Experiments with SpeedMark benchmark

Contents

- Effects of different operating systems
- Effects of different compilers
- Effects of compiler optimization
- Effects of multiple-core processors
- Computer performance comparison

SpeedMark benchmark

- The first step is to select a drive workload that will be used for measurements.
- We will use the SpeedMark (SM) benchmark that measures processor speed when executing a mix of typical floating point and integer operations
- SpeedMark is a harmonic mean of measured floating point and integer speed [operations/minute]
- SM measures a combined performance of processor, cache, bus and memory

SpeedMark components

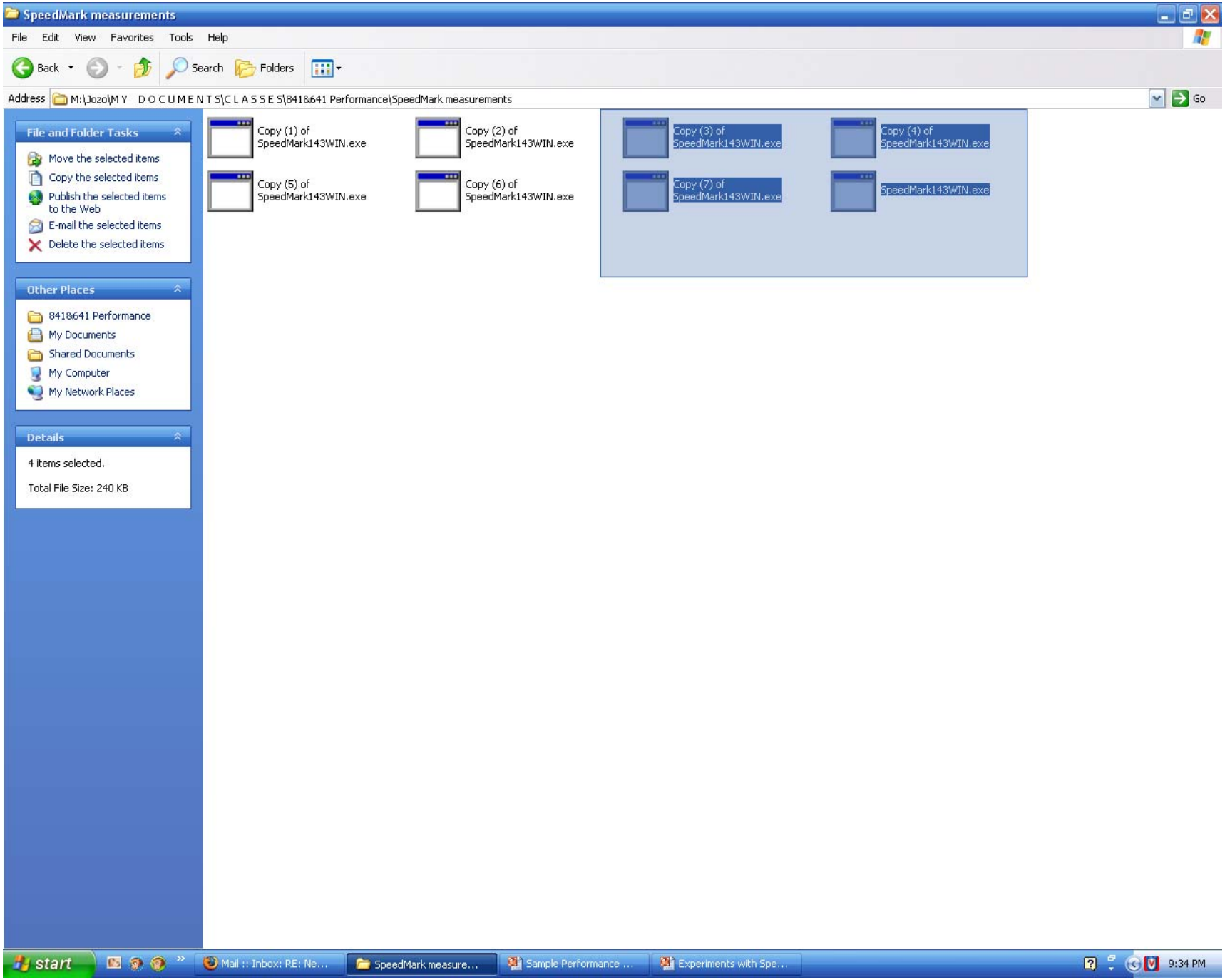
The SpeedMark benchmark combines floating point operations (inversion of a single-index double-precision matrix) and integer operations (recursive quicksort of an integer array) to measure an aggregated **SpeedMark** performance indicator. Fast processors have large SpeedMark value and slow processors have small SpeedMark.

Conditions for Measurement

- Measurements can be done under various conditions. Clear specification of conditions is necessary for proper interpretation of results.
- Various compilers and operating systems can generate different SpeedMark results on the same hardware.
- Adjustable options include: (1) OS, (2) type of compiler, (3) compiler parameters, and (4) the number of SpeedMark benchmarks that run in parallel.

Starting n copies of SpeedMark

- Make a SpeedMark directory
- Store in this directory N copies of Speedmark (N>=n)
- Highlight n copies of Speedmark
- Press Enter


SpeedMark measurements
File Edit View Favorites Tools Help
Back Search Folders
Address M:\Jozo\MY DOCUMENTS\CLASSES\841&641 Performance\SpeedMark measurements
Go
File and Folder Tasks
Move the selected items
Copy the selected items
Publish the selected items to the Web
E-mail the selected items
Delete the selected items
Other Places
841&641 Performance
My Documents
Shared Documents
My Computer
My Network Places
Details
4 items selected.
Total File Size: 240 KB
Copy (1) of SpeedMark143WIN.exe
Copy (2) of SpeedMark143WIN.exe
Copy (3) of SpeedMark143WIN.exe
Copy (4) of SpeedMark143WIN.exe
Copy (5) of SpeedMark143WIN.exe
Copy (6) of SpeedMark143WIN.exe
Copy (7) of SpeedMark143WIN.exe
SpeedMark143WIN.exe
start
Mail :: Inbox: RE: Ne...
SpeedMark measure...
Sample Performance ...
Experiments with Spe...
9:34 PM

Processor performance of Dell Dimension 8200

What are effects of different operating systems?
What are effects of different compilers?

Options for Performance Measurement of Dell Dimension 8200

- Operating system
  - Windows XP
  - Cygwin under Windows XP
  - Linux
- Compiler
  - MS Visual C++
  - GNU g++
- Compiler settings
  - Debug version
  - Release version
  - Code optimization
- Number of SpeedMarks
  - Single SpeedMark
  - Multiple SpeedMarks
    - Equal priority
    - Different priority

Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

OS = RedHat Linux 2.4.7-10

Compiler = g++ -O3

Number of concurrent SpeedMarks = 1

Measured SpeedMark for this machine = 195 operations/min

```
Do not run other programs in parallel with SpeedMark! Simultaneous activation
of multiple copies of SpeedMark is appropriate for multiprocessor machines.
Normal SpeedMark measurement time is constant: 20 seconds. SpeedMark may run
longer than 20 sec on archaic machines, yielding very low SpeedMark values.
SpeedMark is a free program. Feel free to distribute it.

|=================================================================|
| SpeedMark CPU Benchmark V1.4.1  |                               |
| (C) 2006 by Dr. Jozo Dujmovic   |        @@     @@@@@   @@@@@@@ |
|                                 |      @@@    @@   @@  @@      |
| SpeedMark of this machine:      |       @@    @@   @@  @@      |
|---------------------------------->     @@     @@@@@@  @@@@@@   |
| SpeedMark is a mean of floating |       @@         @@       @@ |
| operations (matrix inversions   |       @@    @@   @@  @@   @@ |
| per min) and integer operations |      @@@@@@   @@@@@    @@@@@  |
| (integer quicksorts per minute) |                               |
|=================================================================|
| Float speed = 165.68 minv/min   Integer speed = 235.76 sort/min |
|=================================================================|

If you concurrently executed multiple copies of SpeedMark then add values
from all SpeedMark windows. Enter 'e' to exit, or just close all windows.
```

Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

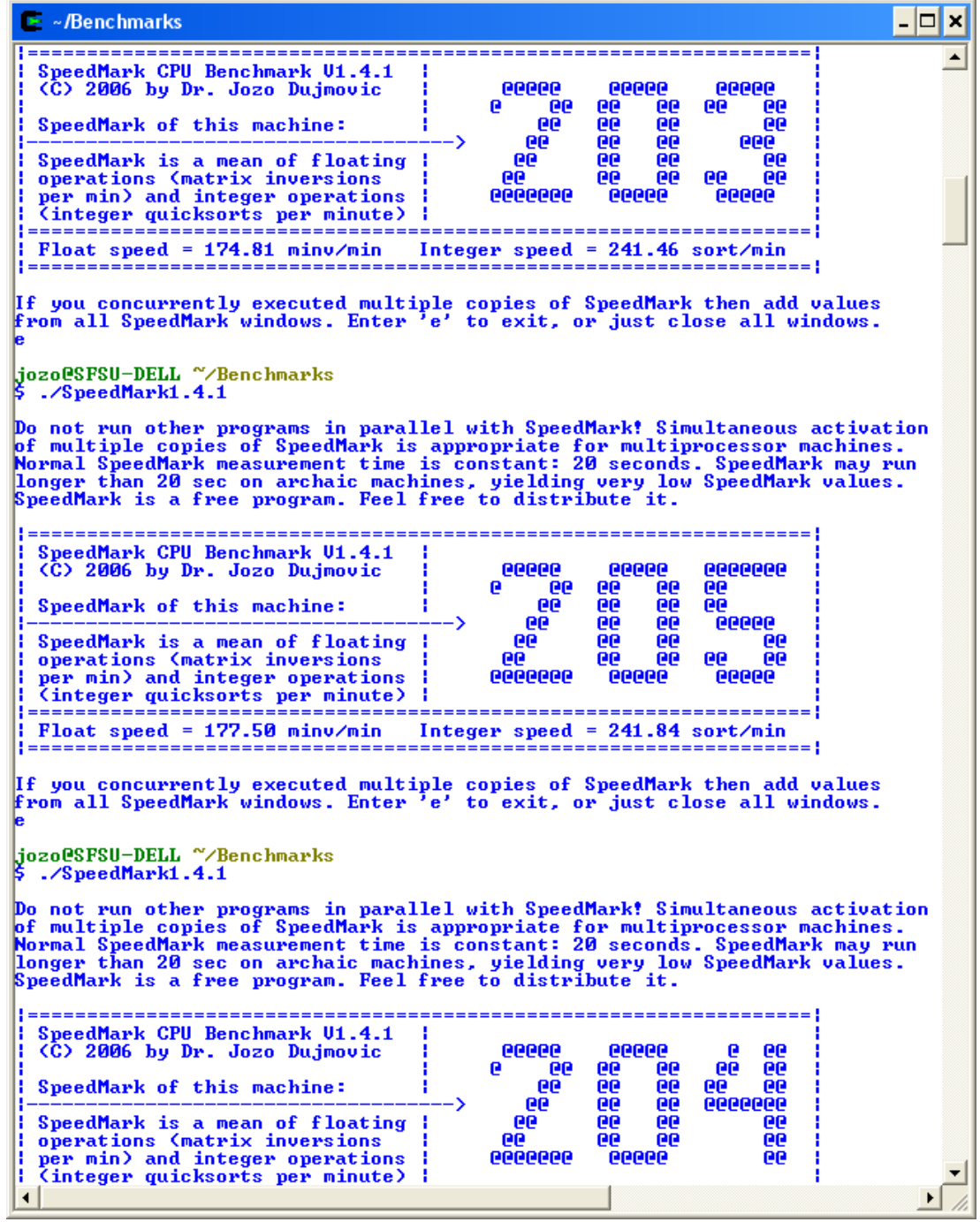
OS = Windows XP + Cygwin

Compiler = g++ -O3

Number of concurrent SpeedMarks = 1

Three separate measuements

Average SpeedMark for this machine = 204 ops/min



Computer = Dell Dimension 8200

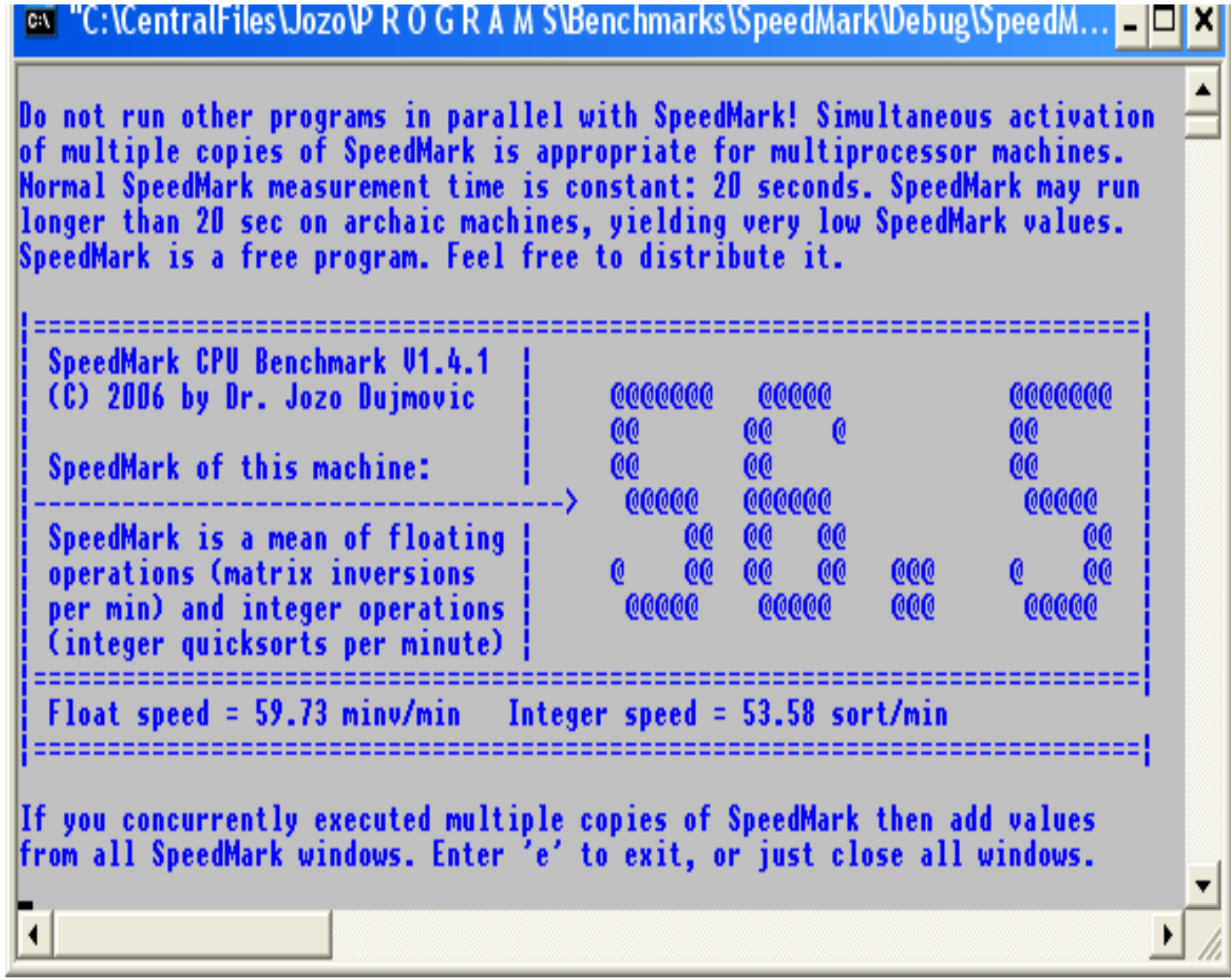
CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

OS = Windows XP

Compiler = MS Visual C++ 6.0
Debug version

Number of concurrent SpeedMarks = 1

Meaured SpeedMark for this machine =
56.5 ops/min



Computer = Dell Dimension 8200

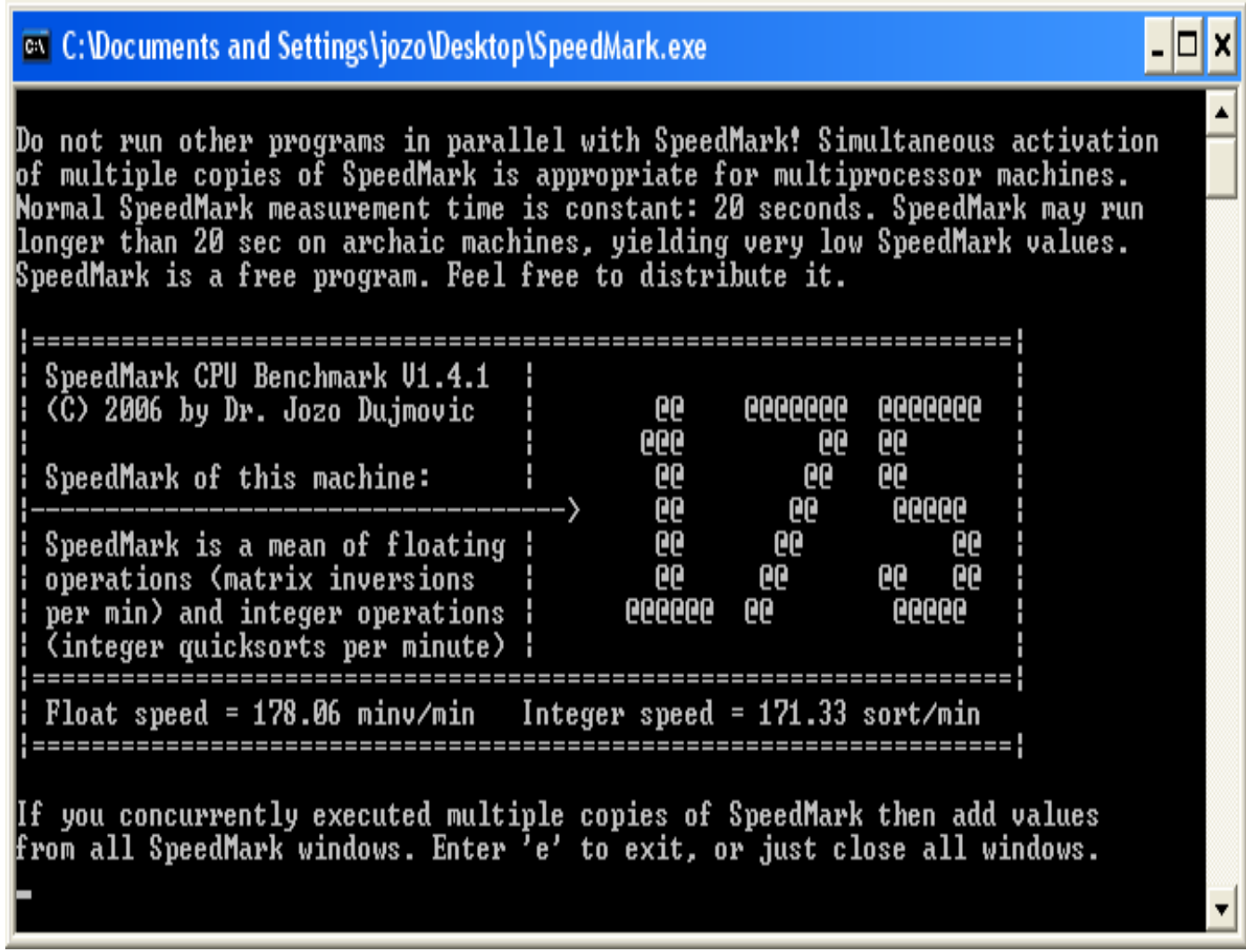
CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

OS = Windows XP

Compiler = MS Visual C++ 6.0
Release version

Number of concurrent SpeedMarks = 1

Meaured SpeedMark for this machine =
175 operations/min



Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

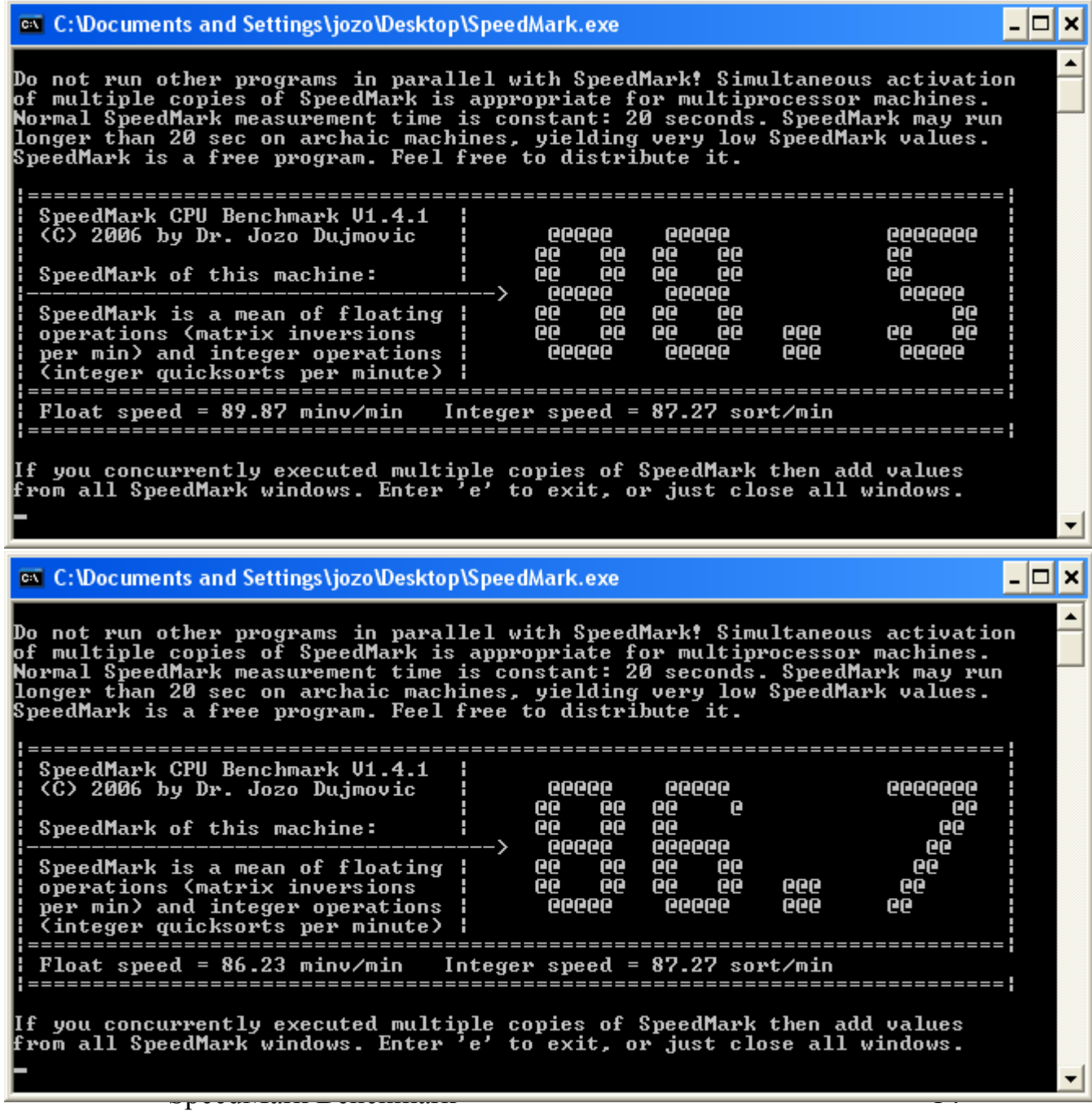
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 2

Program priorities: balanced (2 inactive windows)

Total SpeedMark for this machine:
∑ = 175.2 ops/min



Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

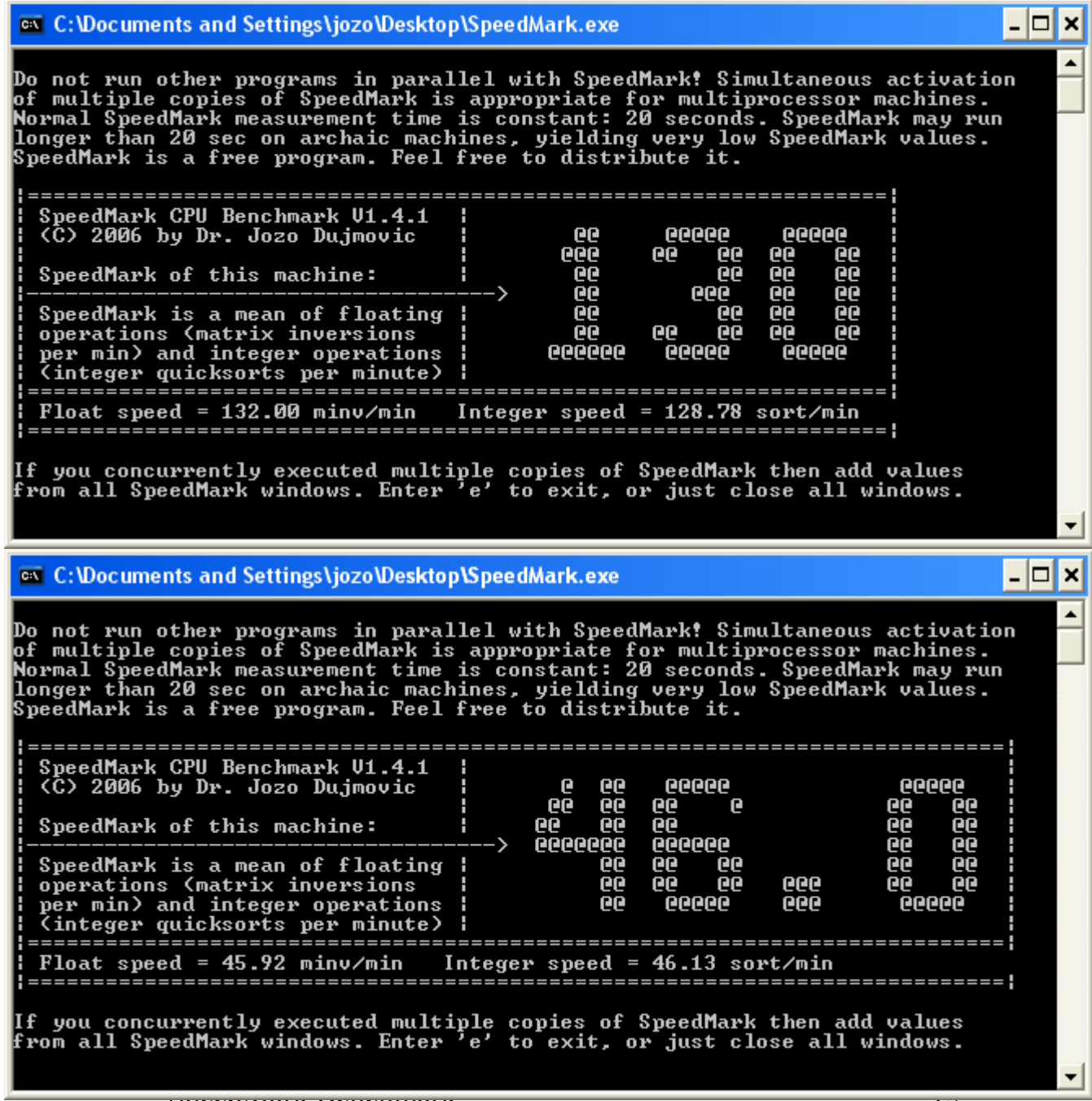
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 2

Program priorities: imbalanced (active window and inactive window)

Total SpeedMark for this machine:
∑ = 176 ops/min



Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

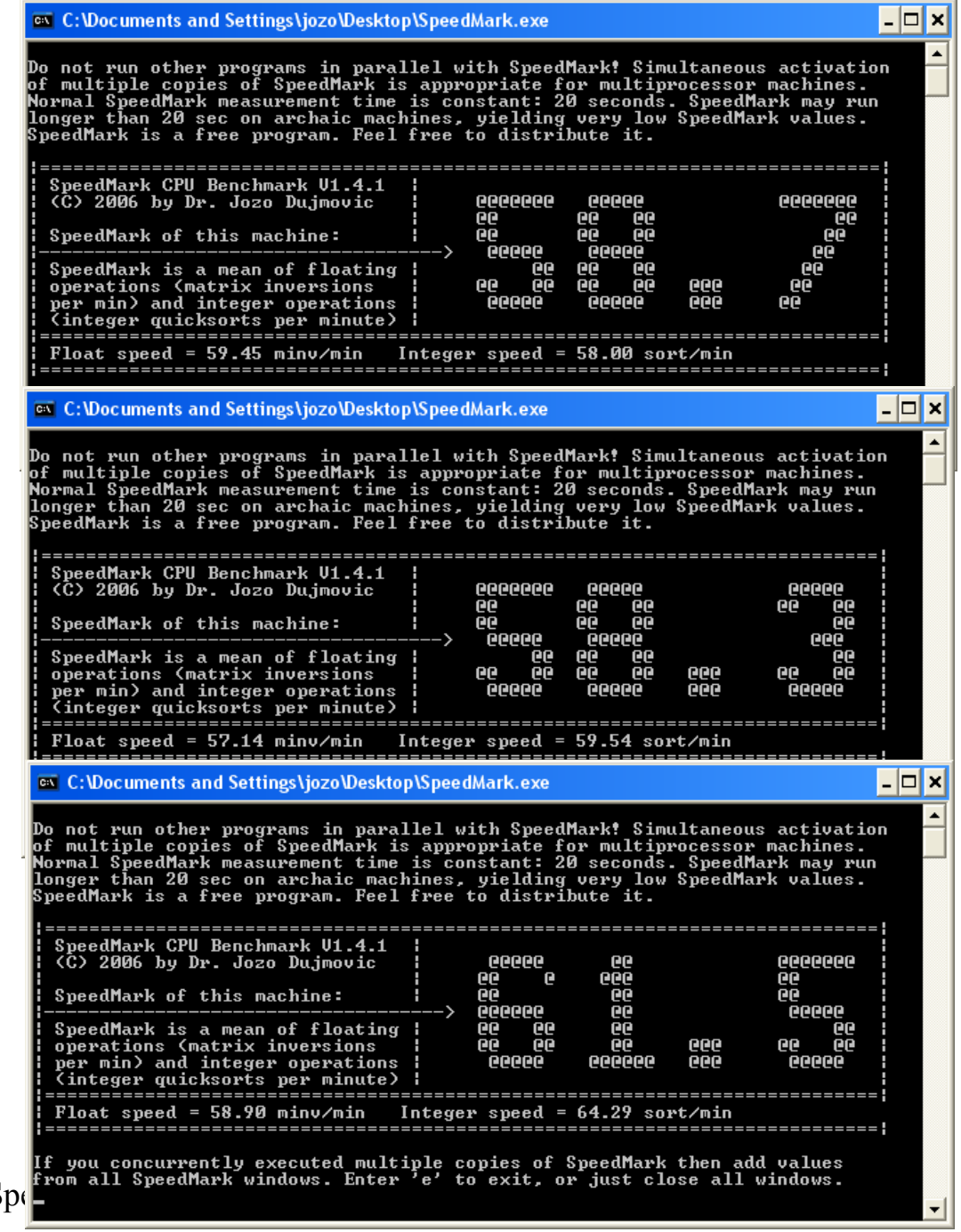
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 3

Program priorities: balanced (3 inactive windows)

Total SpeedMark for this machine:
$\sum$ = 178.5 ops/min



Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 3

Program priorities: imbalanced (1 active window and 2 inactive windows)

Total SpeedMark for this machine:
∑ = 184.2 ops/min

Computer = Dell Dimension 8200

CPU = Pentium 4 @ 1.69 GHz, 256 MB of RAM

OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 6

Program priorities: balanced (6 inactive windows)

Total SpeedMark for this machine:
∑ = 187.9 operations/min

Comparison of Results for Dell Dimension 8200

SpeedMark [ops/min]	Operating system	Compiler and optimization	Number of programs	Equal priority
204	Cygwin/XP	g++ -O3	1	-
195	Linux	g++ -O3	1	-
187.9	Windows XP	VC++ Release	6	Yes
184.2	Windows XP	VC++ Release	3	No
178.5	Windows XP	VC++ Release	3	Yes
176	Windows XP	VC++ Release	2	No
175.2	Windows XP	VC++ Release	2	Yes
175	Windows XP	VC++ Release	1	-
56.5	Windows XP	VC++ Debug	1	-

Conclusions of Dell Dimension 8200 Performance Measurements

- Dell Dimension 8200 delivers SpeedMark in the range from 175 to 205 (single SpeedMark)
- Differences between compilers <= 17%
- Release speed / Debug speed = 3.1
- Win XP high priority / low priority = 2.8
- Cygwin outperforms native Linux mode (!)
- Multiple windows increase the total SpeedMark

How fast is Dell XPS400 desktop compared to the IBM T41 laptop?

(Performance comparison 2-core and 1-core systems using the SpeedMark benchmark)

IBM T41 laptop

Computer = IBM T41 laptop

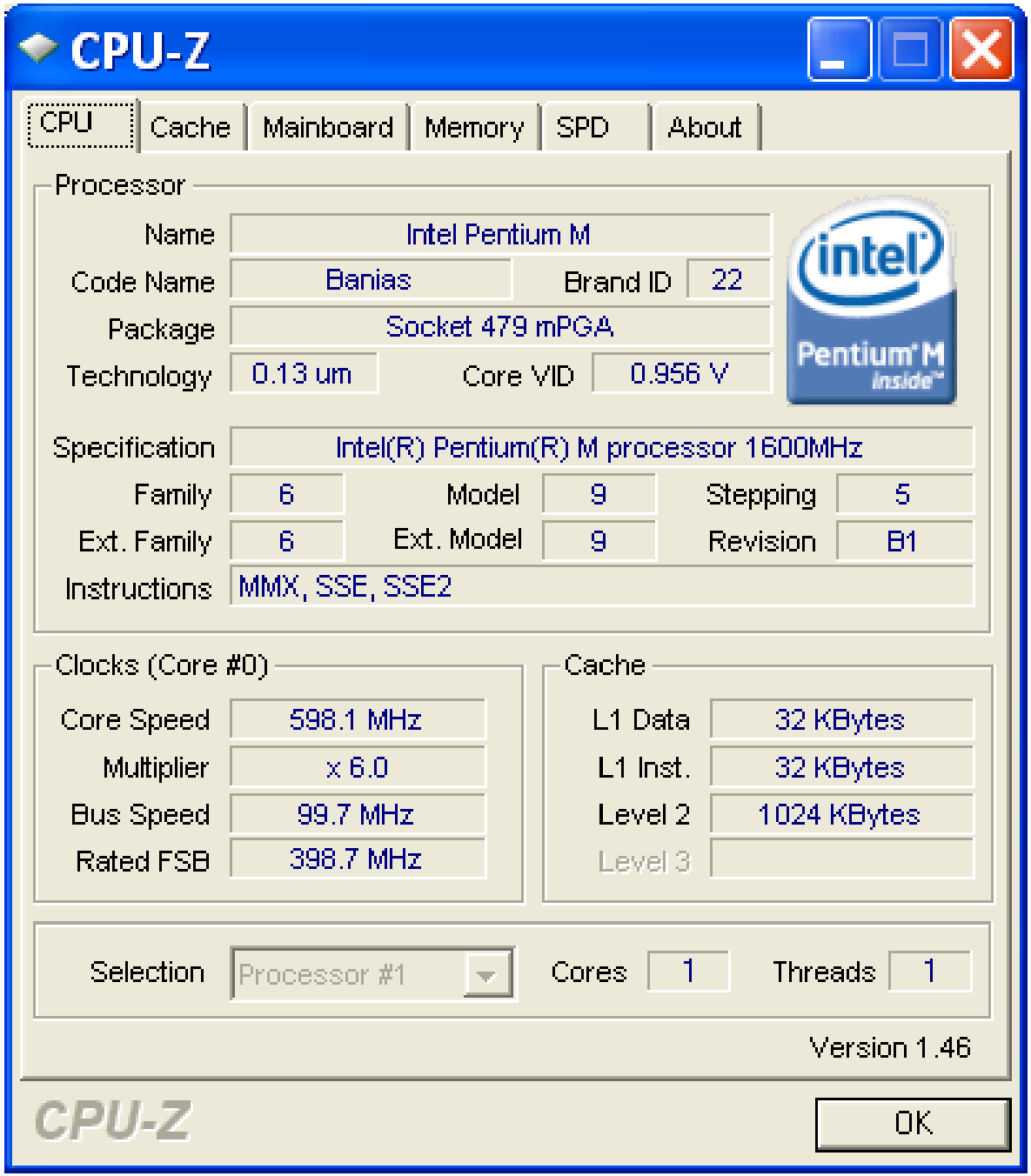
CPU = Pentium M @ 1.6 GHz (single-core Intel Pentium M processor)

Memory = 0.5 GB of RAM

OS = Windows XP

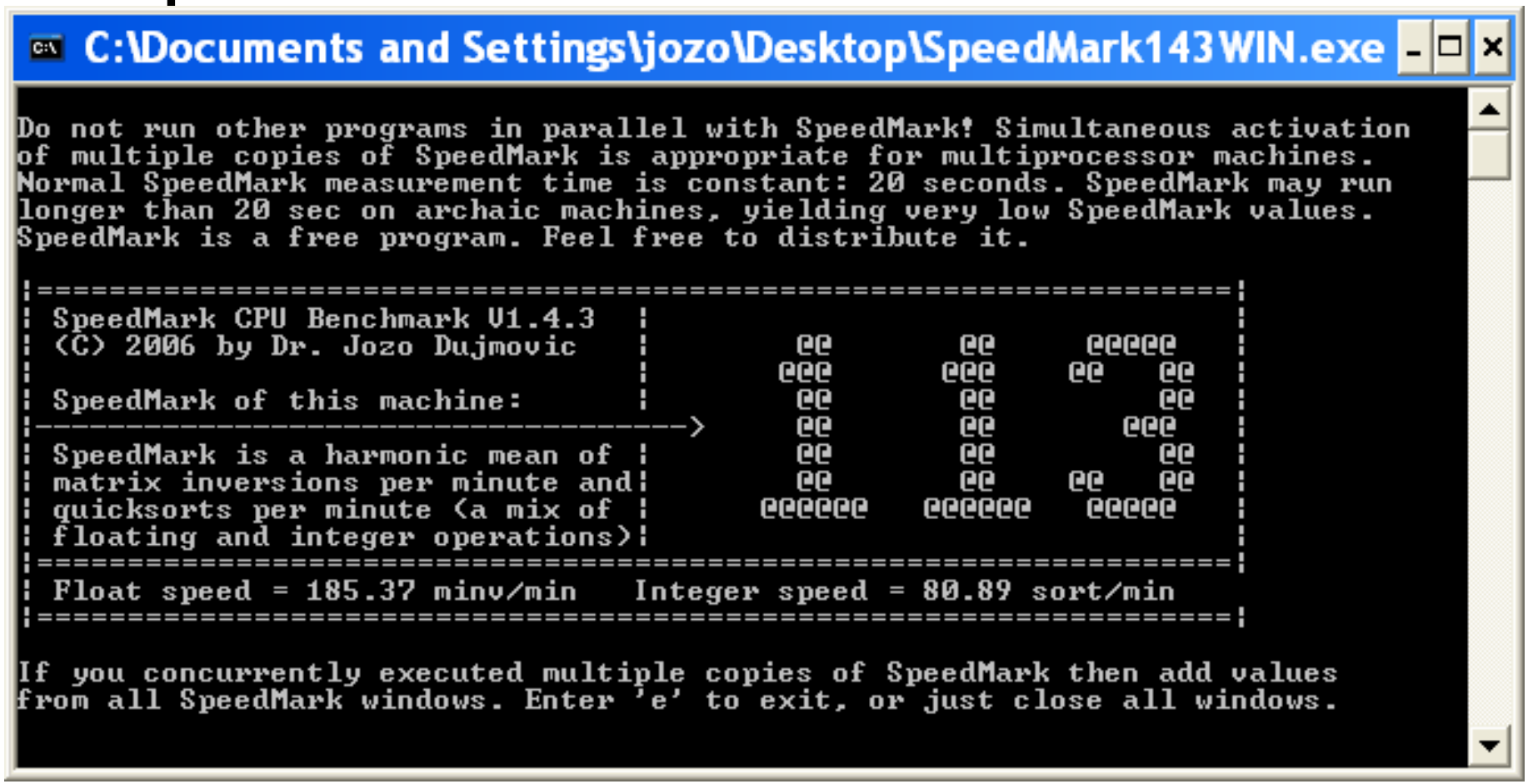
Compiler = MS Visual C++ 6.0 Release version

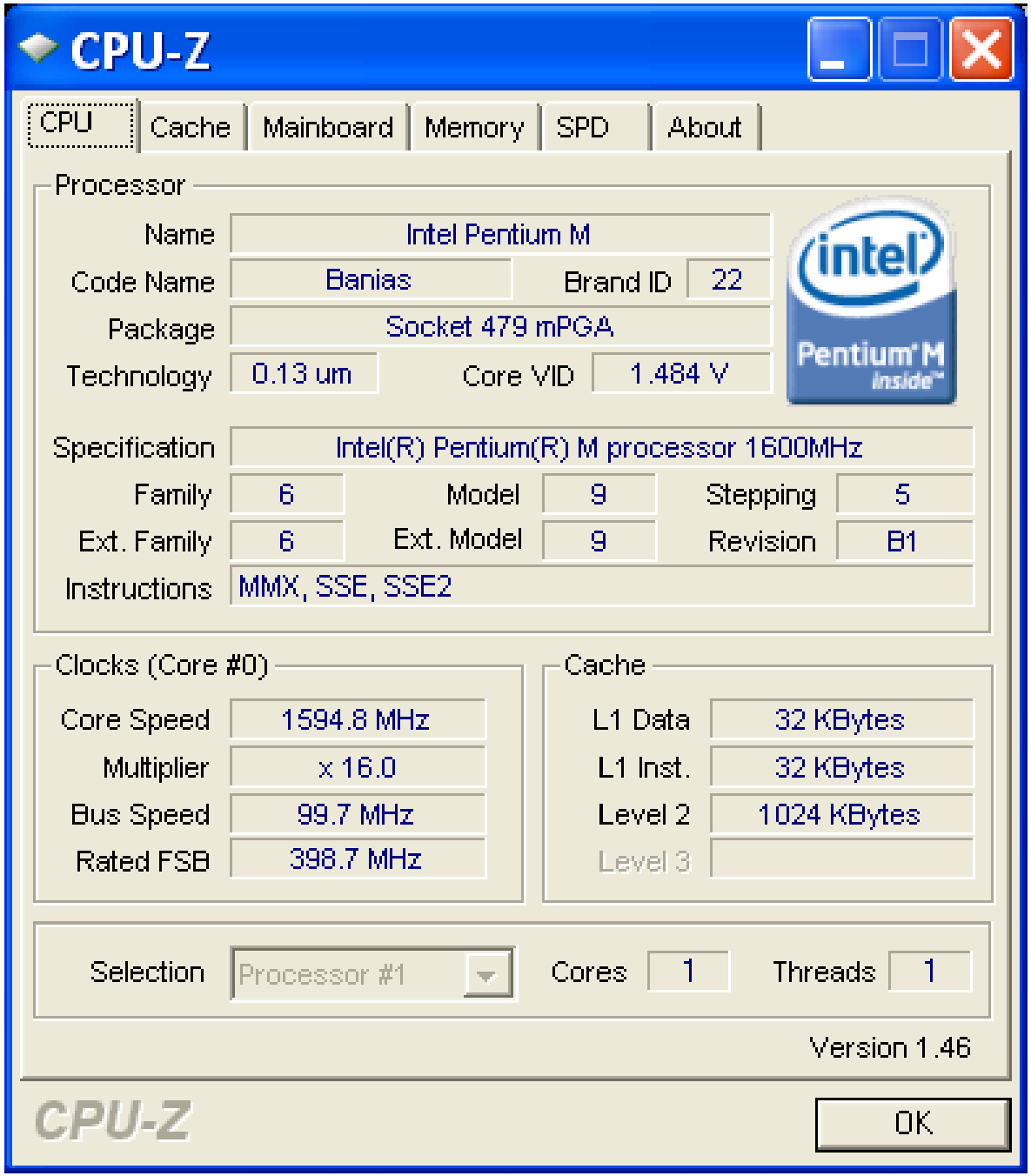
IBM T41 laptop system properties



Pentium M in power saving battery mode runs at the reduced core speed of 598 MHz

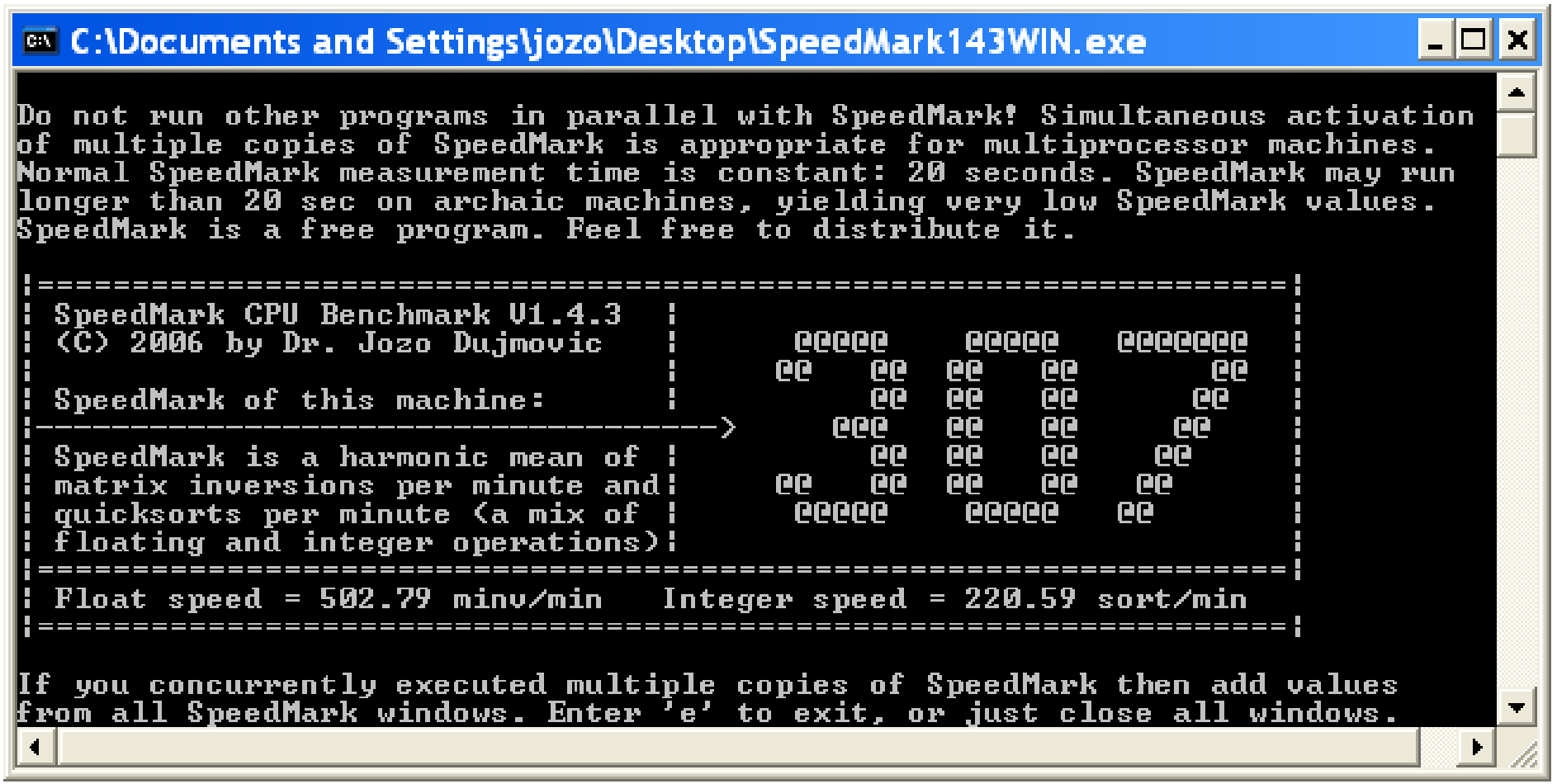
SpeedMark in the 598 MHz mode





Pentium M in the full speed mode runs at the core speed of 1595 MHz

SpeedMark for IBM T41 (Execution of SM Benchmark)

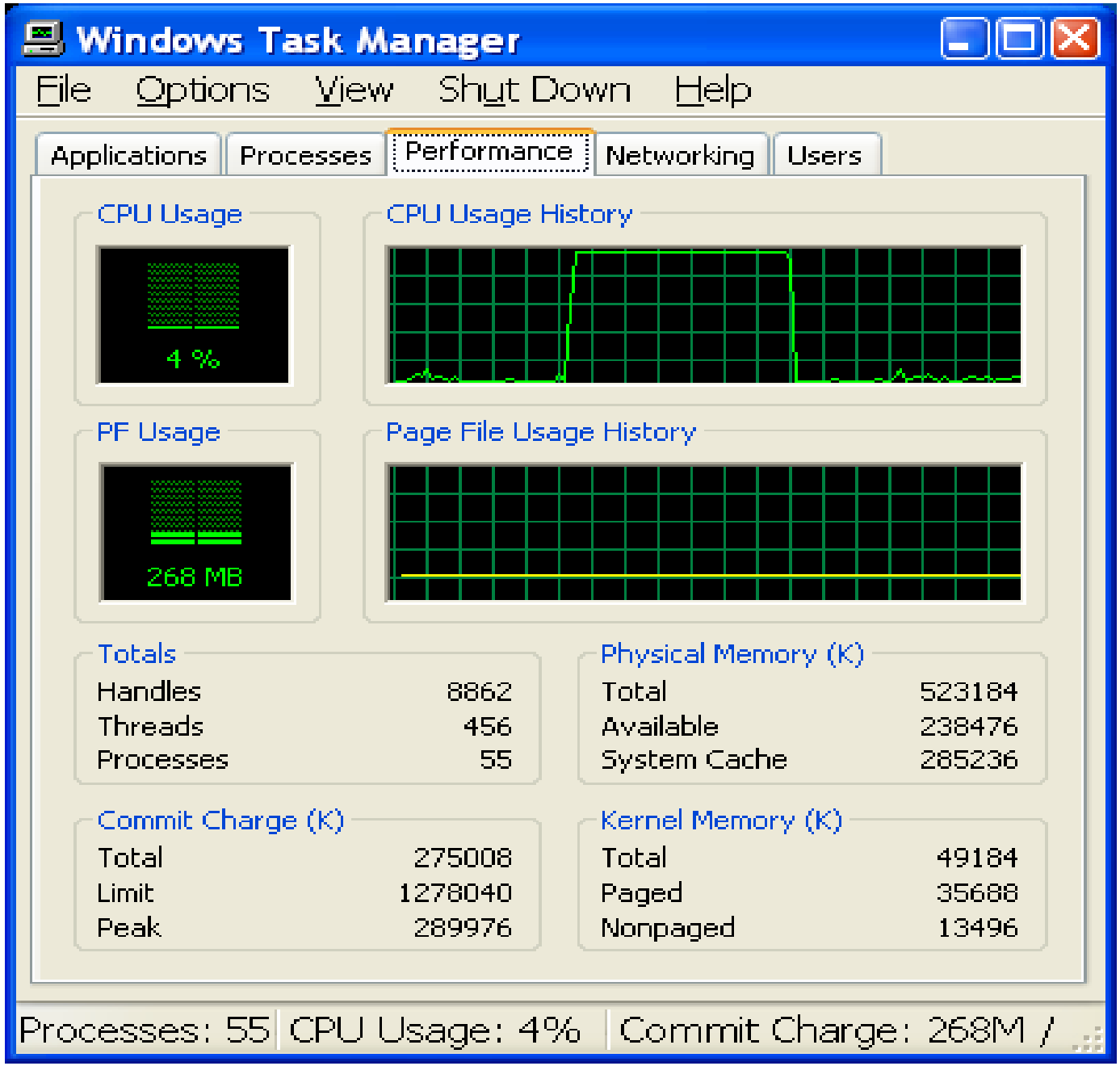


SpeedMark and clock ratios

- SpeedMark: 307/113 = 2.72
- Clock (MHz): 1595/598 = 2.67
- Difference in ratios is less than 2% indicating that SpeedMark is predominantly affected by clock rate

Processor Utilization During the Execution of SM on IBM T41

Processor utilization during the execution of a single SpeedMark benchmark is 100%.



Parallel Execution of 2 SM's on IBM T41

Computer = IBM T41

CPU = Pentium M @ 1.6 GHz, 512 MB of RAM

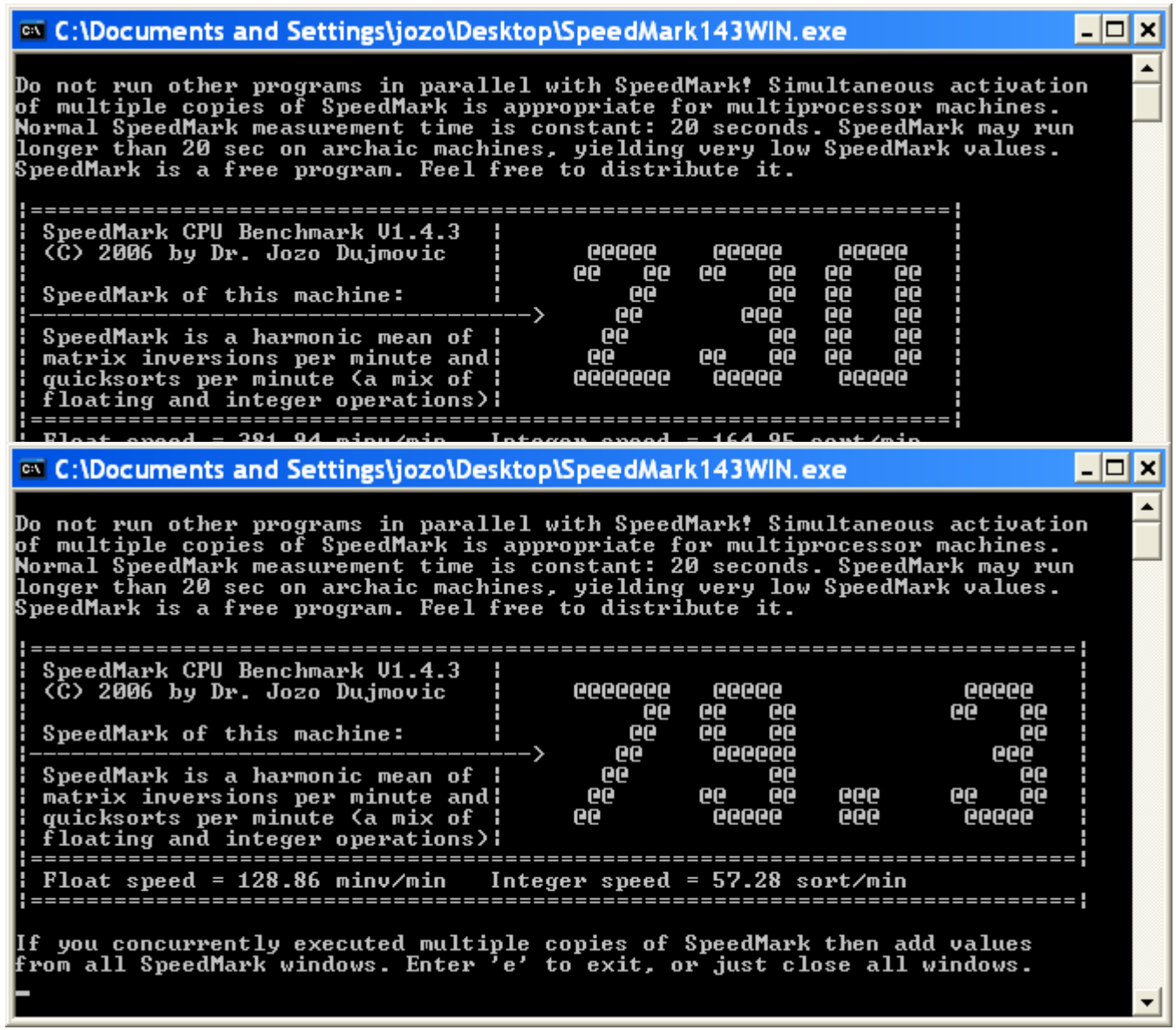
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 2

Program priorities: imbalanced (active window and inactive window)

Total SpeedMark for this machine:
∑ = 309.3 ops/min



Parallel Execution of 2 SM's on IBM T41

Computer = IBM T41

CPU = Pentium M @ 1.6 GHz, 512 MB of RAM

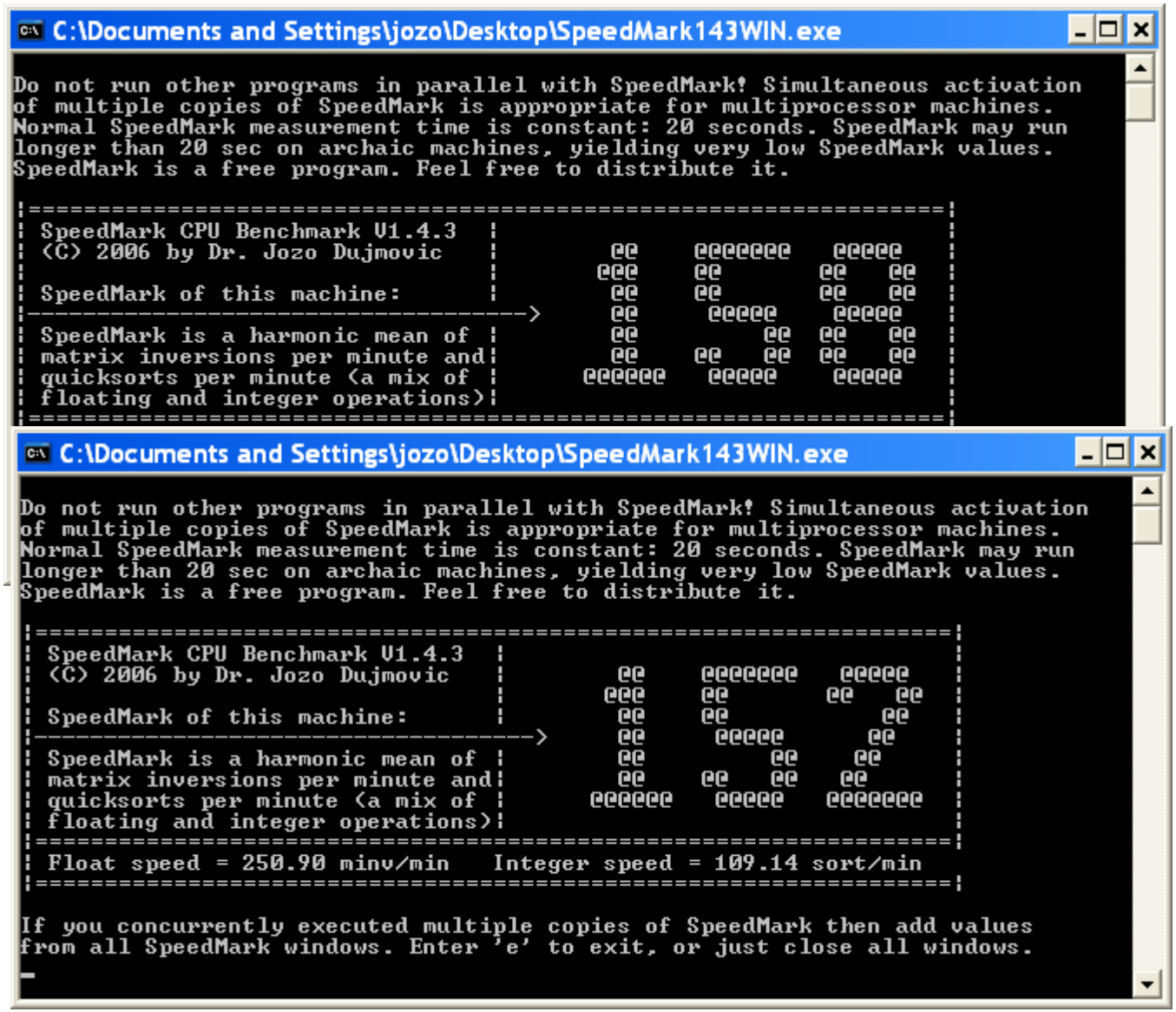
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version

Number of concurrent SpeedMarks = 2

Program priorities: balanced (two inactive windows)

Total SpeedMark for this machine:
∑ = 310 ops/min



Dell XPS 400 Desktop System

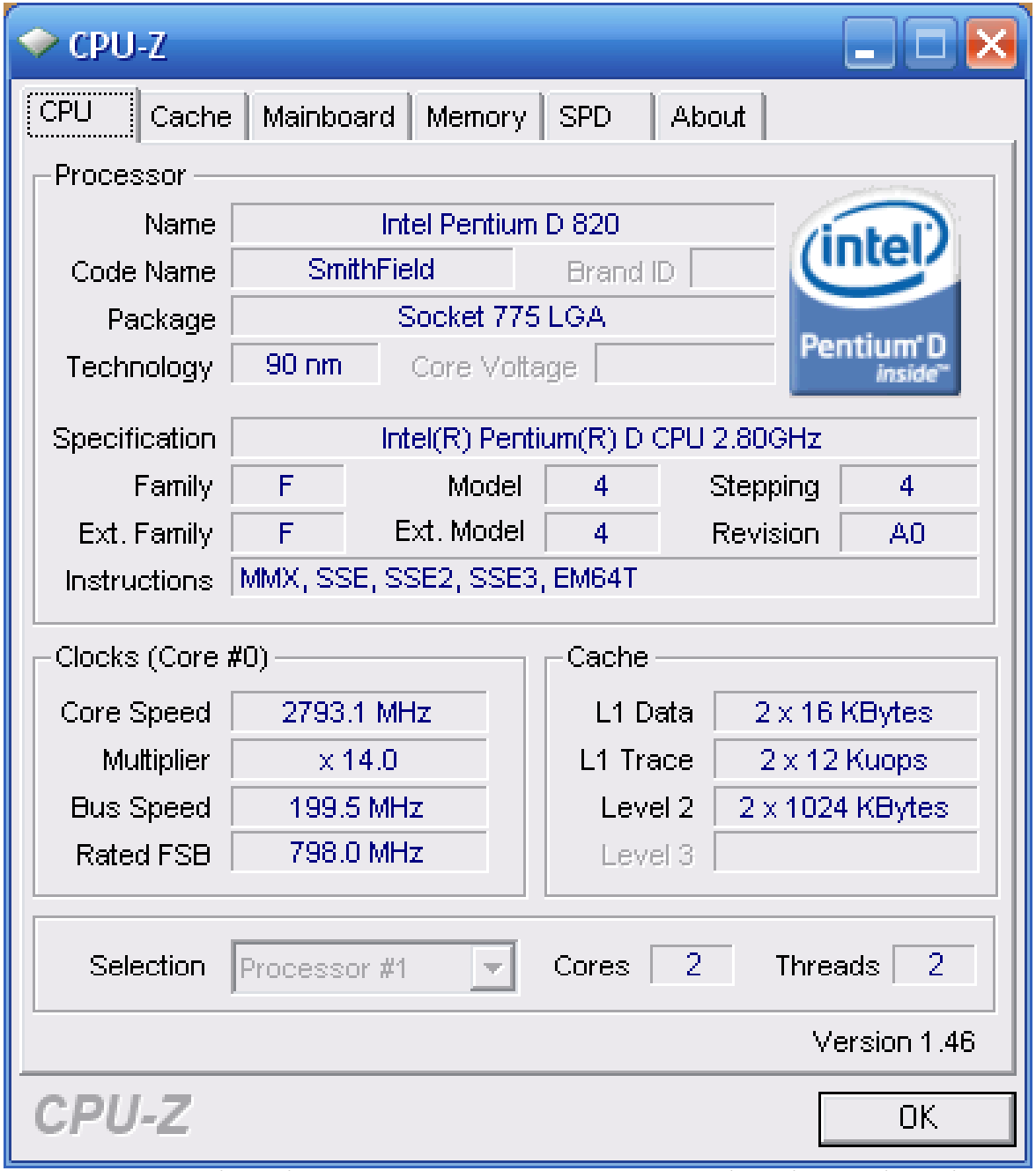
Computer = Dell XPS 400 Desktop

CPU = Pentium D @ 2.8 GHz (dual-core processor = two processors sharing the same interface with the chipset and memory)

Memory = 1 GB of RAM

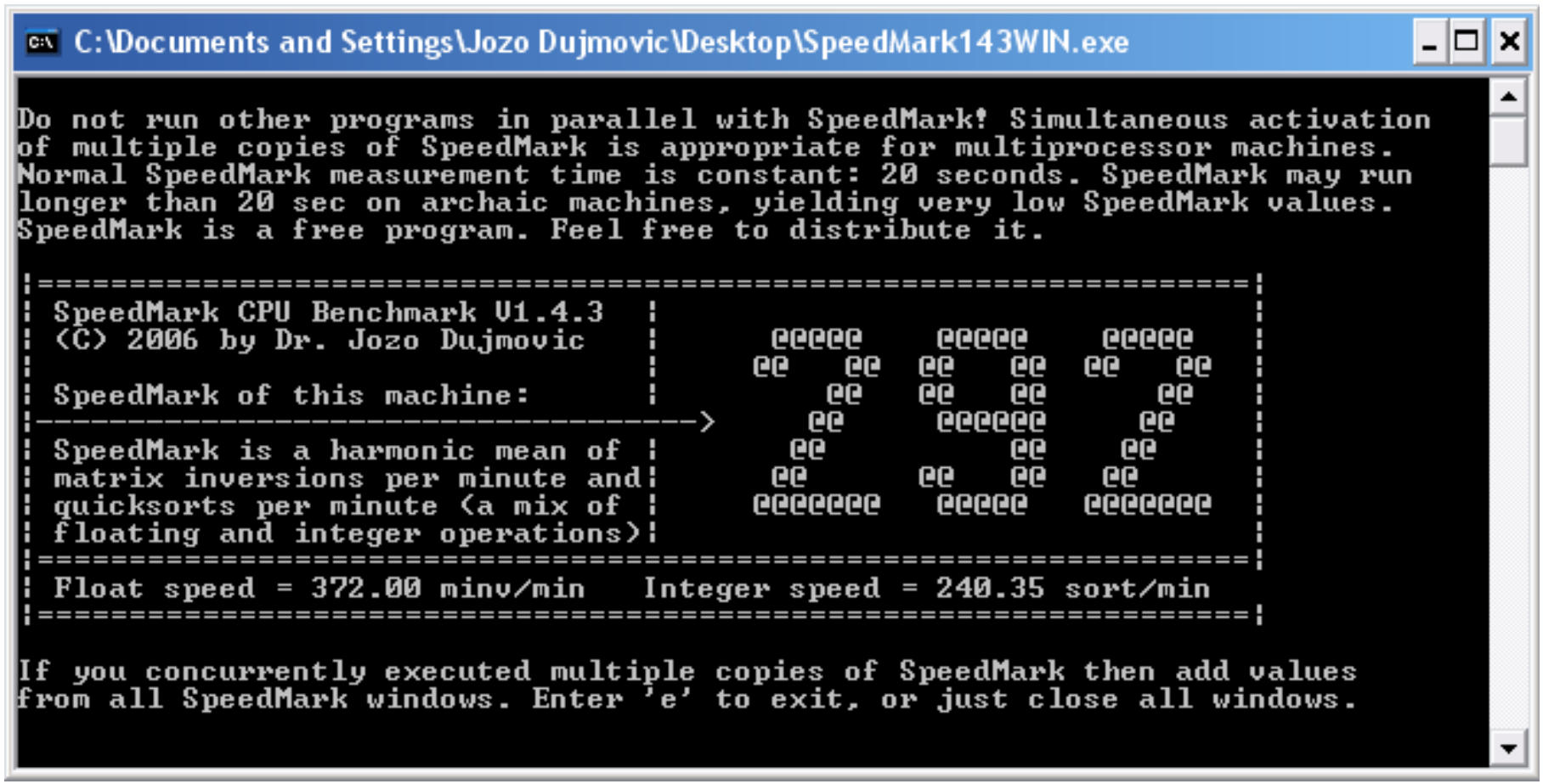
OS = Windows XP

Compiler = MS Visual C++ 6.0 Release version



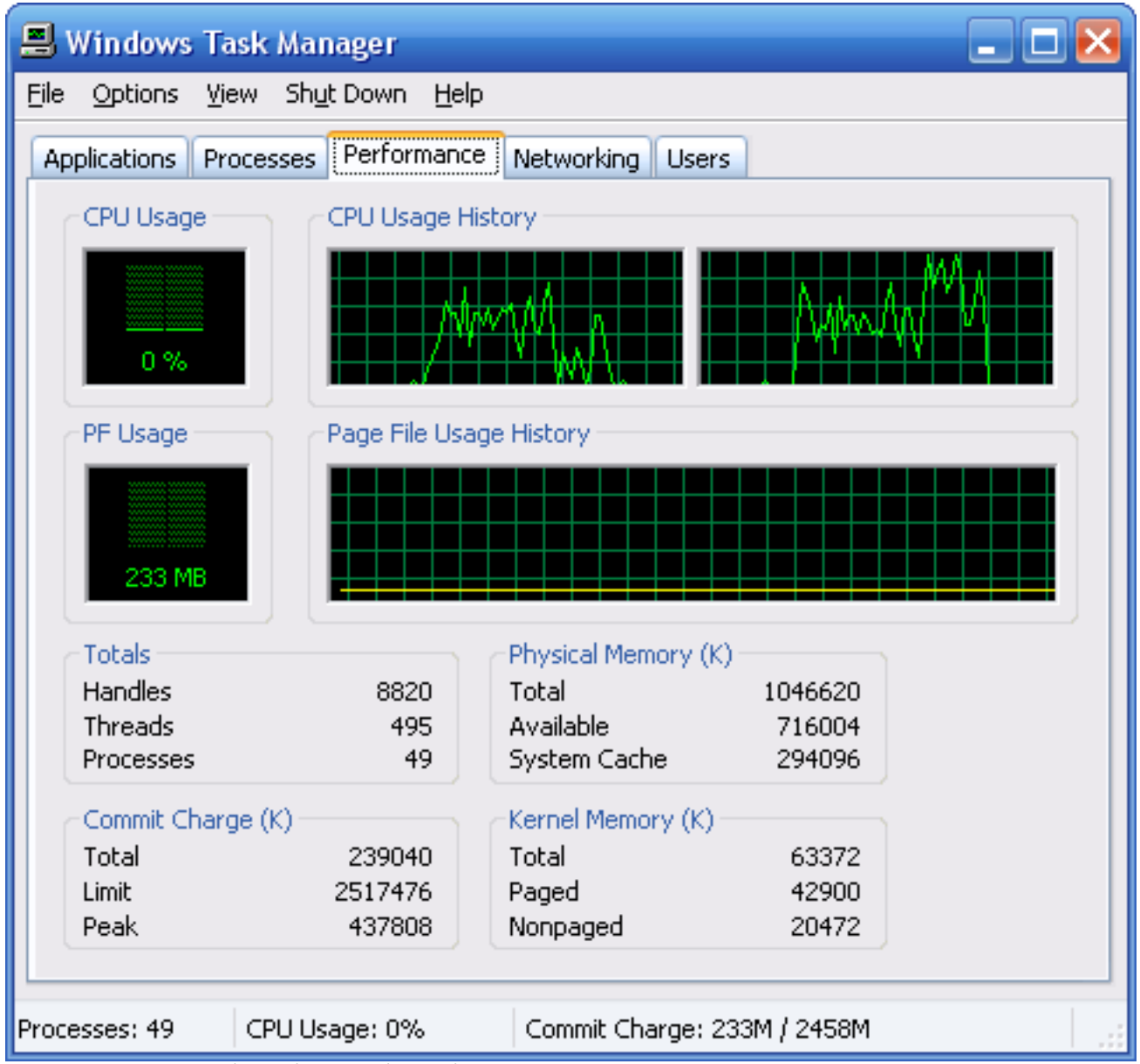
Properties of Dell XPS400

SpeedMark for Dell XPS400



Processor Utilization During the Execution of SM on XPS400

XPS400 has two processors and they share the SM workload. The average utilization of each processor is 50%.



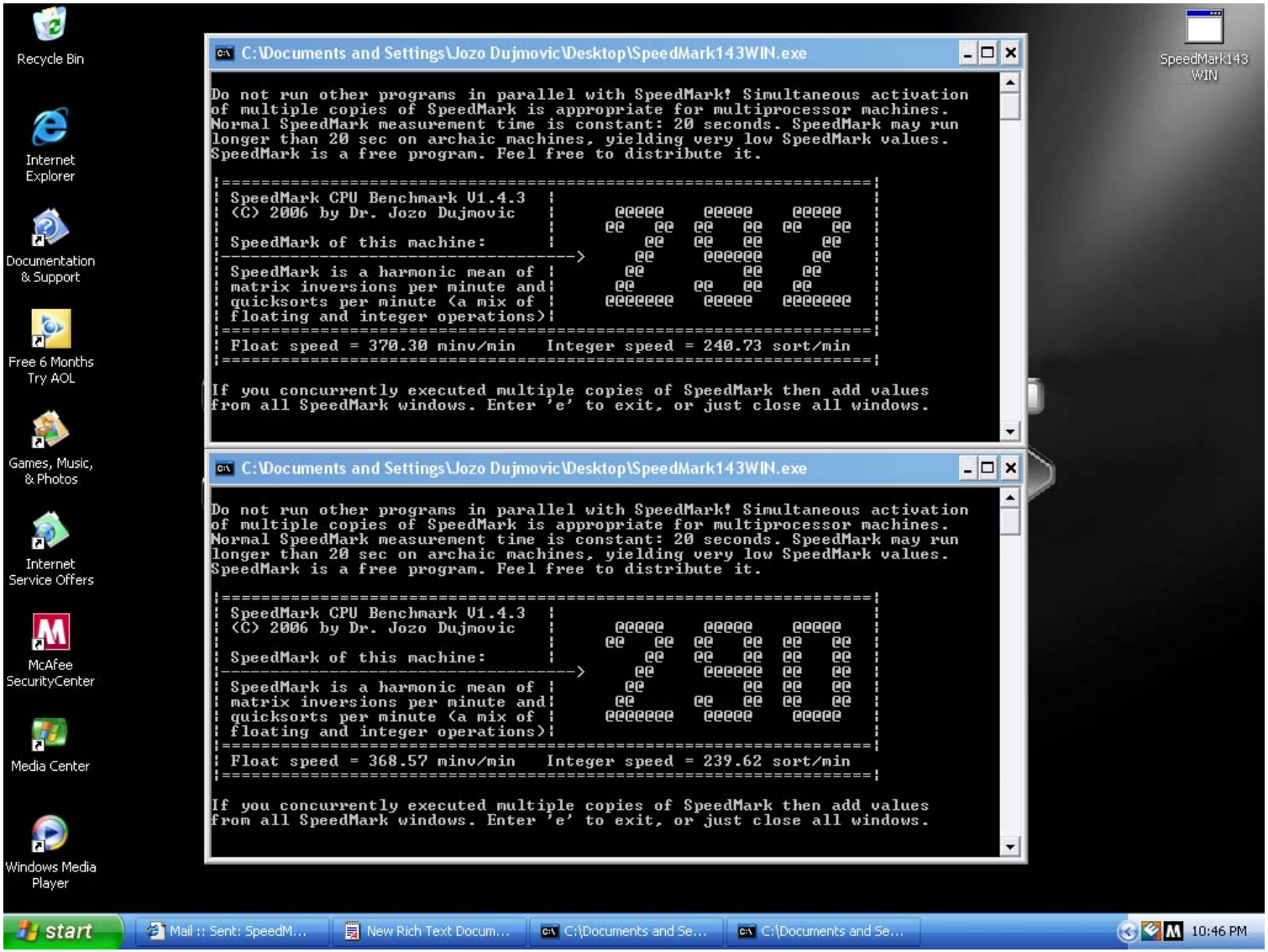
Parallel Execution of 2 SM's on XPS400

SpeedMark remains constant!

Each processor executes one ST.

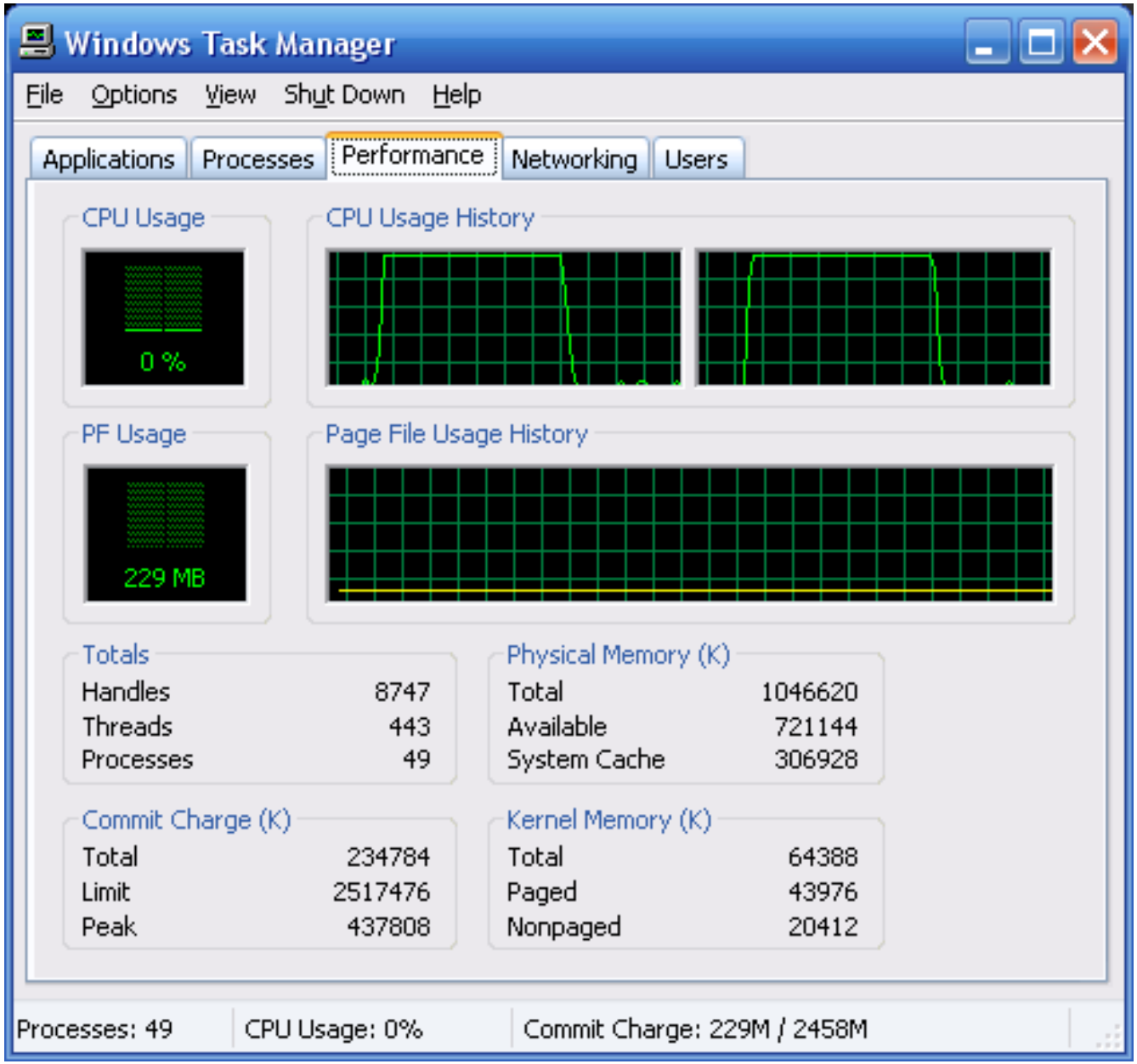
Two processors double the processor power:

Σ = 582



CP Utilization During the Execution of 2 SM's on XPS400

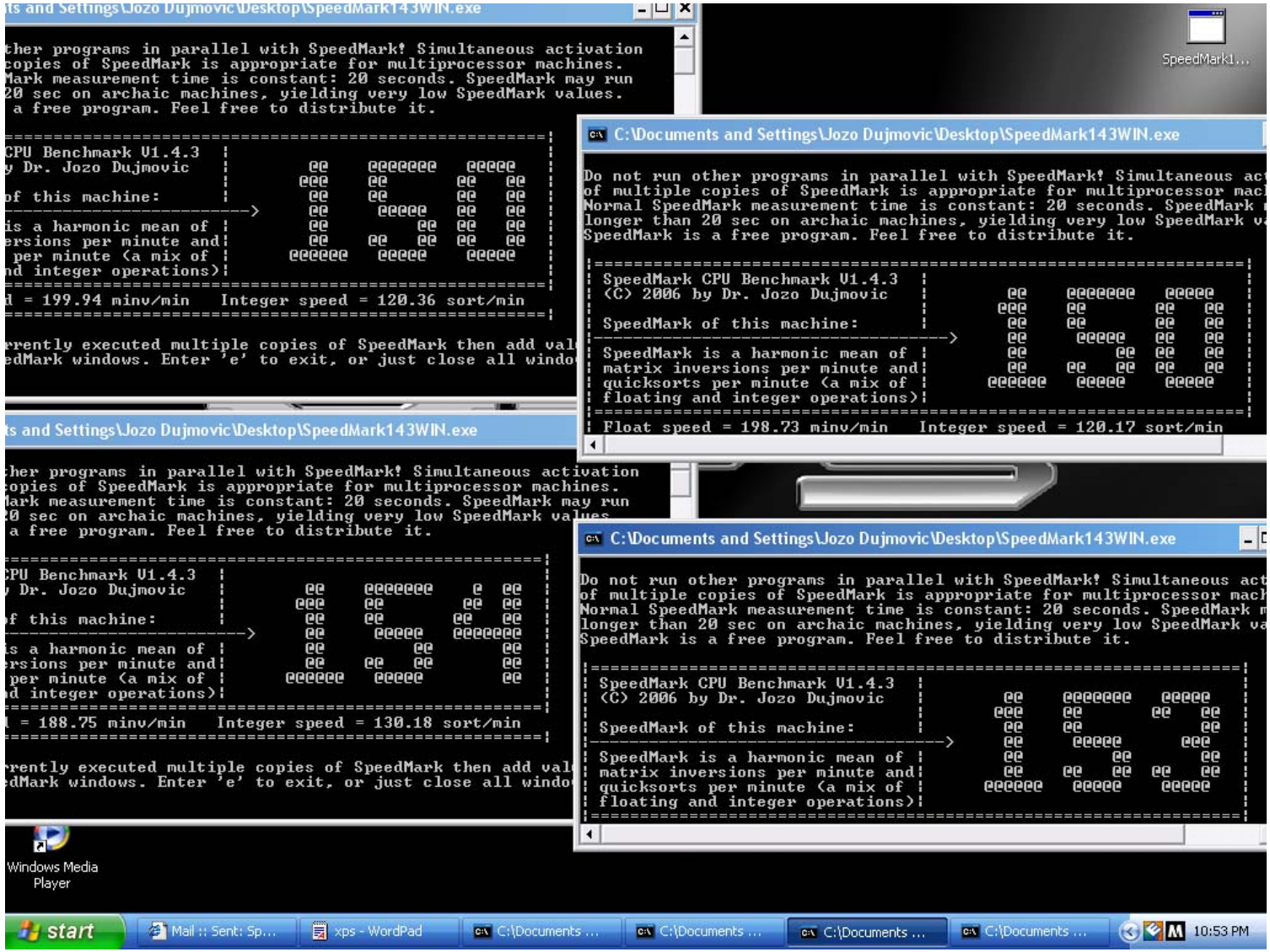
Utilization of each processor during the execution of 2 SM benchmarks is 100%.



Jozo Dujmović

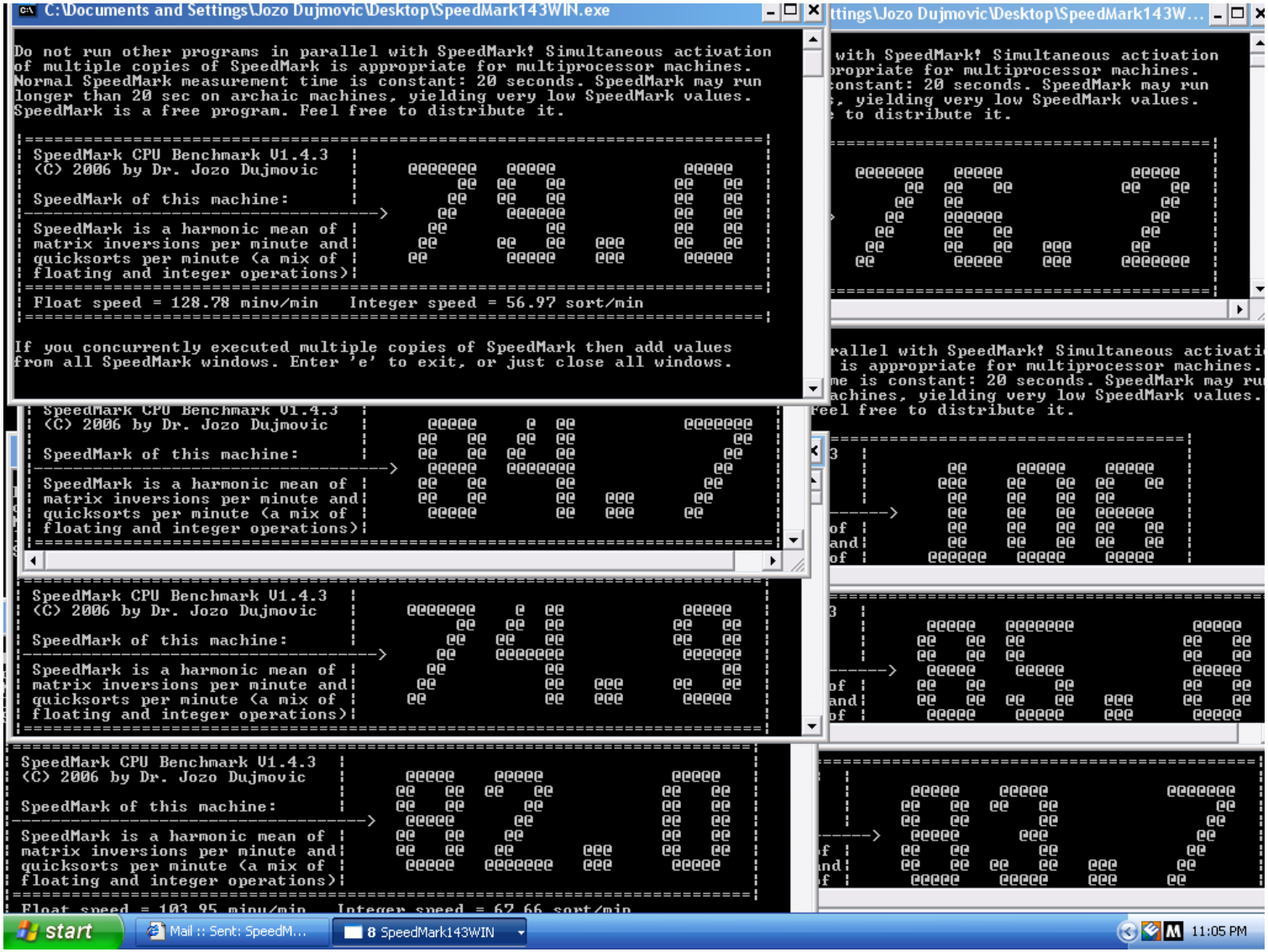
Parallel Execution of 4 SM's on XPS400

$\Sigma = 607$



Parallel Execution of 8 SM's on XPS400

$\Sigma = 672$



Total speed

Total speed is the sum of individual SM indicators. In the case of XPS400, the total speed is an increasing function of the number of simultaneous SM copies:

SM copies:	1	2	4	8
Sum	292	582	607	672

T41 Laptop vs. XPS 400 Desktop

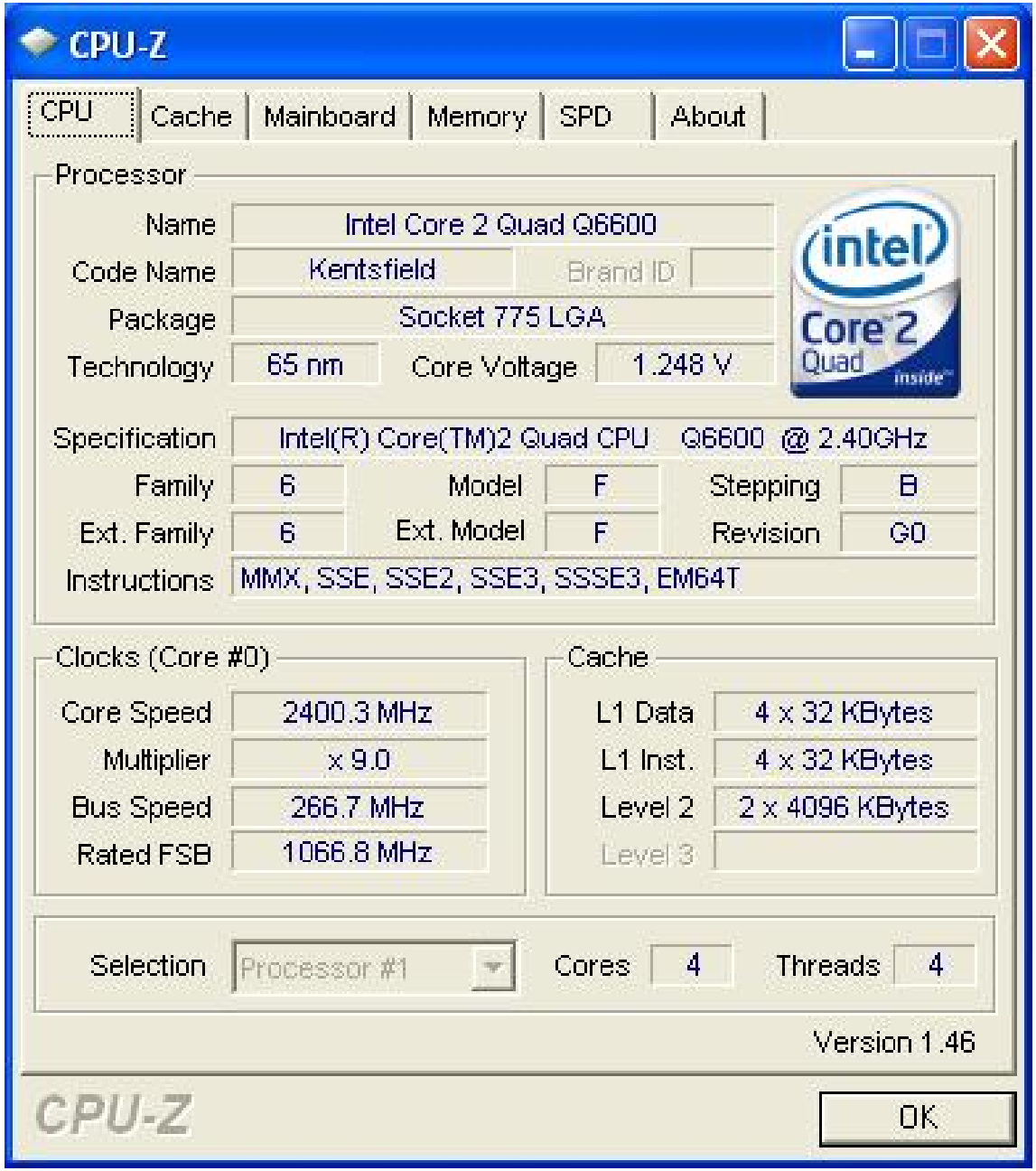
- T41 has a faster processor: SM = 307 vs. 292
- 307/292 = SM ratio ≠ clock ratio = 1595/2793
- XPS 400 has two processors: 2*292=584
- 584/307=1.9 ≈ 1.75=2793/1595
- T41 has faster response time in the case of executing a single program
- XPS 400 has higher throughput and more power for multitasking
- T41 is smaller and lighter
- XPS 400 is less expensive (~ two times)

Using SpeedMark for benchmarking a desktop computer based on a 4-core Intel Q6600 processor

Benchmarking Intel Q6600 processor

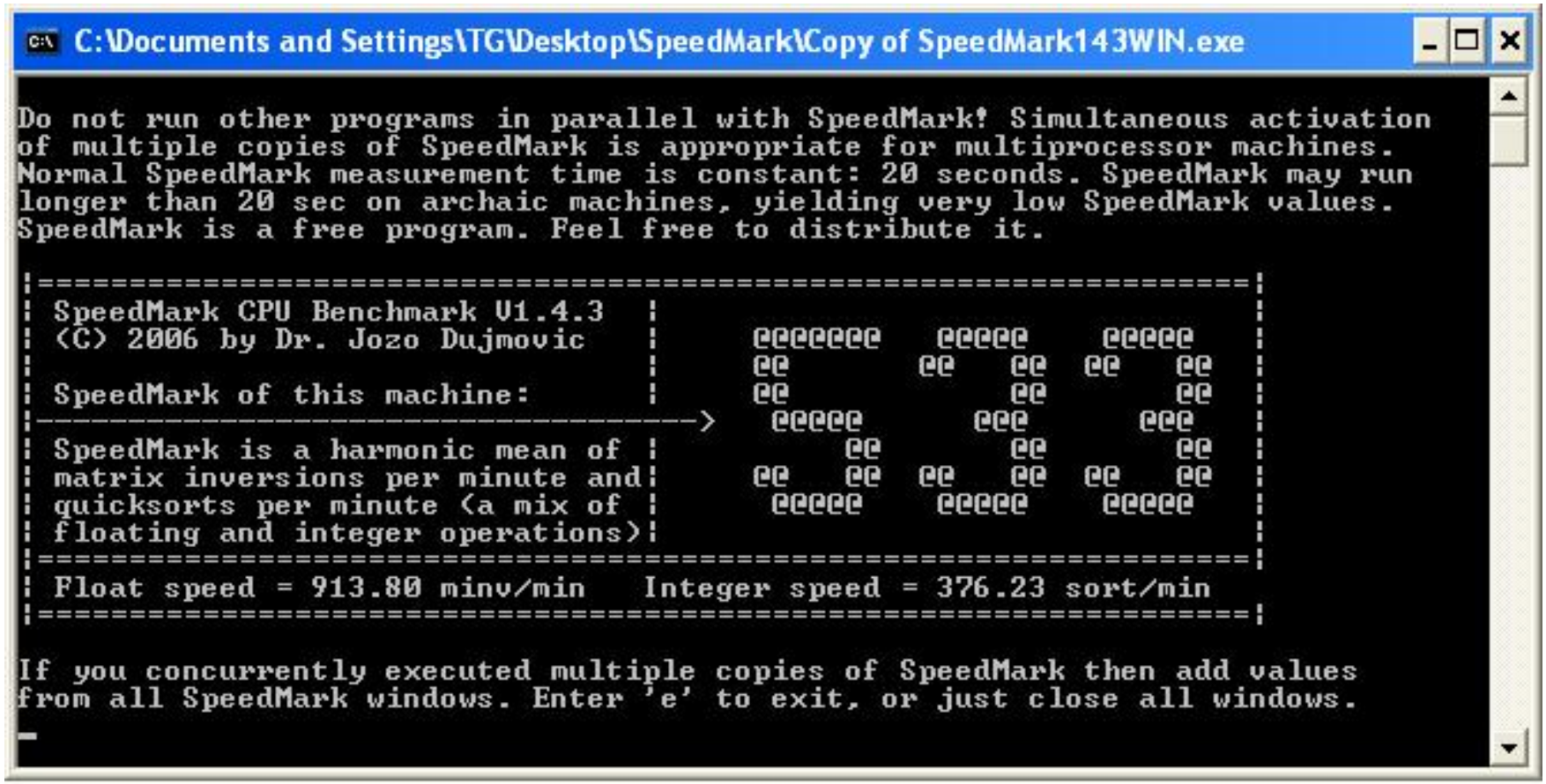
- This processor has C=4 cores
- N = number of SM benchmarks executed in parallel
- U = average processor utilization
- U = 100 min(1, N/C) [%]

N:	1	2	3	4	5	6
U[%]:	25	50	75	100	100	100

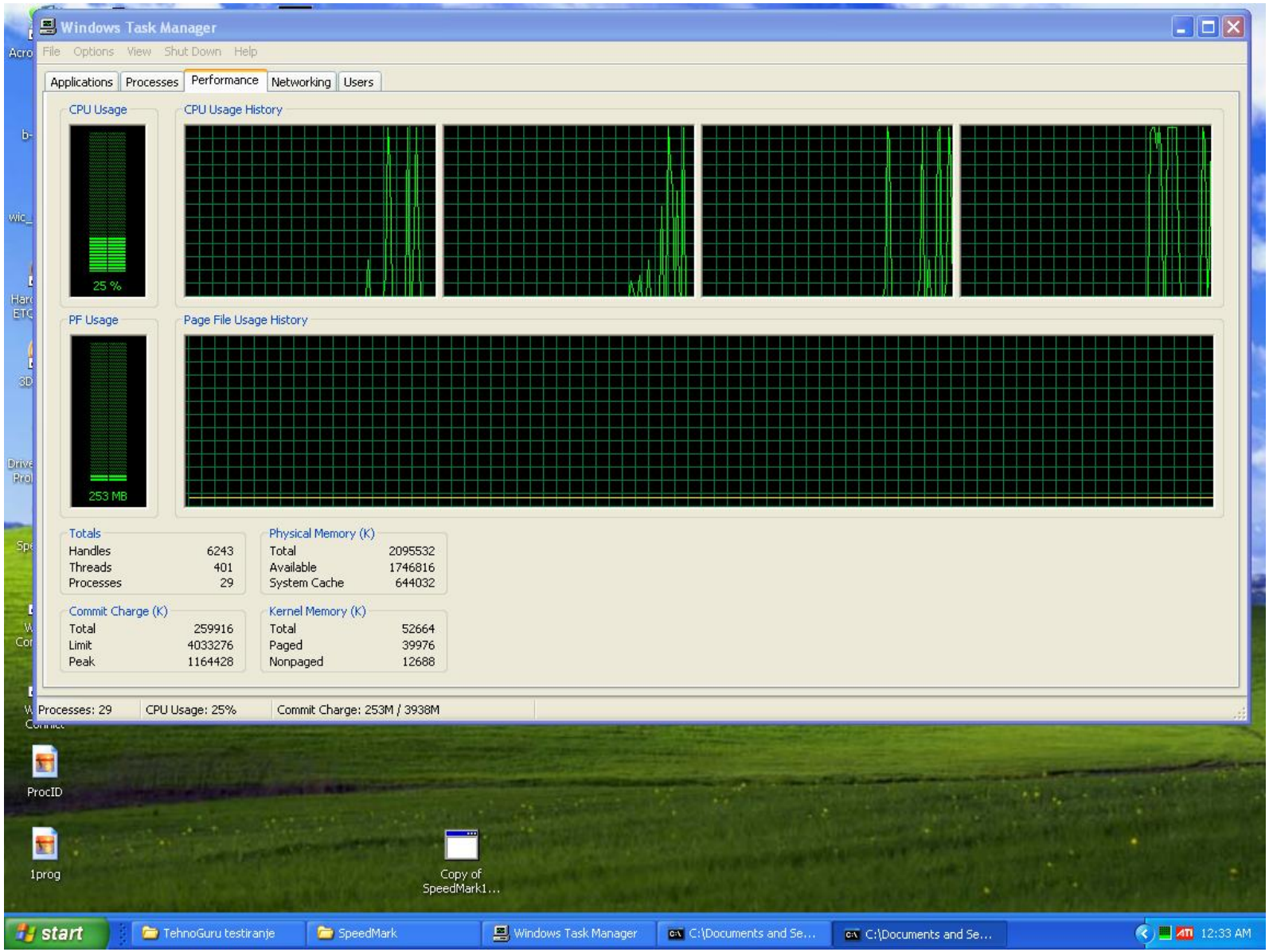


Characteristics of the analyzed Q6600 system

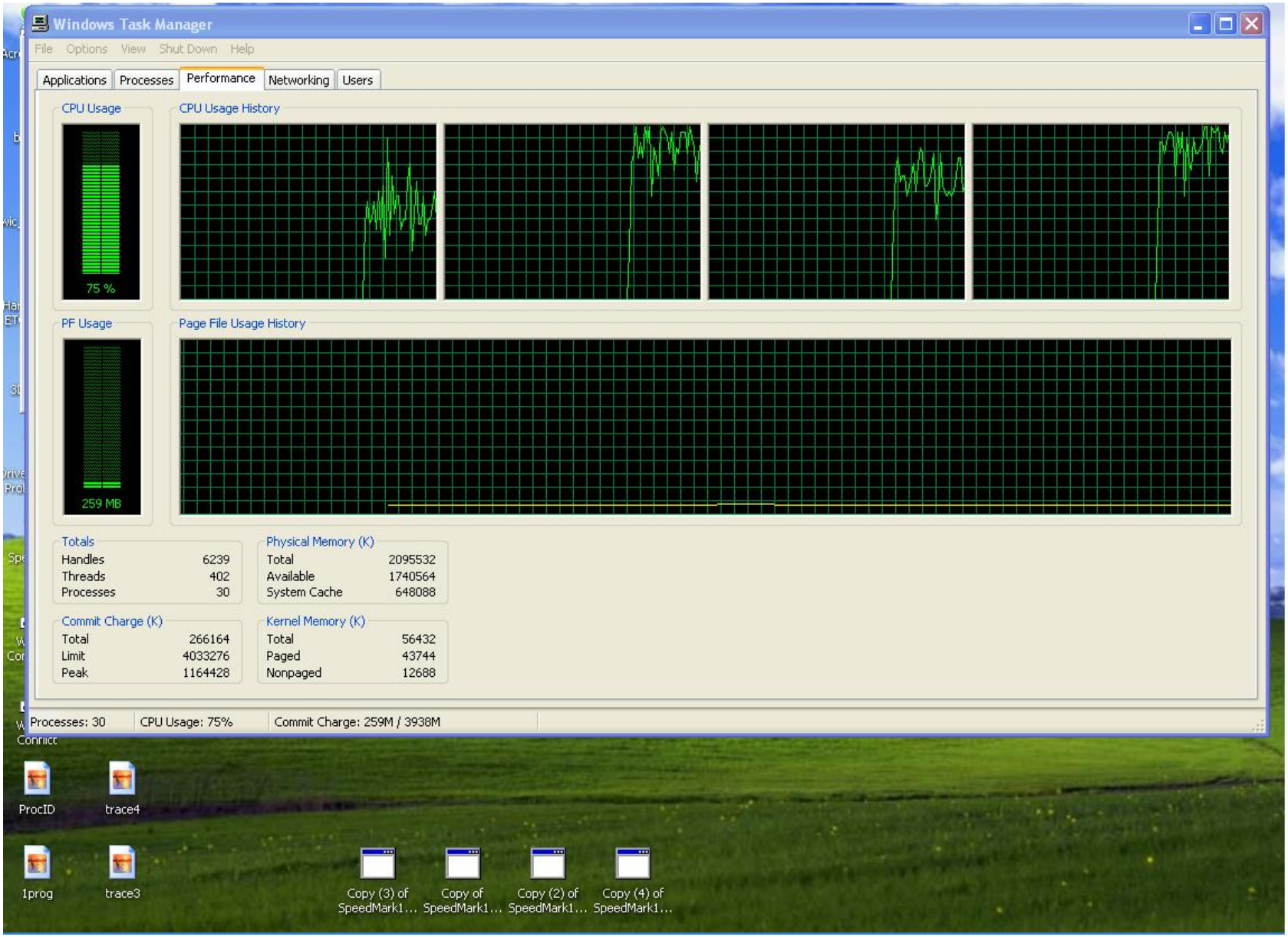
Execution of SM using Intel Q6600 Processor



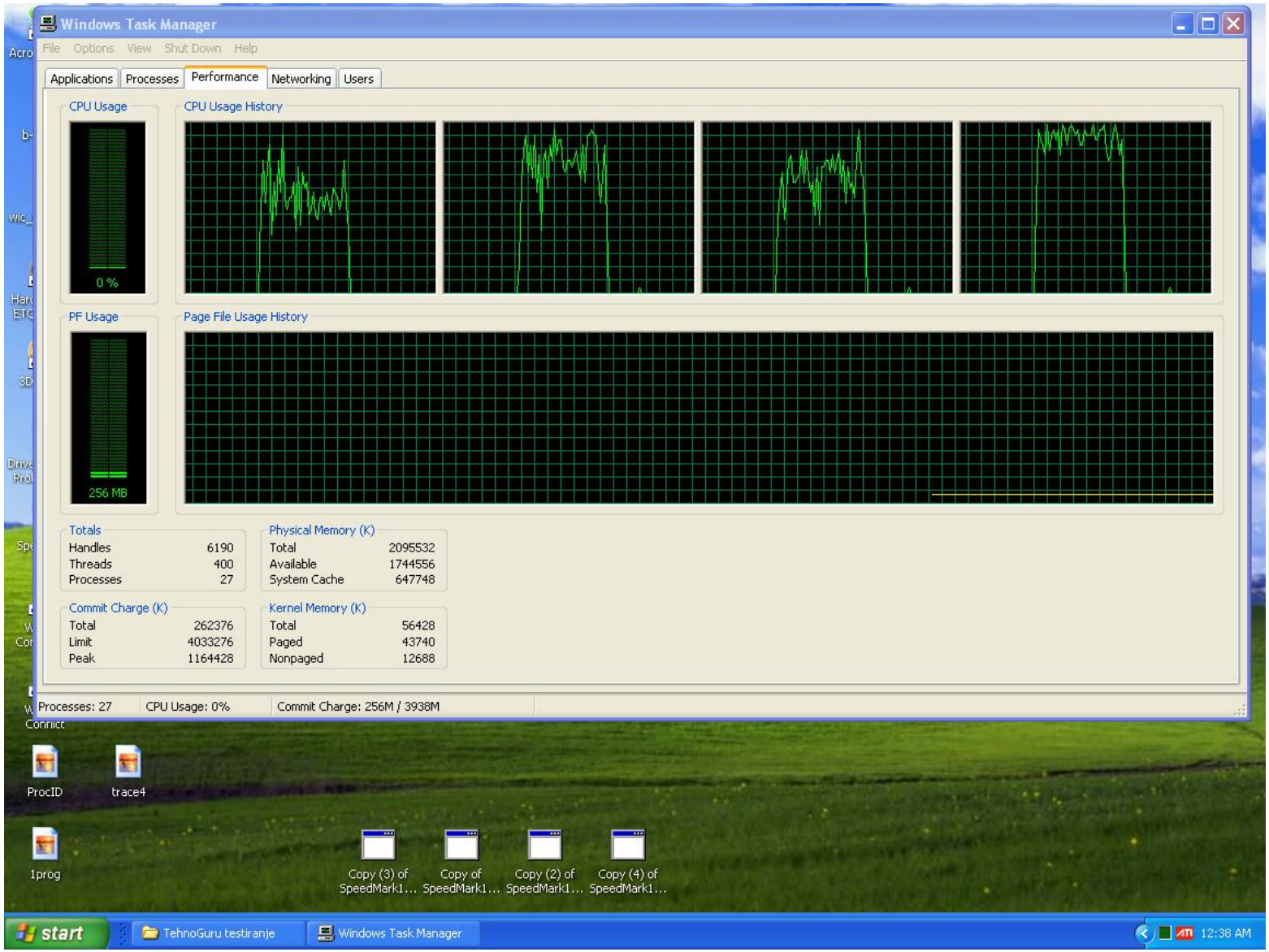
Execution of 1 copy of SM ; U=25%



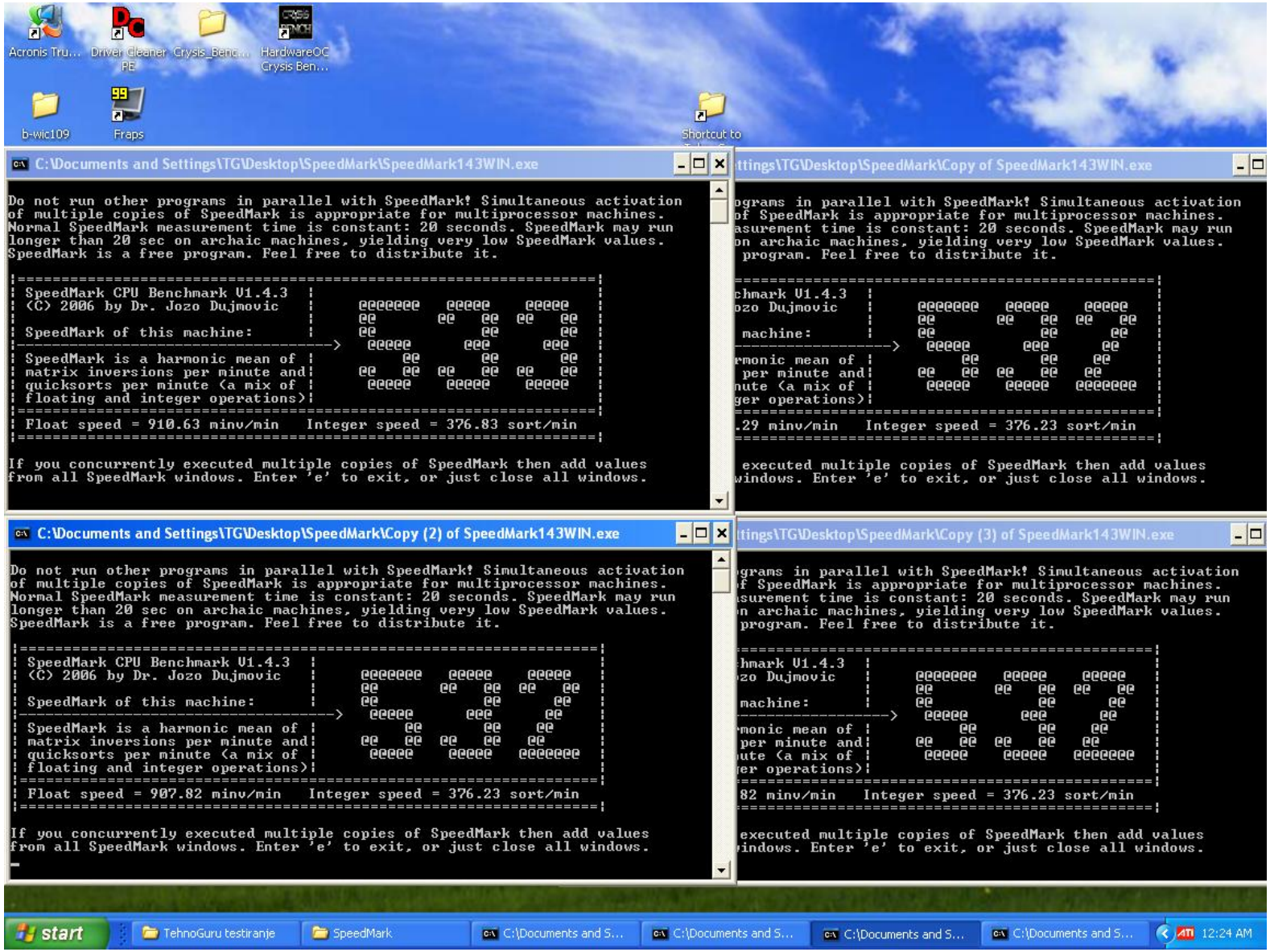
Execution of 3 copies of SM; U=75%



Execution of 3 copies of SM



Execution of 4 copies of SM; Total speed = 2129



Execution of 4 copies of SM ; U=100%