



Bandwidth Guarantee for 802.11b Wireless LAN

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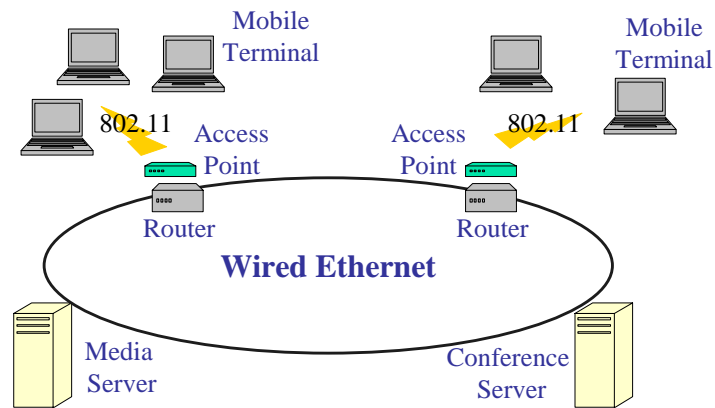


Introduction

- Popularity of 802.11b networks is on the rise, typically as access network to the wired infrastructure
- Current commercial products on the market do not provide QoS support
- Wireless Rether is a system that provides both upstream and downstream **bandwidth guarantee**

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WLAN Configuration



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What is the problem?

- Multimedia applications requires QoS support, specifically bandwidth guarantee
- But radio link is a shared resource and its access is through CSMA/CA protocol → packet collision on the channel
- Collision causes two problems:
 - Non-deterministic access delay
 - Lower effective link throughput

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Wireless Rether

- Rether is a software-only token passing protocol originally developed for shared-segment Ethernet → adapted to WLAN
- Provides bandwidth guarantee to **individual applications**, both upstream & downstream
- No changes to applications are required
- Interoperable with wired network's DiffServ or 802.11p mechanisms

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Wireless Rether

- A WLAN node can send traffic only when it receives the token
- Token circulates among real-time (RT) nodes in a periodic fashion
- Token holding time depends on the total bandwidth reservation on each node
- Whatever residual cycle time left by RT nodes are used by the NRT nodes
- Per-connection packet queuing
- Requires explicit registration from WRC with WRS

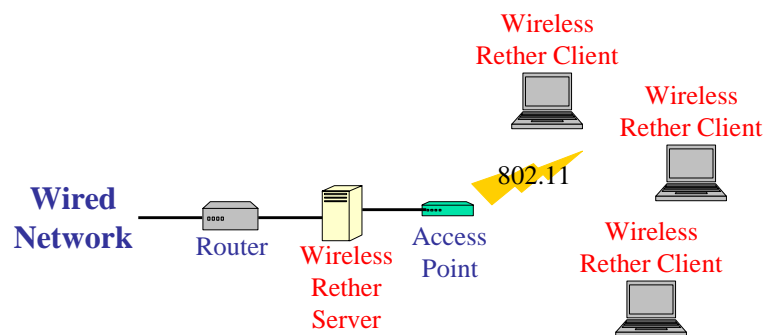
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Architectural Decisions

- Hardware vs. **Software** implementation
- Peer-to-peer vs. **Centralized** token passing
- Work-conserving vs. **Non-work-conserving** network link scheduling
- **To ACK** or Not to ACK
- **Infrastructure** vs. Ad hoc mode
- **Implicit** vs. Explicit bandwidth reservation

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Rether System Architecture



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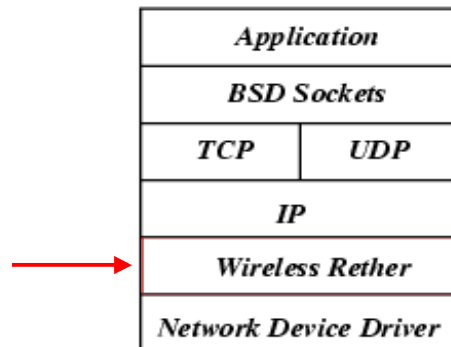
Bandwidth Reservation

- Reservation policy table
 - **SrcAddress/Mask, DestAddress/Mask, SrcPortRange, DestPortRange, Bandwidth Requirement**
- Statistical admission control
- Leave slack to avoid starvation of NRT traffic
- Automatic two-way reservation for TCP
- Intra-LAN connection requires twice the amount of required bandwidth reservation
- Special packet queues for Rether packets and other network control packets (ARP and ICMP)

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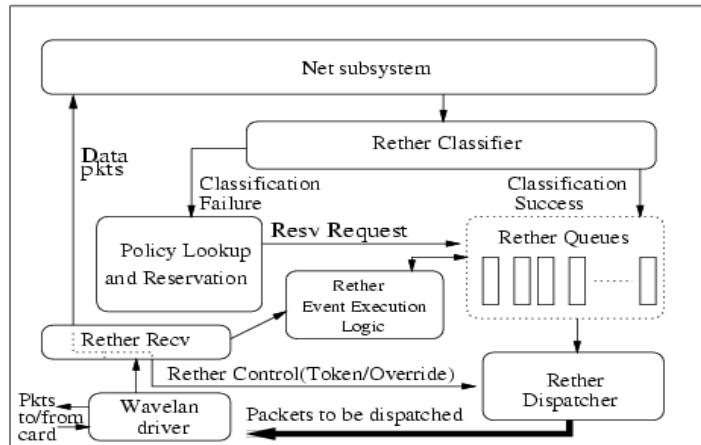


Transparent Packet Scheduling



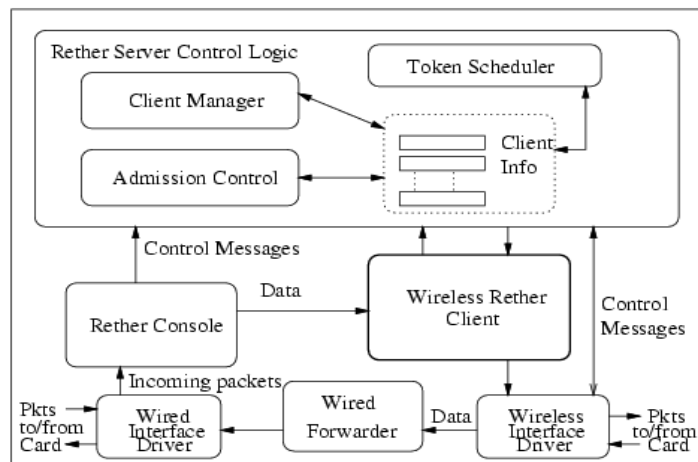
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Wireless Rether Client



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Wireless Rether Server



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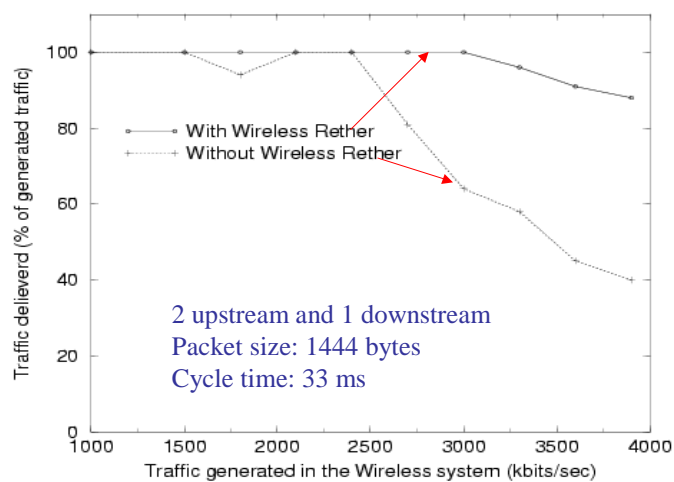
Prototype and Test-bed

- Implemented under Red Hat 7.0
- WRS is a 400-MHz Pentium-II machine with 128 Mbytes of memory
- WRC is 650-MHz Pentium-III portable machine with 64 Mbytes of memory
- Orinoco wireless LAN cards and access point (AP-1000)
- Wired network is Fast Ethernet

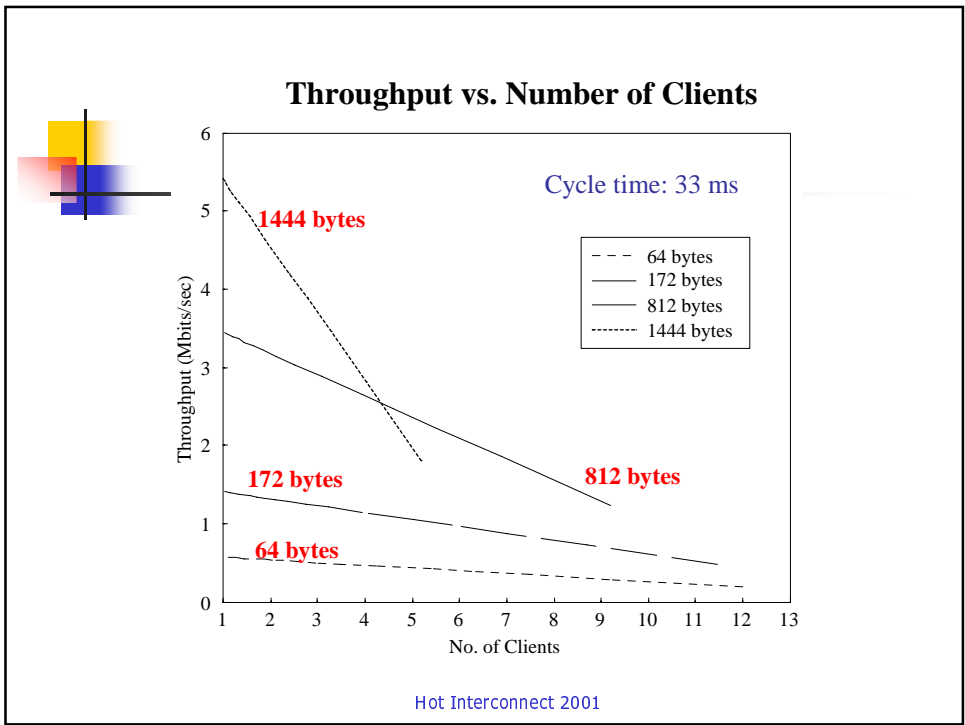
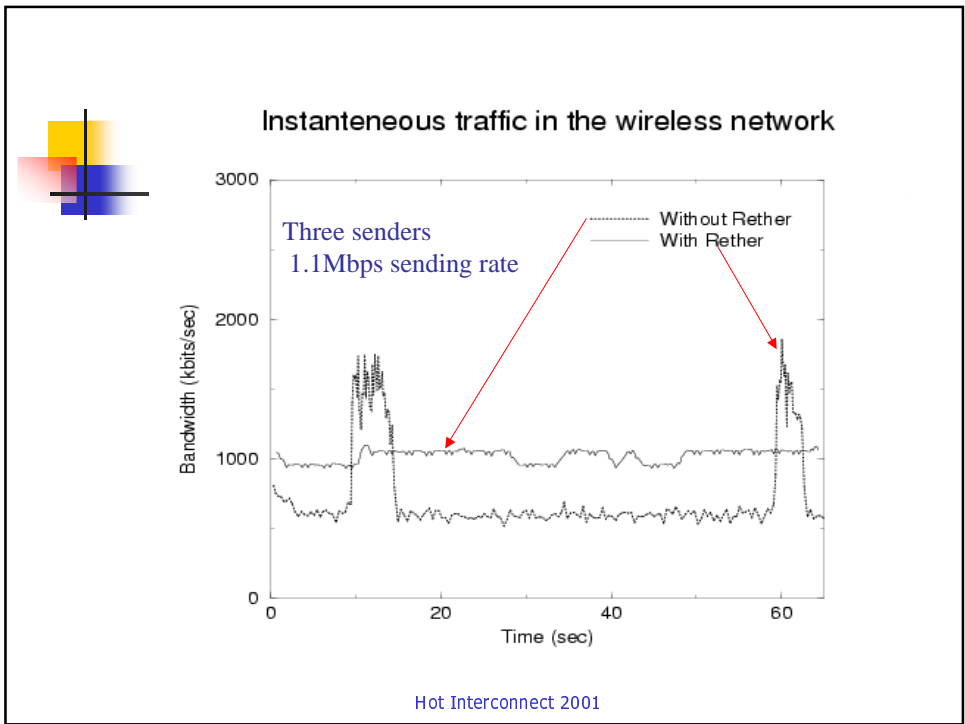
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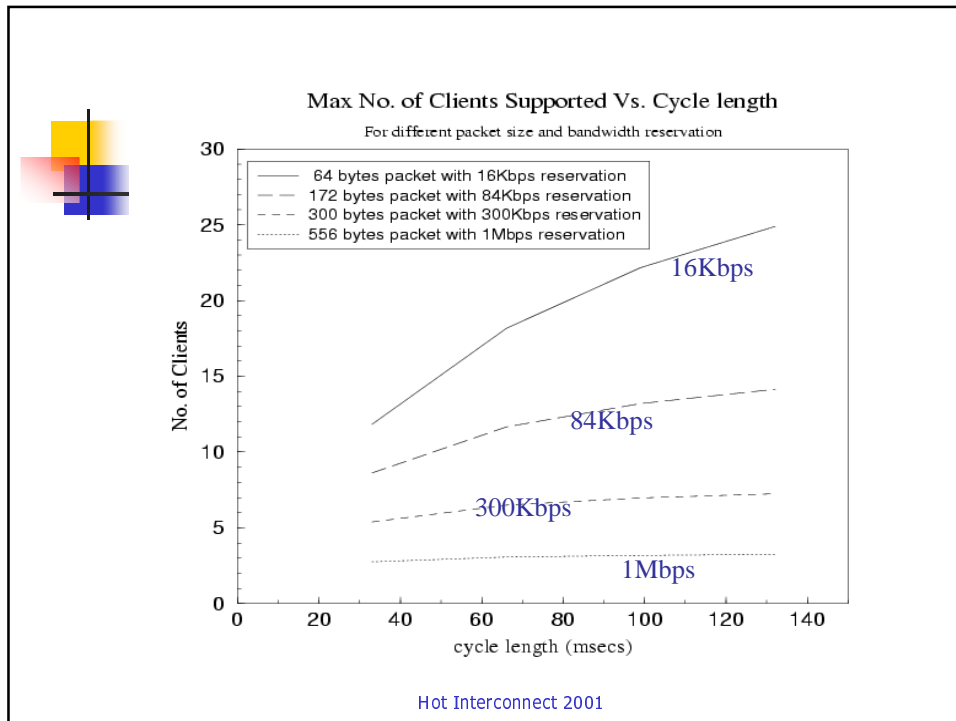


Packet delivery statistics



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- ## Current Work
- TCP-aware good-put management
 - Automatic content-based bandwidth reservation
 - Low-latency hand-off for infrastructure-mode wireless LAN, from 2-3 sec to under 100 ms
 - Vertical hand-off between 802.11b and 2G/GPRS/3G networks
 - Porting to 802.11a is straightforward
 - Leveraging 802.11e standard
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Conclusion

- Wireless Rether is the first to support bandwidth guarantee to individual network applications on wireless LAN and is interoperable with DiffServ on wired networks to provide end-to-end QoS
- No application modification is required
- WRS can be readily used as a traffic manager for downstream traffic on a wireless LAN; no WRC is needed on the mobile terminal
- Major performance problem lies in token passing overhead due to buffering delay at access points

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