Interdomain Multicast Routing Support for Integrated Services Networks

Daniel Zappala, Bob Braden, Deborah Estrin

USC Information Sciences Institute

Scott Shenker

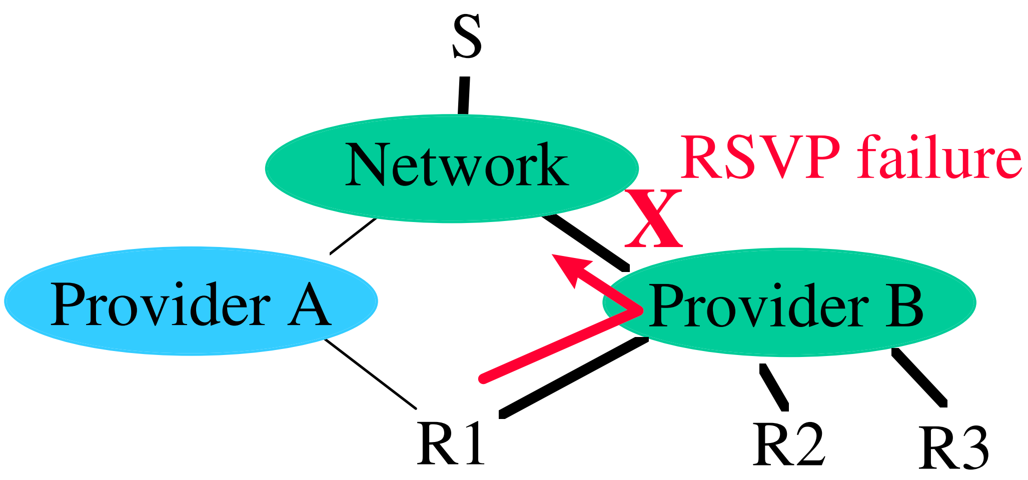
Xerox PARC

Context

- Flows or flow aggregates reserve a QoS using a reservation protocol such as RSVP
- RSVP is designed to operate over current routing infrastructure
  - Opportunistic: routing always uses shortest path, even if previously shortest path is still functioning
  - Shortest path: routing uses a single cost metric (i.e. hop count), chooses least-cost path
- Two problems: failed primary route problem, opportunistic route problem

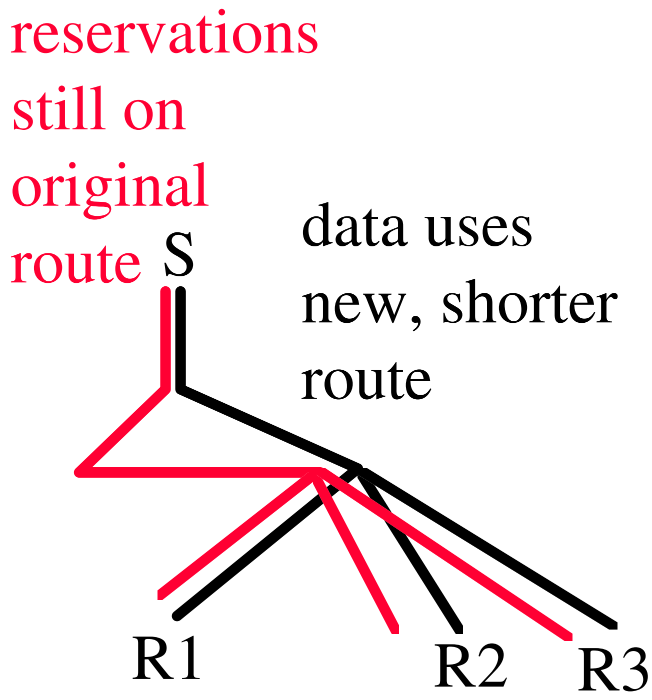
Failed Primary Route Problem

- Applications are limited to using the shortest path route
- If application can't obtain desired service over this route, it has no alternative
- Other paths may exist that can accommodate the flow



Opportunistic Routing Problem

- Routing switches to shortest path, even when the current route is still operational
- Data uses new route, reservations are on old route
- Length of service disruption depends on how fast RSVP can re-establish reservation
- If reservation denied on new path, disruption can be indefinite.



Solutions : Failed Primary Route

- Choose a primary route that is known a priori to have sufficient resources
- QoSPF for intradomain routing
  - Global distribution and synchronization of link resources and flow reservations
  - These are rapidly varying quantities: global distribution not viable for interdomain routing

Solutions : Failed Primary Route (2)

- Quality of Route (QoR) routing for interdomain routing
  – Use several static metrics (i.e. maximal bandwidth or minimal latency) and keep a routing table for each
  – Interactive apps can avoid satellite links, bulk data transfer can seek maximum bandwidth
  – Can improve chances of securing a reservation, but does not avoid the problem

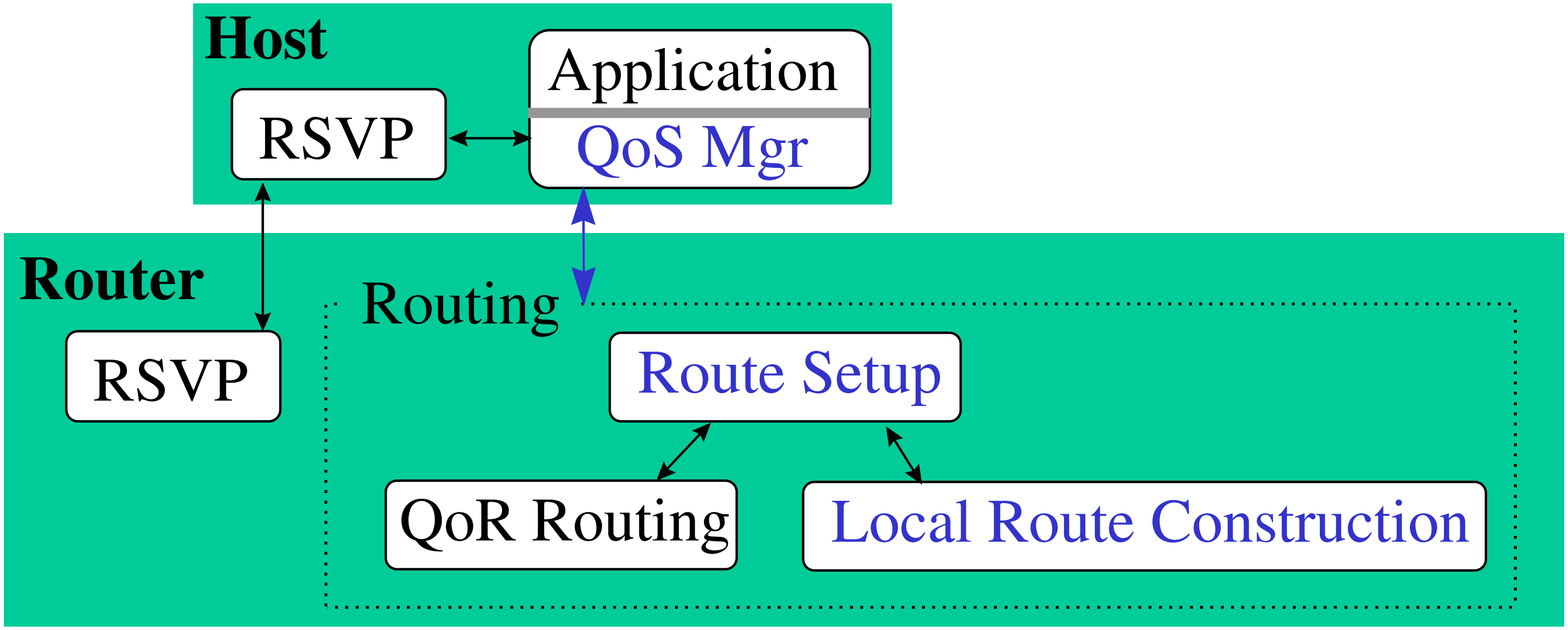
Our Solution for Failed Primary Route

- Receivers can request an alternate route when a reservation request fails on default QoR route
- Augment routing with:
  - (1) Localized route construction to find alternate routes
  - (2) Interdomain routing mechanism for installing and maintaining alternate routes
- Scalable route construction that does not require globally synchronized state or selection algorithm
- Simple, robust, receiver-oriented mechanism for installing multicast routes

Our Solution for Opportunistic Routing

- Receivers can request that routes be pinned
- Current route will only change if it ceases to function
- Integrated with multicast routing, so receivers can choose either opportunistic or pinned routes

Architecture

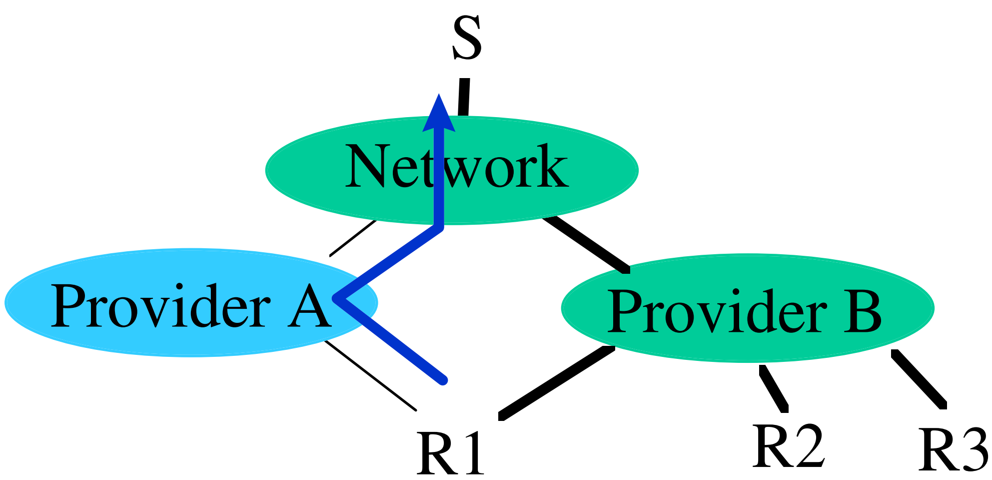


- QoS Mgr -- issues RSVP, alternate path, route pinning requests on behalf of application
- Routing -- contacts local route construction agent for route, then initiates route setup

Local Route Construction Agent

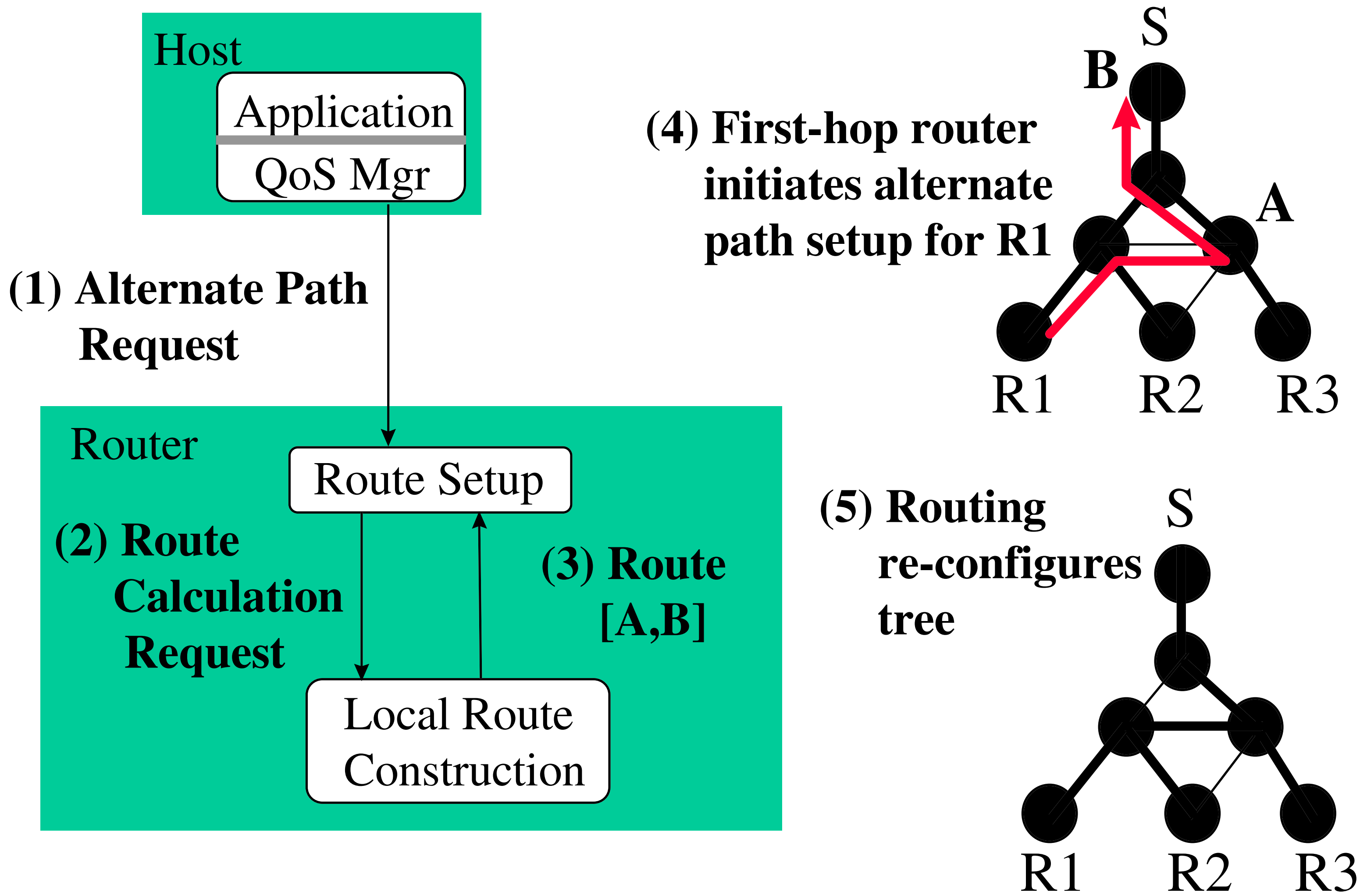
- Scales to large internet
  - Doesn't need to coordinate decisions with other agents
  - Can utilize information not captured by QoR static metrics, i.e. status of local reservation requests, resource information not globally distributed
  - Can use metrics that are not necessarily least-cost because route computation is not distributed
- Screens routes to ensure that they don’t undermine integrity or efficiency of multicast trees
- Chooses routes for local receivers; route setup mechanism resolves conflicts within multicast tree

Route Setup: Alternate paths



- May specify only a portion of the path
- Routing uses alternate path {R1, A , S} for R1
- Hops R1, A, S are fixed
- Segments [R1 - A] and [A - S] are opportunistic

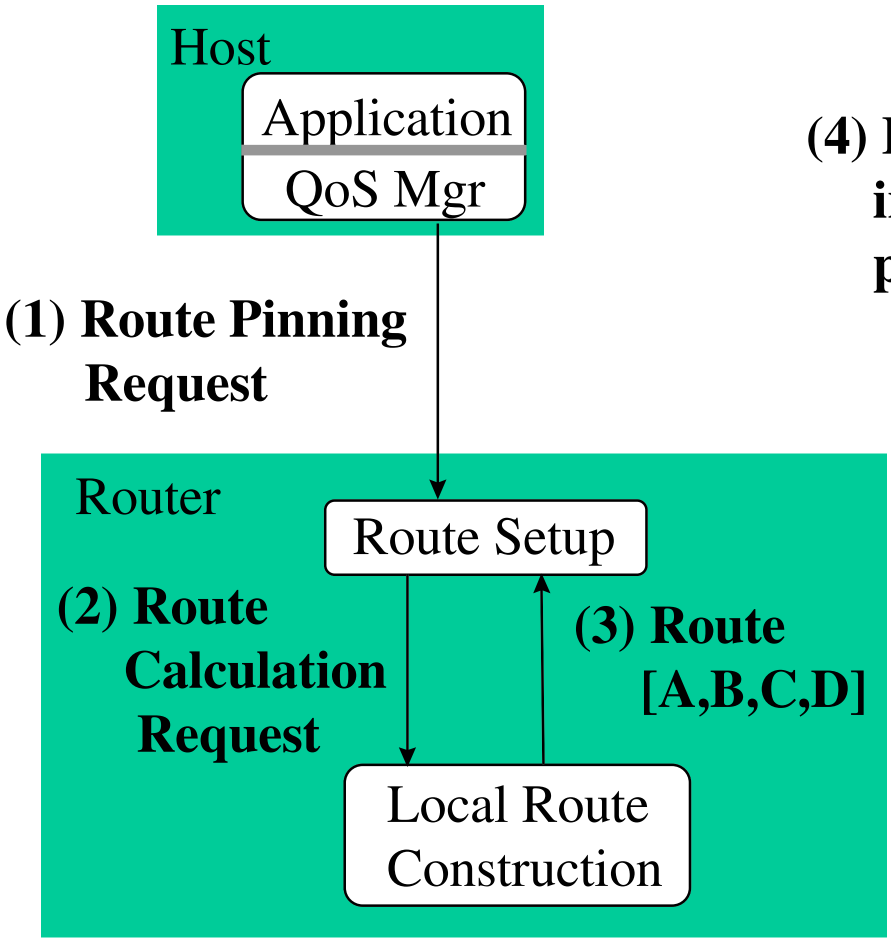
Example of Alternate Path Setup



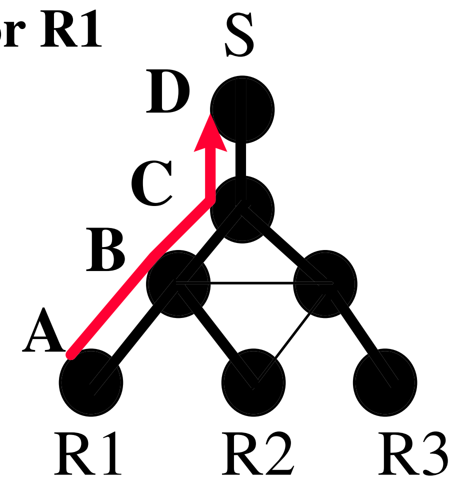
Route Setup: Route Pinning

- Route pinning requires that the complete path be specified
- May be applied to alternate paths
- May convert an opportunistic path into a pinned path
  - Take advantage of computation provided by current routing protocols
  - May want conversion when application obtains a reservation over opportunistic route

Example of Route Pinning



(4) First-hop router initiates route pinning for R1



Research Status

- Route setup mechanisms designed and prototyped (further details forthcoming)
- Currently simulating a simple scheme for local route construction to determine effectiveness of using local information to construct alternate paths
- Exploring other routing services
- See white paper at **http://netweb.usc.edu/daniel**