# MTA Performance Comparison:

## sendmail vs. postfix on *BSD

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http://www.shub-internet.org/brad/papers/mtacomparison/

snow

UNIX & JAVA SPECIALISTS

# Overview

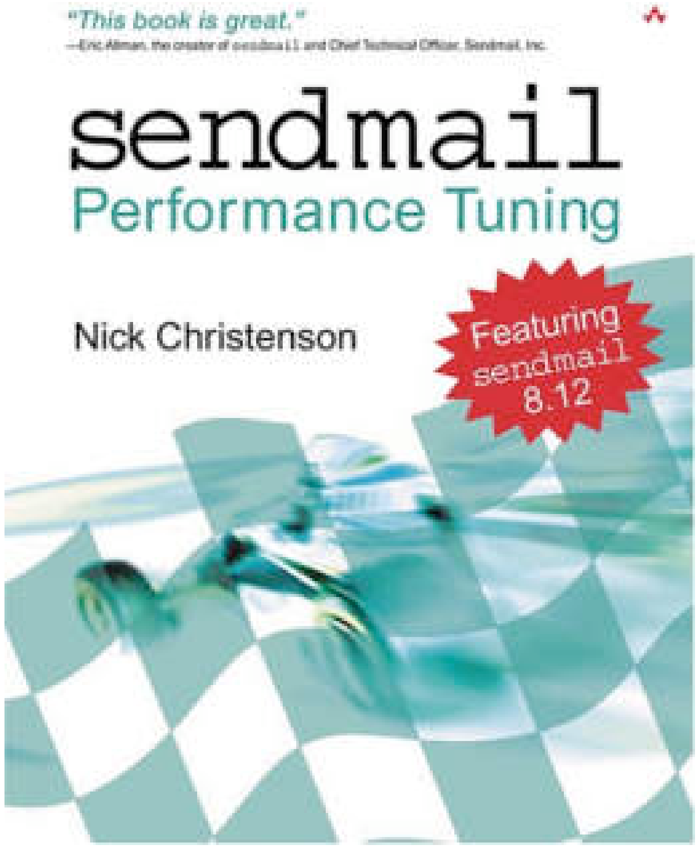
- Goal
- Meta Information
  - Hardware Used
  - Software Tested
  - Tools Used
  - Methodology
- Test Results
- Conclusions

# Goal

- Show you what it looks like to do MTA performance tuning
  - On as many *BSD platforms as I could
- Focus on the process, not the numbers or expected/desired outcome
  - You get to see (most) everything, warts and all

# Goal

- Basically, chapter 3 from the book <u>`sendmail` Performance Tuning</u> by Nick Christenson
  - See <u>http://www.jetcafe.org/~npc/book/sendmail/</u>



# Meta Information

- Hardware Used
- Software Tested
- Benchmark Tools
- Methodology

# Hardware Used

- NetBSD
  - Twinhead “Twinstation 5G” (Sun SPARCstation 5 clone)
    - Not UltraSPARC, but the ancient SPARC 5

| | |
|---|---|
| OS: | NetBSD 1.6-RELEASE |
| CPU: | microsSPARC-II @ 110MHz |
| RAM: | 32MB real, 384MB virtual |
| NIC: | On-board “Lance” 10Base-T Ethernet<br>& SBus QuadFastEthernet |

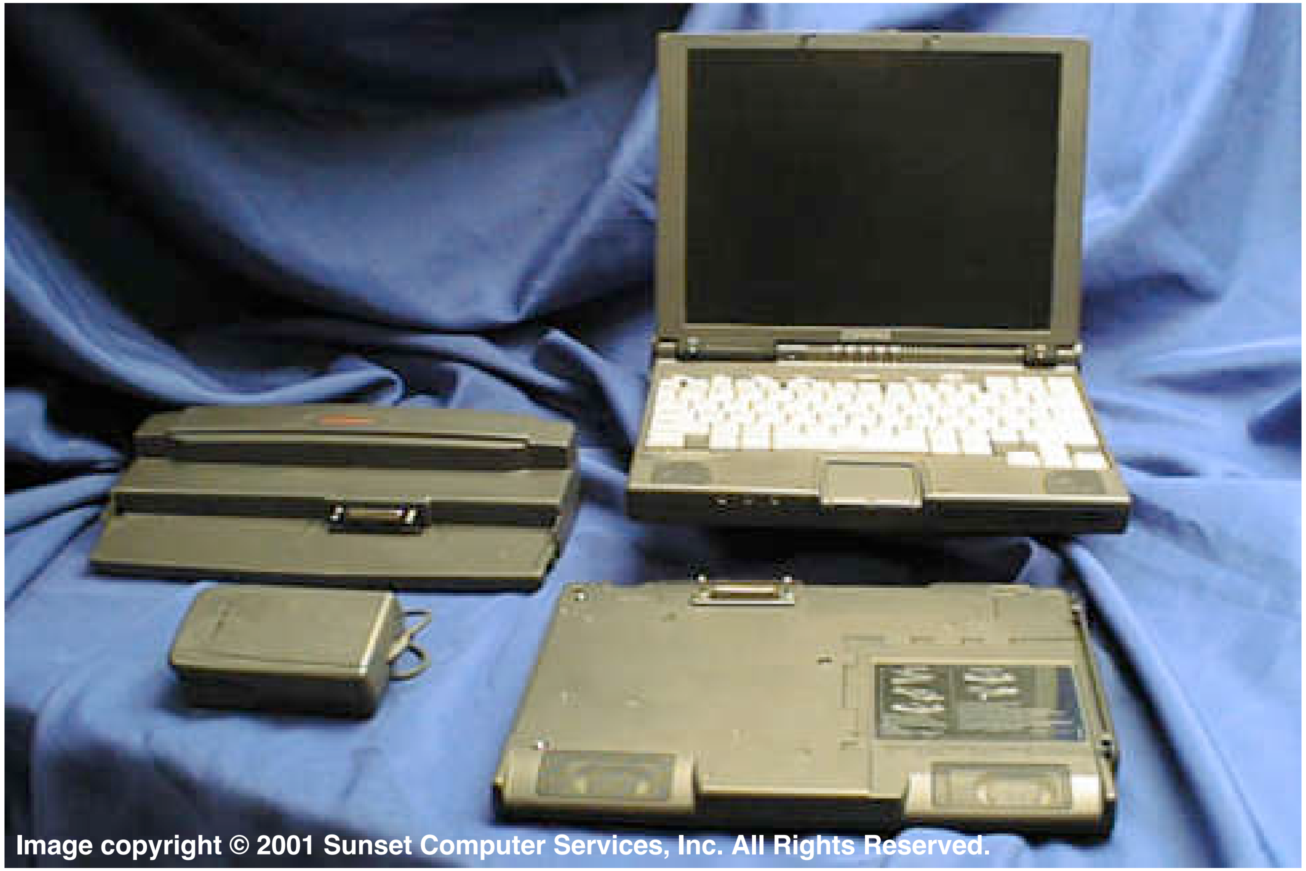
- Unfortunately, disk drives died before testing could be performed (bug in NetBSD regarding SCSI tagged command queueing for old drives?)

# Hardware Used

- FreeBSD
  - Compaq Armada 4131T
    - OS: FreeBSD 4.6.2-RELEASE
    - CPU: Pentium 133
    - RAM: 48MB real, 384MB virtual
    - NIC: Asanté FriendlyNET AL1011 “Prism2” 802.11b WiFi PCMCIA
    - HD: 10GB IBM Travelstar 20GN
      - 4200 RPM
      - 12ms avg. seek

# Hardware Used:

## FreeBSD



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# Hardware Used

- MacOS X (Part 1)
  - PowerBook G3 “Pismo”
    - OS: MacOS X 10.2.1
    - CPU: PowerPC G3 @ 400MHz
    - RAM: 1GB real, 2GB virtual
    - NIC: Apple AirPort 802.11b WiFi
    - HD: 48GB IBM Travelstar 40GH
      - 5400 RPM
      - 12ms avg. seek

# Hardware Used:

## MacOS X (Part 1)

# Hardware Used

- MacOS X (Part 2)
  - PowerBook G4 (DVI)
    - OS: MacOS X 10.2.2
    - CPU: PowerPC G4 @ 800MHz
    - RAM: 1GB real, 2GB virtual
    - NIC: Apple AirPort 802.11b WiFi
    - HD: 40GB Toshiba MK4018GAS
      - 4200 RPM
      - 12ms avg. seek

# Hardware Used:

## MacOS X (Part 2)

# Software Tested

- Sendmail 8.12.6
  - ftp://ftp.sendmail/org/pub/sendmail/sendmail.8.12.6.tar.gz
- Postfix 1.1.11
  - http://www.postfix.org/ftp-sites.html
- Exim 4.10
  - Tried every way I could think of, but could not get it configured to relay back to an IP address or port on the same machine

# Tools Used

- Disk Benchmarking
  - PostMark from Network Appliance
    - http://www.netapp.com/tech_library/3022.html
  - Bonnie++ from Russell Coker
    - http://www.coker.com.au/bonnie++/
- SMTP Benchmarking
  - smtp-source/smtp-sink from Wietse Venema
    - Included with postfix distribution
  - Postal from Russell Coker (with smtp-sink)
    - http://www.coker.com.au/postal/

# Methodology

- Get disk subsystem baseline by performing benchmarking
  - For each platform & filesystem configuration
    - PostMark
      - See http://www.shub-internet.org/brad/FreeBSD/postmark.html
    - Bonnie++
      - Configured to test similar parameters
        - » File sizes, numbers, & subdirectories according to the four PostMark tests

# Methodology

- For FreeBSD, we only test turning on or off “soft updates”
  - We do not test (turned on by default)
    - vfs.vmiodirenable
    - dirprefs
    - dirhash
  - For data on all the possible combinations of the above, see “Recent Filesystem Optimisations in FreeBSD” at http://www.usenix.org/events/usenix02/tech/freenix/dowse.html
  - For comparison data of Journaling vs. Soft Updates, see “Journaling Versus Soft Updates: Asynchronous Meta-data Protection in File Systems” at http://www.usenix.org/publications/library/proceedings/usenix2000/general/seltzer.html

# Methodology

- For MacOS X
  - We test only
    - HFS+
      - Apple’s Extended Hierarchical File System
    - MFS
      - Memory-based filesystem created using RamBunctious 2.0

# Methodology

- For MacOS X
  - We do ***NOT*** test
    - UFS
      - IMO, Apple broke it while porting HFS+ to Mach
      - Many applications do not recognize it, in addition to MacOS 9 itself
      - “Classic” requires that boot device be HFS+ and MacOS 9 must be installed before MacOS X
    - HFS+ with Journaling
      - Too new, introduced with MacOS X Server 10.2.2
      - Initial reports indicate ~20% performance loss

# Methodology

- For MacOS X
  - Does not have a native “poll.h” or “libpoll” (required by postal)
    - Install manually from source http://www.clapper.org/software/poll/
    - Install using “fink”
      - MacOS X package/port manager based on Debian “dselect”
  - Unable to test Bonnie++
    - Need further assistance from the author to find out why it is crashing

# Methodology

- Perform SMTP benchmarking
  - For each hardware & software configuration, test
    - Test direct source->sink connection
      - Demonstrate maximum possible performance
    - Test source->relay->sink
      - Show relay performance
  - Note
    - Testing only relaying, not local delivery
    - Test generated on, relayed through, and terminated on “loopback” network
      - Eliminate all question of network or NIC performance

# Test Results

- Chart data only
  - PostMark table data available from http://www.shub-internet.org/brad/FreeBSD/postmark.html
  - Bonnie++ table data not yet available
  - smtp-source/smtp-sink data not yet available
    - \``hostname`\` must be legal (I.e., does not end with ".")
  - Postal data not yet available

# Test Results

- Dumb "Driver" Scripts
  - My "runpostmark" script available at http://www.shub-internet.org/brad/runpostmark
  - My "runbon" script available at http://www.shub-internet.org/brad/runbon
  - My "runsmtp" script available at http://www.shub-internet.org/brad/runsmtp

# Test Results:

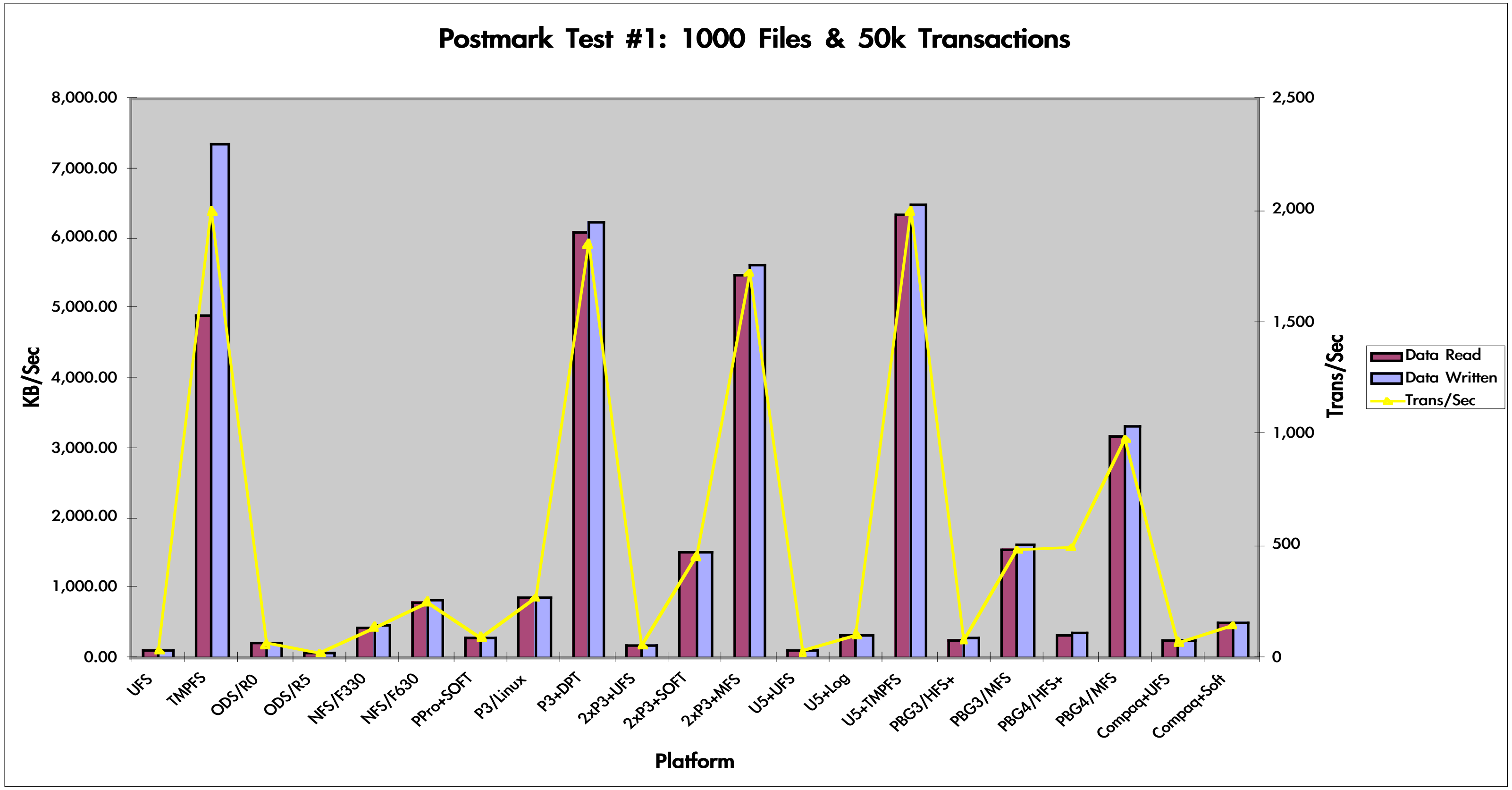
## PostMark Sample Run

```
% cd /var/tmp
% postmark
PostMark v1.5 : 3/27/01
pm>set number 1000
pm>set transactions 50000
pm>show
Current configuration is:
The base number of files is 1000
Transactions: 50000
Files range between 500 bytes and 9.77 kilobytes in size
Working directory: /var/tmp
Block sizes are: read=512 bytes, write=512 bytes
Biases are: read/append=5, create/delete=5
Using Unix buffered file I/O
Random number generator seed is 42
Report format is verbose.
pm>run
```

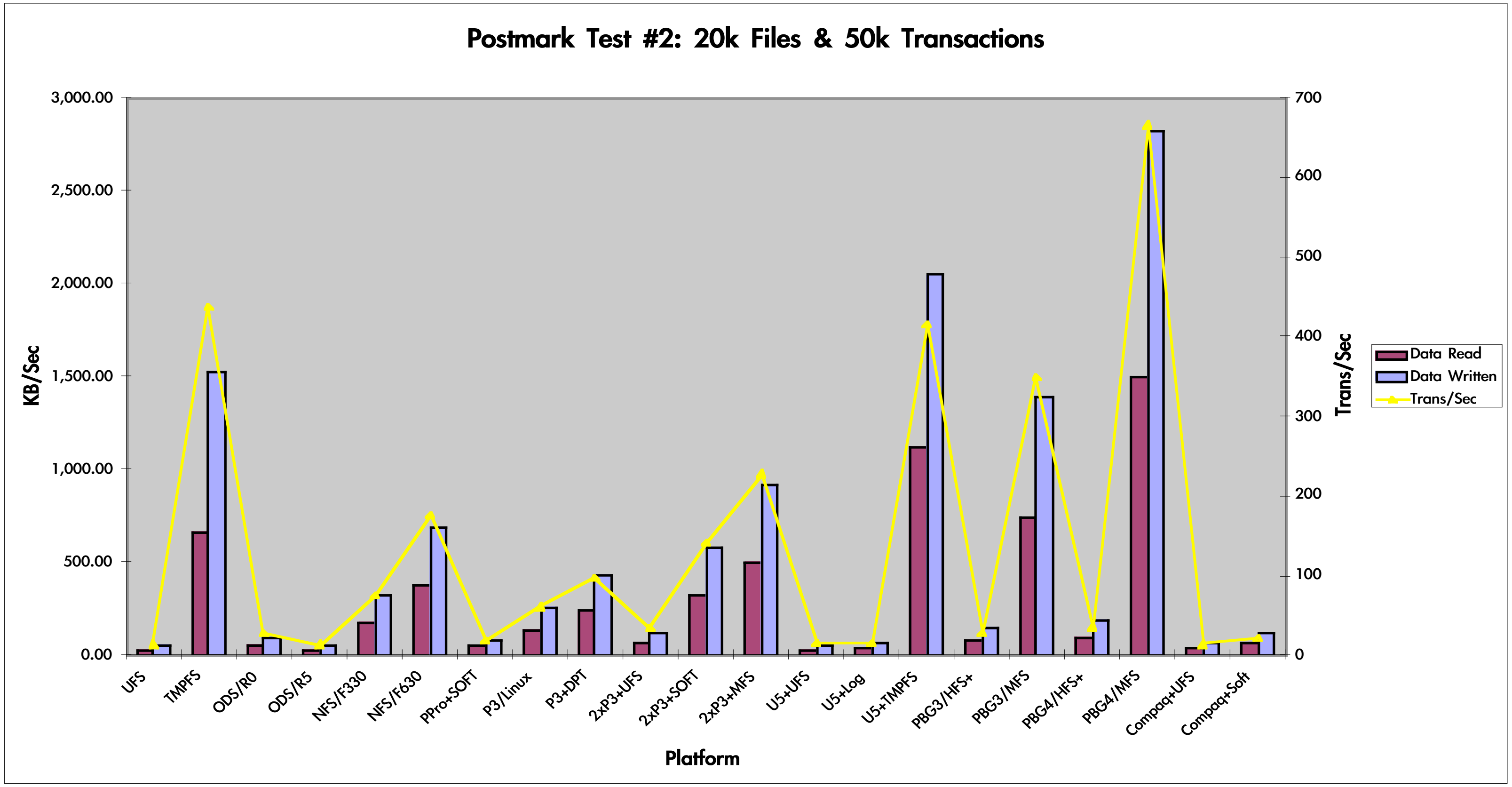
# Test Results:
# PostMark Sample Run

```
Creating files...Done
Performing transactions........Done
Deleting files...Done
Time:
        497 seconds total
        492 seconds of transactions (101 per second)

Files:
        26014 created (52 per second)
                Creation alone: 1000 files (500 per second)
                Mixed with transactions: 25014 files (50 per
second)
        24868 read (50 per second)
        24880 appended (50 per second)
        26014 deleted (52 per second)
                Deletion alone: 1028 files (342 per second)
                Mixed with transactions: 24986 files (50 per
second)

Data:
        161.15 megabytes read (332.02 kilobytes per second)
        168.38 megabytes written (346.92 kilobytes per second)
```

# PostMark Test Results

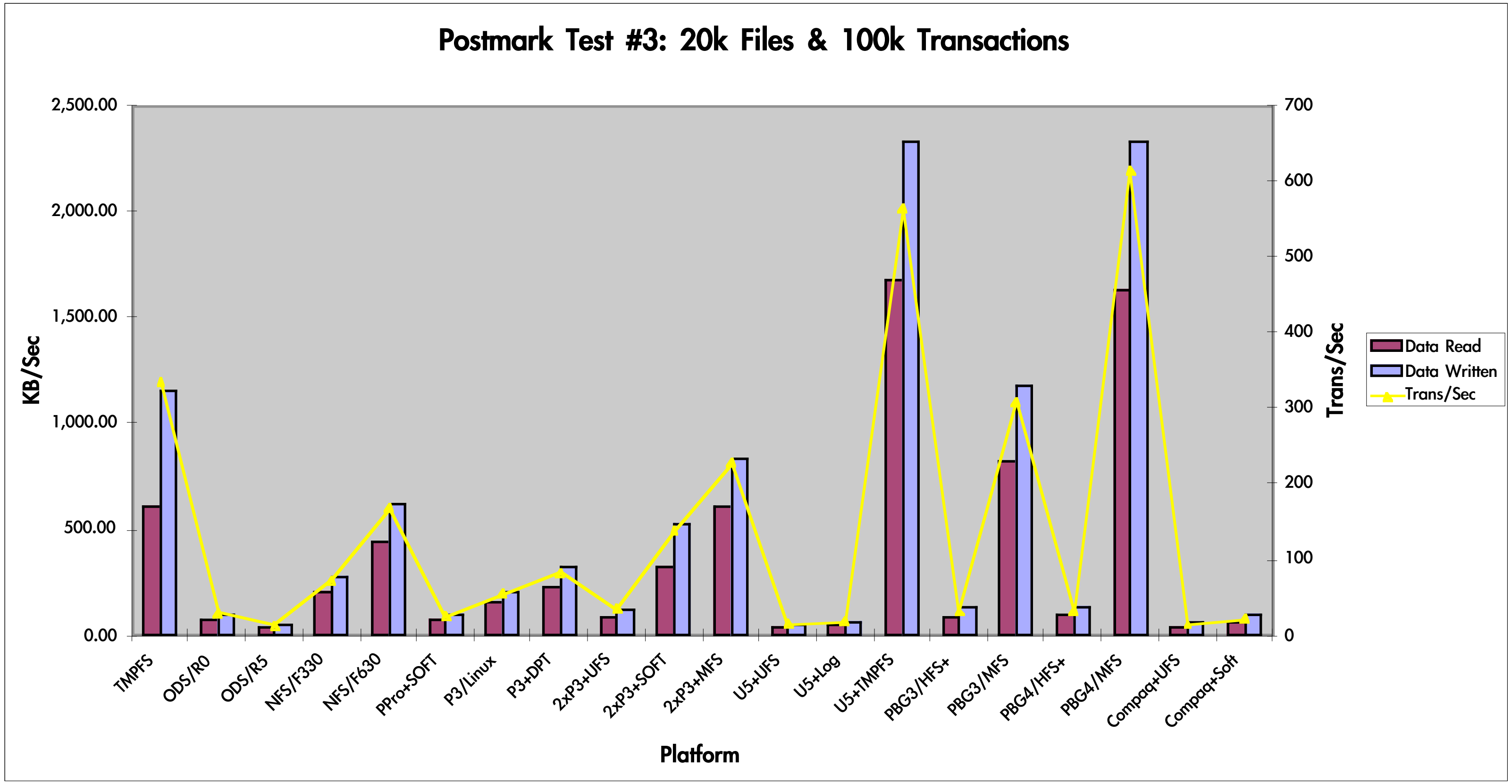


# PostMark Test Results



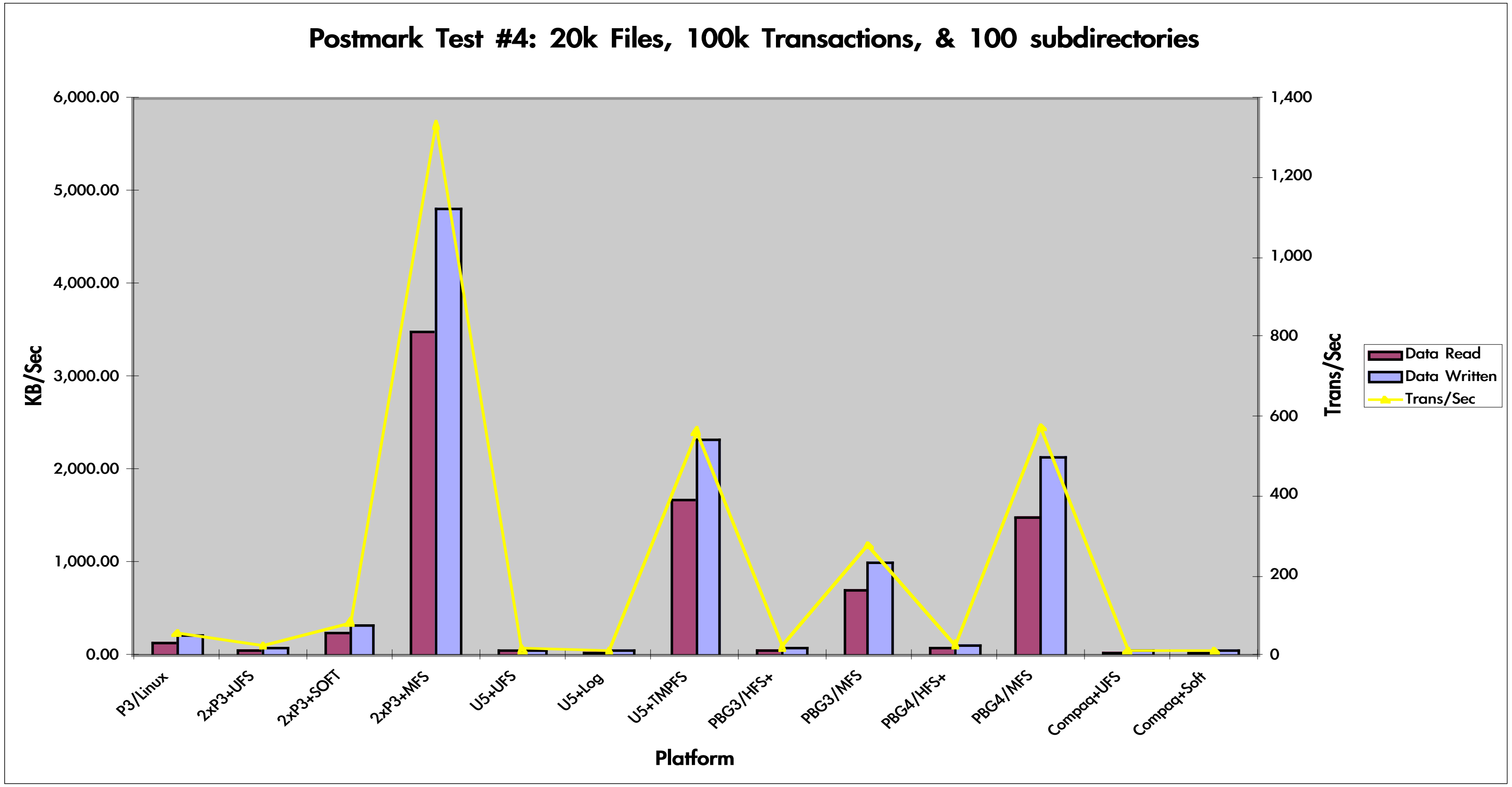
Postmark Test #2: 20k Files & 50k Transactions

# PostMark Test Results

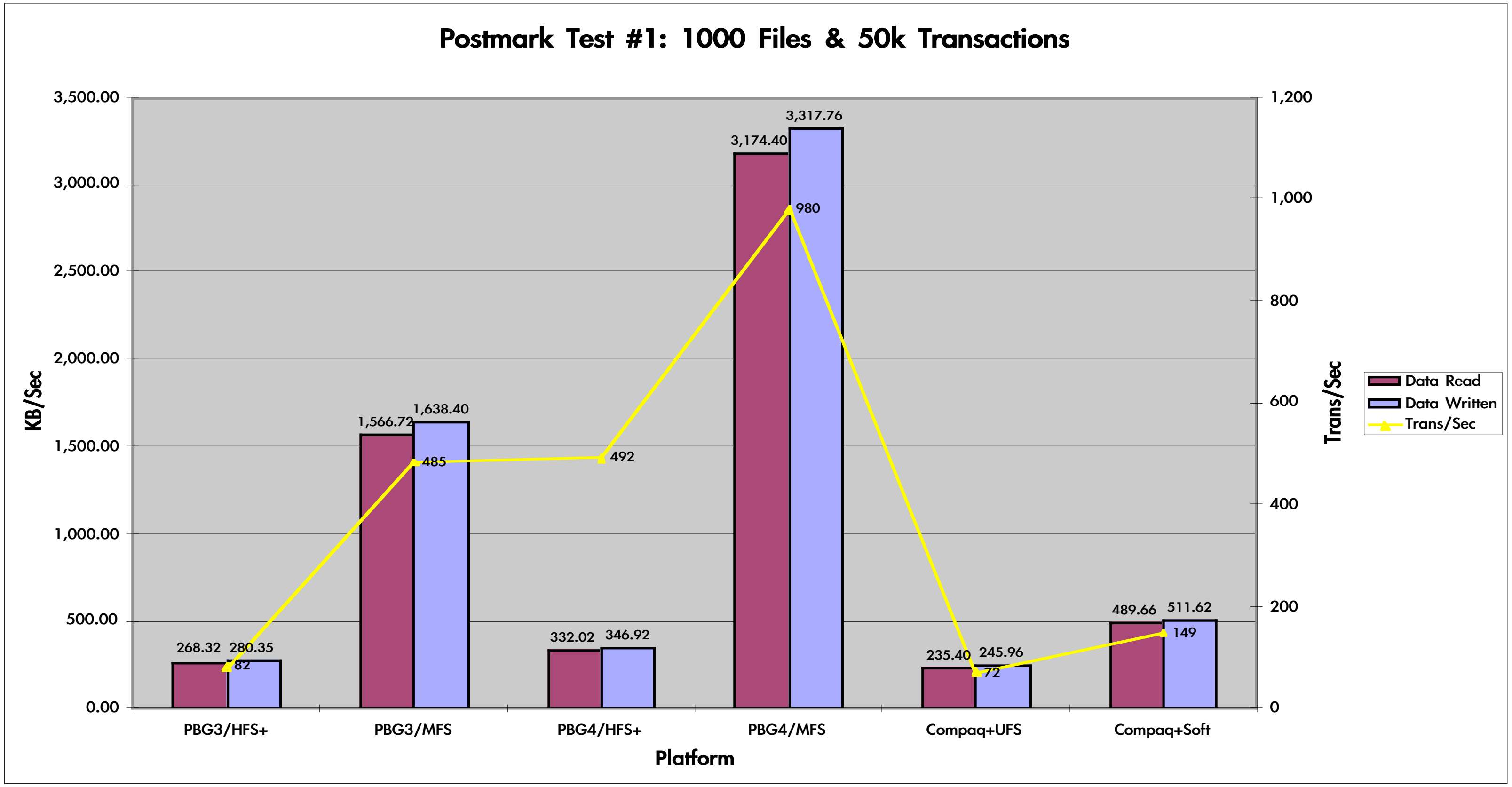


Postmark Test #3: 20k Files & 100k Transactions

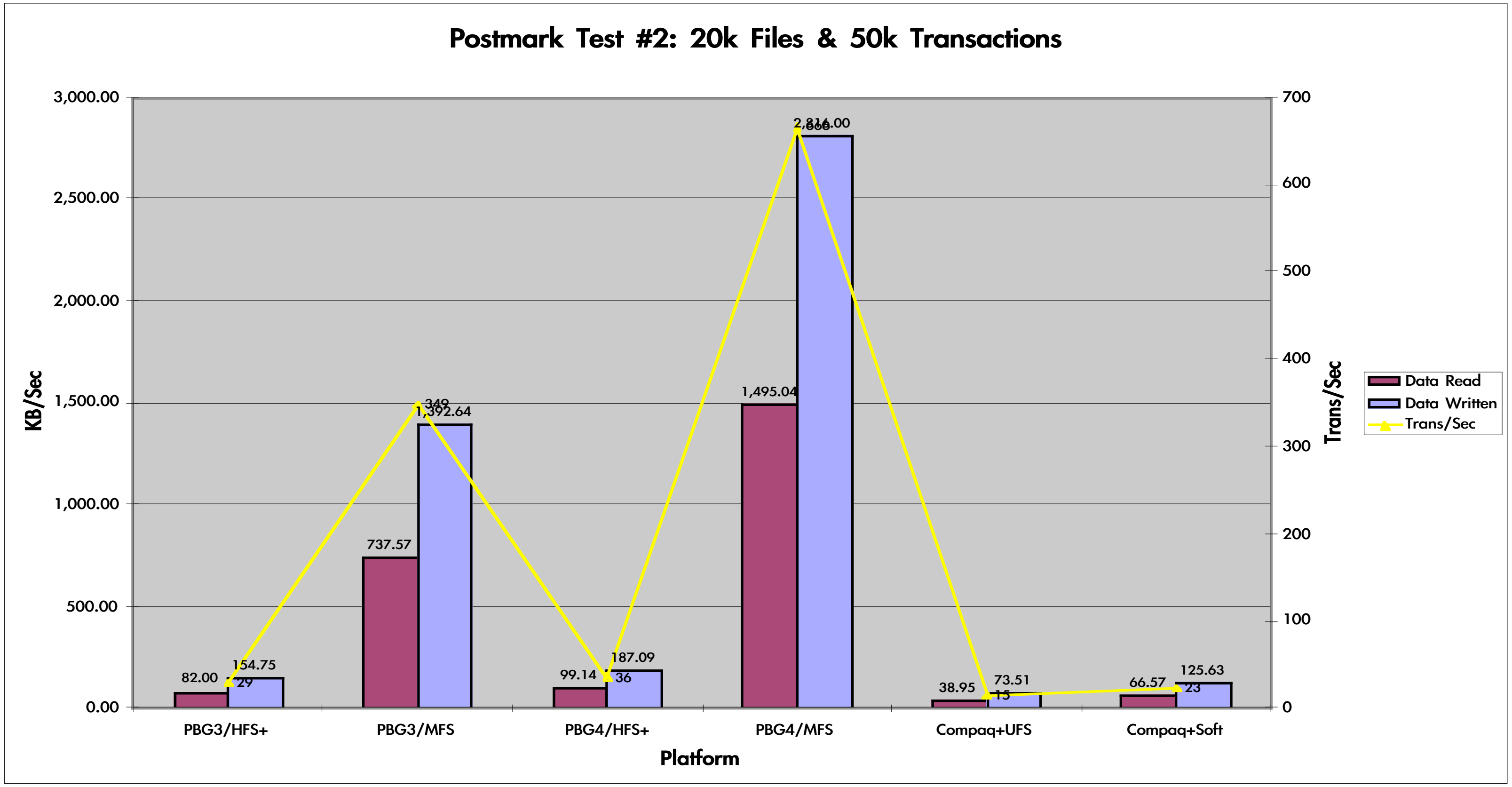
# PostMark Test Results



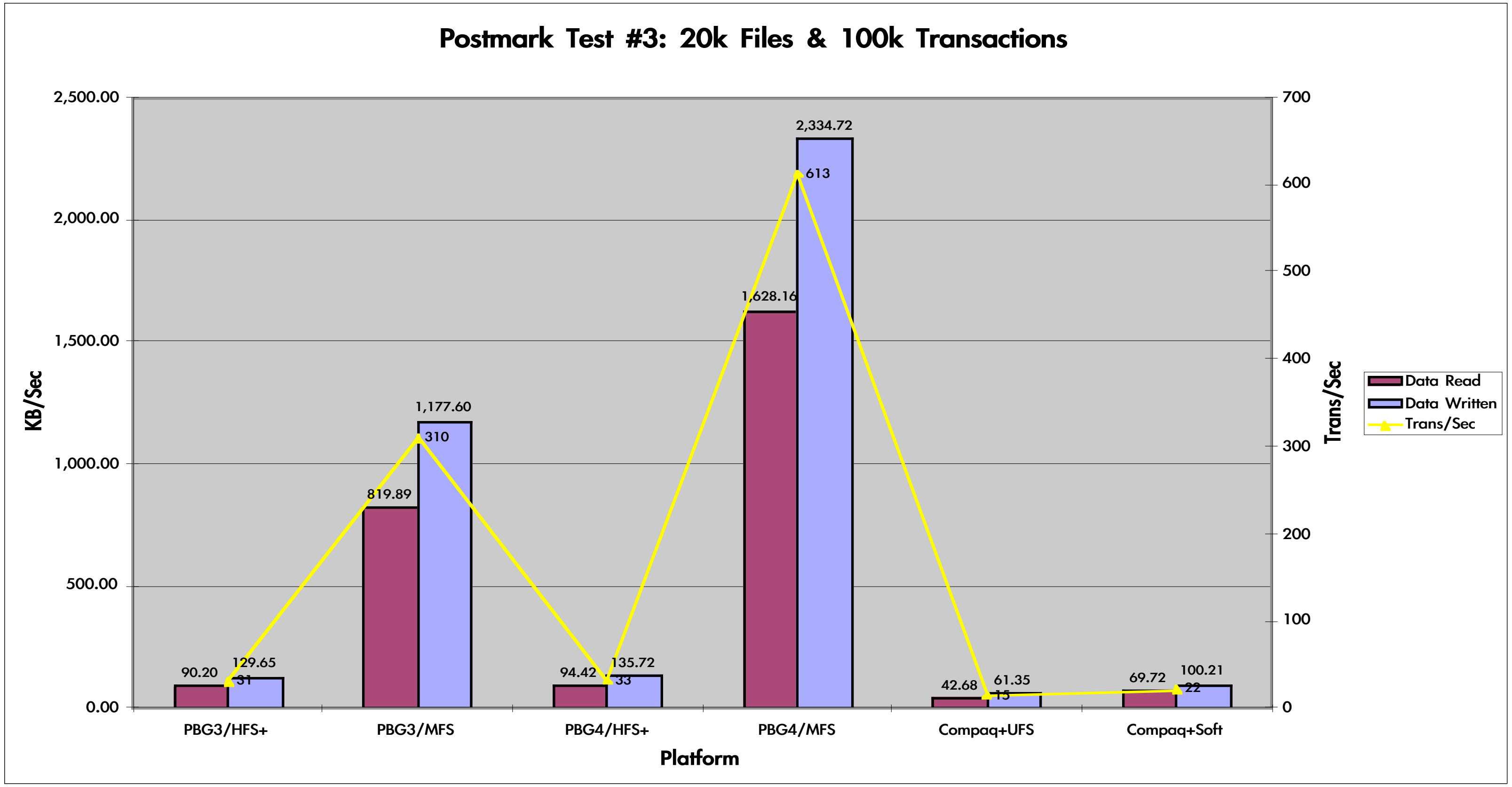
# PostMark Test Results



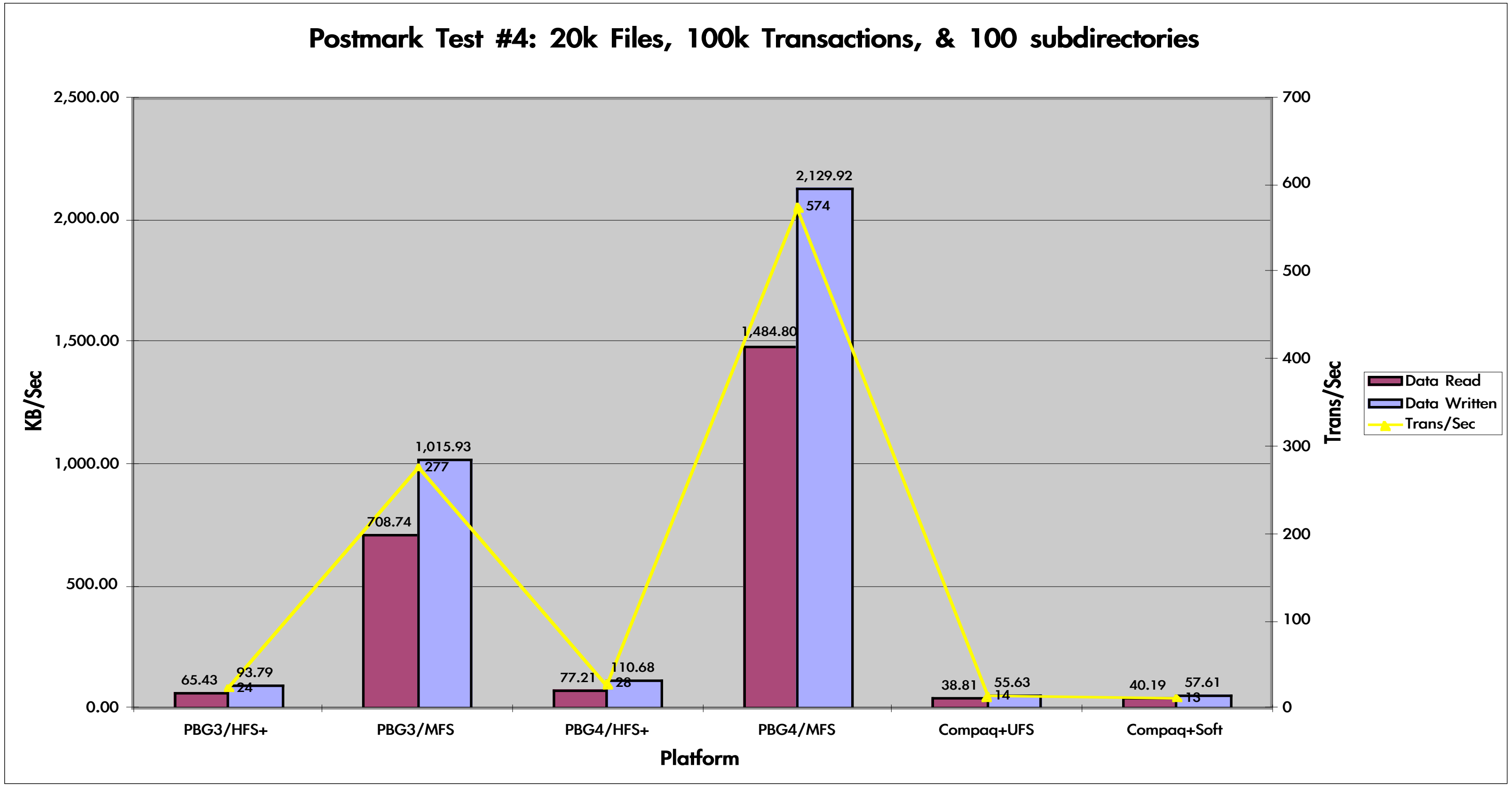
# PostMark Test Results



# PostMark Test Results



# PostMark Test Results

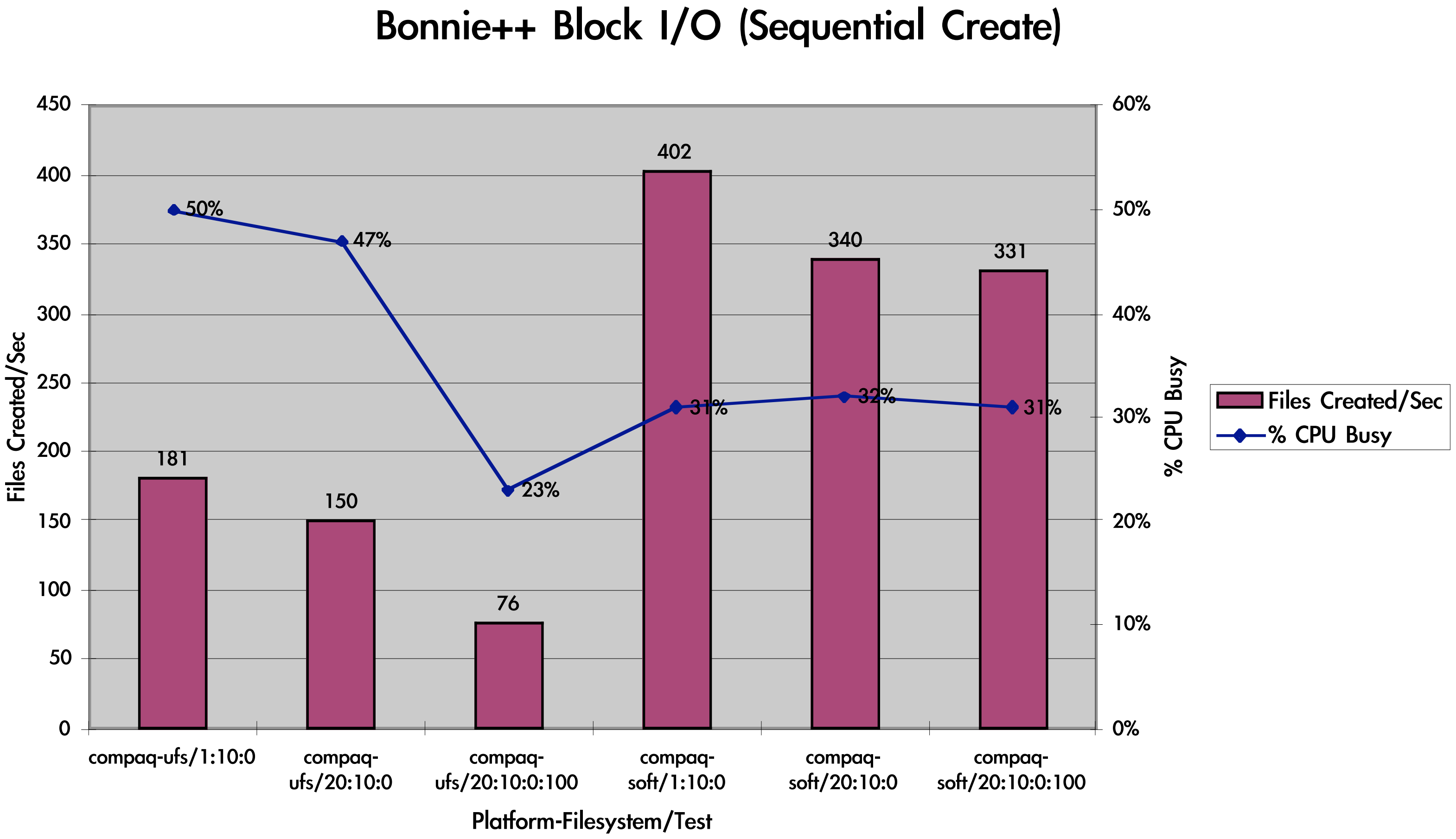

Postmark Test #4: 20k Files, 100k Transactions, & 100 subdirectories

# Test Results:

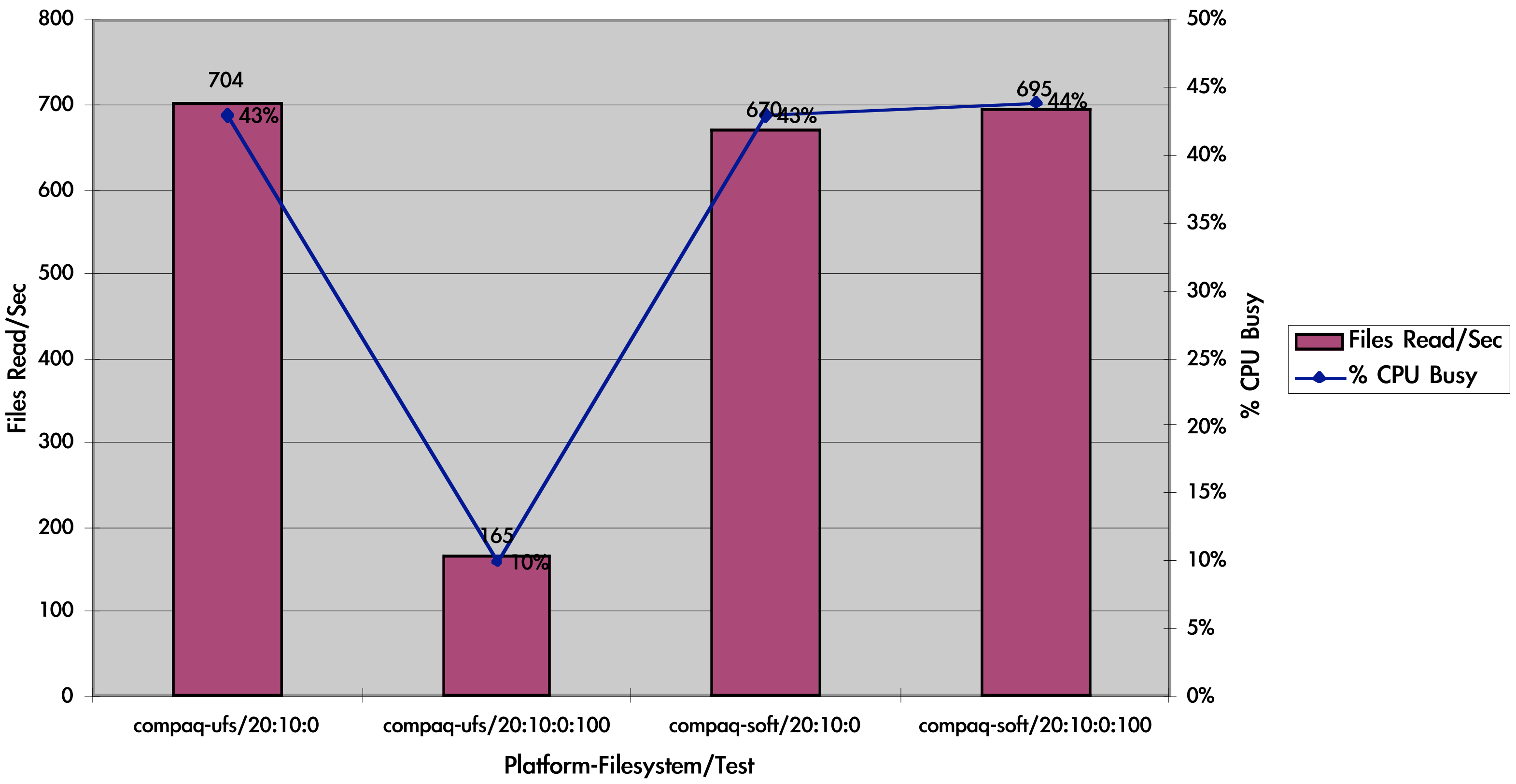
## Bonnie++ Sample Run

```
% bonnie++ -d /var/tmp/bonnie -n 1:10k:0 -m compaq-soft -r 48m
Writing with putc()...done
Writing intelligently...done
Rewriting…done
Reading with getc()...done
Reading intelligently...done
start 'em...done...done...done...
Create files in sequential order...done.
Stat files in sequential order...done.
Delete files in sequential order...done.
Create files in random order...done.
Stat files in random order...done.
Delete files in random order...done.
Version 1.02d       ------Sequential Output------ --Sequential Input- --Random-
                    -Per Chr- --Block-- -Rewrite- -Per Chr- --Block-- --Seeks--
Machine        Size K/sec %CP K/sec %CP K/sec %CP K/sec %CP K/sec %CP  /sec %CP
compaq-soft    300M  2407  67  4584  39  2052  21  1948  53  3644  18  57.8   3
                    ------Sequential Create------ --------Random Create--------
                    -Create-- --Read--- -Delete-- -Create-- --Read--- -Delete--
files:max            /sec %CP  /sec %CP  /sec %CP  /sec %CP  /sec %CP  /sec %CP
             1:10:0   402  31 +++++ +++   832  49   564  46 +++++ +++  1746  99
compaq-soft,300M,2407,67,4584,39,2052,21,1948,53,3644,18,57.8,3,1:10:0,402,31,
+++++,+++,832,49,564,46,+++++,+++,1746,99
```

# Bonnie++ Results



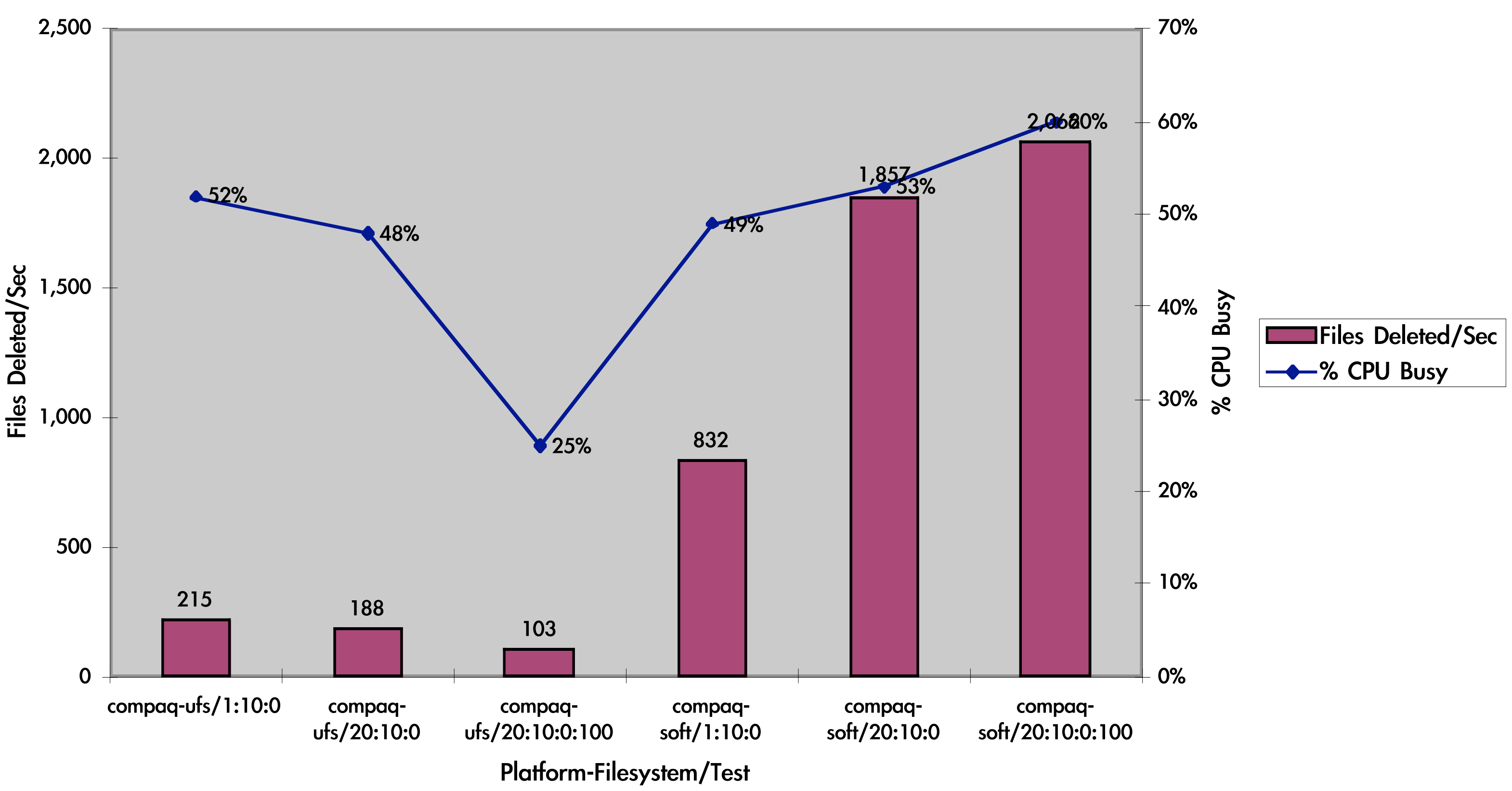
# Bonnie++ Results



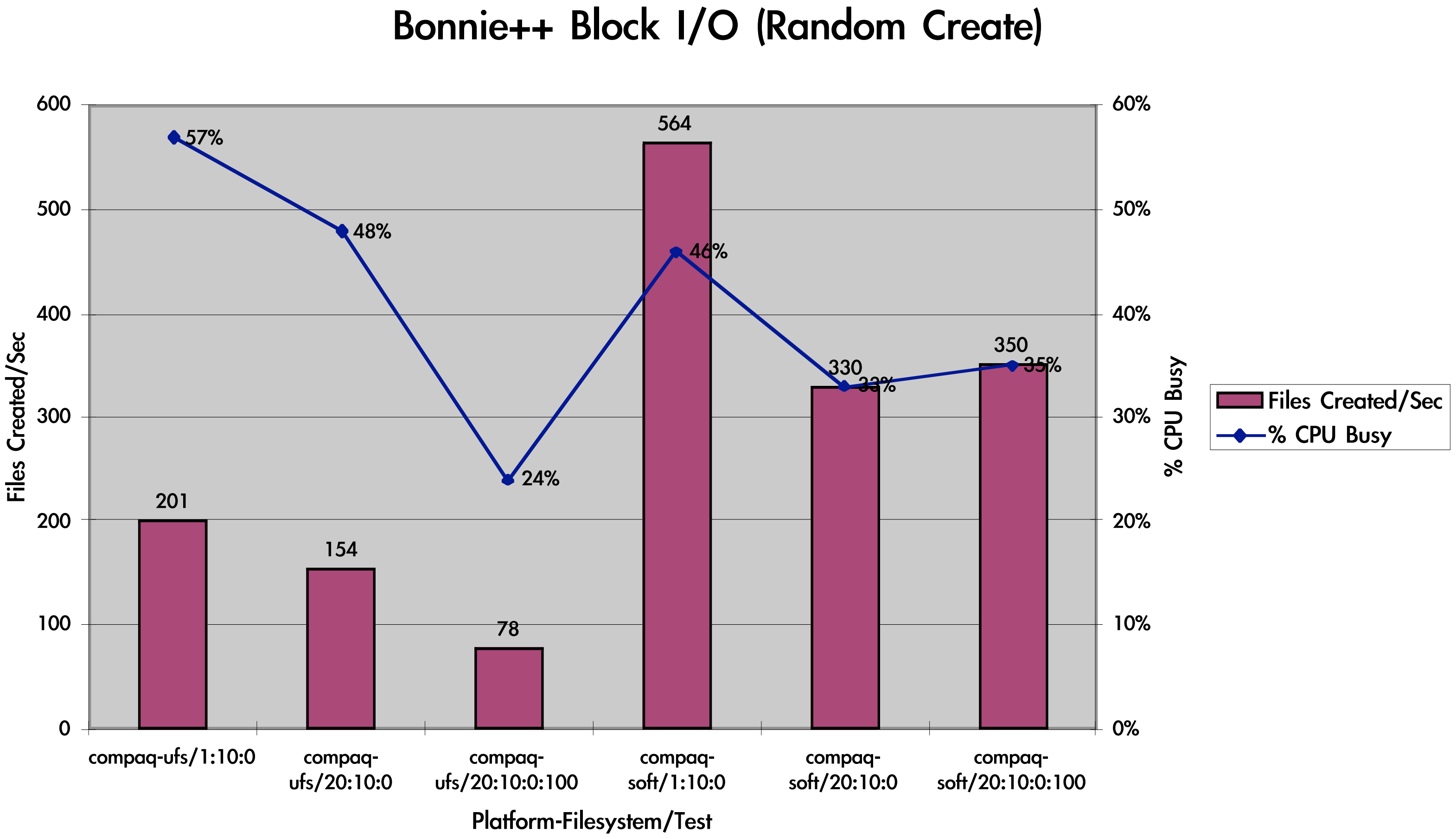
Bonnie++ Block I/O (Sequential Read)

# Bonnie++ Results

Bonnie++ Block I/O (Sequential Delete)

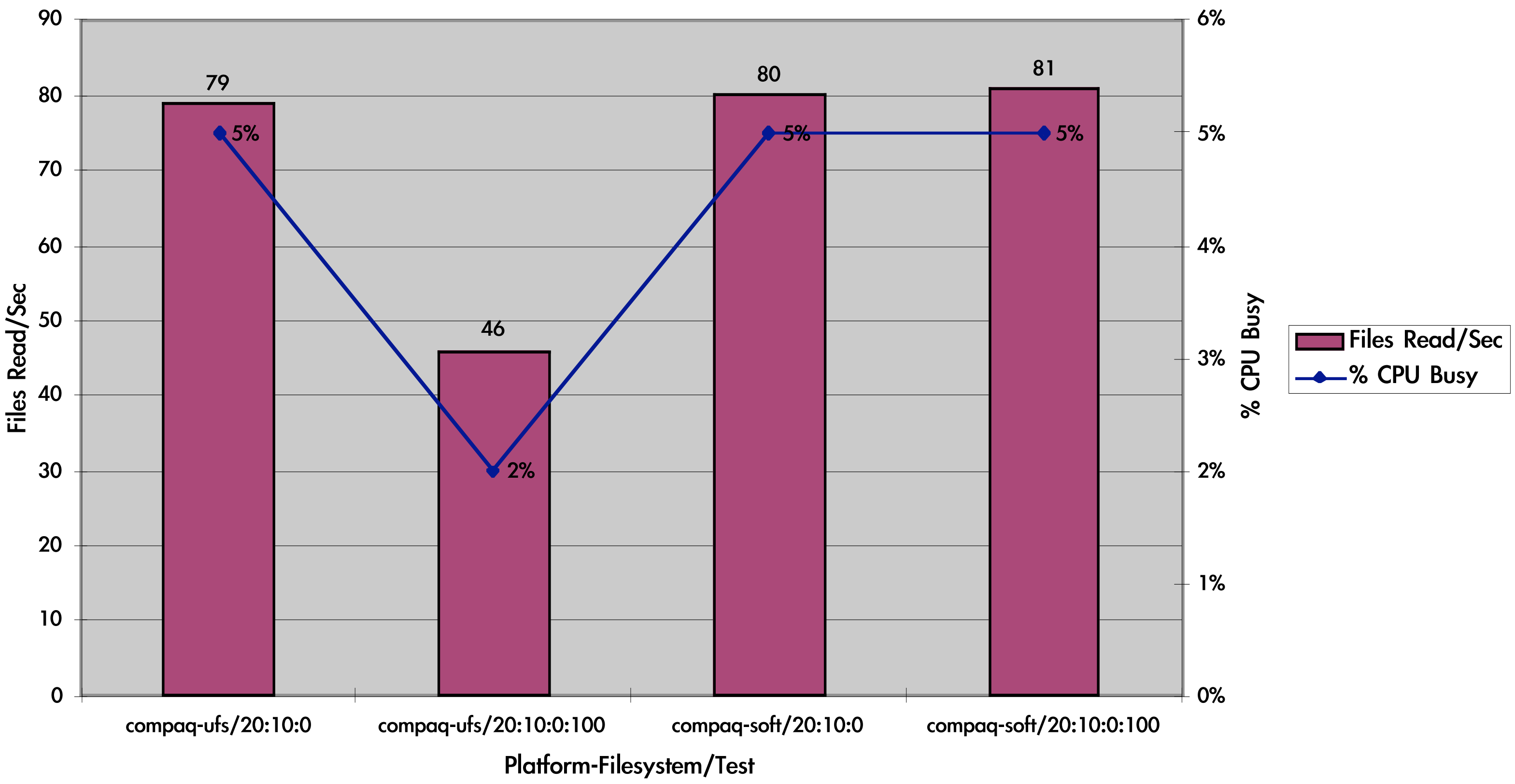


# Bonnie++ Results

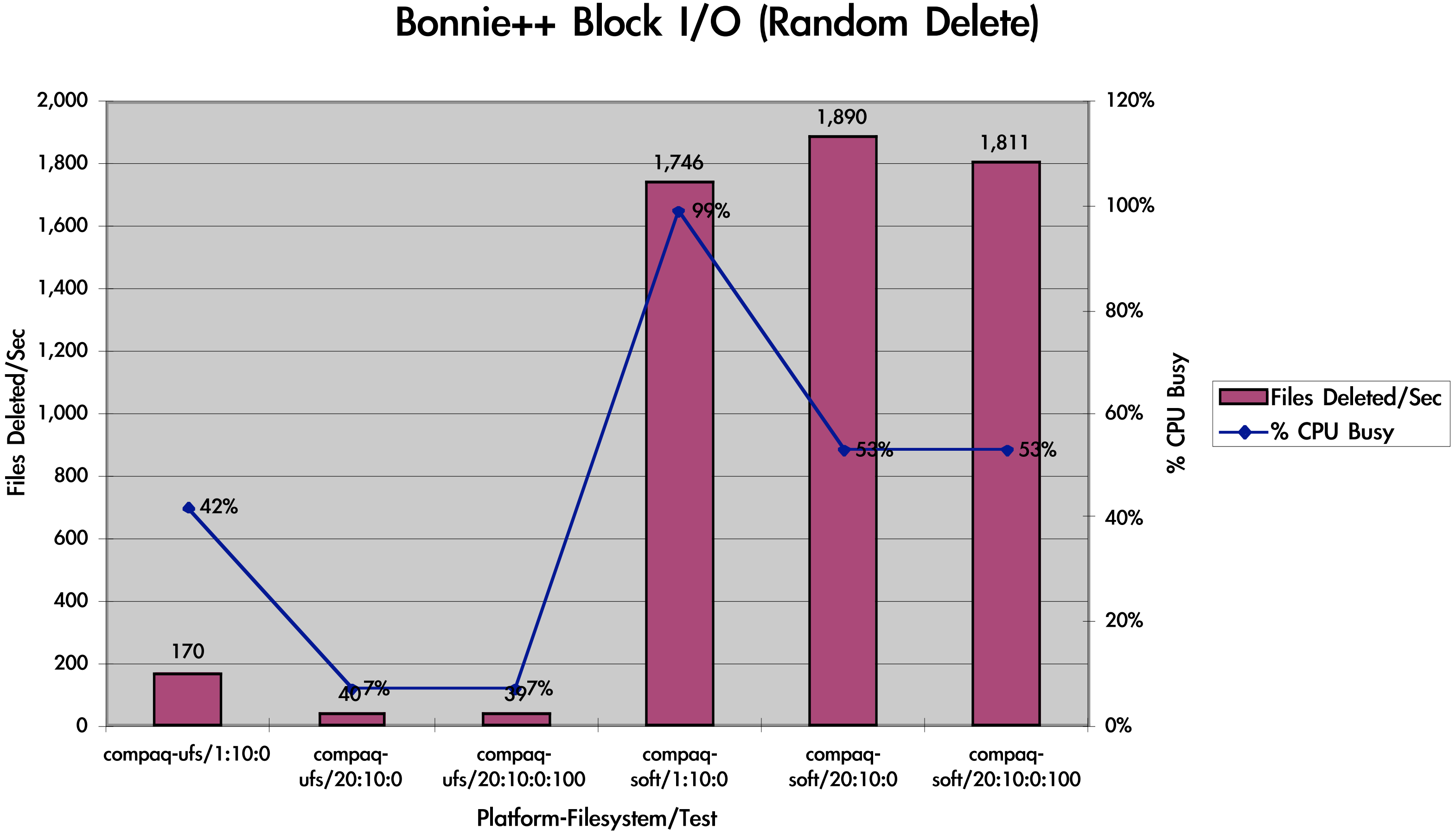


# Bonnie++ Results

Bonnie++ Block I/O (Random Read)



# Bonnie++ Results



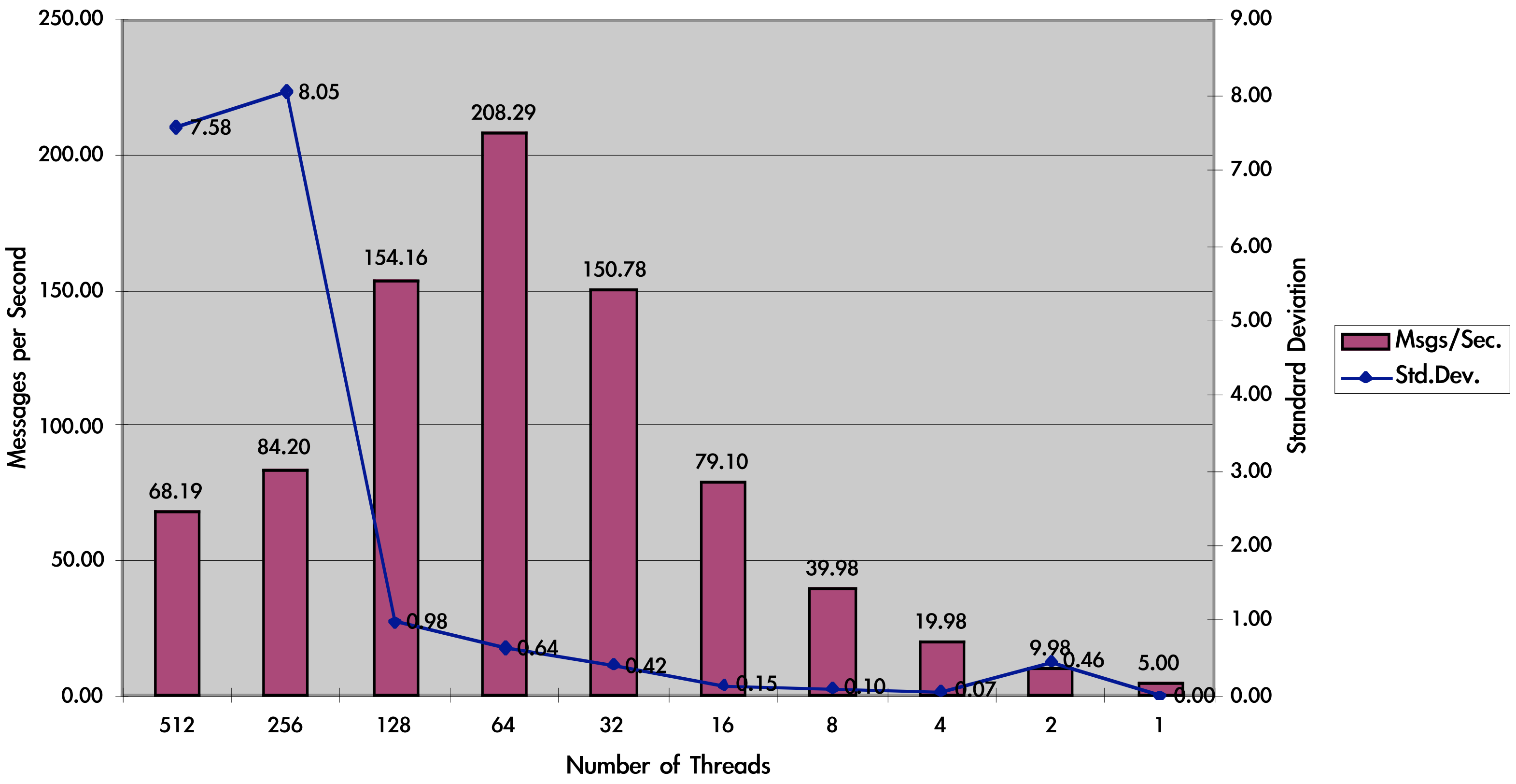
# Test Results:

## SmtpStone Sample Run

```
% sudo smtp-sink 127.0.0.1:25 1024 &
% foreach I (1 2 3 4 5 6 7 8 9 10)
foreach? /usr/bin/time smtp-source -l 10240 -f fred@example.net \
-t george@example.net -m 1000 -s 512 127.0.0.1:25
foreach? end
        8.06 real         0.22 user         1.65 sys
        9.03 real         0.26 user         1.45 sys
smtp-source: fatal: connect: Operation timed out
       32.00 real         0.17 user         1.68 sys
       13.08 real         0.19 user         1.43 sys
       10.98 real         0.31 user         1.28 sys
        9.02 real         0.24 user         1.52 sys
        8.04 real         0.25 user         1.57 sys
smtp-source: fatal: lost connection while reading server greeting
       16.51 real         0.19 user         1.61 sys
       10.99 real         0.19 user         1.53 sys
       16.52 real         0.25 user         1.50 sys
```

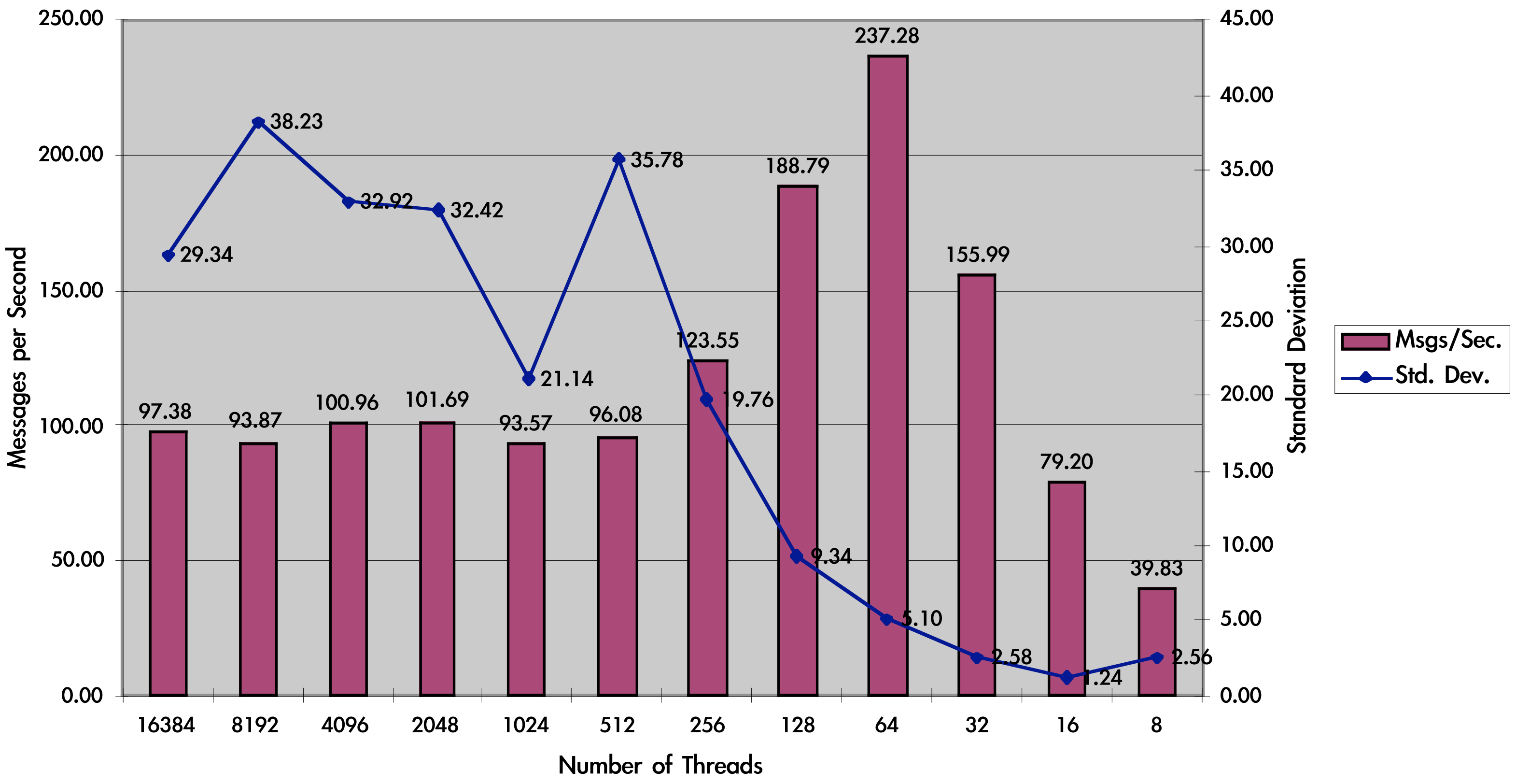
# SmtpStone Results

PowerBook G4 SmtpStone Performance (1000 messages)

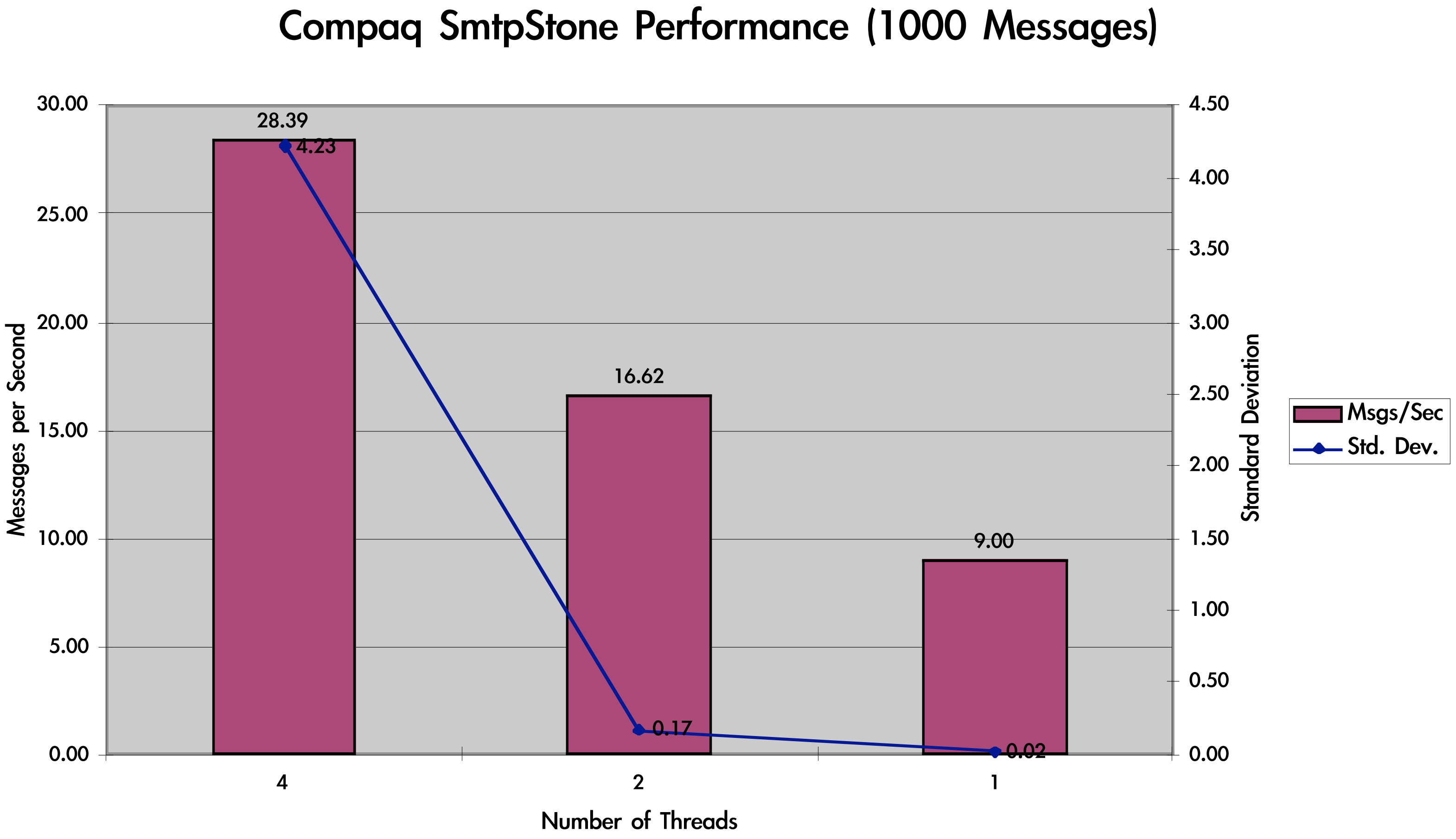


# SmtpStone Results

PowerBook G4 SmtpStone Performance (20000 messages)



# SmtpStone Results



# Test Results:

## Postal Sample Run

```
% sudo smtp-sink 127.0.0.1:25 1024 &
% postal -m 10k -p 64 -c 1 127.0.0.1 postal.user -
time,messages,data(K),errors,connections,SSL connections
23:05,7651,41262,0,7715,0
23:06,7795,41656,0,7795,0
23:07,7847,42305,0,7847,0
23:08,7616,41528,0,7616,0
23:09,7670,41659,0,7670,0
23:10,7413,39922,0,7413,0
23:11,7765,41886,0,7765,0
23:12,7752,41960,0,7752,0
23:13,7423,39835,0,7423,0
23:14,7475,39697,0,7475,0
23:15,7458,39981,0,7458,0
23:16,7462,40332,0,7462,0
23:17,7281,39294,0,7280,0
23:18,7408,40022,0,7409,0
23:19,7595,40882,0,7586,0
23:20,7737,41991,0,7746,0
23:21,7646,41122,0,7646,0
^C
```

# Test Results:

## Postal Sample Run

```
% sudo smtp-sink 127.0.0.1:25 1024 &
% postal -m 10k -p 128 -c 1 127.0.0.1 postal.user -
time,messages,data(K),errors,connections,SSL connections
23:27,8283,43988,0,8411,0
23:28,8965,48165,0,8965,0
23:29,8952,48100,0,8952,0
23:30,8785,46803,0,8785,0
23:31,7948,42811,0,7933,0
Server timed out on read.
Server timed out on read.

      [ .. .. Deletia .. .. ]

Server timed out on read.
Server timed out on read.
23:32,8016,43367,28,8059,0
23:33,8960,47748,0,8960,0
23:34,9054,48507,0,9022,0
23:35,8737,47175,0,8769,0
23:36,9057,48586,0,9057,0
23:37,8800,46722,0,8800,0
23:38,8933,48092,0,8933,0
23:39,8969,48155,0,8955,0
23:40,8984,48576,0,8998,0
^C
```

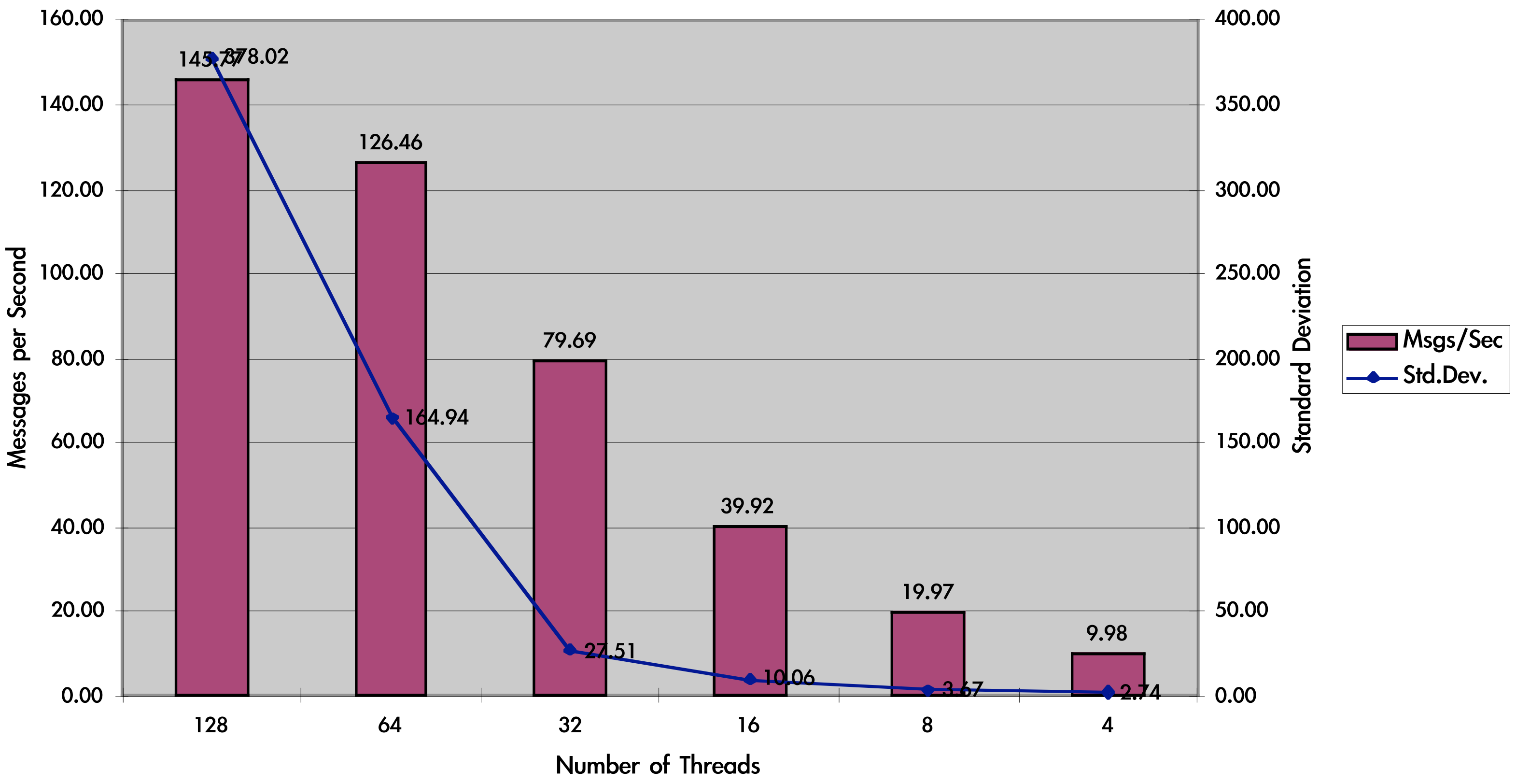
# Test Results:

## Postal Sample Run

```
% sudo smtp-sink 127.0.0.1:25 1024 &
% postal -m 10k -p 256 -c 1 127.0.0.1 postal.user -
Usage: postal [-m maximum-message-size] [-p processes] [-l local-address]
              [-c messages-per-connection] [-r messages-per-minute] [-a]
              [-b [no]netscape] [-[z|Z] debug-file]
              [-s ssl-percentage]
              smtp-server user-list-filename conversion-filename

Postal Version: 0.61

% postal -m 10k -p 32 -c 1 127.0.0.1 postal.user -
time,messages,data(K),errors,connections,SSL connections
Can't connect to 127.0.0.1 port 25.
Can't connect to 127.0.0.1 port 25.
Can't connect to 127.0.0.1 port 25.
Can't connect to 127.0.0.1 port 25.
Can't connect to 127.0.0.1 port 25.
```

# Postal Results

PowerBook G4 Postal Performance



# Notes for Testing

- When testing real MTAs, you need to watch more than just the output from the testing program
  - Not unusual for MTAs to accept mail faster than they can process it, especially under heavy load
- Also watch
  - Mail queue size
    - `mailq | grep '[0-9][0-9]:[0-9][0-9]' | wc -l`
  - CPU load
    - `iostat 5`
  - Memory utilization
    - `vmstat 5`

# Notes for Postfix

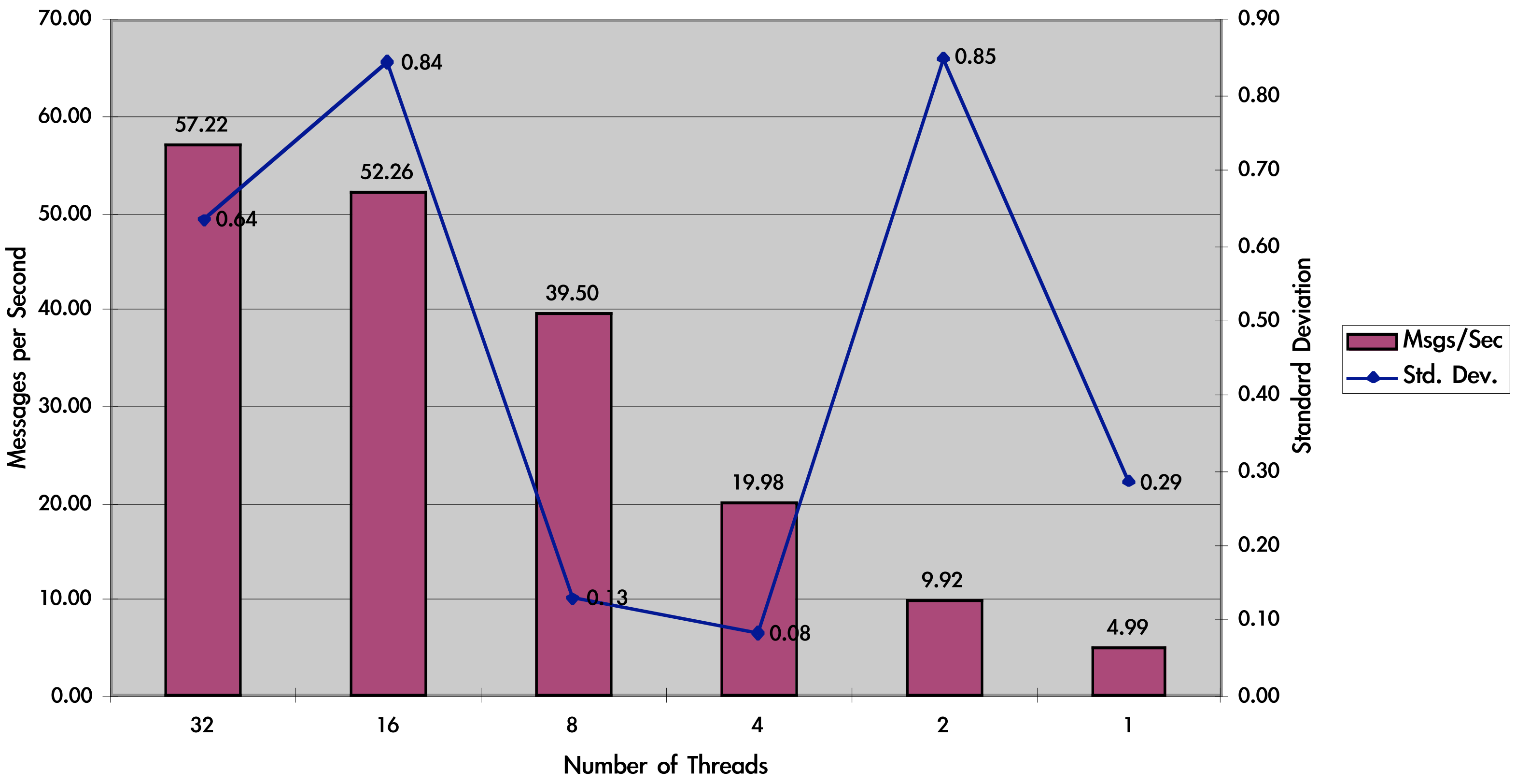
- Make sure that you modify `/etc/postfix/main.cf` to be suitable
  - Need to boost
    - `local_destination_concurrency_limit`
    - `default_destination_concurrency_limit`
- Check `/etc/postfix/master.cf` to make sure there are no artificial limits on processes like `smtp`, `smtpd`, `bounce`, `cleanup`, `rewrite` etc…

# Notes for MacOS X

- Unfortunately, Apple broke `iostat`
  - Still mostly okay for what we want to watch (CPU user %, system %, and idle %)
- Apple doesn’t even provide `vmstat`
  - `vm_stat` is not the same program, although it is similar

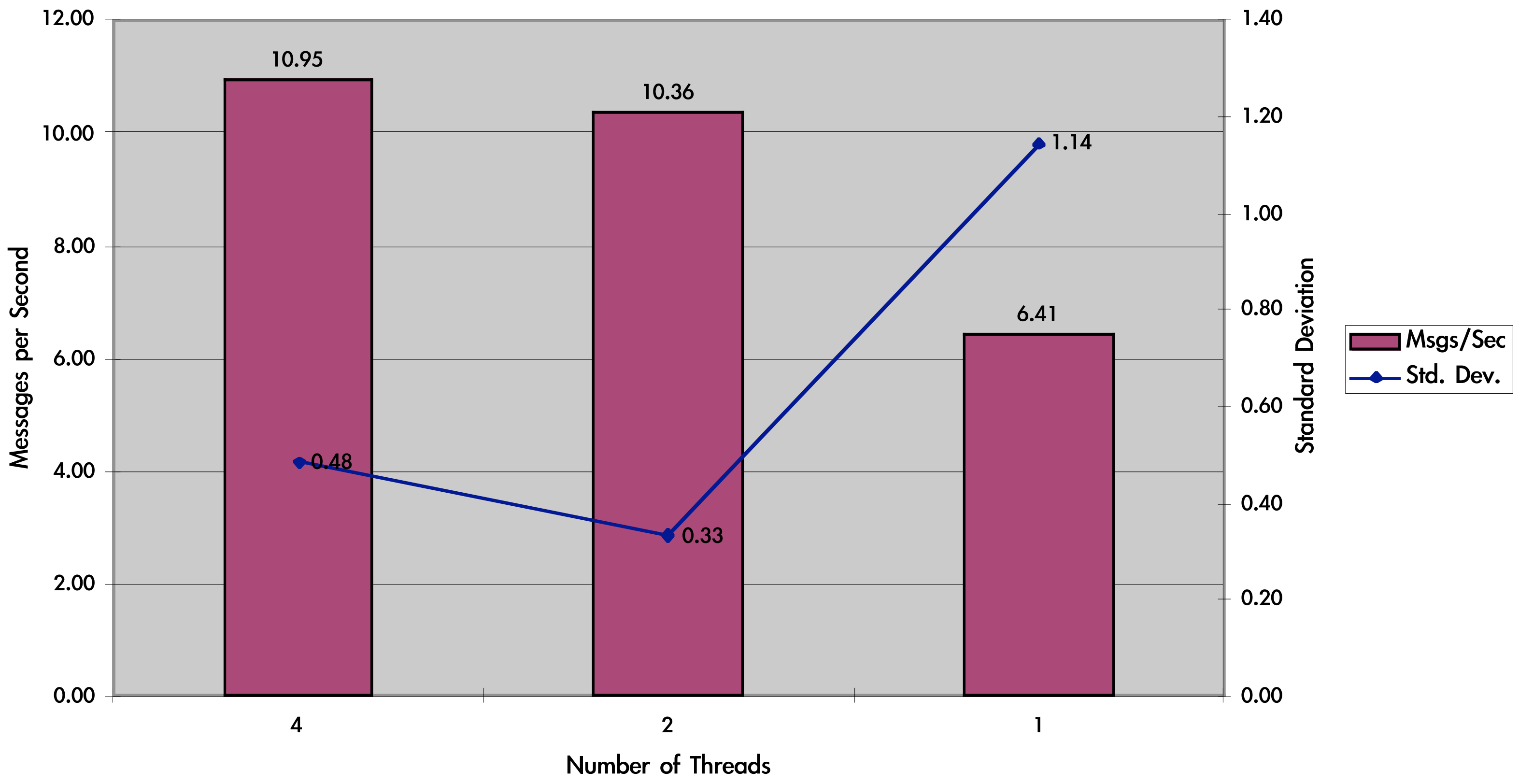
# Postfix SmtpStone Results

PowerBook G4 Postfix SmtpStone Performance (1000 messages)



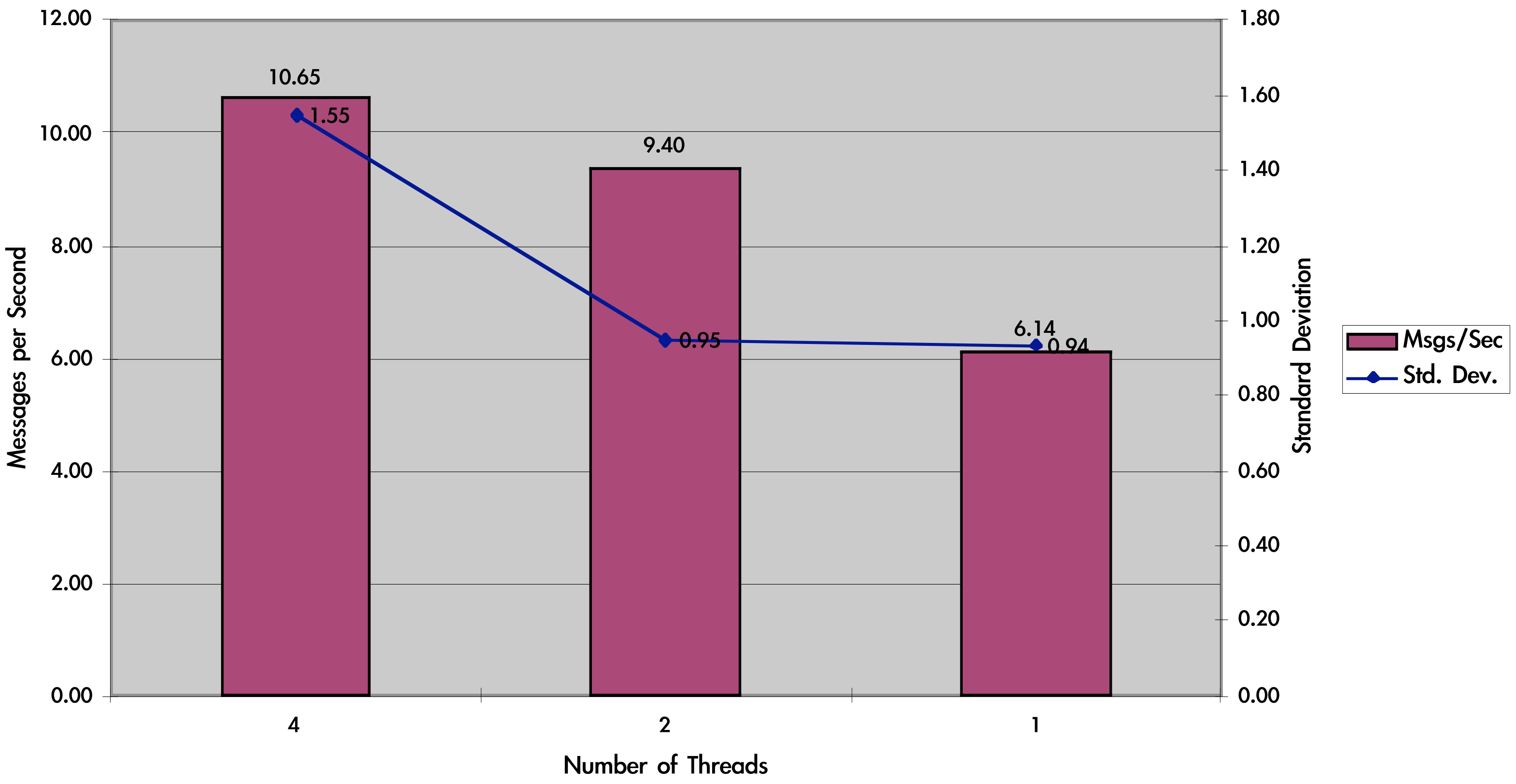
# Postfix SmtpStone Results

Compaq+UFS SmtpStone Performance (1000 messages)



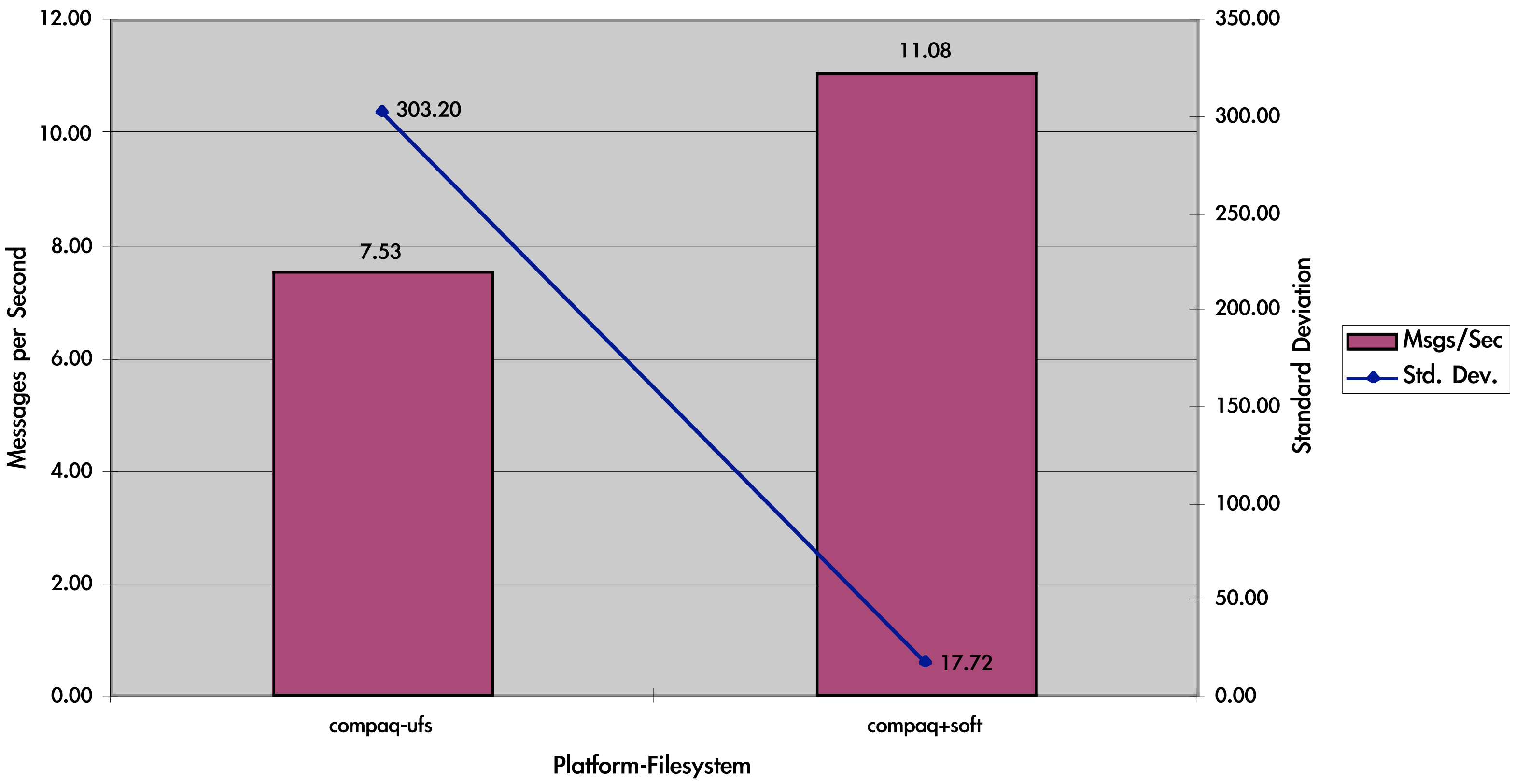
# Postfix SmtpStone Results

Compaq+Soft SmtpStone Performance (1000 messages)

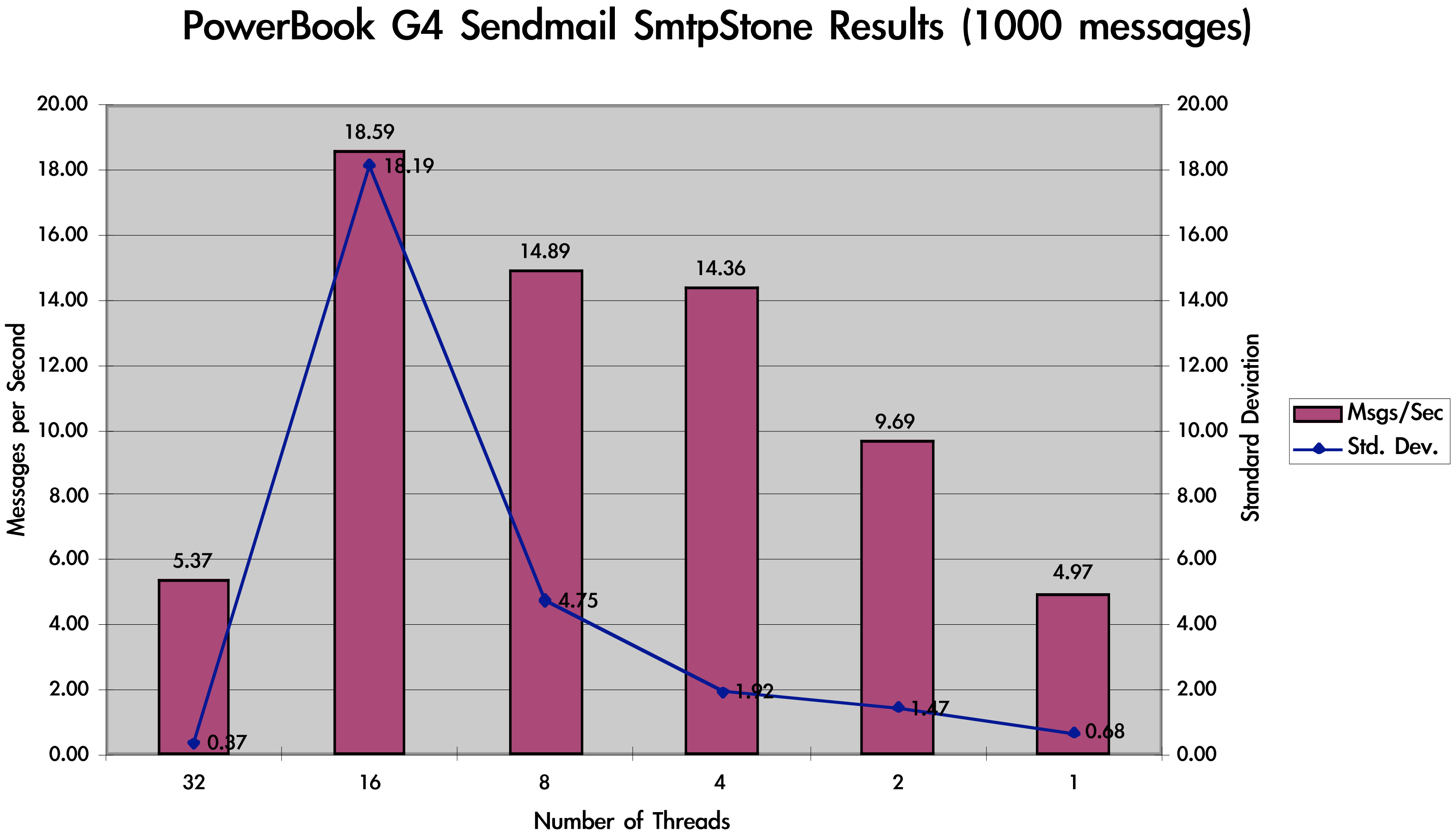


# Postfix SmtpStone Results

Compaq Postfix SmtpStone Results (20000 messages/4 Threads)

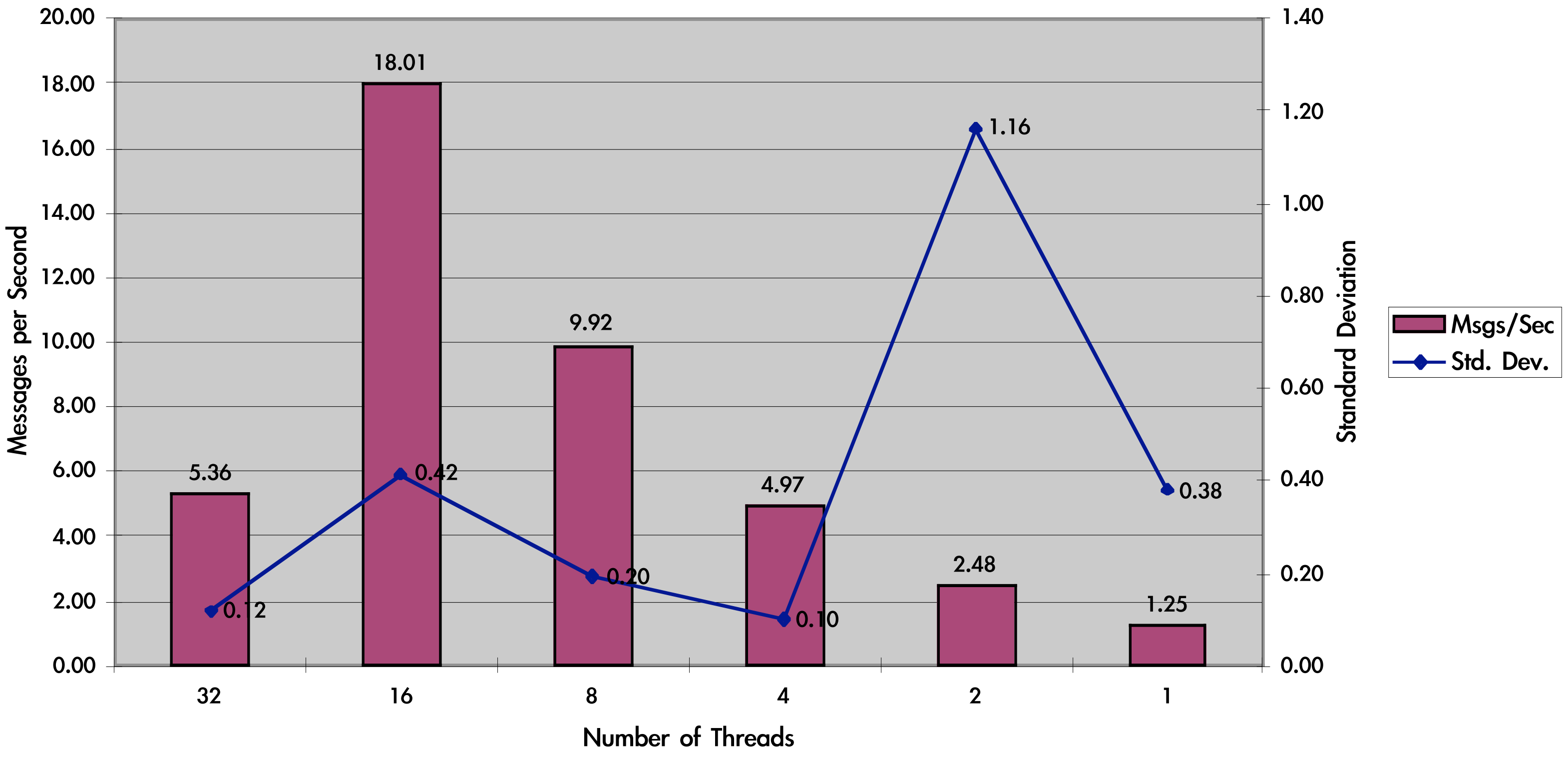


# Sendmail SmtpStone Results


PowerBook G4 Sendmail SmtpStone Results (1000 messages)

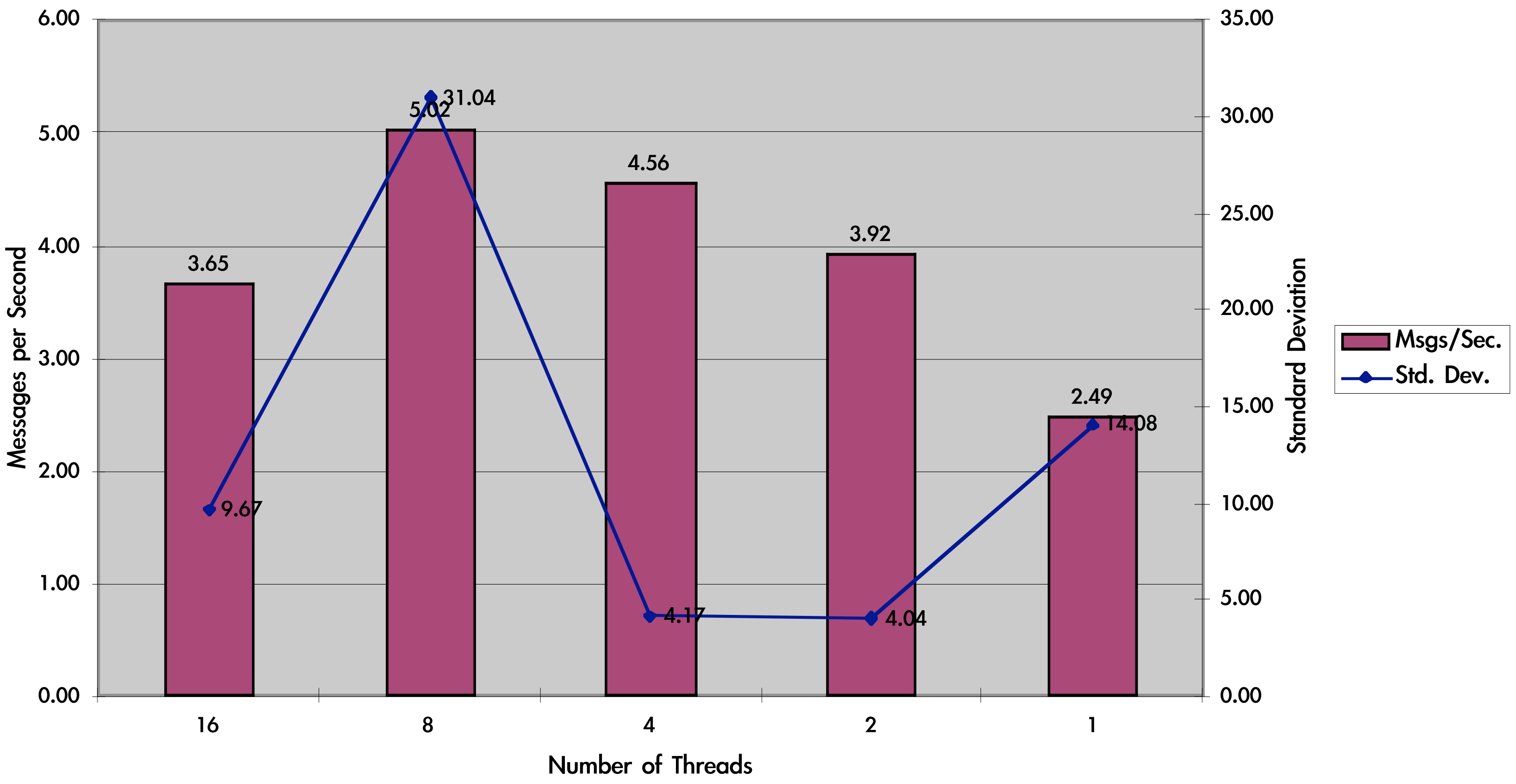
# Sendmail SmtpStone Results

PowerBook G4 Sendmail+Async SmtpStone Results (1000 messages)



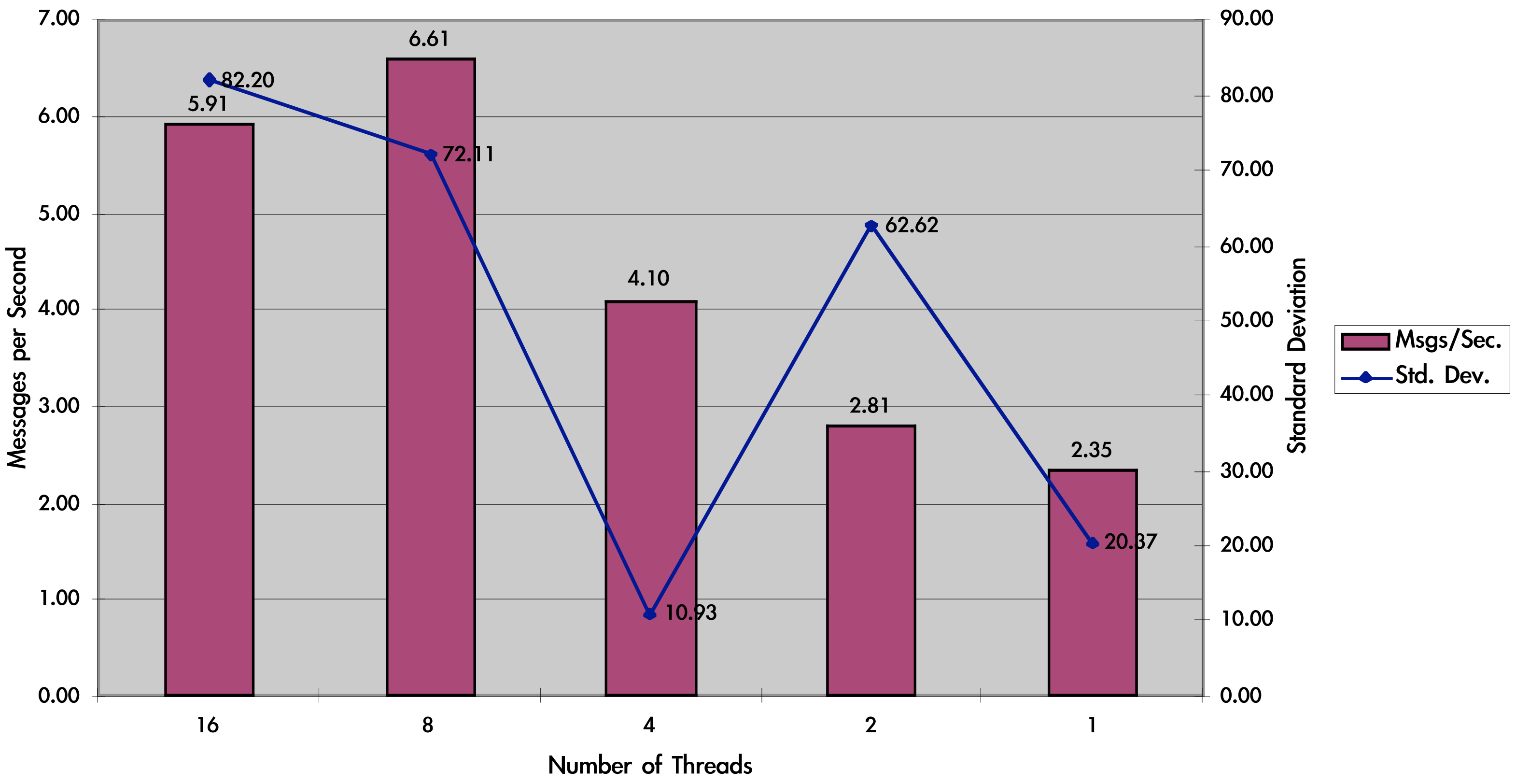
# Sendmail SmtpStone Results

Compaq Sendmail-UFS SmtpStone Results (1000 messages)



# Sendmail SmtpStone Results

Compaq Sendmail+Soft SmtpStone Results (1000 messages)



# Performance Tuning: Syslog

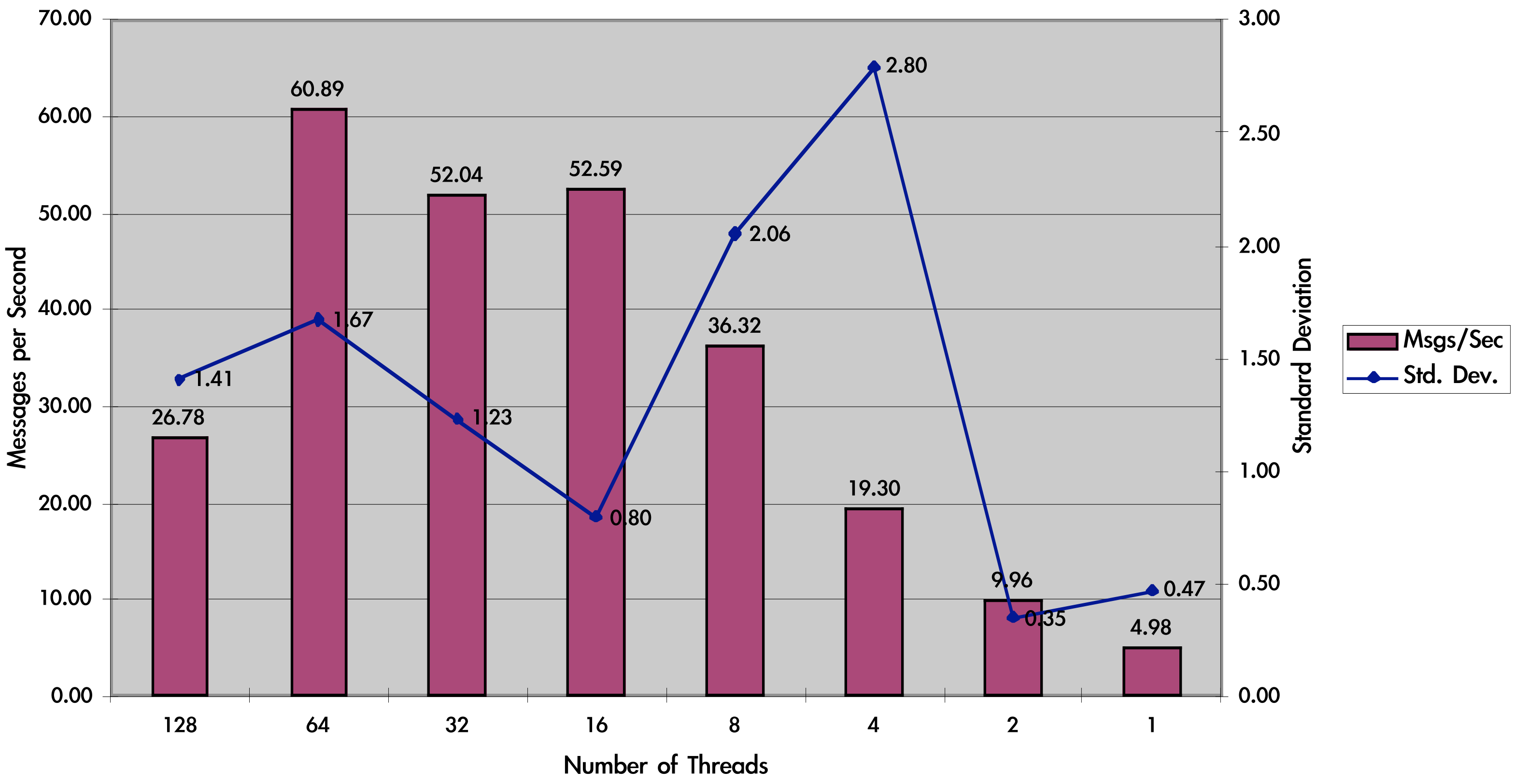
- Problem
  - Local `syslog` can cause excessive load on busy mail system
- Solutions
  - Configure `syslog` to write to logs asynchronously
    - Perhaps via a “–” (dash) before the filename
  - Run `syslog` on a central log server, across the network
    - Also allows you to perform more in-depth log processing, without interfering with mail services
    - Generally logs are much easier to manage centrally
    - Can also combine with other central `syslog` processing applications
      - E.g., Addamark Log Management System

# Performance Tuning: Syslog

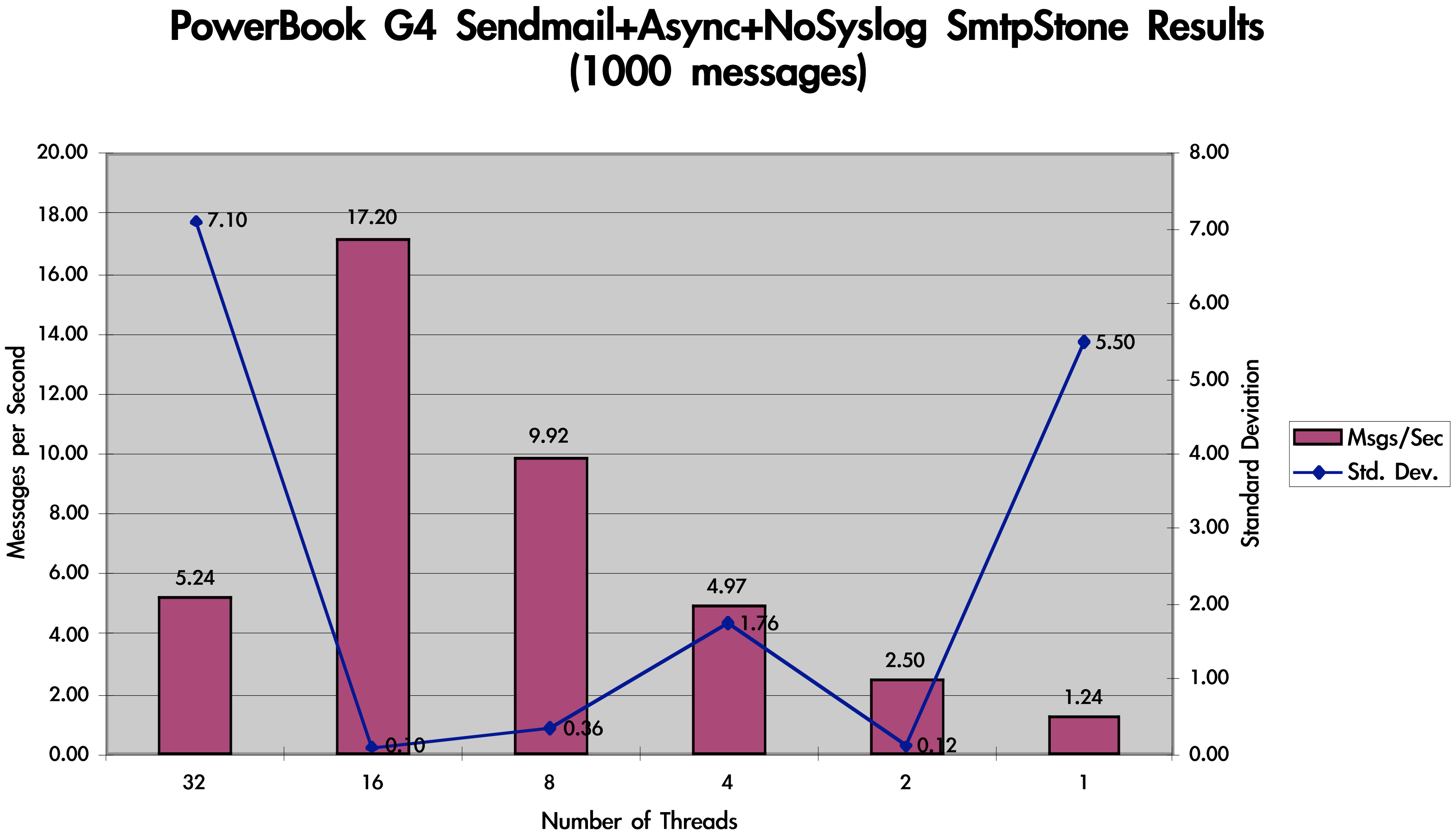
- Problem
  - Classic `syslog` uses UDP, can lose 75% or more of packets sent across the network
- Solution
  - Replace classic `syslog` with `nsyslog`, `ssyslog`, or `syslog-ng` and use TCP instead of UDP
    - Depending on your particular requirements for hardware, OS, environment, etc….

# Postfix SmtpStone Results

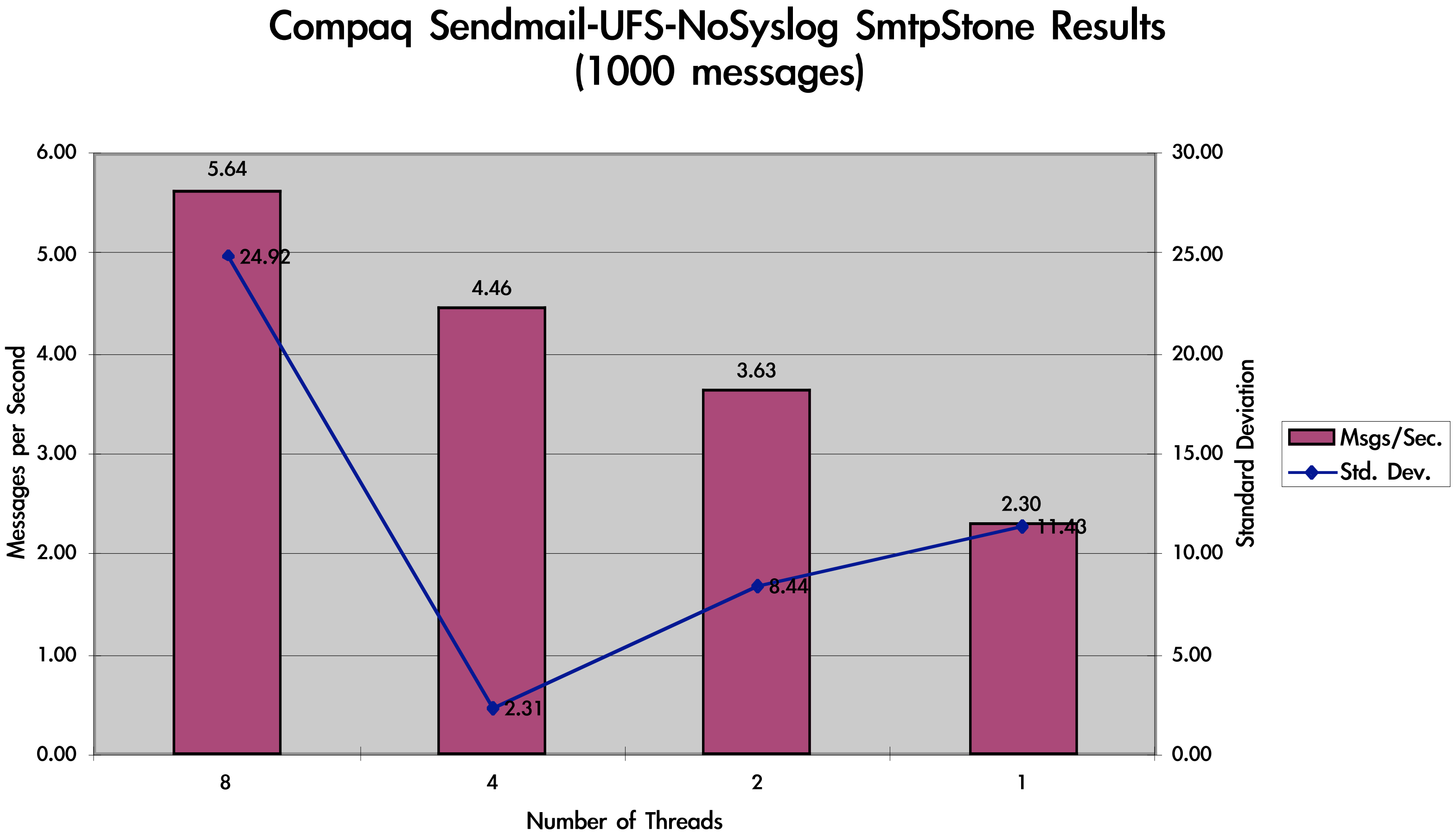
PowerBook G4 (no syslog) Postfix SmtpStone (1000 messages)



# Sendmail SmtpStone Results



# Sendmail SmtpStone Results



# Conclusions

- This process can be difficult and time-consuming to get right, but it pays off
- Graphs & charts can help a great deal
  - But they don't tell the whole story
- Software
  - Postfix is a lot faster than even I had thought
  - Wasn't able to get sendmail tuned for the performance I'm confident it can deliver
  - Benchmarking tools (esp. Bonnie++ and postal) need more work to be useful

# Conclusions

- Use the Scientific Method
  - Try to set aside personal bias
  - Trust only what you can prove
  - Process
    - Generate Hypothesis
    - Generate test for Hypothesis
    - Test Hypothesis
      - Prove or Disprove
    - If disproven, modify or generate new Hypothesis

# Related Work

- Nick Christenson
  - sendmail Performance Tuning book http://www.jetcafe.org/~npc/book/sendmail/
  - “Performance Tuning Sendmail Systems” slides http://www.jetcafe.org/~npc/doc/performance_tuning.pdf
- Brad Knowles
  - “Sendmail Performance Tuning for Large Systems” slides http://www.shub-internet.org/brad/papers/sendmail-tuning/

# Related Work

- Matthias Andree
  http://www-dt.e-technik.uni-dortmund.de/~ma/postfix/vsqmail.html
  http://www-dt.e-technik.uni-dortmund.de/~ma/postfix/bench2.html
- Nakamura Motonori
  http://www.kyoto.wide.ad.jp/mta/eval1/eindex.html
- Ciprian Ascante
  http://www.benchmarks.dmz.ro/index.php?topic=LinMSB