Modelling and Performance Analysis of WMAC Protocols

Overview

1. DFWMAC
2. Simulation tool
3. DFWMAC model
4. Simulation results
5. Conclusions

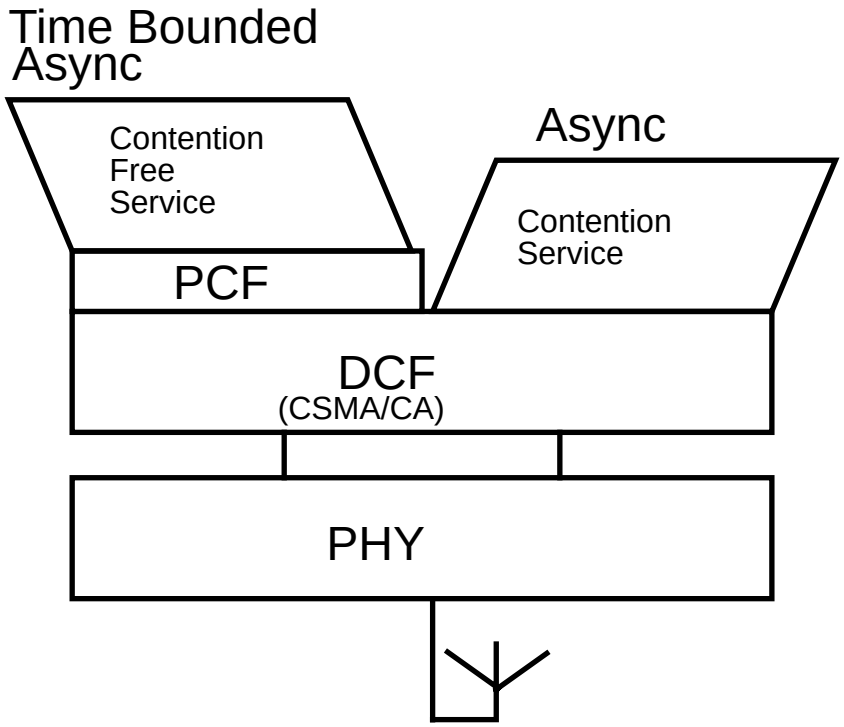
DFWMAC

- **Preferred MAC protocol in the IEEE 802.11 standardisation group**

  ⇒*Draft standard*
- **Consists of two parts**
  - *Basic access method (pseudo CSMA/CA)*
  - *Contention Free Service support*
- **Two working modes**
  - *Ad-Hoc*
  - *Infrastructure (can overlap with Ad-Hoc)*
- **Supported services**
  - *Asynchronous Data Service*
  - *Contention Free Service (optional)*
    - Asynchronous Contention Free
    - Time Bounded Service (voice)

DFWMAC (cont.)

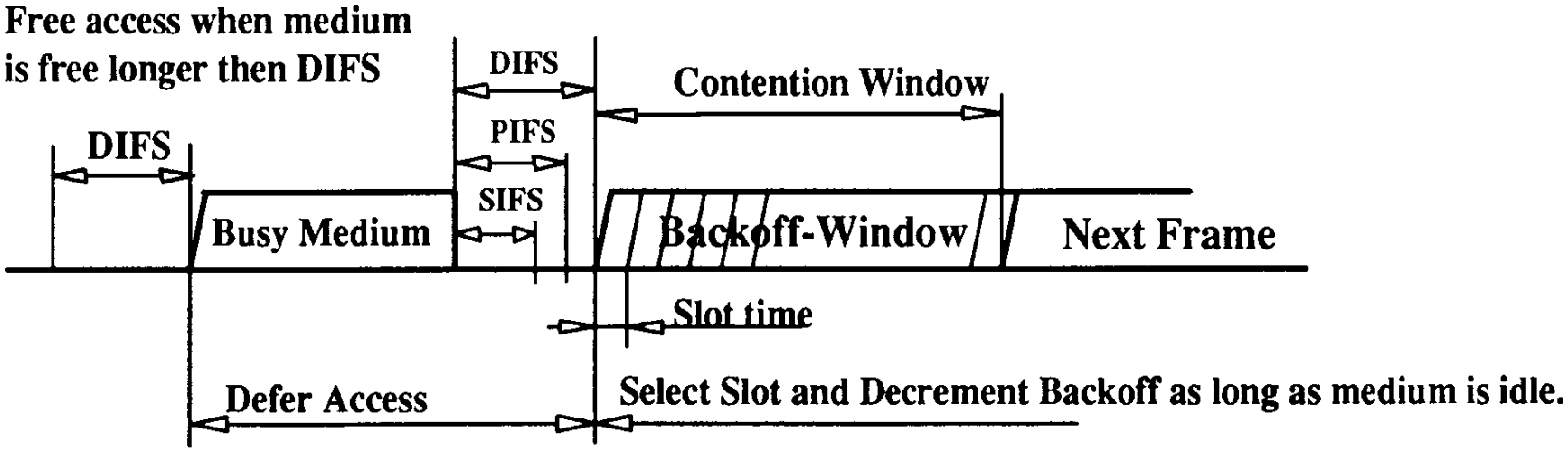
Service Model



DFWMAC (cont.)

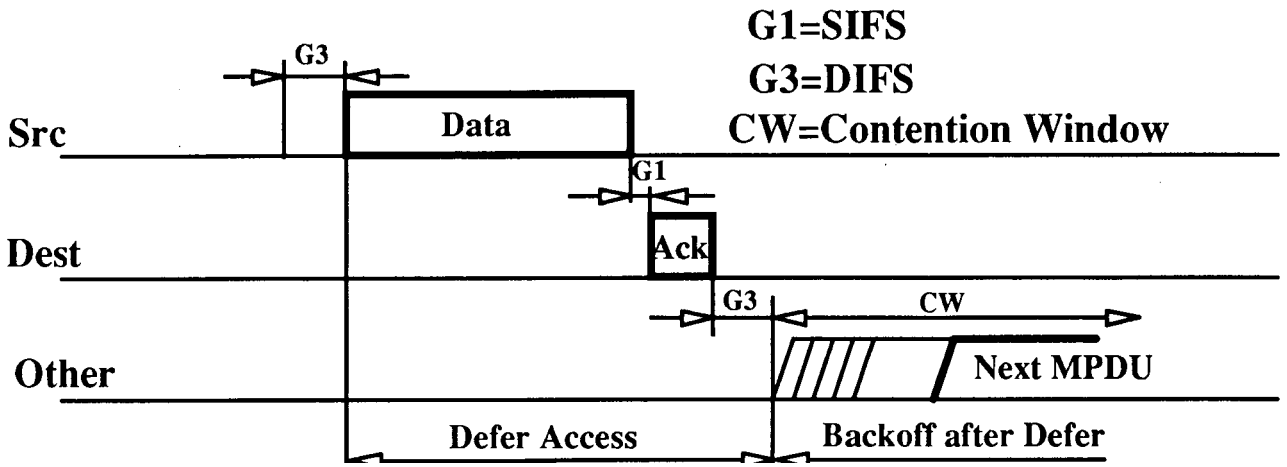
Basic access method

- **Distributed Access Protocol**
  - *MAC level recovery (immediate Ack for unicast transmission)*
  - *optional RTS/CTS (provide virtual circuit - hidden node problem)*
  - *different priority levels (IFS - needed for Ack or PCF)*

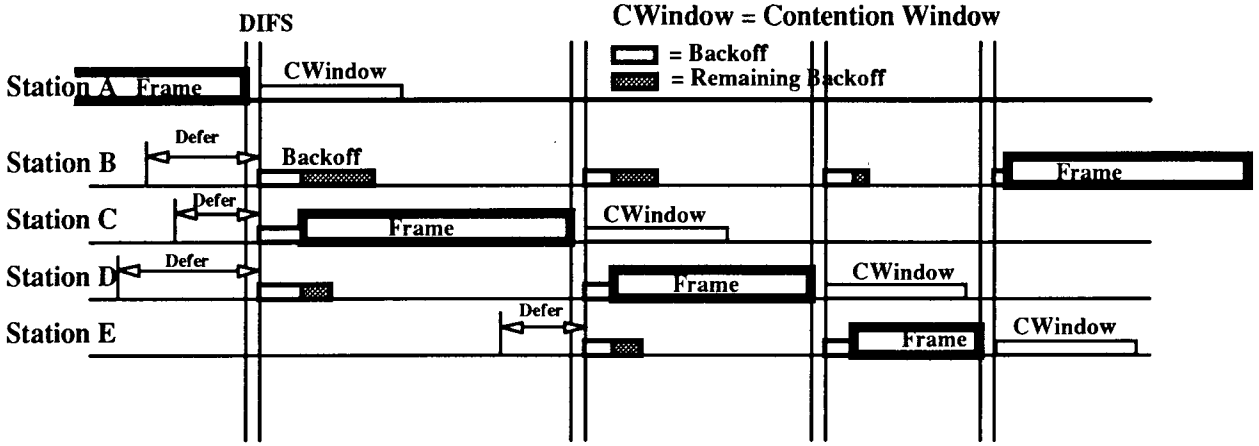


DFWMAC (cont.)

Access procedure with immediate Ack

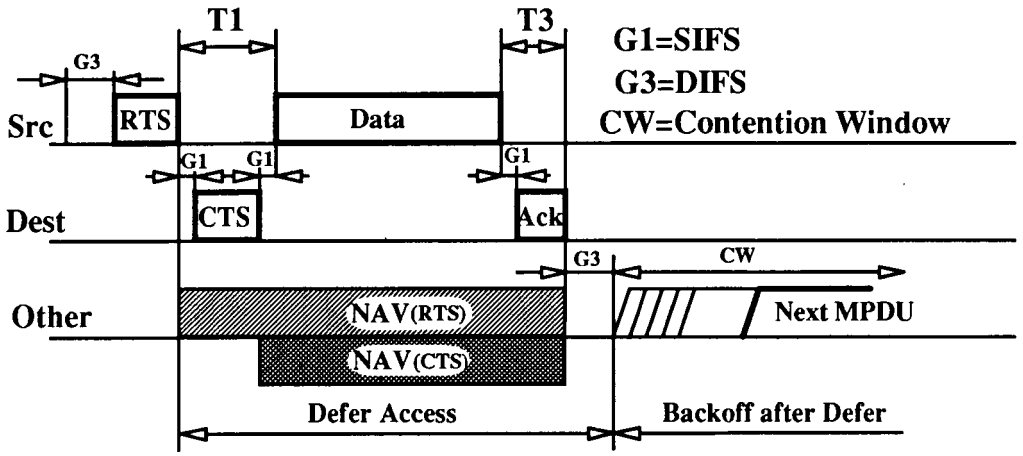


Access Backoff procedure

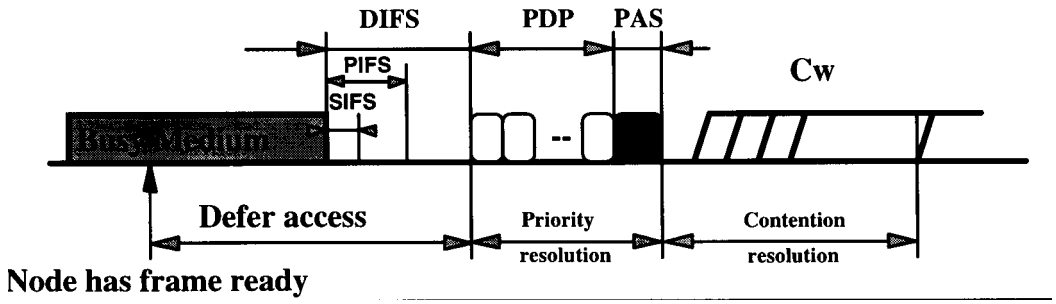


DFWMAC (cont.)

RTS/CTS extension

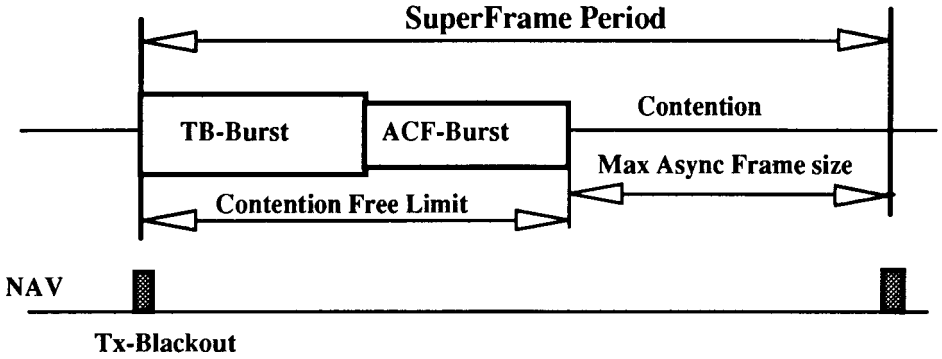


Active priority signalling (APS)



DFWMAC (cont.)

Contention Free Service



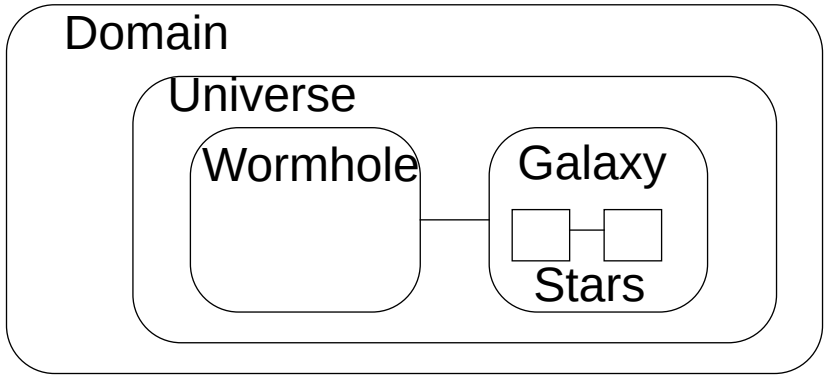
- **Registration for time bounded and asynchronous contention free transmission in the contention period**
- **polling of terminals by a control station**
- **use of shorter IFS for high priority traffic**

Simulation tool

- **available tools: PTOLEMY, OPnet, SES/workbench, SMURPH (LANSF), CSIM**

  ⇒*PTOLEMY*
  - general purpose simulation tool
  - many connectable simulation environments (discrete event, synchronous data flow, concurrent processes) for several simulation types
  - object oriented
  - relative simple modelling (rich library)
  - graphical interface or Tcl-based interpreter
  - free source code
  - lots of users (newsgroup, maintenance)

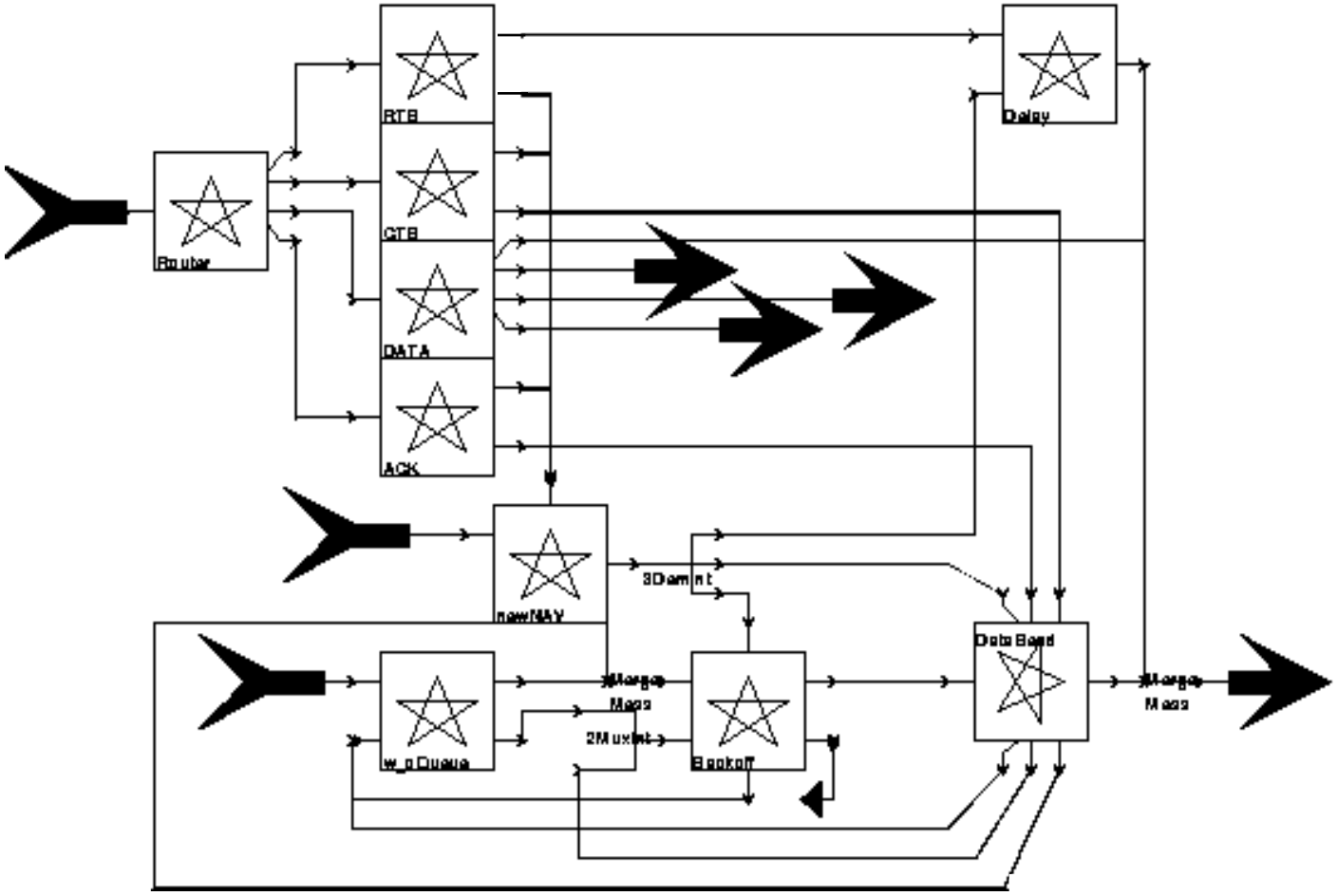
- **PTOLEMY model structure**



DFWMAC model

- **only DCF (CSMA/CA with Ack and RTS/CTS implemented)**

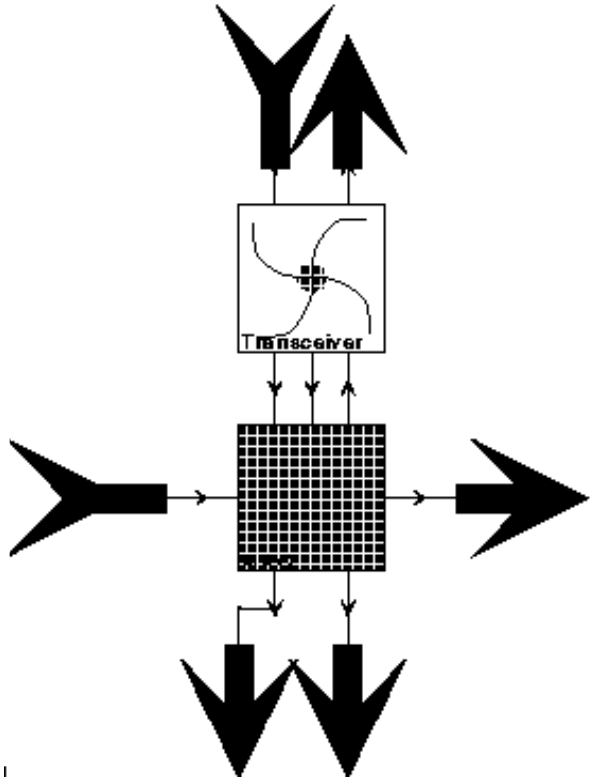
MAC model



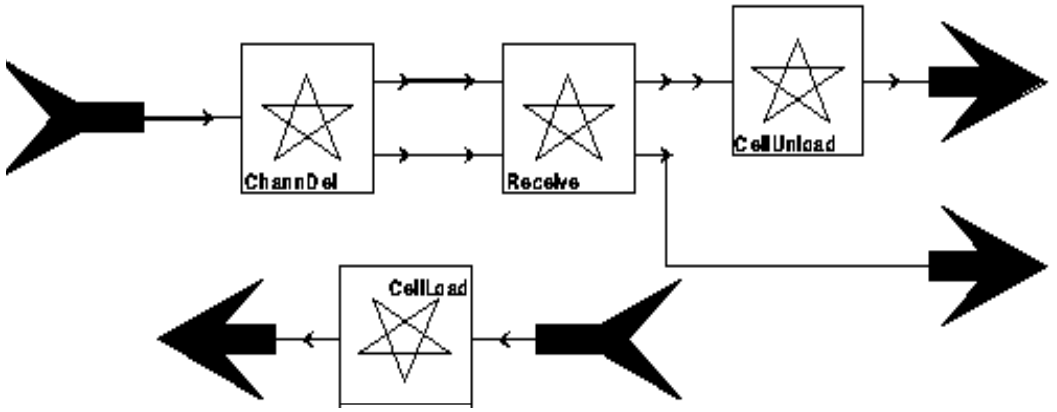
DFWMAC model (cont.)

MAC model and transceiver

MAC+Transceiver

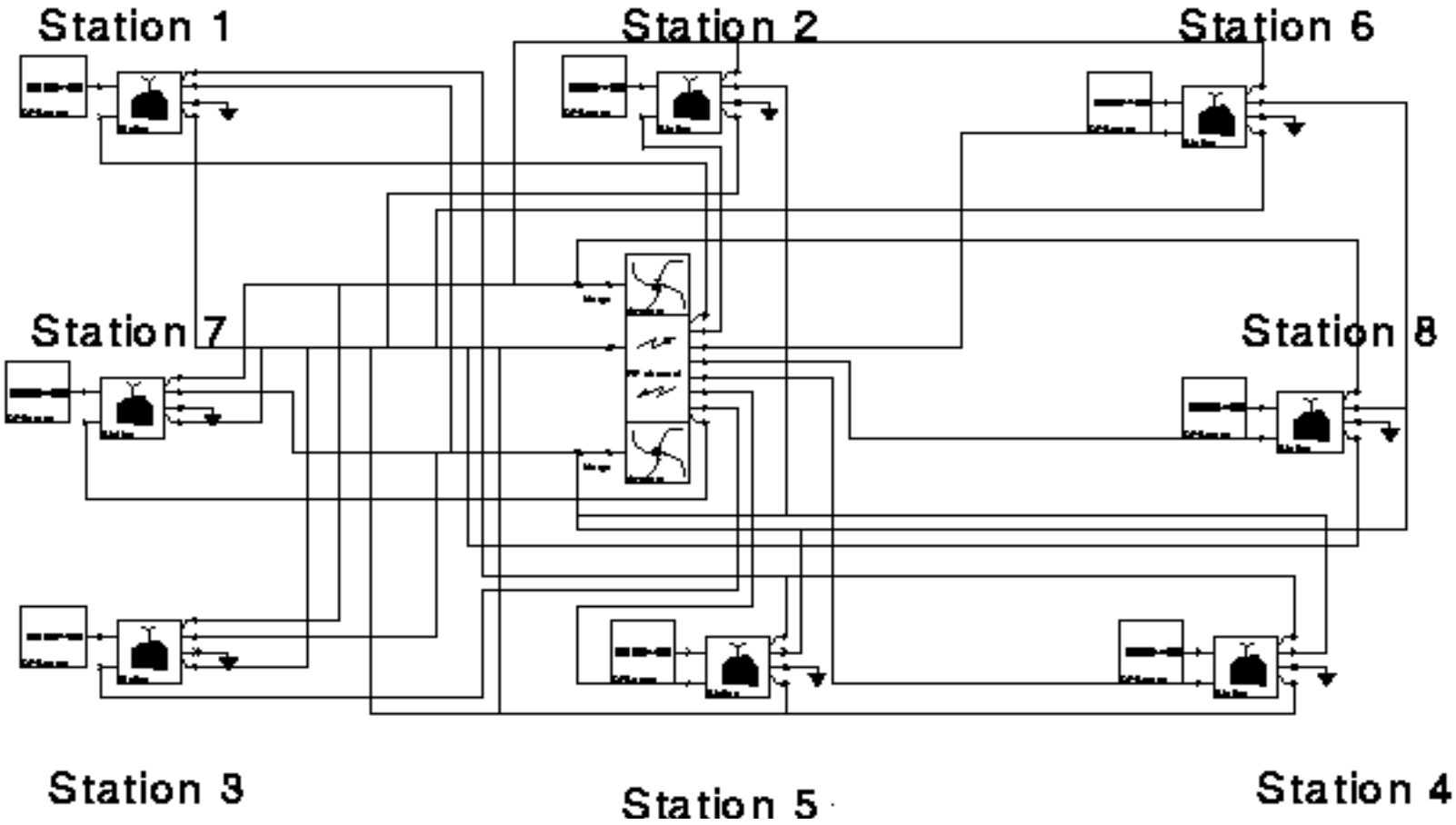


Transceiver



DFWMAC model (cont.)

Simulation model with 8 stations

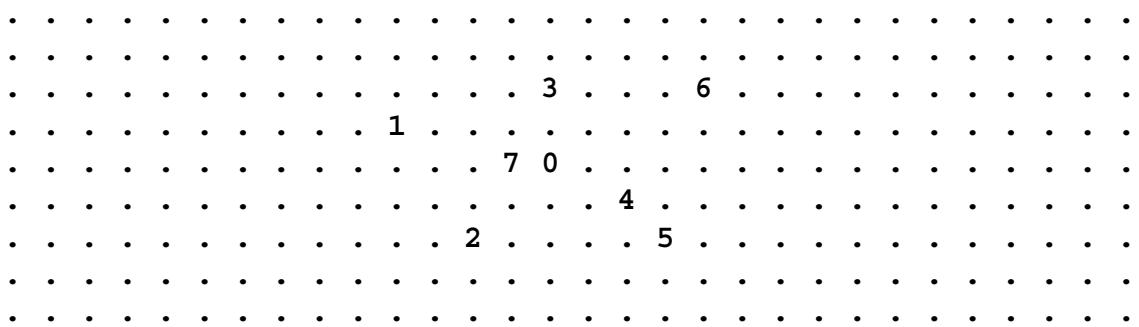


DFWMAC model (cont.)

Channel model

- **propagation delay**

  ⇒*position of stations (one dot = 10 meter)*



- **transmission rate (2 Mbit/s)**
- **attenuation coefficient (2.0)**
- **Error Probability (Poisson process, mean value 10^{-4})**
- **currently no moving stations**
- **currently no co-channel, adjacent channel interference**

Simulation results

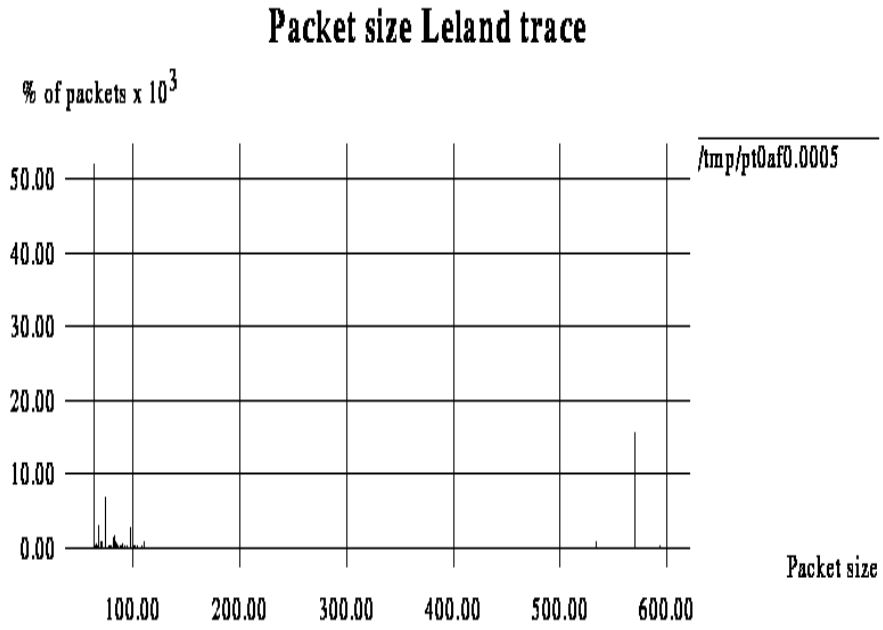
- **Simulation of**
  - *Throughput*
  - *Access delay*
- **Parameter of simulation**
  - *Channel Access Mechanism*
    - pure CSMA/CA with/without binary exponential backoff
    - CSMA/CA with Ack (DFWMAC) with/without RTS/CTS
    - CSMA/CA with Ack (DFWMAC) with/without RTS/CTS and APS
    - CSMA/CA with Ack (DFWMAC) with modified backoff algorithm no APS
  - *Contention Window Size*
  - *Load pattern:*

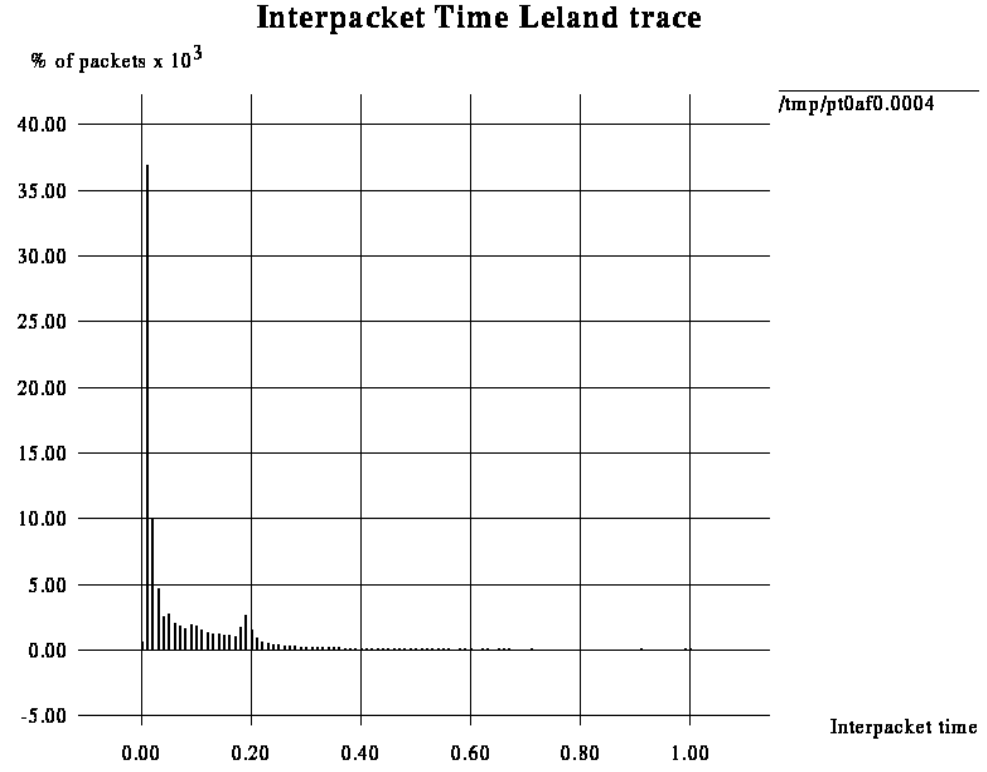
$$\mathrm{Load} = \frac{1}{(\mathrm{InterPacketTime} + \mathrm{TransmissionTime})} \cdot \mathrm{PacketSize}$$

  - *Packet Size*
    - fixed packet size of 53, 64, 256, 512, 1024 bytes
    - variable packet size (Leland trace)
  - *no RTS/CTS (RTS/CTS depending on packet size)*

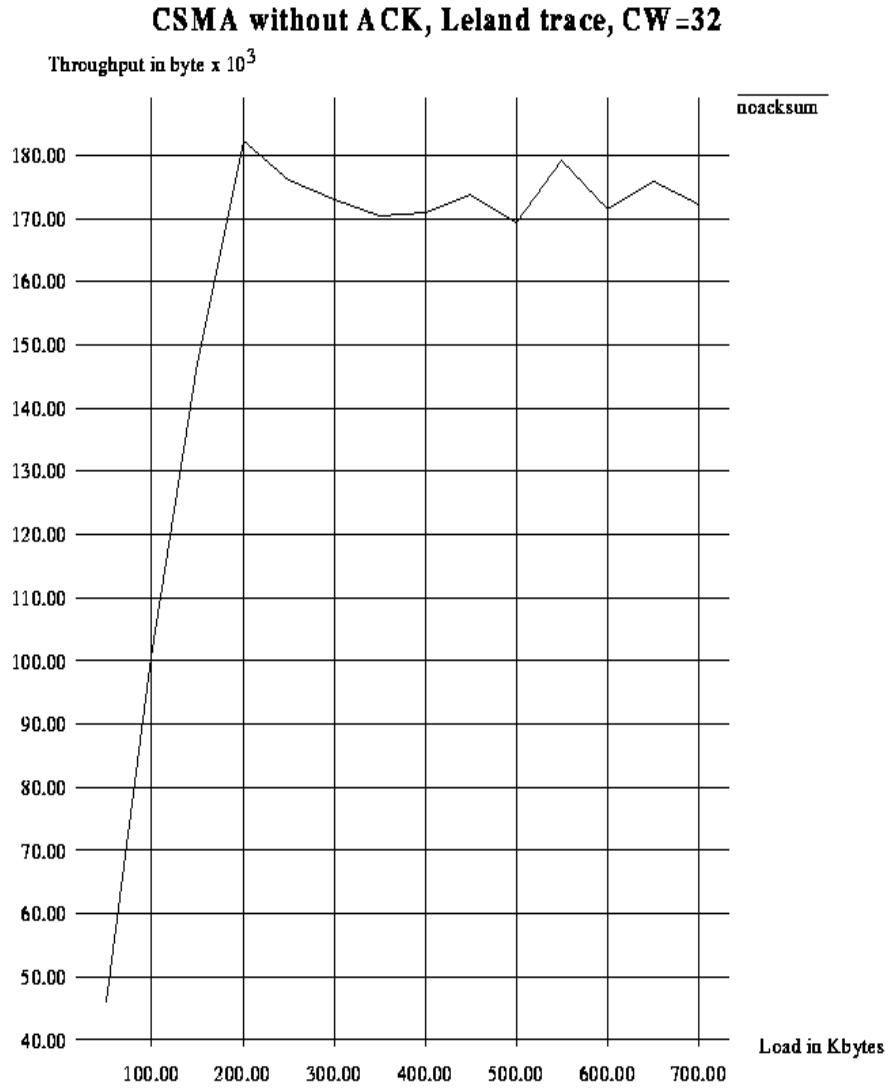
Simulation results

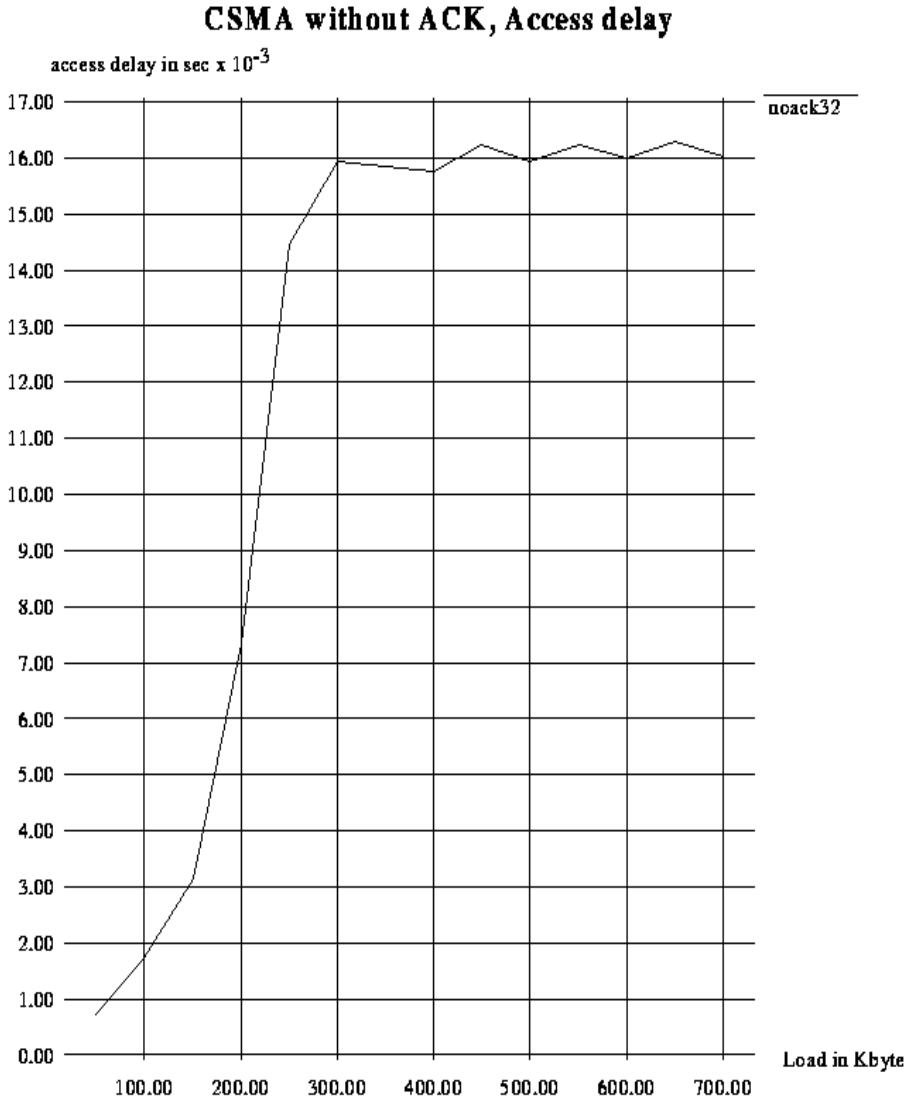
- **Leland trace**
  - *measurement on a 10BaseT Ethernet at Bellcore Morristown, October 1989*
  - *1 million packet arrivals*
  - *accuracy roughly 10 msec*
  - *Note: limitation to Ethernet packet sizes (64 to 1518 bytes)*



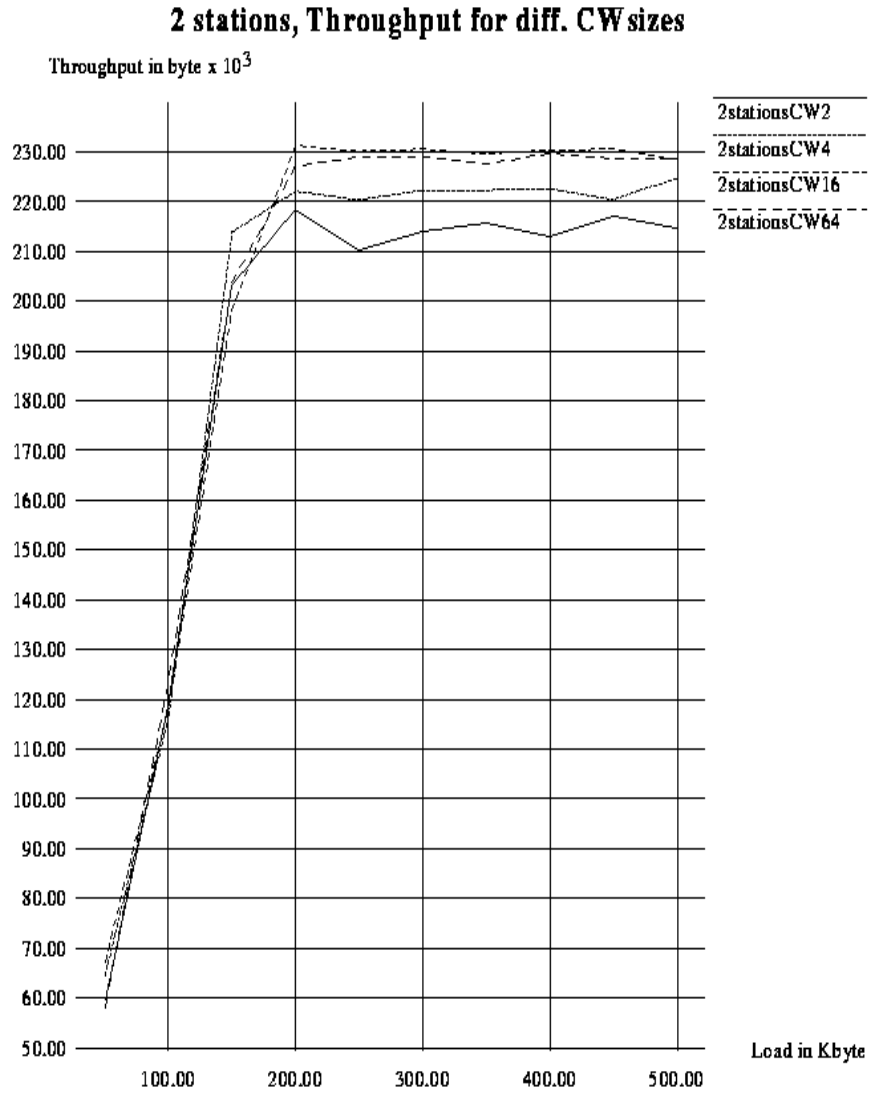


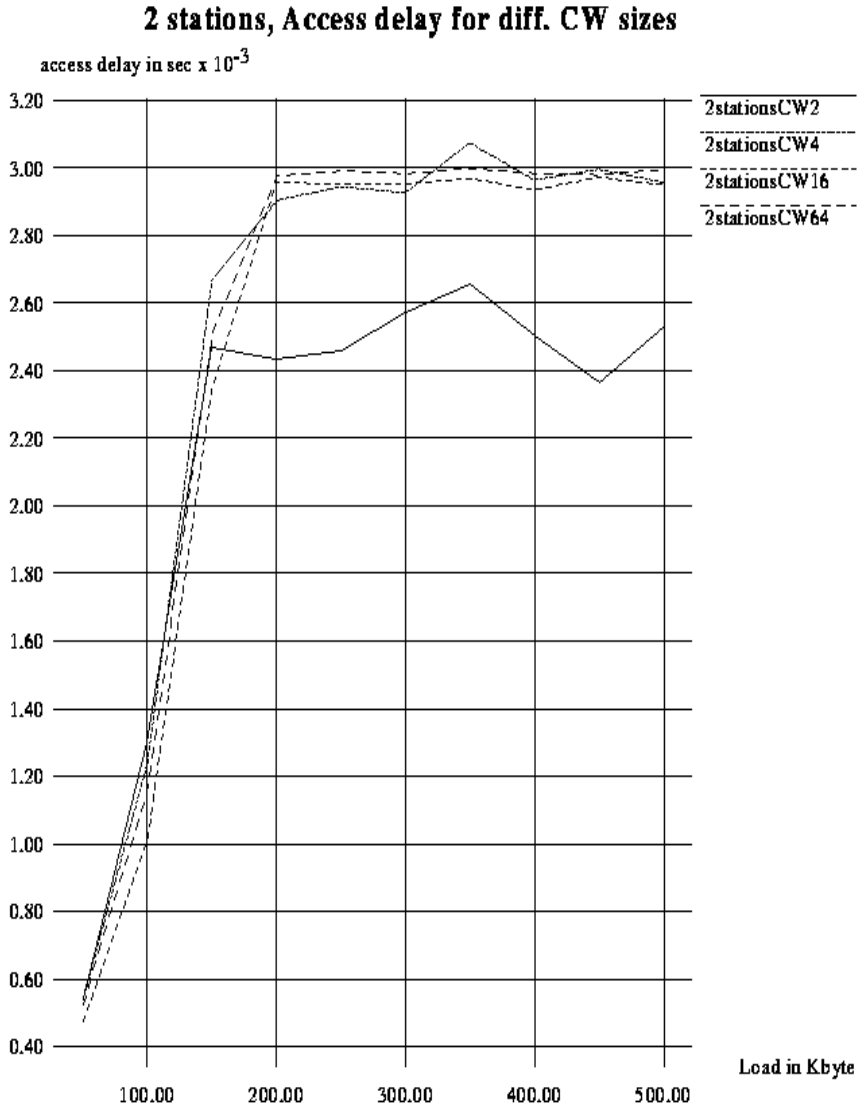
Simulation results (cont.)



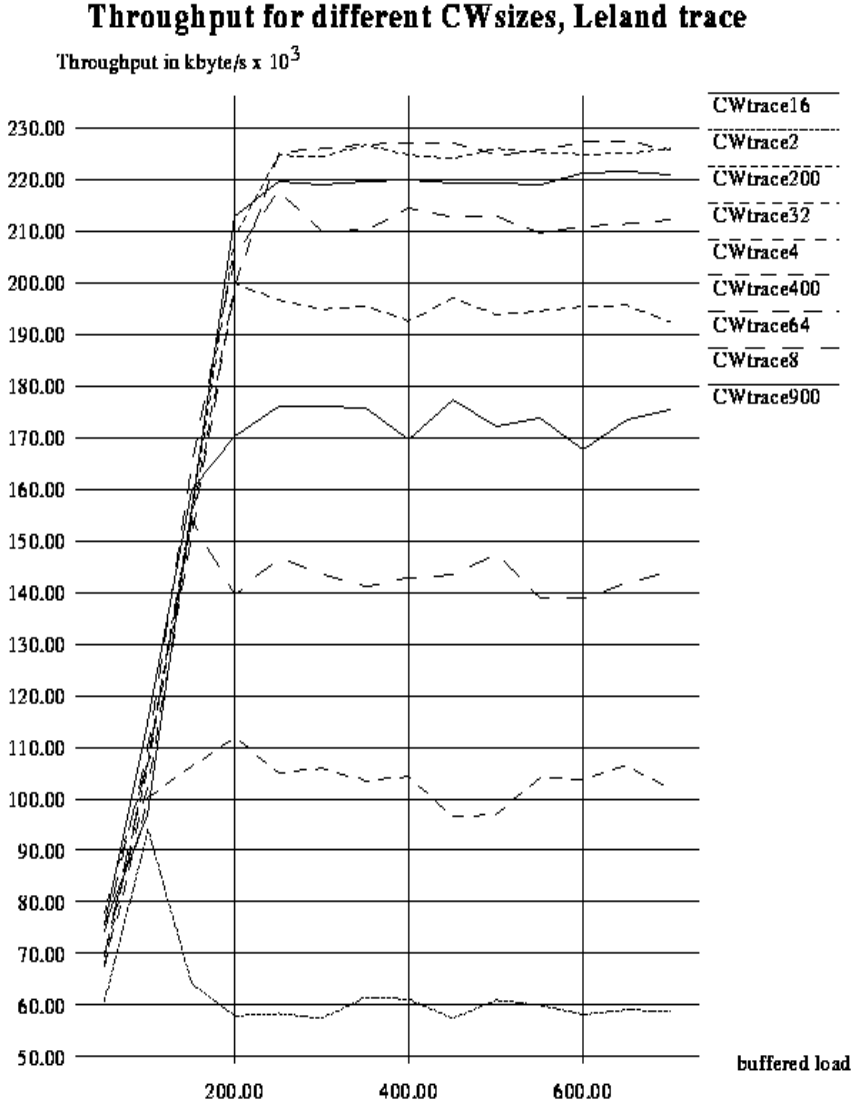


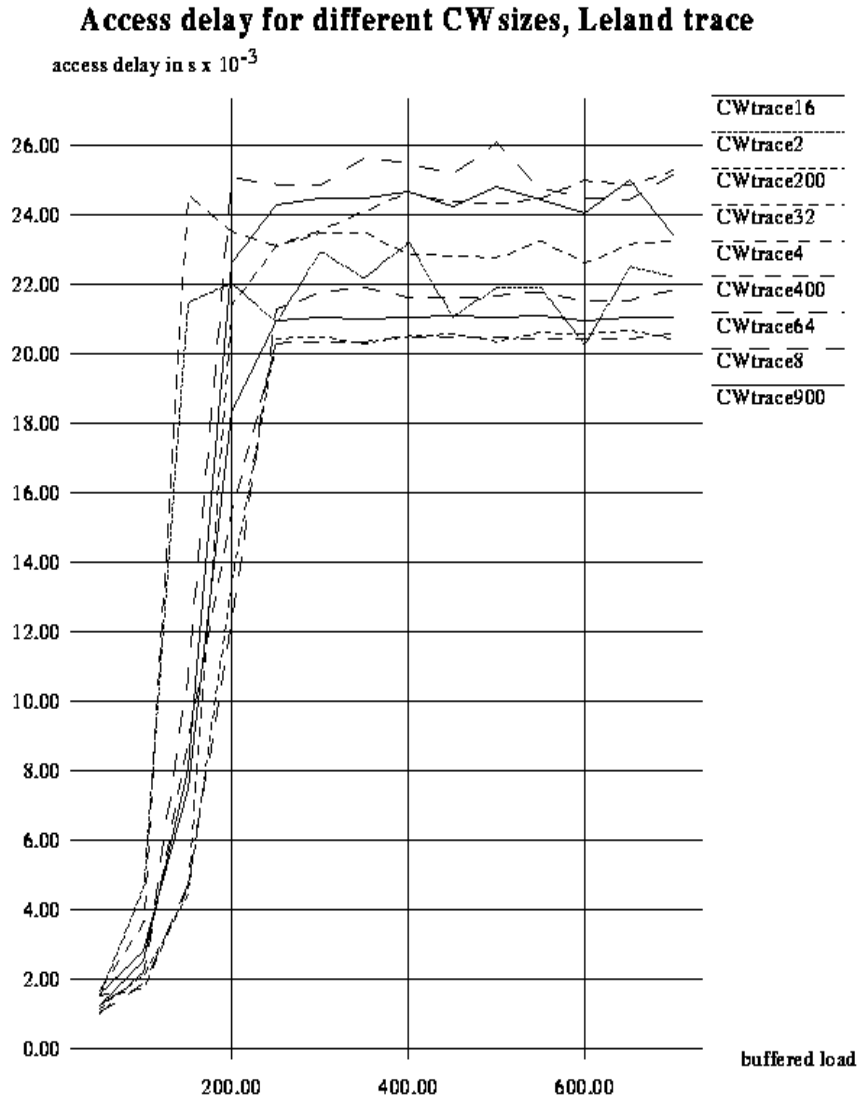
Simulation results (cont.)



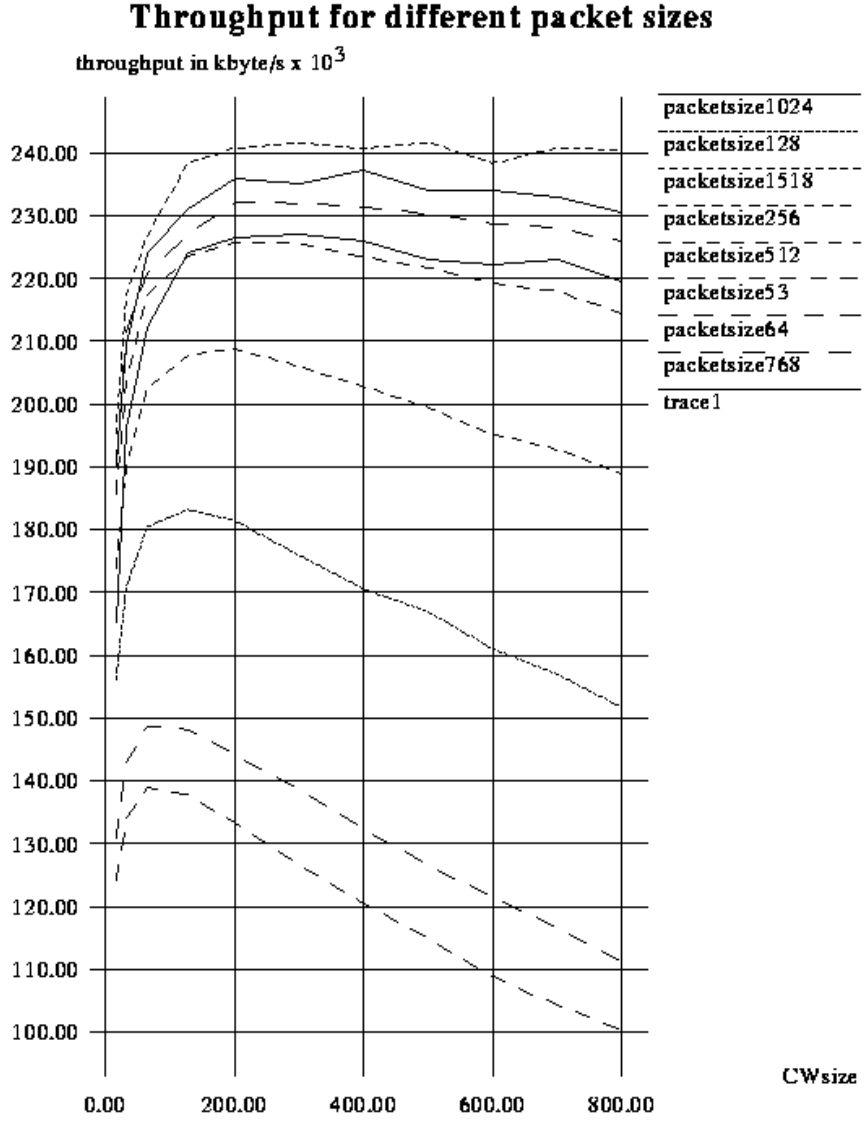


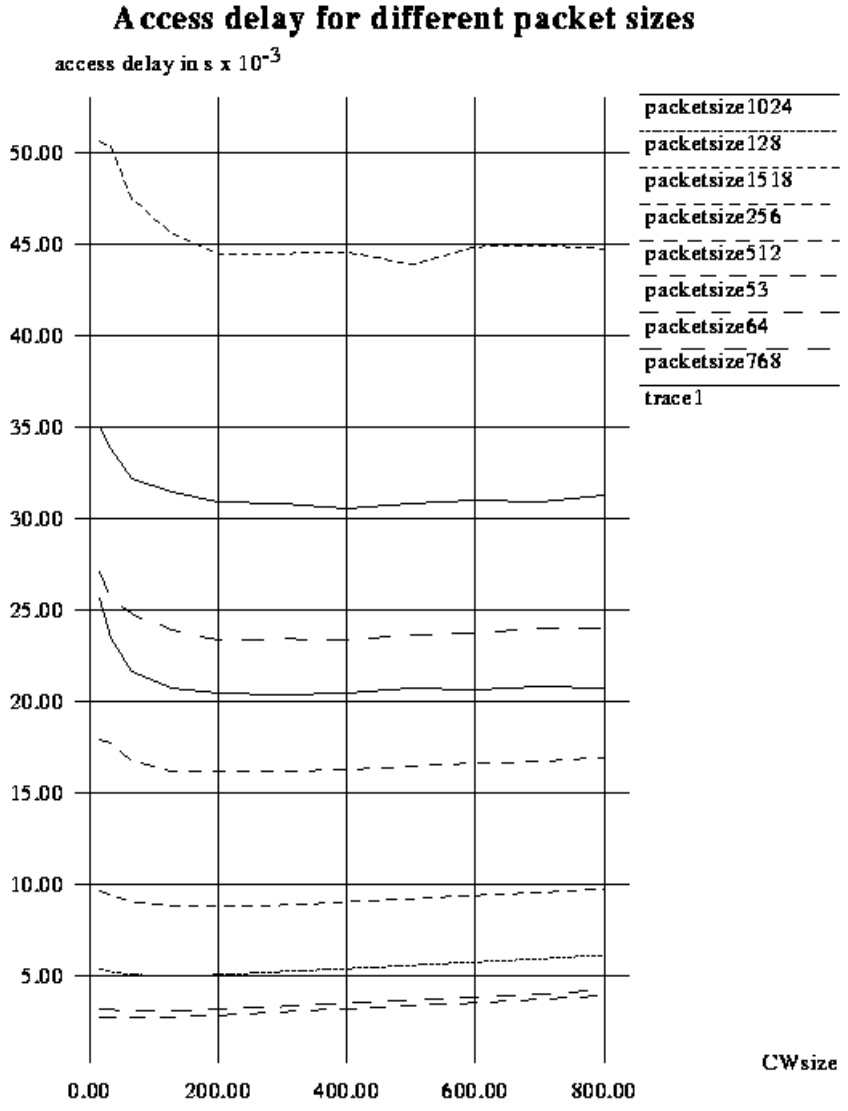
Simulation results (cont.)



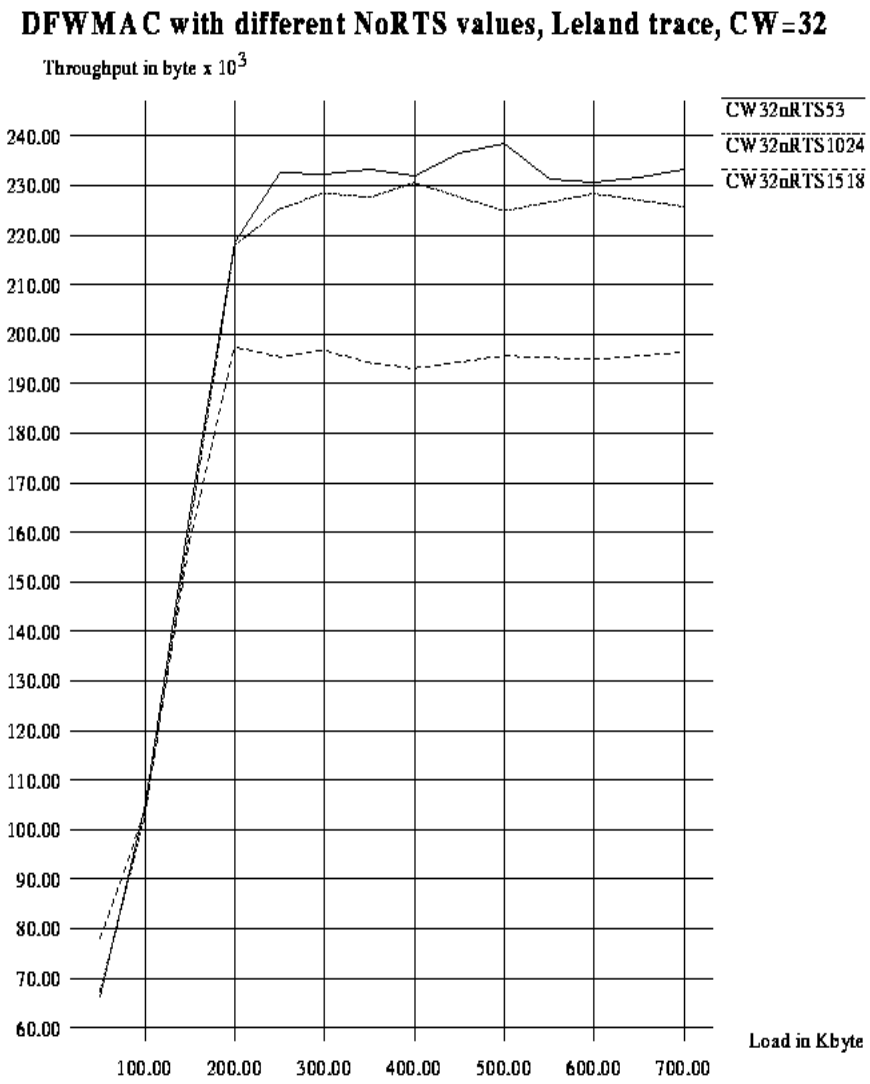


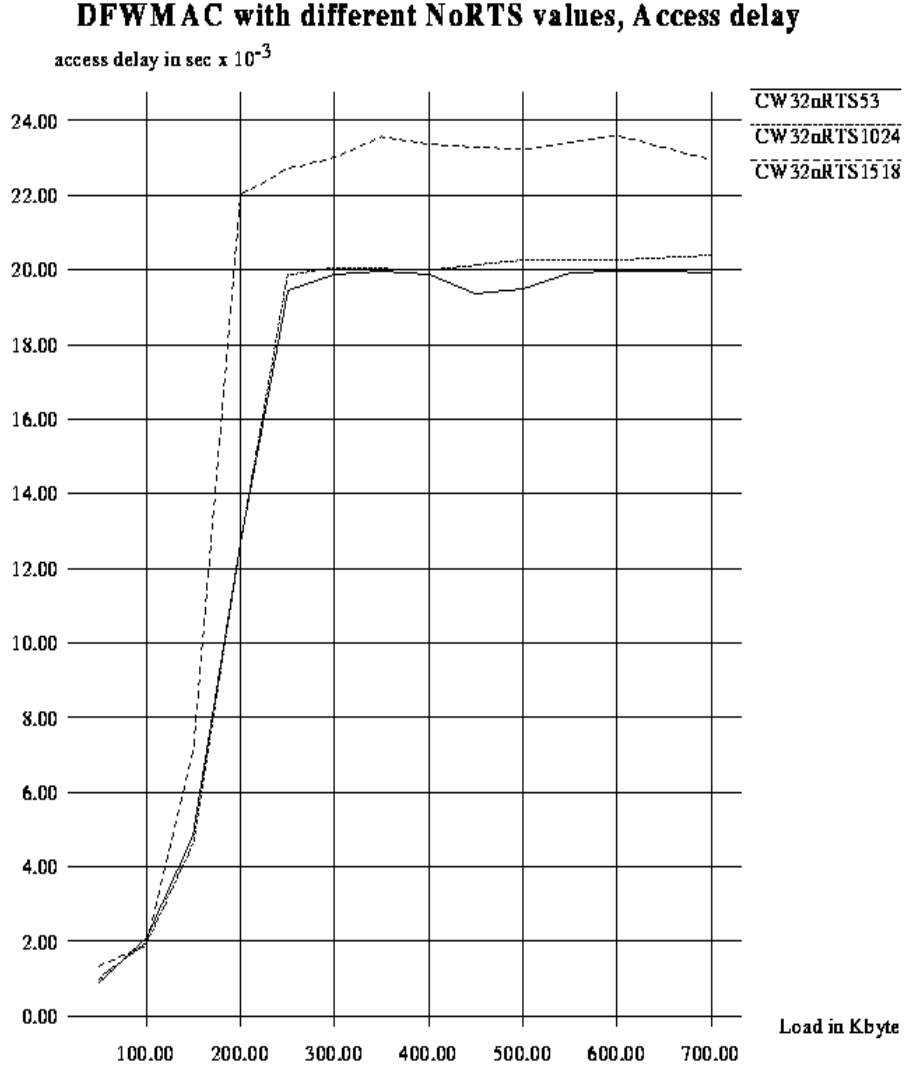
Simulation results (cont.)



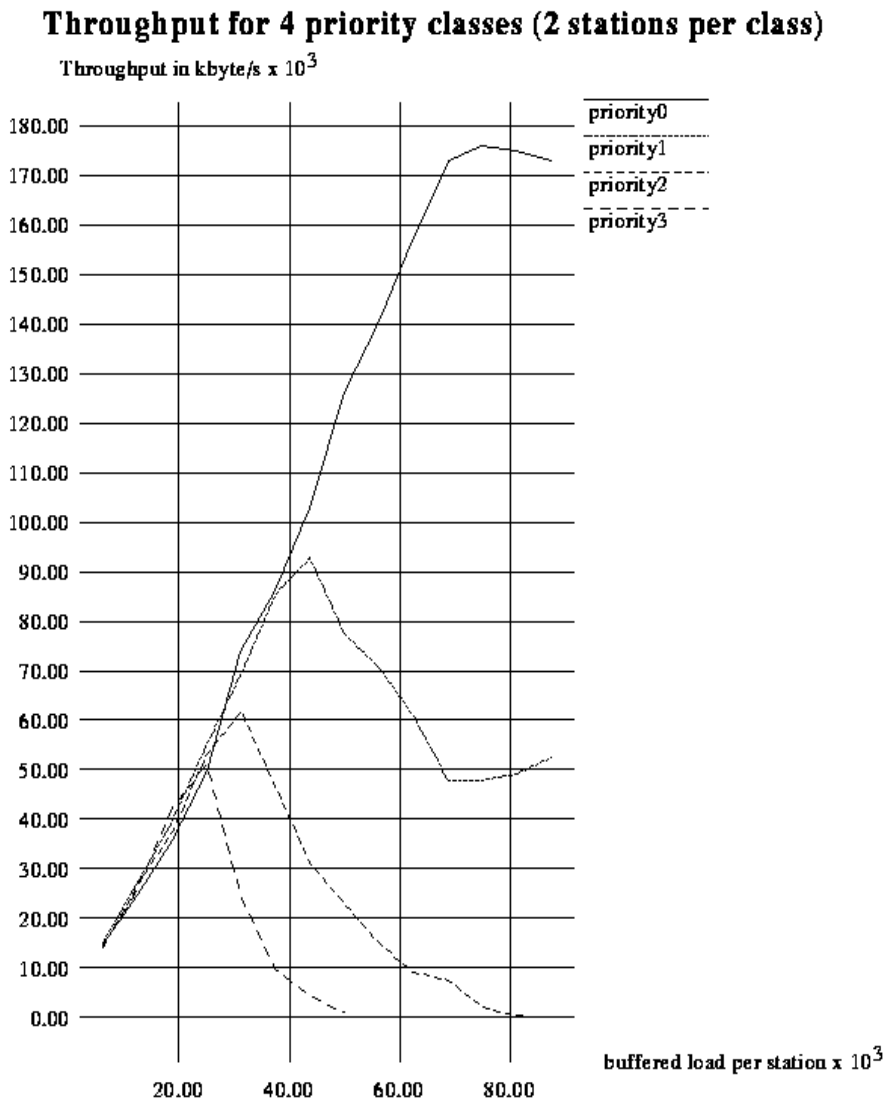


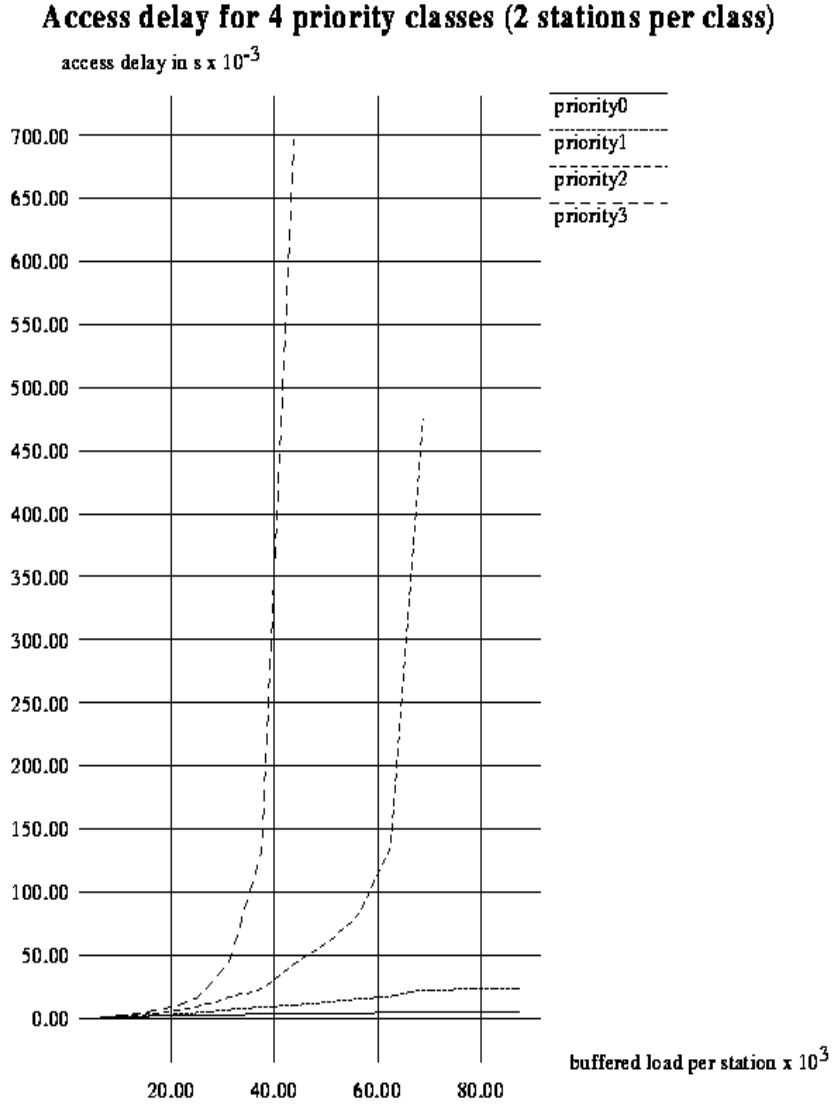
Simulation results (cont.)



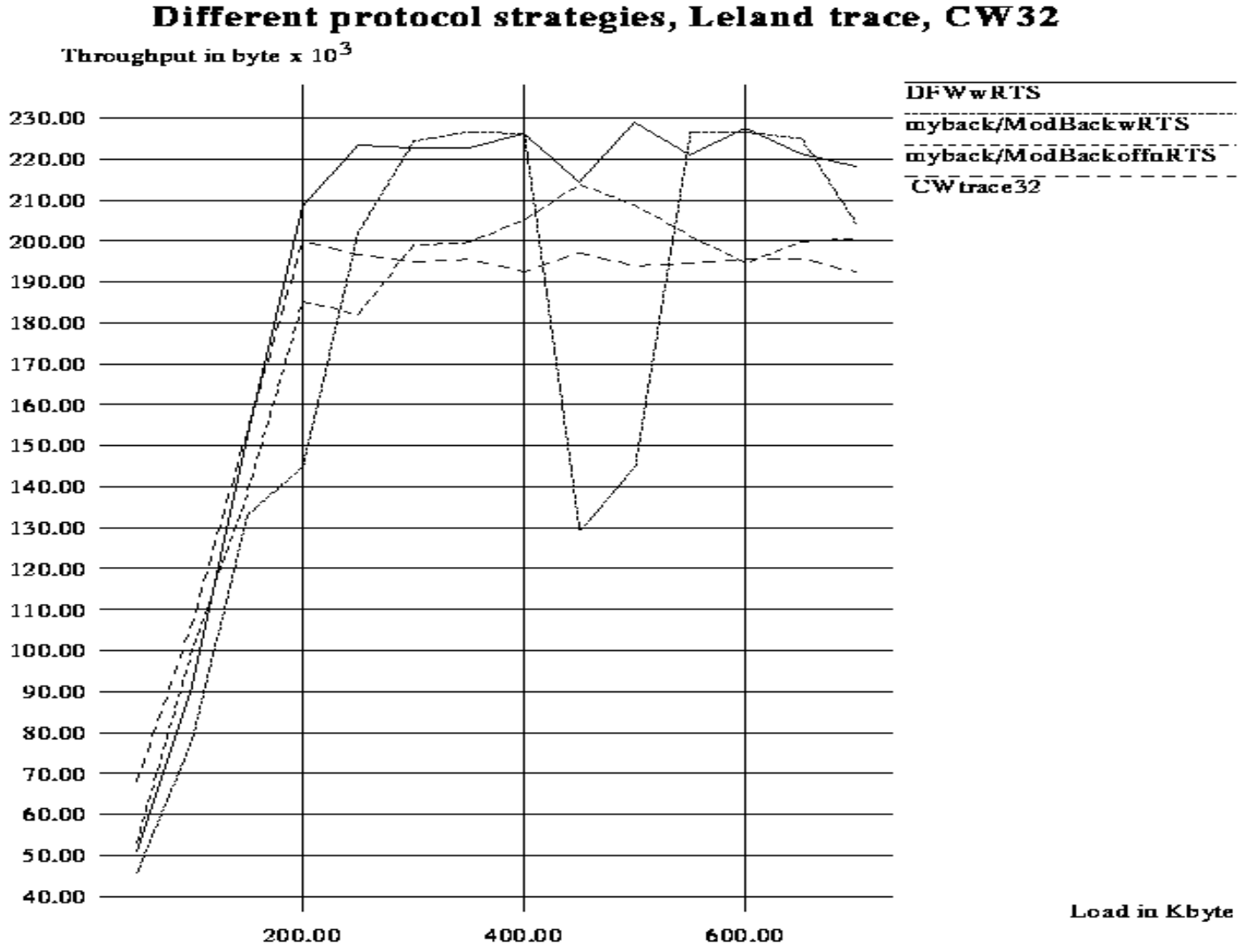


Simulation results (cont.)





Simulation results (cont.)



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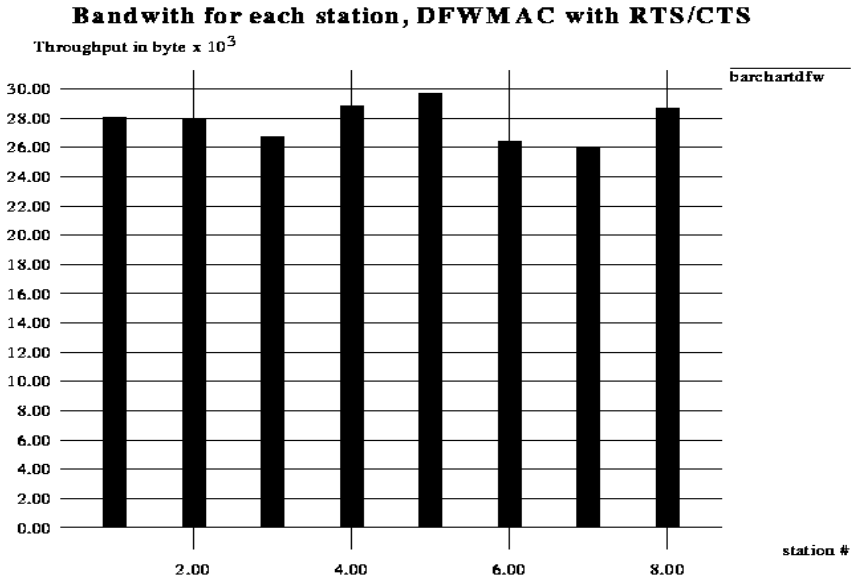

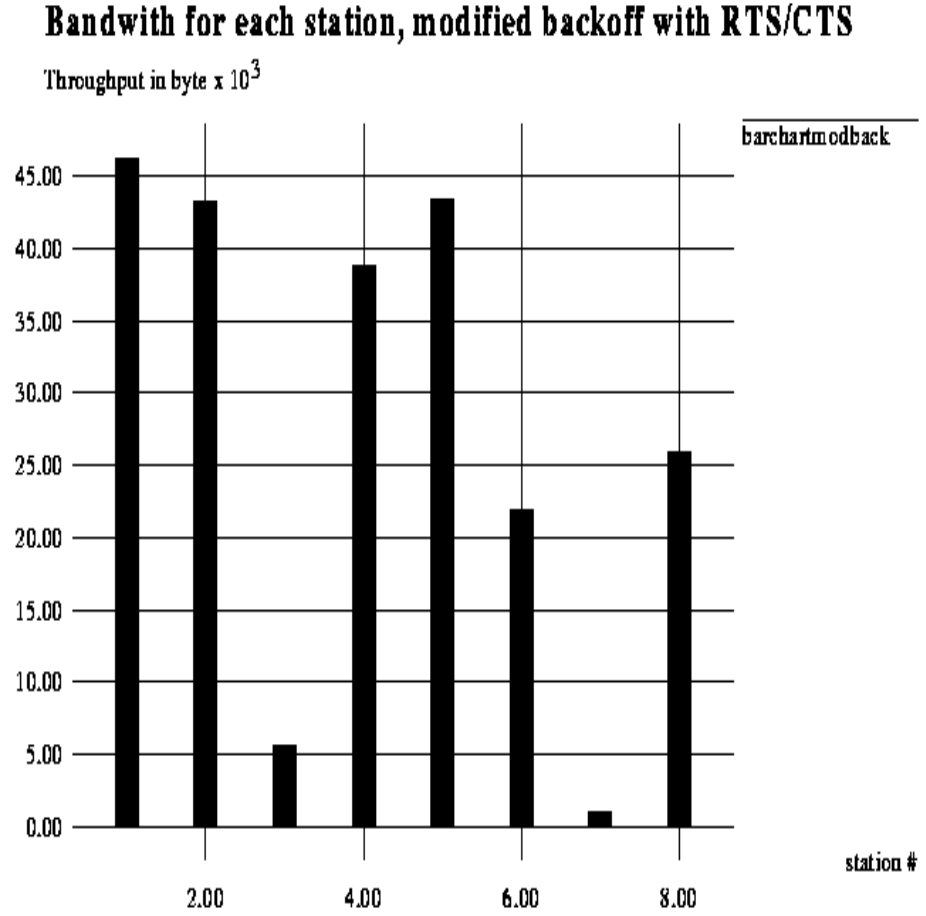

Conclusions

- **Contention window size should depend on:**
  - *number of stations*
  - *packet size*
- **RTS/CTS leads to a better protocol behaviour even in the case of exposed stations**
- **Current backoff scheme has reserves**

  ⇒*modified backoff scheme leads to a better throughput but to unfairness*

  ⇒*more research on backoff schemes*

Near Future

- **more detailed results on DFWMAC**
- **other protocols like URN, COMB, EY-NPMA, WATM**

Farther Future

- **contributions to a High-speed WMAC (HWMAC)**