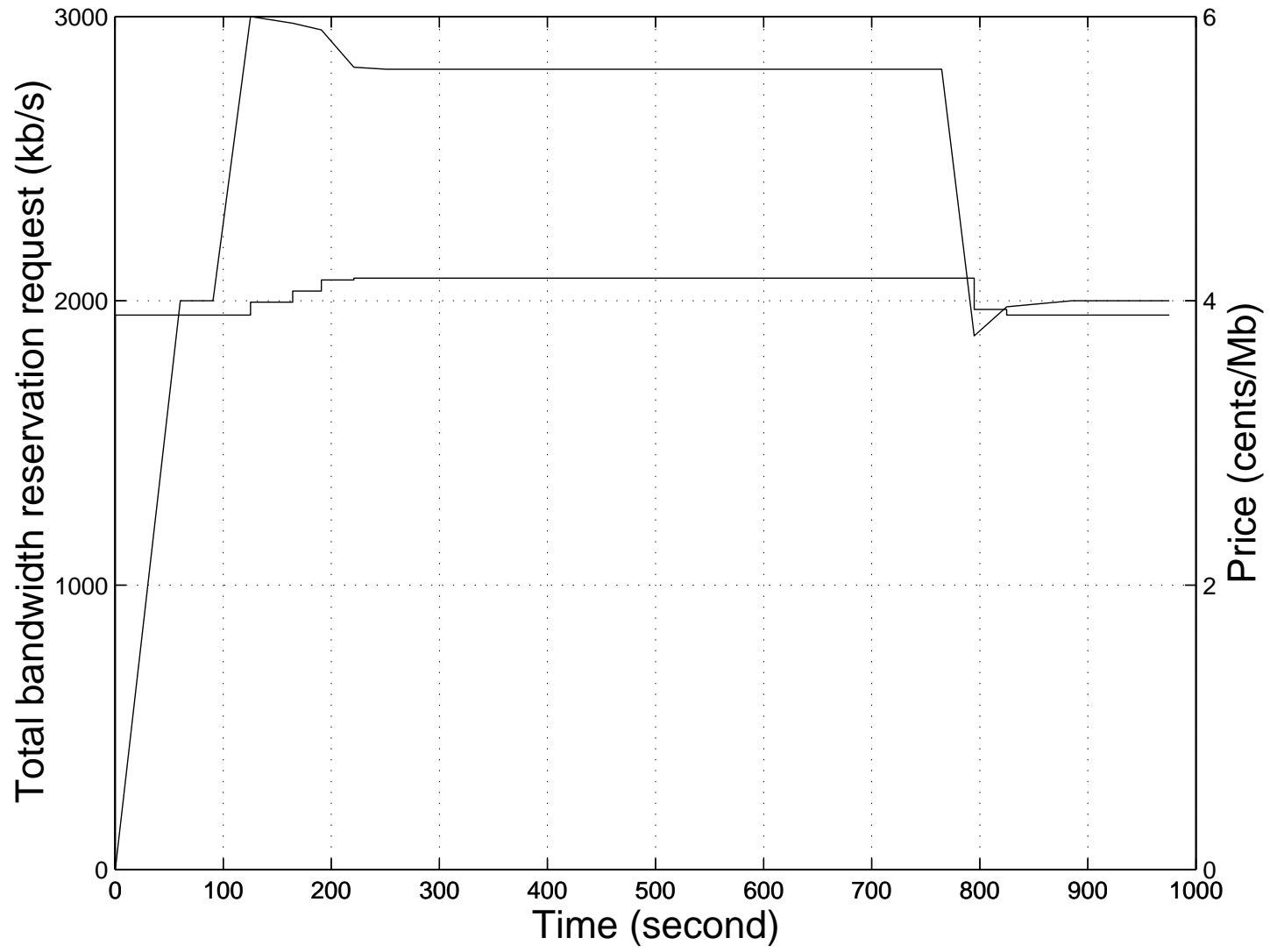
Commit: network admits service

Close: negotiation session

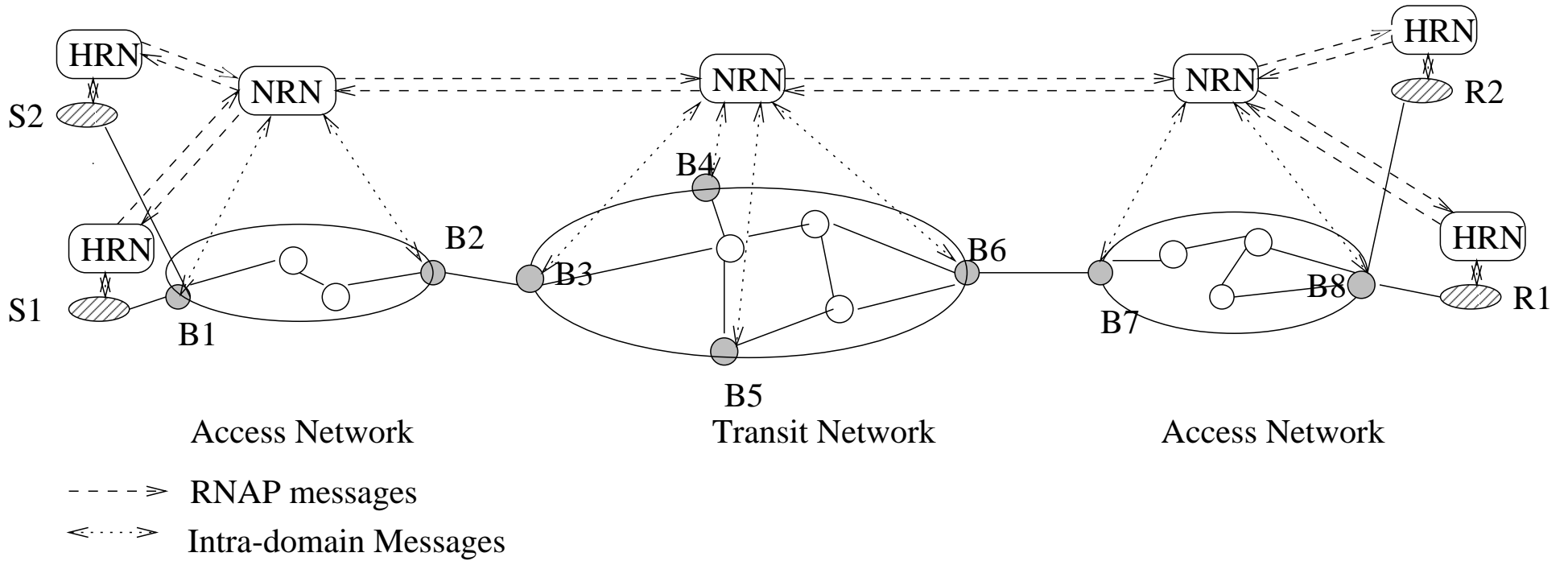
Notes on Pricing

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

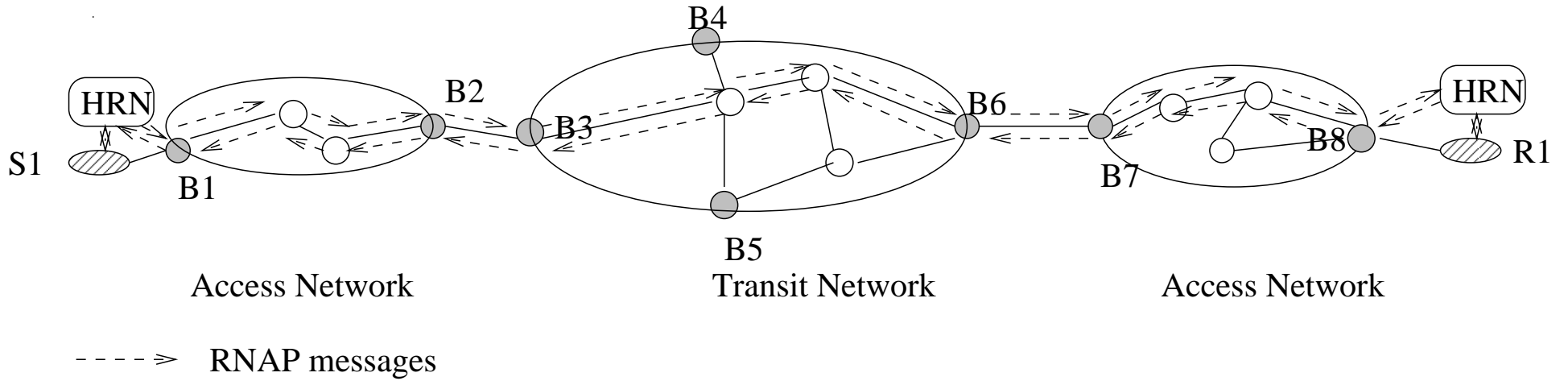
RNAP Pricing Example



RNAP: Centralized



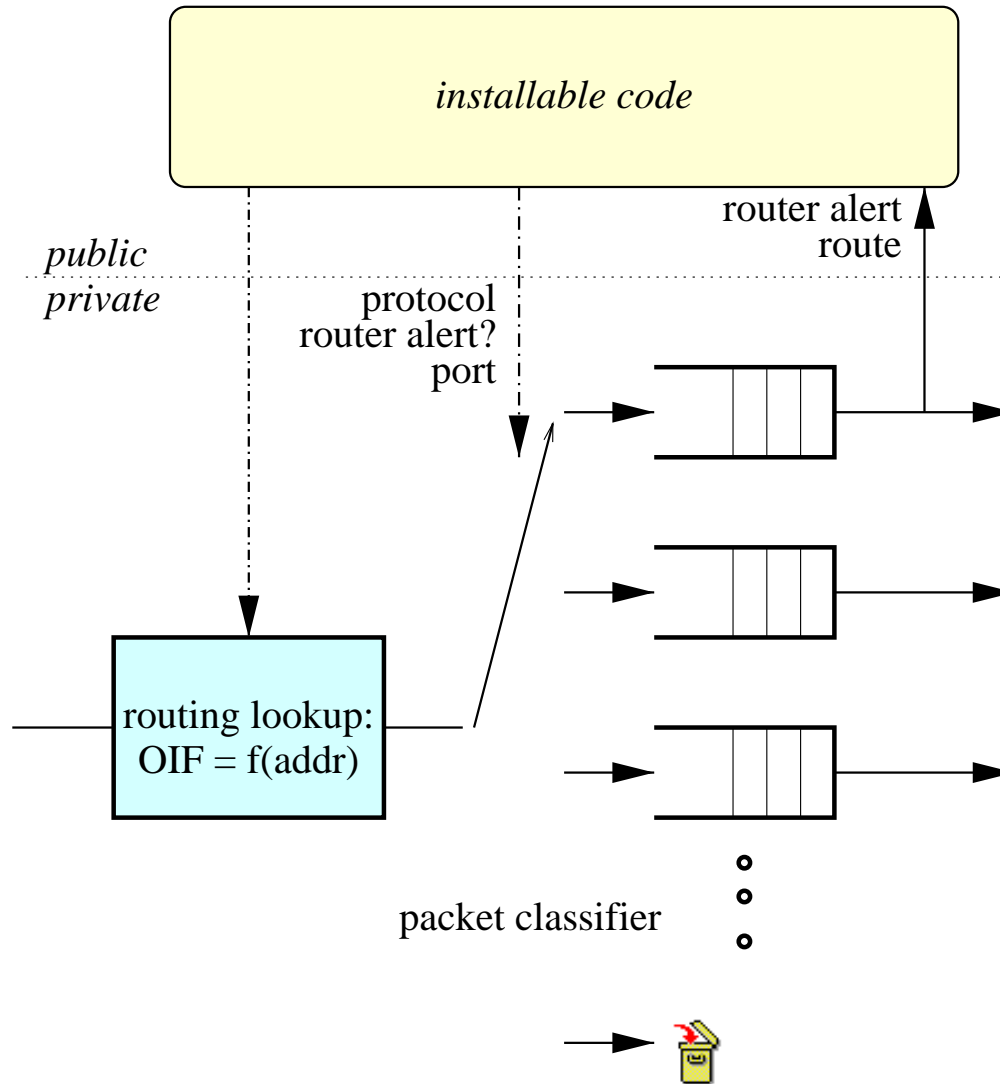
RNAP: Distributed



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



Monitoring

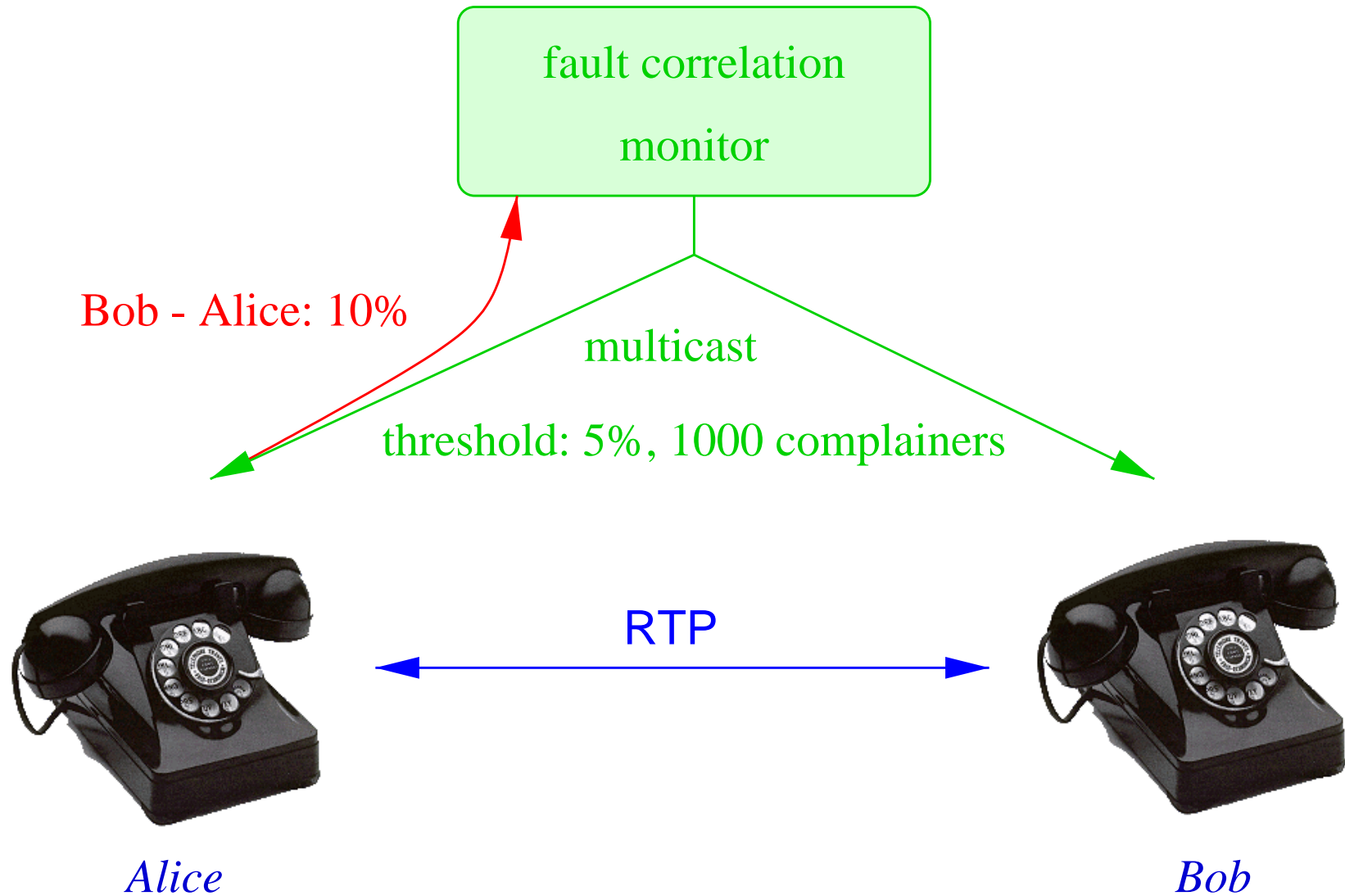
	↔	granularity	access
SNMP	pull	interface	limited
mrouterd	push	mcast group	mcast only
RTCP	push	mcast group	RTP only

- 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



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?”