



# **Comparison of processors using SpeedMark benchmark**

## **Processors:**

**Intel Pentium 4**

**AMD Phenom**

**Intel Core i5**

**Jozo Dujmović**

# SpeedMark

- SpeedMark = benchmark program for measurement of CPU speed
- SMop = SpeedMark operation defined as a mix of 50% floating point operations (matrix inversion) and 50% integer operations (Quicksort)
- CPU speed is measured in SMops/min



# INTEL PENTIUM 4 PROCESSOR

Intel Pentium 4 CPU @ 3.2 GHz

# Basic characteristics of the analyzed Pentium 4

- Years: 2000-2008
- Clock rate 3.2 GHz
- Number of cores = 1 (2 virtual cores)
- Hyperthreading: multiple threads run at the same time on the same physical processor
- Memory = 2 GB
- Computer = IBM Think Centre
- OS = MS Win XP Professional (2002, SP 3)

# Pentium 4 processor executing 1 to 8 copies of SpeedMark benchmark

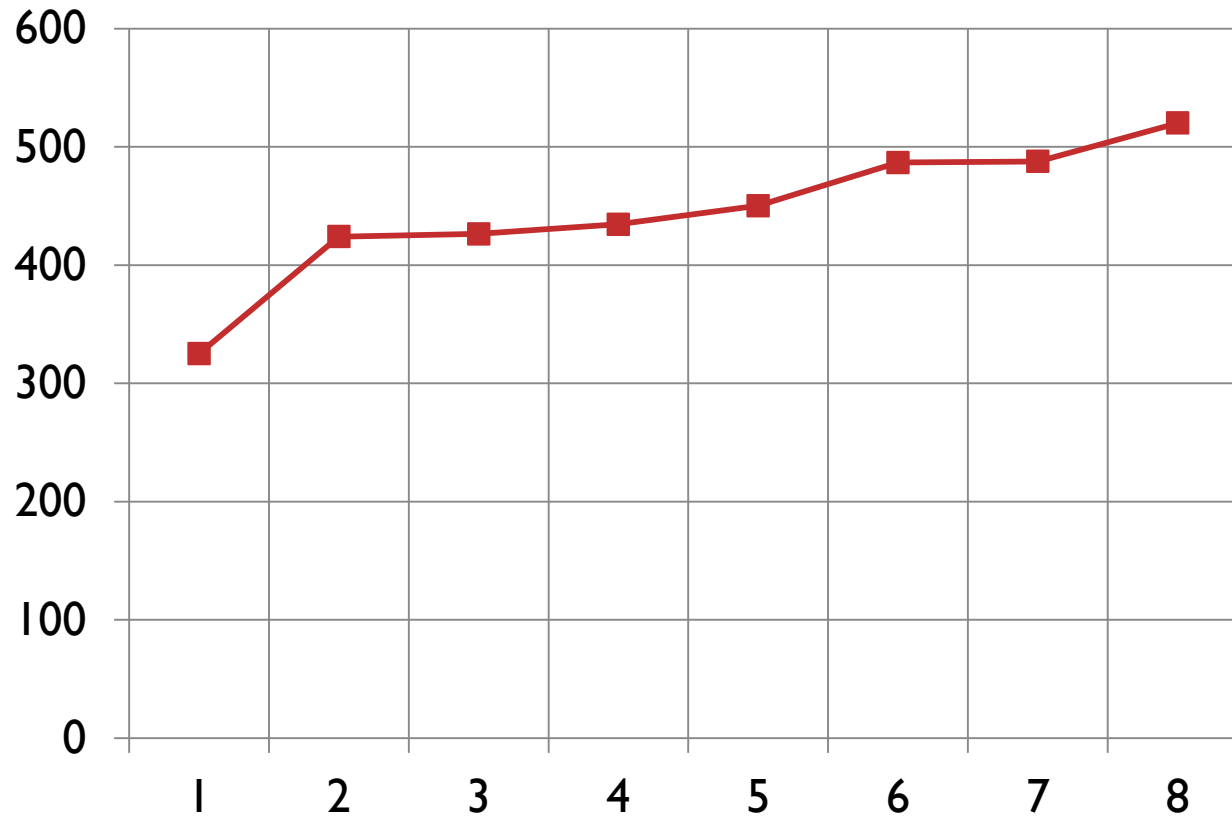
SM	1	2	3	4	5	6	7	8	$\Sigma$
1	325								325
2	215	209							424
3	167	187	72.3						426.3
4	144	104	89.5	97					434.5
5	126	92.3	75.1	84.2	72.6				450.2
6	132	85.6	68.8	67.9	68.1	64.3			486.7
7	116	61	58.7	59.5	61.1	59.6	71.7		487.6
8	119	74.4	58.3	58.3	52.3	50.3	55	52.6	520.2

$$424/325 = 1.3 < 2$$

$$V(2)/V(1) \in [1,2]$$

30% improvement obtained from hyperthreading (virtual cores)

# Intel Pentium 4 Processor



# Intel Pentium 4 Processor

- Virtual threads provide better utilization of processor resources (30%)
- For more than 3 SMs all benchmarks cannot start simultaneously; the increasing pattern is caused by late starts of last programs in all larger groups of programs
- Max SM speed  $V_{\max} \approx 425$  SMops/min
- Clock rate = 3.2 GHz
- SM parallelism ratio =  $425/3.2 = \underline{\underline{132.8}}$



# SM parallelism ratio

- Clock rate reflects the CPU speed limit without the use of parallelism (based on technology and the efficiency of cooling)
- Performance can be improved using multiple resources and their parallel use:
  - One core + hyperthreading
  - Multiple cores
- SM parallelism ratio =  
$$= (\text{Maximum SM speed}) / (\text{Clock rate})$$





# AMD PHENOM PROCESSOR

AMD Phenom II X4 955 CPU  
@ 3.2 GHz

# ZT Computer

## View basic information about your computer

### Windows edition

Windows 7 Professional

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Service Pack 1

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### System

Manufacturer: ZT SYSTEMS

Rating:  [4.1 Windows Experience Index](#)

Processor: AMD Phenom(tm) II X4 955 Processor 3.20 GHz

Installed memory (RAM): 6.00 GB (5.75 GB usable)

System type: 64-bit Operating System

Pen and Touch: No Pen or Touch Input is available for this Display

### ZT SYSTEMS support

Phone number: 888-984-8899

Website: [Online support](#)

### Computer name, domain, and workgroup settings

Computer name: ZT

Full computer name: ZT

Computer description:

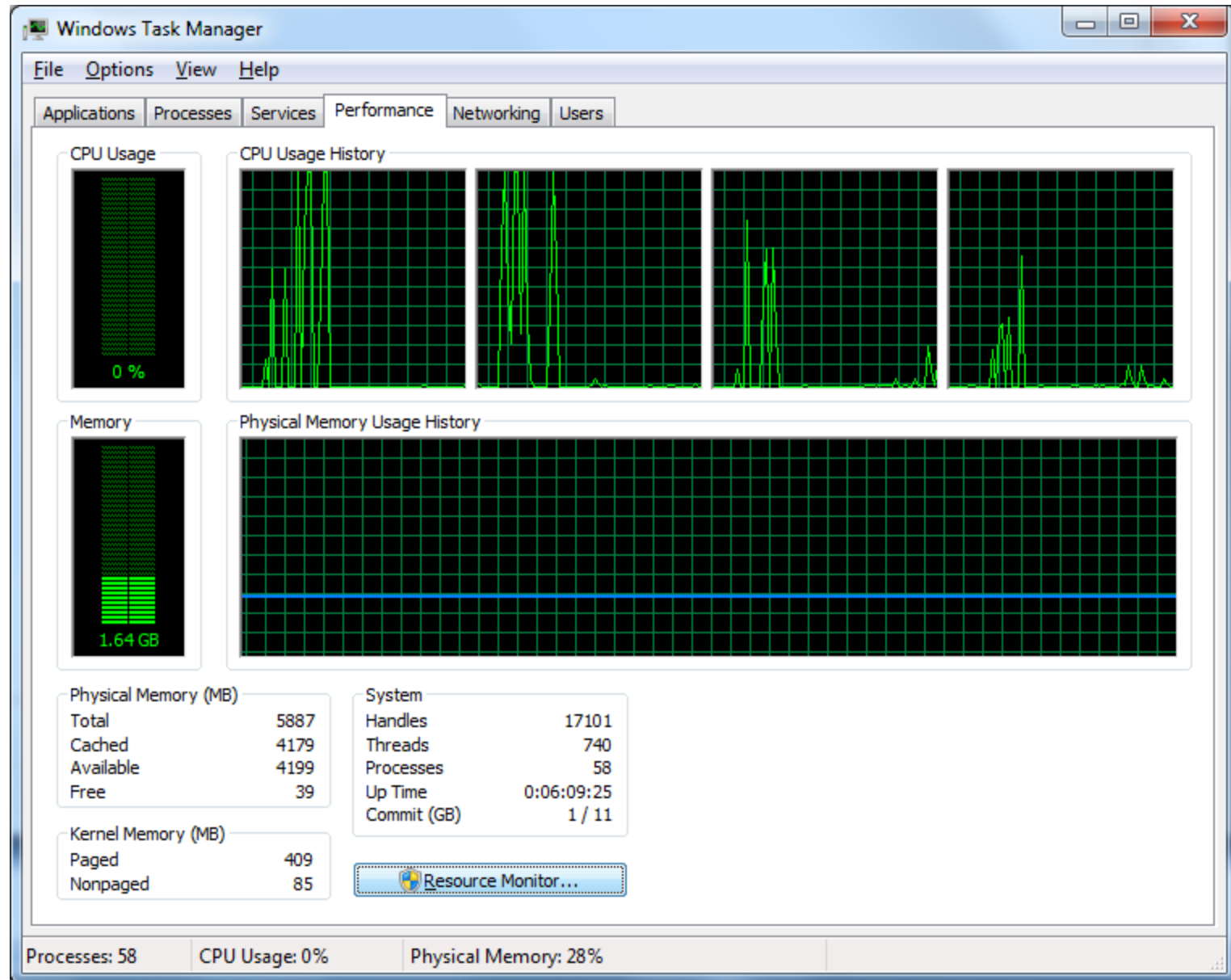
Workgroup: WORKGROUP

### Windows activation

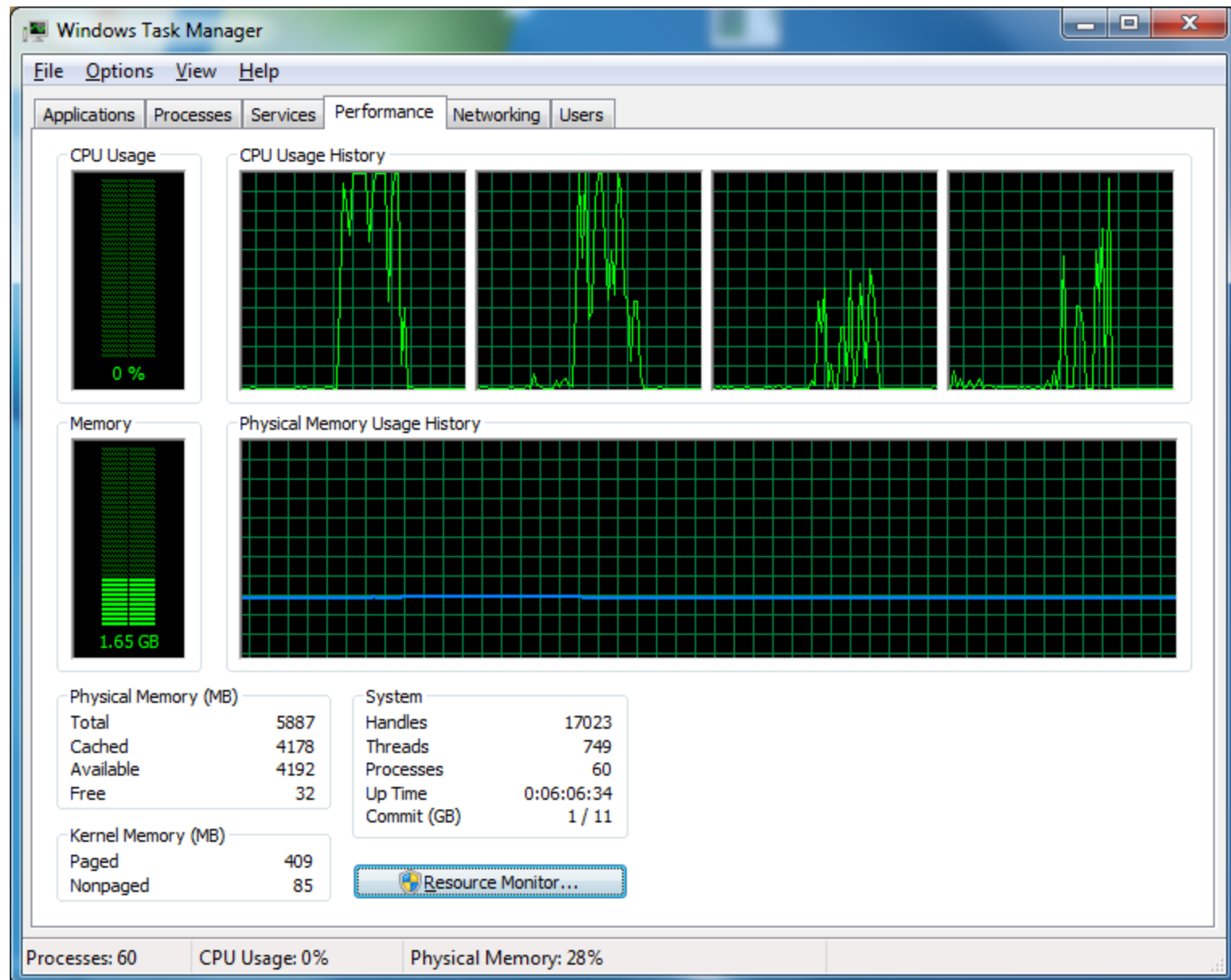
Windows is activated

Product ID: 00371-OEM-8992671-00352

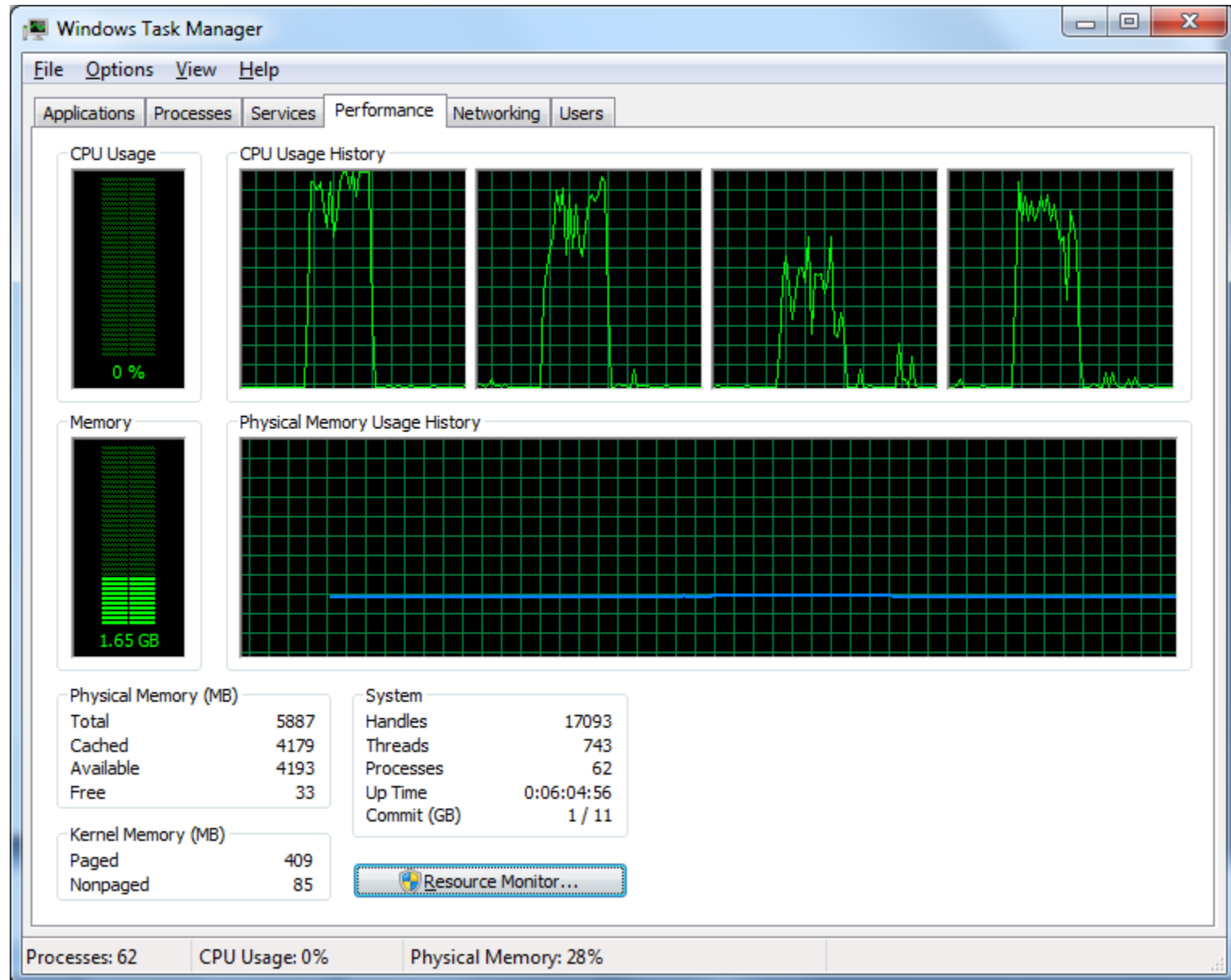
Single  
program  
U=25%



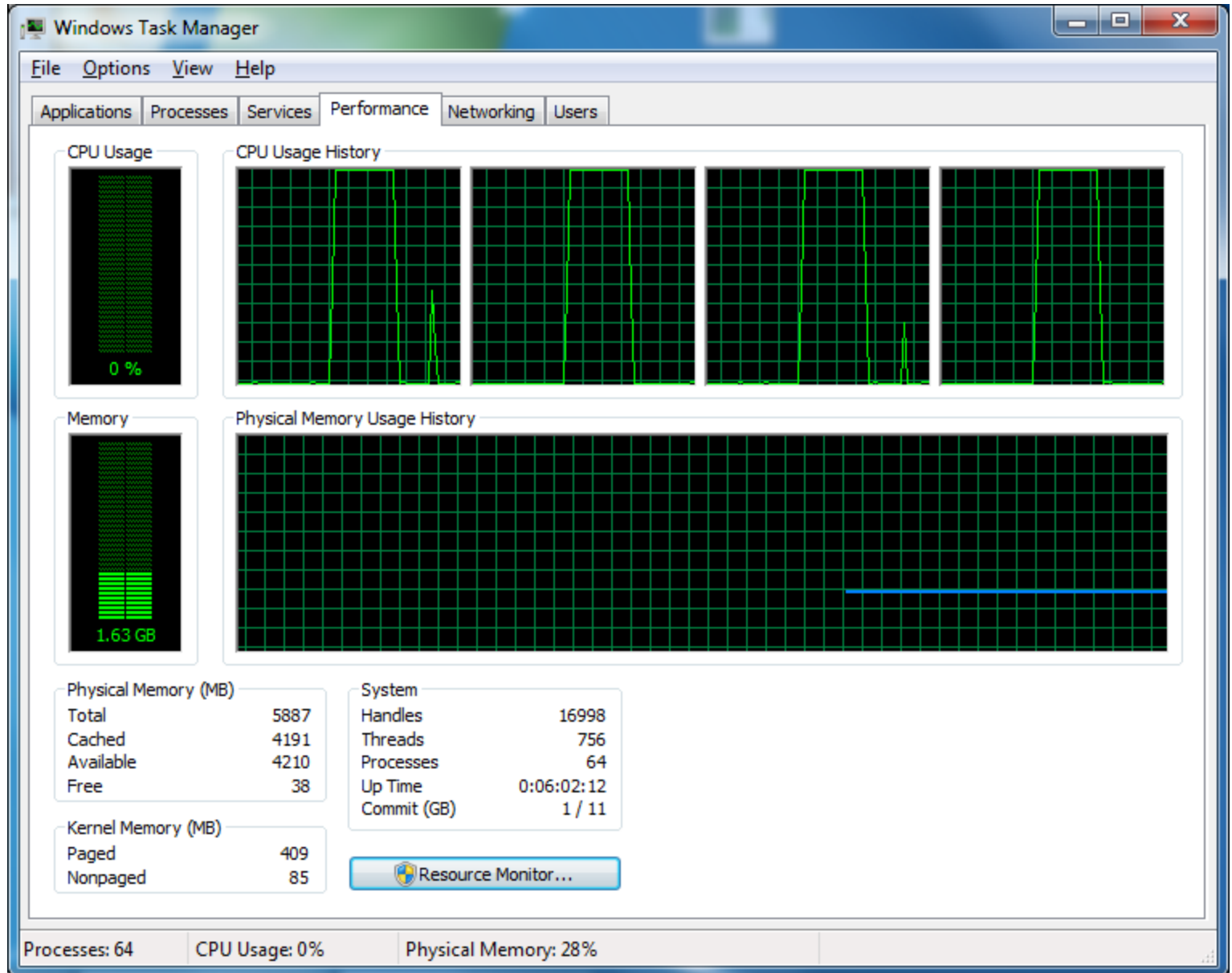
Two  
programs  
 $U=50\%$



Three  
programs  
 $U=75\%$



Four  
programs  
U=100%



# AMD Phenom processor executing 1 to 8 copies of SpeedMark benchmark

SM	1	2	3	4	5	6	7	8	$\Sigma$
1	545								545
2	545	545							1090
3	545	544	544						1633
4	544	542	545	545					2176
5	286	545	541	546	271				2189
6	393	285	164	545	274	542			2203
7	398	270	277	283	270	157	543		2198
8	403	280	281	279	271	270	267	159	2210

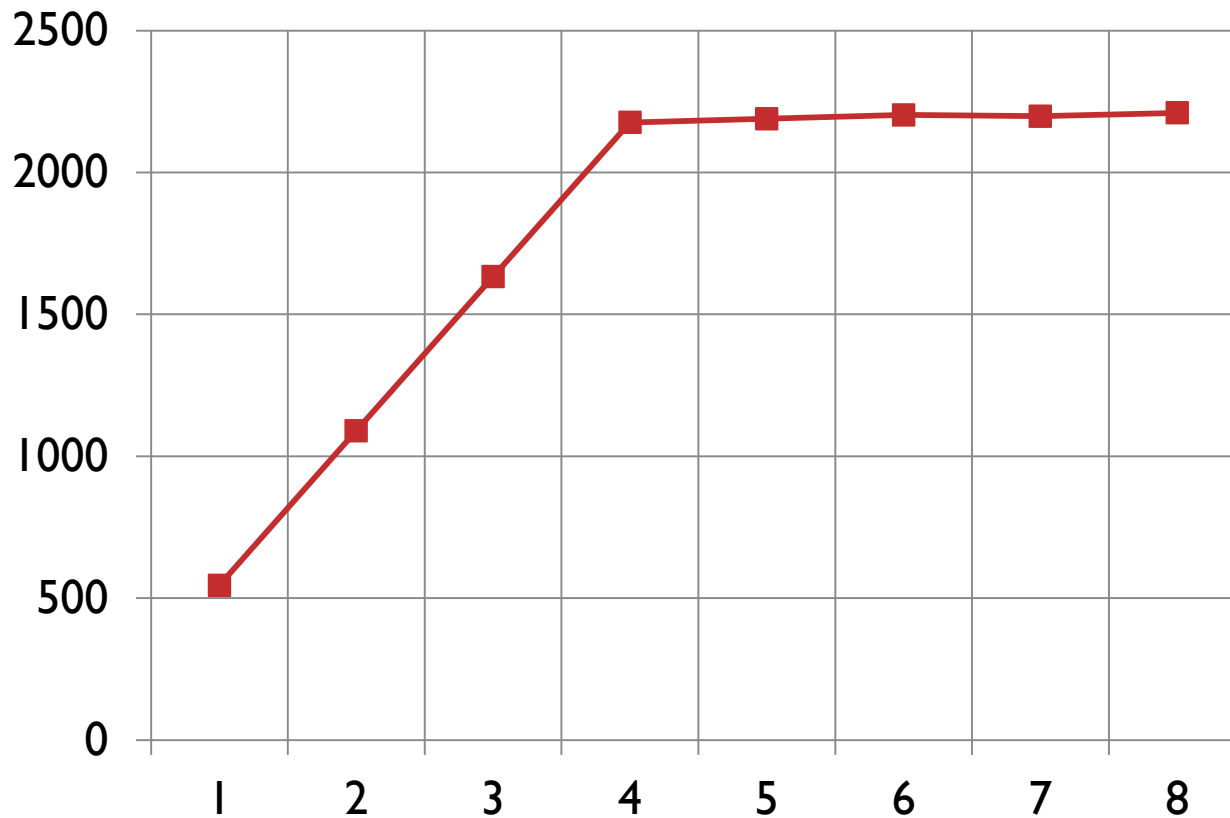
$$1090/545 = 2$$

$$V(2)/V(1) \in [1,2]$$

100% improvement obtained from multiple cores



# AMD Phenom Processor



# AMD Phenom Processor

- Linear characteristic up to 4 independent processor cores
- Stable linear behavior for more than 4 SpeedMark benchmarks
- Max SM speed  $V_{max} = 2210$  SMops/min
- Clock rate = 3.2 GHz
- SM parallelism ratio =  $2210/3.2 = \underline{\underline{690.6}}$



# INTEL I5 PROCESSOR

Intel Core i5 – 3475S CPU  
@ 2.9 GHz

# Dell Optiplex 9010

## Windows edition

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Windows 7 Home Premium


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Service Pack 1

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## System

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Manufacturer:	Dell
Model:	Optiplex 9010
Rating:	 <a href="#">Windows Experience Index</a>
Processor:	Intel(R) Core(TM) i5-3475S CPU @ 2.90GHz 2.90 GHz
Installed memory (RAM):	8.00 GB (7.89 GB usable)
System type:	64-bit Operating System
Pen and Touch:	No Pen or Touch Input is available for this Display

## Dell support

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Website: [Online support](#)

## Computer name, domain, and workgroup settings

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Computer name:	jozo-PC
Full computer name:	jozo-PC
Computer description:	
Workgroup:	WORKGROUP

## Windows activation

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Windows is activated

Product ID: 00359-OEM-8992687-00095

# Intel i5 processor executing 1 to 8 copies of SpeedMark benchmark

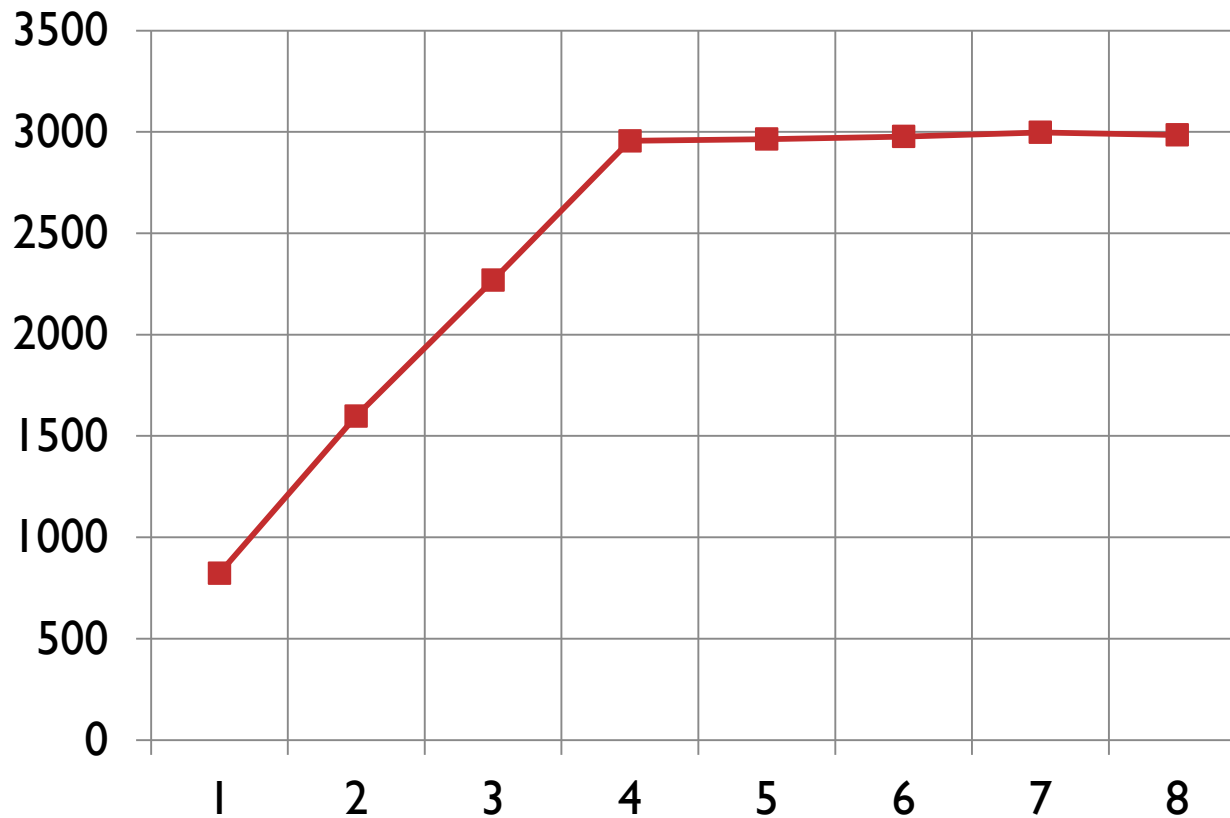
SM	1	2	3	4	5	6	7	8	$\Sigma$
1	822								822
2	799	799							1598
3	757	756	756						2269
4	740	740	739	737					2956
5	563	734	738	199	731				2965
6	563	372	740	366	199	737			2977
7	454	738	375	161	739	370	161		2998
8	561	375	247	252	370	246	738	196	2985

$$1598/822 = 1.944$$

$$V(2)/V(1) \in [1,2]$$

94% improvement obtained from multiple cores

# Intel i5Processor

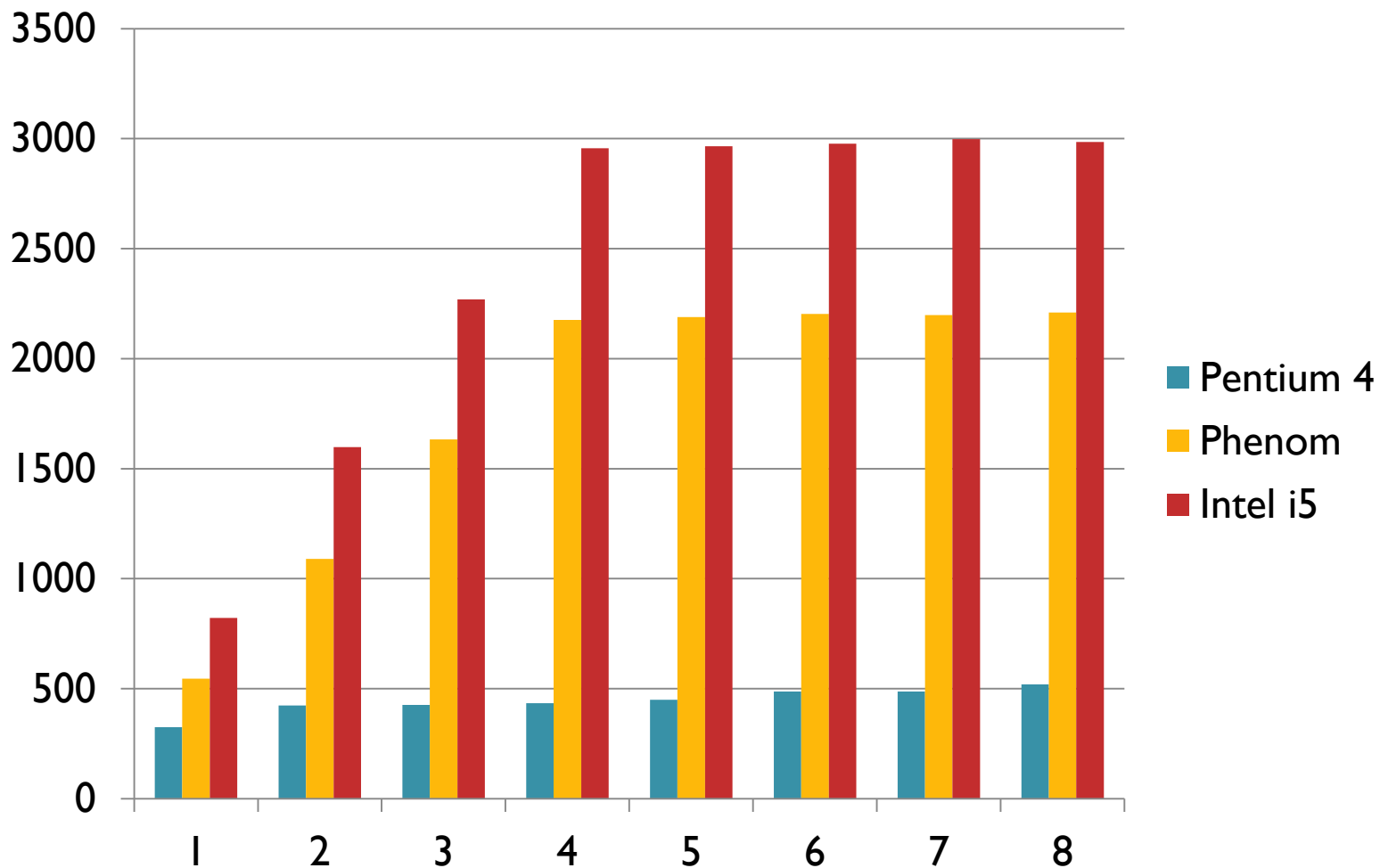


# Intel i5Processor

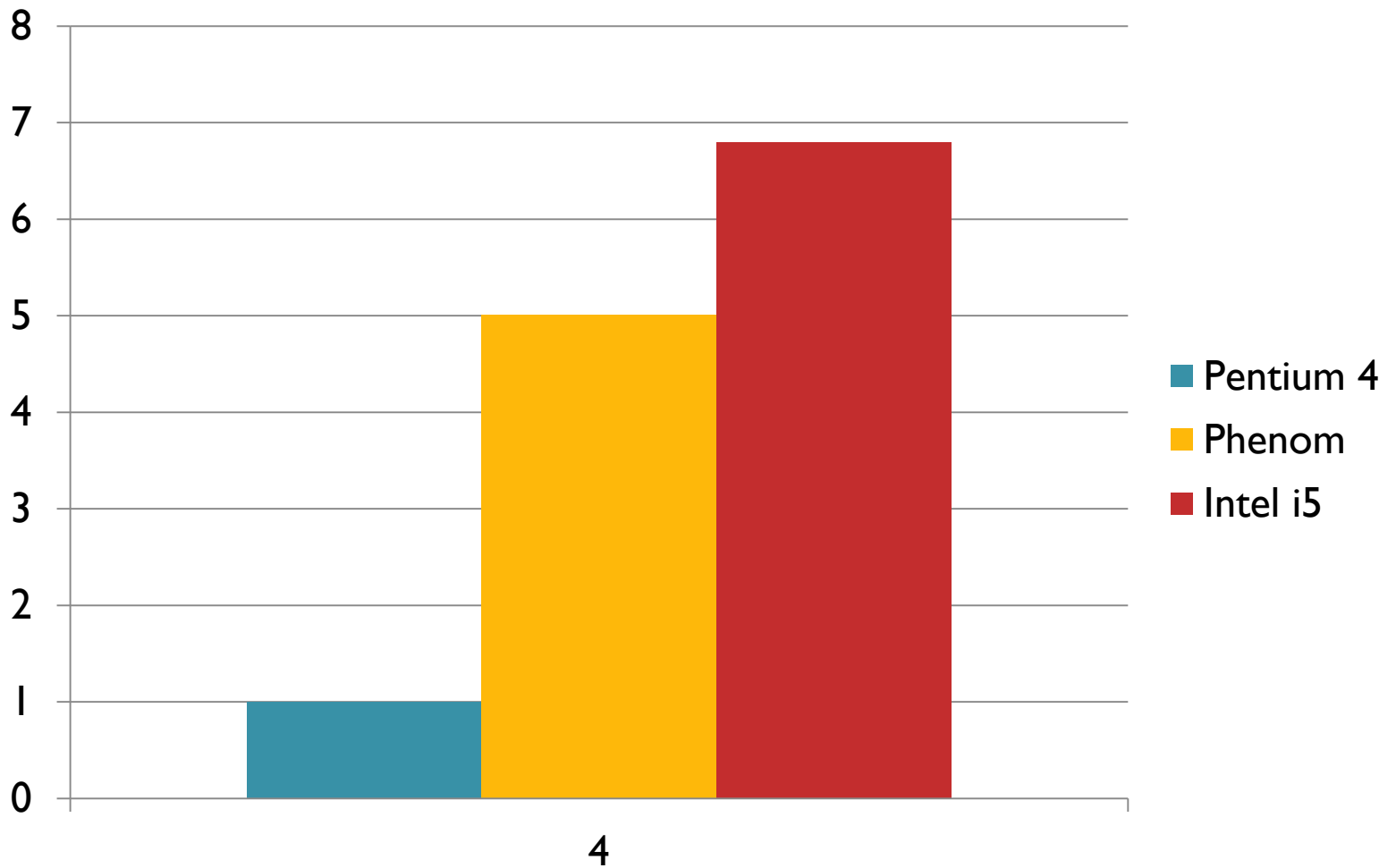
- Almost linear characteristic up to 4 independent processor cores
- Slightly increasing linear behavior for more than 4 SpeedMark benchmarks
- Max SM speed =  $V_{max} = 2998$  SMops/min
- Clock rate = 2.9 GHz
- SM parallelism ratio =  $2998/2.9 = \underline{\underline{1033.8}}$



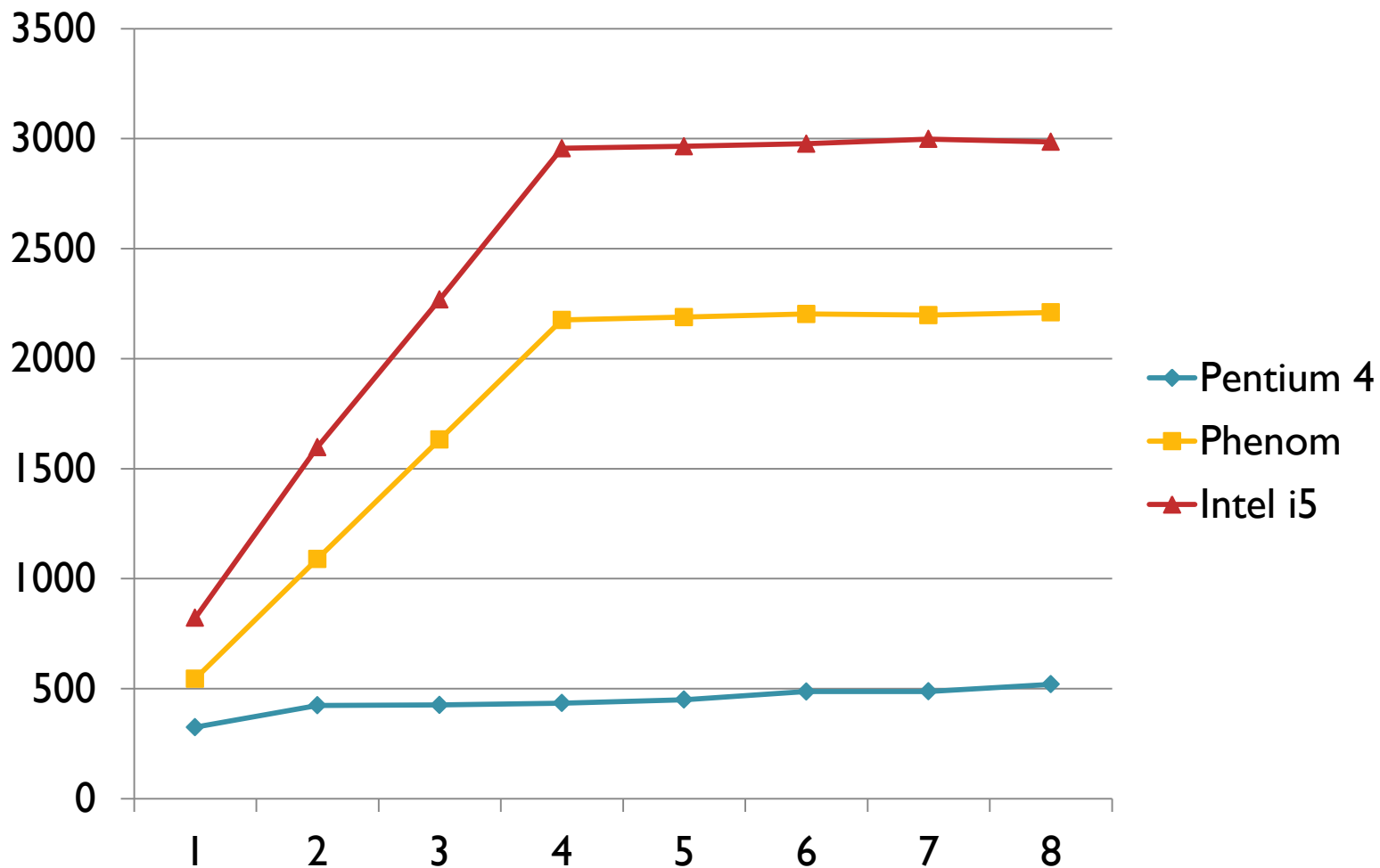
# Comparison (I)



# Comparison (2)



# Comparison (curves)



# Modeling SM processing speed for multicore processors

- $N$  = number of cores
- $V_{\max}$  = maximum speed
- $n$  = number of SM programs
- $V(n)$  = speed in SM operations per min
- The ideal case (fully parallel activity of cores):

$$V(n) = V_{\max} * \min(1, n/N)$$

# Conclusions

- SpeedMark is a suitable benchmark for comparison of speed and for evaluating effects of parallelism supported by modern processors
- Various processors working at the same clock rate can deliver various levels of performance