Removing the MAC Retransmission Times from the RTT in TCP

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Problem: RTT modification

- TCP works very well in wired links
  - very few physical losses
  - most losses are due to network congestion
    - TCP reduces packet rate, in order to eliminate congestion
- TCP is not adapted to wireless links <= interferences
  - short => MAC retransmissions => increase of RTT
    - RTT as congestion indicator (queue length) is no longer appropriate
    - RTO depends on RTT, it is falsely modified too
  - long => lost packets
    - => inappropriate congestion control actions, since not congestion

Problem: RTT effects

- Several CC mechanisms use the RTT:
  - each RTT: TCP Vegas
  - the smallest RTT: Westwood+, TIBET
  - any solution where RTT might be used: RTP/RTCP over UDP
- TCP Vegas: for each packet reception, it compares its RTT against the estimated RTT:
  - if diff $< \alpha$, reduces rate
  - if $\alpha <$ diff $< \beta$, maintain rate
  - if diff $> \beta$, increases rate

Proposition

- Put in packets the time spent on MAC retransmissions

- A TCP option is added
- Network cards have a timer
- Cards add to the TCP option the time lost in MAC retransmissions
- Receiver echoes back the time
- Source takes the appropriate action

Plan

- Principle
  - transmitting information to the source
  - retransmission time computing
- Simulations
  - ns2 modification
  - background: shadowing wireless propagation model
  - results
- Related work
- Conclusions, future work

Principle: transmitting information

- TCP option:
  - unit: 20μs
  - size: 2 bytes => $65536*20\mu s \simeq 1.3s$
    - 802.11b standard: max 1023 or retransmission window
- Source sets the field to 0
- The field is modified by network cards
- Receiver echoes back the value of the corresponding data packet (exactly like timestamp option)
- Source receives the information
- => Incremental deploying possible

Principle: retransmission time computing

- Each network card has a timer
- For each packet:
  - when the packet is sent, the timer is initialised with the value of the TCP option
  - each time the packet is resent, the value of the timer is stored in the option => lost times are added

```
Fixed src                    AP                      Mobile dest
    0   ------------->        0  -------->X
                             54  ---------------->      54
                                          X<-----       54
                                      X<---------       93
                             123<----------------       123
    123<-------------        123
```

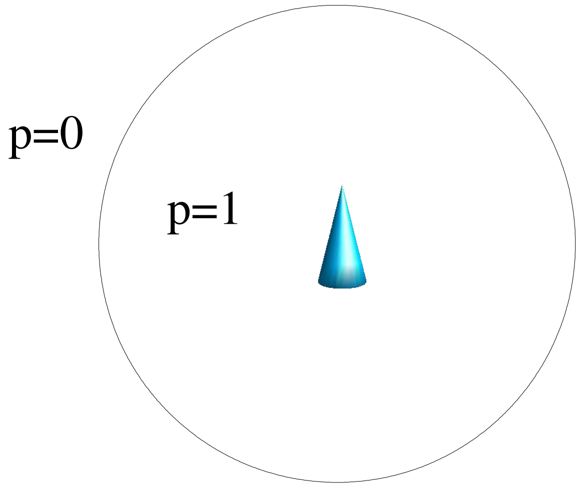
Simulations: ns2 modifications

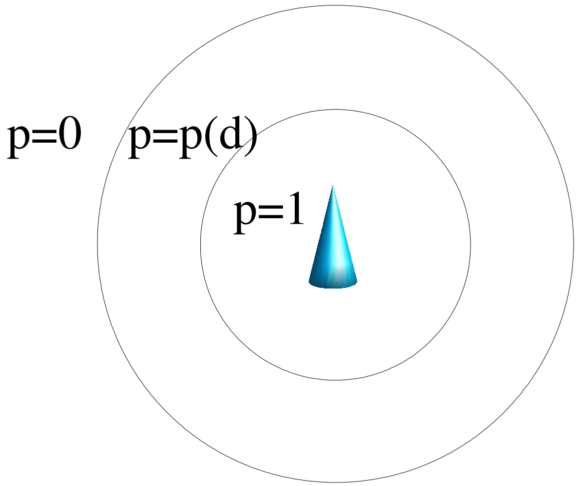
- Addition of the rets field to TCP header
- The sending part of TCP/Vegas
- The sending part of 802.11
  - value used: the time between packet sending time and the reception of its MAC ACK
- Sending part of TCPSink
- Receiving part of TCP/Vegas

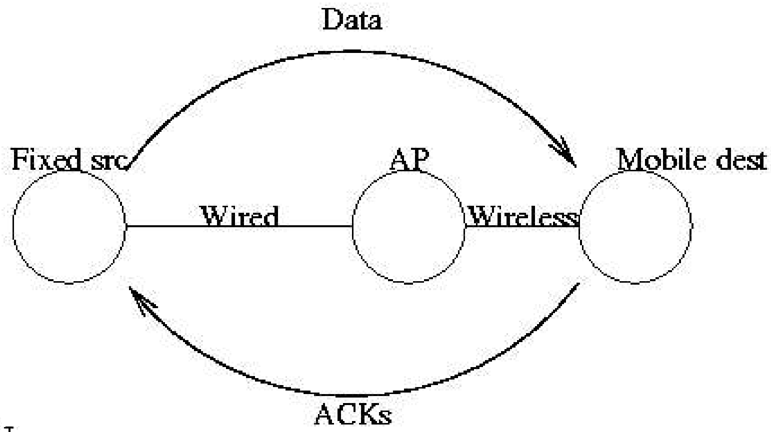
- All tests are available on Web page

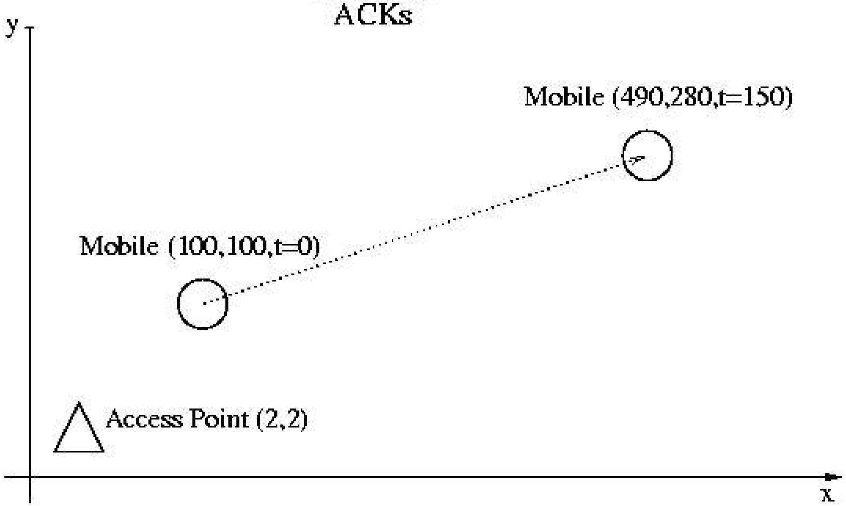
Background: propagation models in ns2

- All or nothing:
  - FreeSpace
  - TwoRayGround
- Probability-based after a certain distance
  - Shadowing <= used in the tests

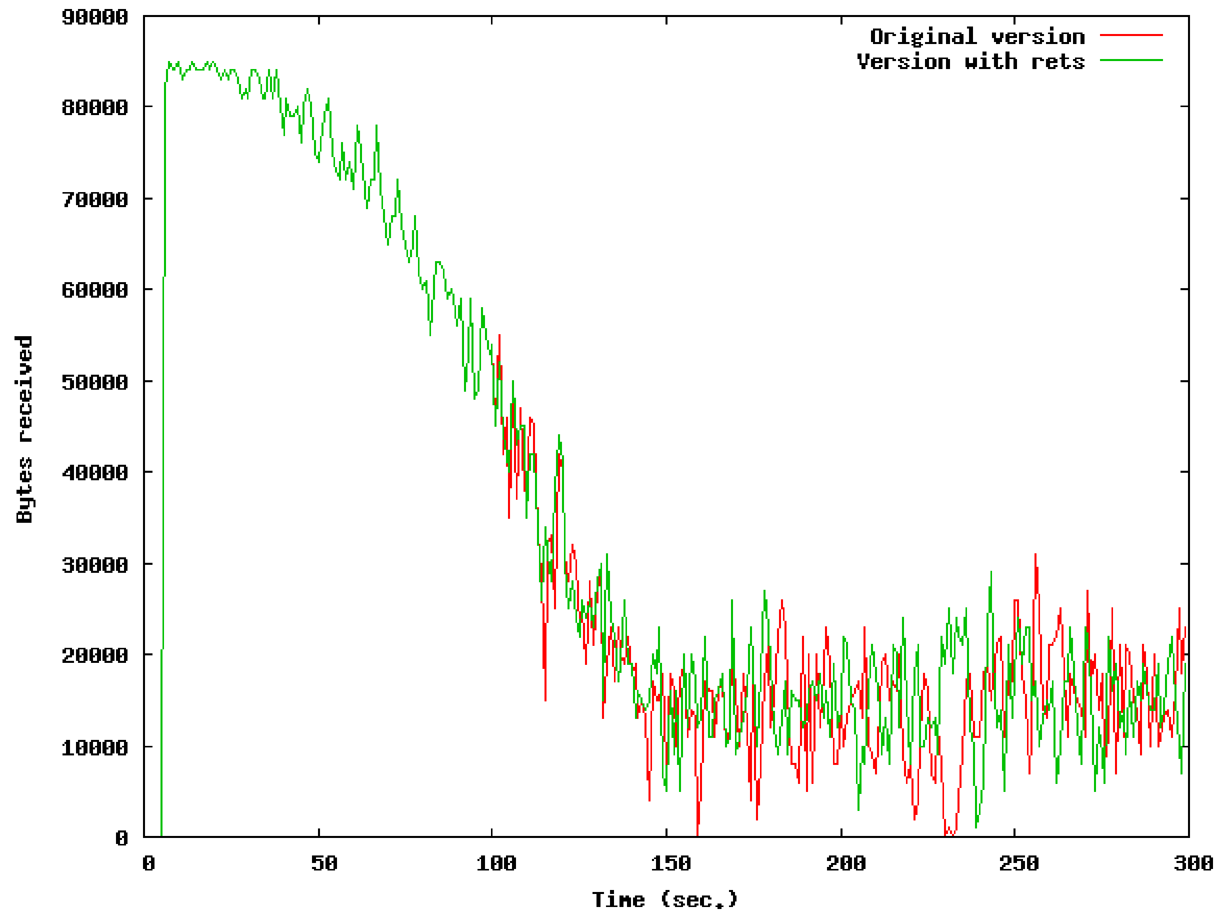








Simulations: results



- t < 5, ftp starts at 5s
- 5 < t < 100, identical
- 150 < t, 4.5% improvement
- 150 < t < 250, 15% improvement

max 1Mb/s

Related work: general

- Packet loss in wireless:
  - [Jing et al. 2000], a timestamp is added by AP in each packet => can detect packet loss even for out-of-order packets => source is informed faster about packet loss
- RTT influence on RTO:
  - [Scharf et al. 2004], analytical model of RTO based on network parameters
  - [Möller et al. 2004], artificial delay at AP => RTT increases => RTO increases => false TCP retransmissions decreases => higher overall throughput

Related work: packet delay in wireless

- [Ratnam et al. 1998], AP divides the connection in two connections and estimates the packet delay
- Integrates within timestamp TCP option
  - timestamp granularity is machine-dependent
- => Each time a packet is resent, its timestamp is replaced with the most recent timestamp of the same flow
  - => estimation
  - => network cards: memory and CPU consuming
- Results: the more losses in wired part of connection, the higher the throughput

Conclusions

- A method to remove the effect of packet MAC delay
- Network cards have a timer which is added to the TCP option of the packet
- Receiver echoes back the value of the option
- Simulations: improvement of bandwidth

Drawbacks and future work

- Network cards have access to level 4
- Deployment: source and destination (and AP)
- Restricted use (uses RTT)

- Analysis of more complex scenarios
  - competing flows in wireless
  - lossy wired links
- Real experiments (pb.: access the MAC firmware)
- If successful, define a complete proposal