

QoS Routing Tools for Smart Networks

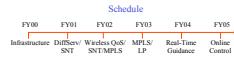
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Results



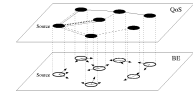
- Integrated demonstration
 - Real-time emulation of a large network corresponding to a military scenario
 - Prediction of link quality
 - QoS routing based on a Hierarchical Linear Program
 - Distributed scheduling for providing QoS guarantees at the MAC layer
- Linear Program
 - Two-level Hierarchy for scalability
 - Calculates optimal paths for a network with wireless shared channels
 - Adapts to mobility by dynamically reoptimizing routing
- Other New Algorithms
 - Developed a Delay Constrained Least Cost Routing Algorithm.
 - Dynamic Provisioning Algorithms for Service Level Agreements

Impact of Our Research

- Smart Network Toolkit (SNT)
 - Provides API for network management functions
 - Rapid deployment and reconfiguration of large-scale, complex networks including both wireless and wired network
- Resource allocation issues in DiffServ
 - Aggregation of SLAs to provide QoS and maximize throughput
- QoS issues in ad-hoc wireless networks
 - Load adaptive and robust QoS routing using link layer information
 - Help mitigate congestion storms and network meltdown
- MPLS traffic engineering
 - Non-shortest-path routing for better use of network
 - Quick reroutes for protection against failures

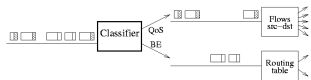
QoS Routing overview

- Objectives:
 - Carry traffic with QoS requirements in a wireless shared medium
 - Maximize available bandwidth for best effort service
- Overlay network:
 - BE traffic: AODV
 - QoS traffic: QoS routing algorithm proposed



QoS Routing overview

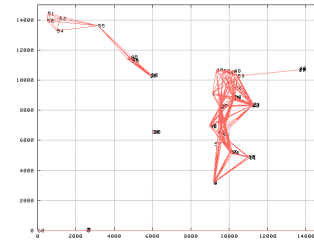
- Capabilities offered:
 - Feasible path selection in a shared 802.11 medium with different link speeds
 - High priority flow bandwidth reservation
 - Proactive reoptimization of paths prevents interruption by predicting link breakage when nodes move
 - Hierarchical and scalable solution



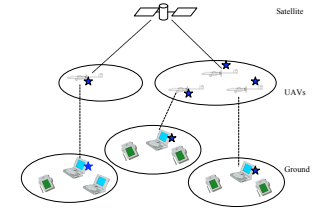
QoS Routing overview

- QoS route optimizer procedure
 - Prediction of maximum link throughput: based on signal strength measurements of the links.
 - Adding new flows: a Linear Program (LP) finds feasible paths for multiple new QoS flows simultaneously in a shared medium. Therefore the LP solution is more optimal than algorithms based on sequential path selection.
 - Dynamic reoptimization: proactively and periodically reroute flows before link quality deteriorates due to high mobility
 - Reservation capabilities added on top of the 802.11 MAC layer using adaptive rate limiting of the best effort traffic being sent by each node.
 - Configuration commands are sent back to the network emulator over a TCP connection.

Sample scenario



Sample scenario

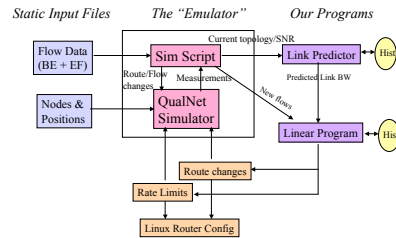


★ Gateway per domain

Demonstration

- Components:
 - Emulator: Qualnet
 - Real network
 - QoS routing: Linear Predictor and Linear Program
 - QoS routing input:
 - Flow requests
 - Network topology
 - QoS routing output:
 - Paths for the new flows (routing entries)
 - MAC layer rate limiting
- ⇒ Configuration of real hardware nodes (laptops) and the virtual nodes in the emulator.

QoS Routing Blocks



QoS Routing Details

- The Simulator Script processes the Flow Data traffic and provides the Link Predictor the current topology and an estimate of the signal quality.
- The Link Predictor converts the signal level measurement to the total available throughput of the link and provides this information to the Linear Program.
- The Script also provides the Linear Program with any new high priority flow requests.
- The Linear Program takes as input the new flow requests and the network topology with the quality of the link.
- The Linear Program then calculates a path for the flow and provides this information to the simulator by specifying Route Changes and Rate Limits (applied in the Mac layer).

Conclusions

- Two classes of traffic
 - BE traffic: AODV, routing tables
 - QoS traffic: QoS routing algorithm proposed, src-dst flows
- Hierarchical and scalable solution
 - Interdomain routing
 - Intradomain routing
- 802.11 shared medium with different link speeds support
- Proactive reoptimization by predicting link breakage when nodes move