

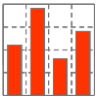
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# Performance Baseline of SPARC T5 Oracle Database Server

Part I: CPU Performance

Technical Presentation

February 2014



## **1 Introduction to CPU Performance Tests**

2 CPU and Server Configuration

3 CPU Benchmark Results – Basic Arithmetic Operations

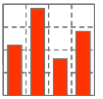
4 CPU Benchmark Results – Mixed Operations with SQL built-in functions

5 CPU Benchmark Results – Algorithms

6 Reviewing CPU Benchmark Results

# CPU Performance

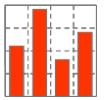
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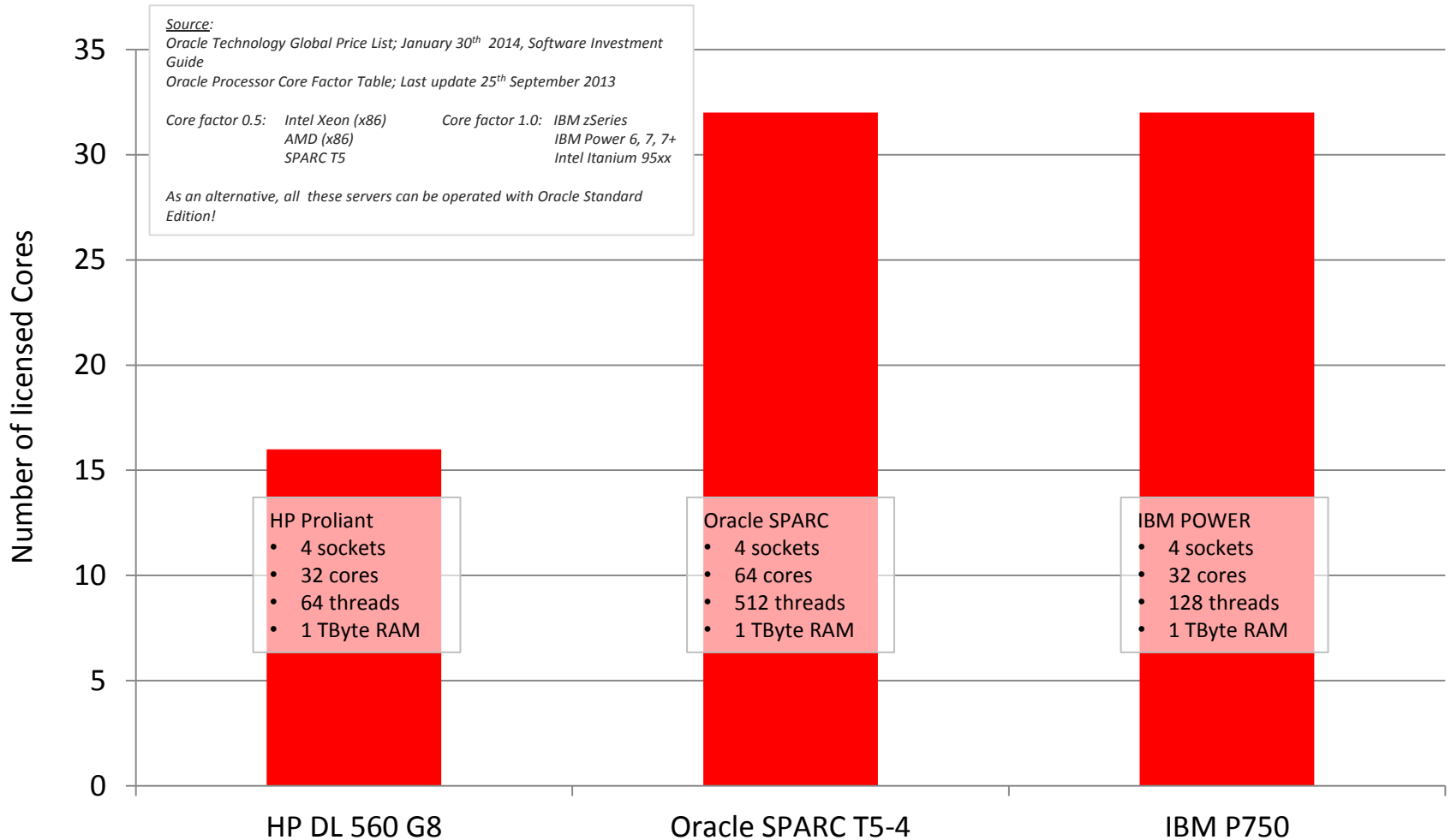
Why measure CPU performance?

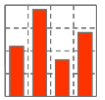
- CPU performance has a huge impact on
  - Oracle license (*core factor*) and maintenance cost - even with Unlimited License Agreement (ULA)
  - Performance of most database operations
  - Performance of compute intensive operations

# CPU Performance



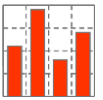
## Oracle EE Core Licensing – Price Performance Ratio?





## What is measured?

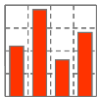
- CPU performance from the Oracle point of view
  - Pure processor performance
  - Including level 1, 2, 3 cache
  - No memory access
  - No I/O operations
  - Using Oracle data types and Oracle SQL built-in functions
- Speed of single thread
  - Elapsed time [s] for algorithms
  - Operations per second [ops]
- Maximum throughput of system
  - Operations per second [ops]
- Scalability
  - Throughput per process for  $n = \{1, 2, 4, 8, \dots, n\}$
- Efficiency of
  - Multi threading
  - Virtualization
  - Encryption



How is CPU performance measured?

- Following data types are most important for Oracle applications
  - PLS\_INTEGER
  - NUMBER
  - VARCHAR2
  - DATE
  
- Benchware uses Oracle data types in PL/SQL to measure the performance characteristics of a CPU

# CPU Performance

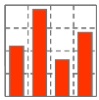


## Overview of CPU performance tests with Benchware test codes

Oracle CPU Performance	Test Code for	Test Code for	Test Code for	Test Code for	Test Code for
speed and throughput of arithmetic operations with typical Oracle data types and SQL built in functions; native compiled PL/SQL	SIMPLE_INTEGER	SIMPLE_FLOAT	PLS_INTEGER	NUMBER	VARCHAR2
▪ Basic arithmetic operation	CPU-11	CPU-12	CPU-13	CPU-14	-
▪ Mixed operations and SQL built in functions	-	CPU-22	CPU-23	CPU-24	CPU-25

Oracle CPU Performance	Test Code for	Test Code for	Test Code for	Test Code for	Test Code for
speed of recursive algorithms; native compiled PL/SQL	SIMPLE_INTEGER	SIMPLE_FLOAT	PLS_INTEGER	NUMBER	VARCHAR2
▪ Fibonacci numbers n = {39, 40, 41, 42}	CPU-31	-	-	CPU-34	-
▪ Prime numbers [2'000'000, 2'001'000]	CPU-41	-	-	CPU-44	-

# CPU Performance



## Monitoring

### ■ CPU utilization, speed and throughput

Speed:

- Only 1 process
- No conflicts
- No contention

Run	Tst	Code	#N	#J	#T	CPU busy [%]	CPU sys [%]	CPU user [%]	CPU idle [%]	Throughput ops/sec [ops]	lap time [s]
15	19	CPU-14	1	1	1	4	0	3	96	3.682E+07	121
	20	CPU-14	1	2	1	7	1	6	93	7.364E+07	121
	21	CPU-14	1	4	1	13	1	12	87	1.461E+08	122
	22	CPU-14	1	8	1	25	0	25	75	2.901E+08	120
	23	CPU-14	1	16	1	50	1	49	50	5.570E+08	125
	24	CPU-14	1	32	1	94	0	94	6	5.794E+08	127

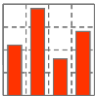
Max throughput:

- All cpu resources are utilized

**Legend:**

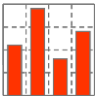
- Run* benchmark run id
- Tst* benchmark test id
- Code* benchmark test code
- #N* number of RAC nodes
- #J* number of jobs, round robin distributed to all nodes
- #T* number of threads (PX)
- [ops]* operations per second
- [s]* elapsed time in seconds





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- 2 CPU and Server Configuration**
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# CPU Performance



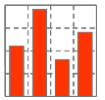
## CPU architecture

CPU		SPARC T5-2	SPARC T5-4
Launch date		2013	2013
Clock rate [GHz]		3.6	3.6
Max number of sockets		2	4
#cores per socket		16	16
Multithreading		8-fold	8-fold
<b>Performance Numbers from other Benchmarks</b>			
SPECint_base2006 (speed)		No SPEC results available	
Oracle CPU speed in sys.aux_stats\$			

### Remark:

- Oracle has an internal estimation about CPU speed in sys.aux\_stats\$, but none estimation about CPU throughput.
- This value does not correlate with SPECint\_base2006

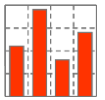
# CPU Performance



## Server configuration

Server		SPARC T5-2	SPARC T5-4 Cluster
#sockets		2	8
#cores		32	128
#threads		256	1'024
Comment		-	Equivalent to T5-8 Equivalent to SuperCluster HR
Performance Numbers from other Benchmarks			
SPECint_base_rate_2006 (throughput)		16 cores: 441	3'490
Software			
Operating System		Solaris 11	Solaris 11
Oracle Database System		Oracle 11.2.0.3	Oracle 11.2.0.3
Benchware Performance Suite			

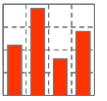
# CPU Performance



## Oracle Licensing

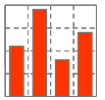
Oracle Enterprise Edition		SPARC T5-2	SPARC T5-4 Cluster
Oracle core license factor		x 0.5	x 0.5
Oracle license cost <small>(list price 30th of January 2014)</small>			
<ul style="list-style-type: none"> <li>▪ Enterprise Edition (47'500)</li> <li>▪ Partition Option (11'500)</li> <li>▪ Diagnostic Pack (5'000)</li> <li>▪ Tuning Pack (5'000)</li> </ul>		760'000 184'000 80'000 80'000	3'040'000 736'000 320'000 320'000
Total Oracle license cost		1'104'000	4'416'000

Oracle Standard Edition		SPARC T5-2	SPARC T5-4 Cluster
Oracle core license factor		x 0.5	x 0.5
Oracle license cost <small>(list price 30th of January 2014)</small>			
<ul style="list-style-type: none"> <li>▪ Standard Edition (17'500)</li> </ul>		560'000	-
Total Oracle license cost		560'000	-

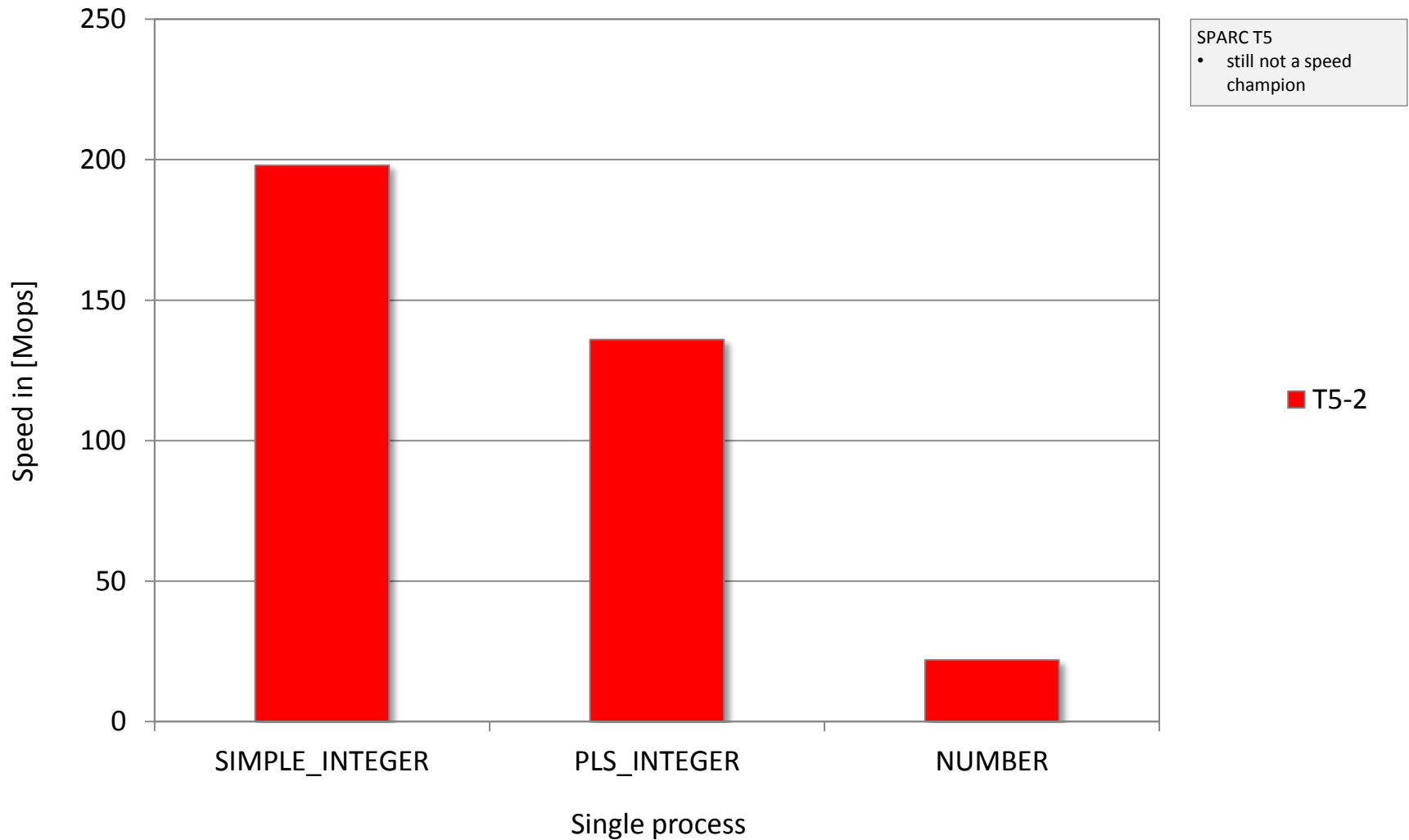


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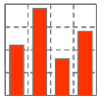
# CPU Performance



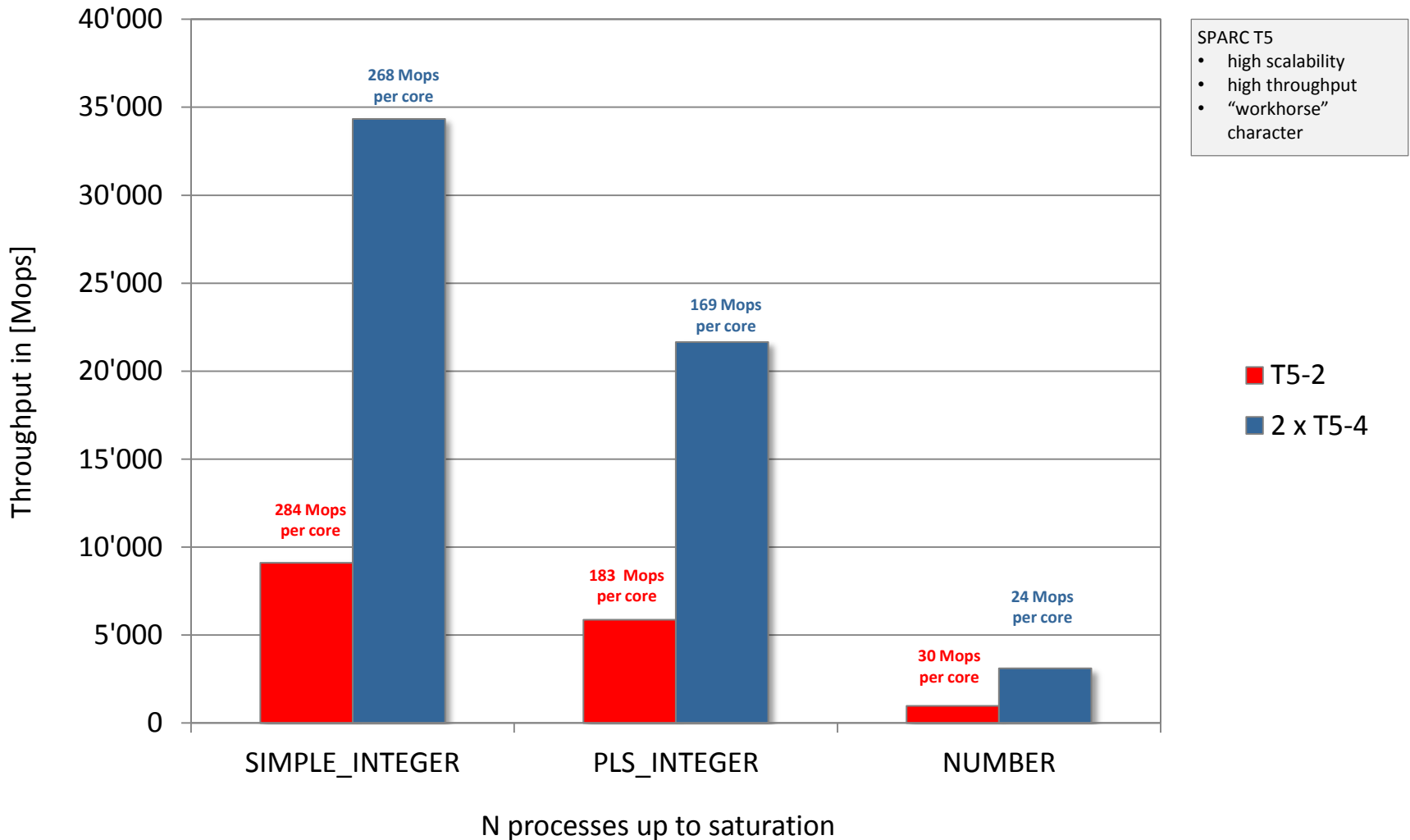
Single core / process speed of arithmetic ADD operation



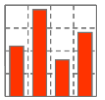
# CPU Performance



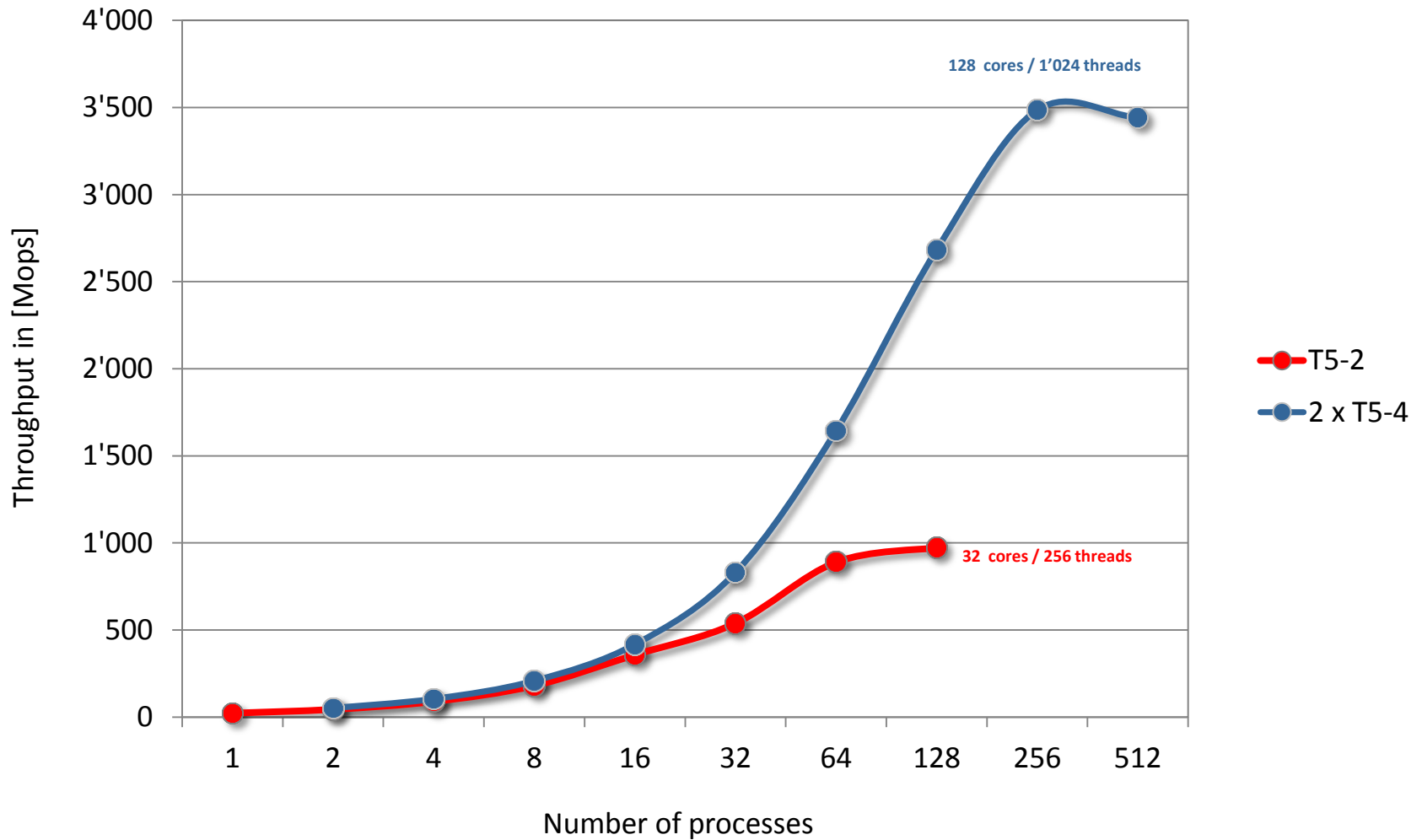
Throughput of arithmetic ADD operation, different Oracle data types



# CPU Performance

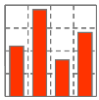


Oracle CPU performance on data type NUMBER add operation





# CPU Performance



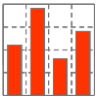
Oracle CPU performance on data type NUMBER add operation

SPARC T  
5-2

Run	Tst Code	#N	#J	#T	CPU busy [%]	CPU user [%]	CPU sys [%]	CPU idle [%]	Throughput ops/sec [ops]	Elap time [s]
2	33 CPU-14	1	1	1	0	0	0	100	2.233E+07	86
	34 CPU-14	1	2	1	1	1	0	99	4.465E+07	86
	35 CPU-14	1	4	1	2	2	0	98	8.930E+07	86
	36 CPU-14	1	8	1	3	3	0	97	1.807E+08	85
	37 CPU-14	1	16	1	6	6	0	94	3.572E+08	86
	38 CPU-14	1	32	1	11	11	0	89	5.389E+08	114
	39 CPU-14	1	64	1	24	24	0	76	8.896E+08	125
	40 CPU-14	1	128	1	49	49	0	51	9.726E+08	127

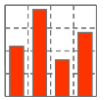
SPARC Cluster  
2 x T5-4

Run	Tst Code	#N	#J	#T	CPU busy [%]	CPU user [%]	CPU sys [%]	CPU idle [%]	Throughput ops/sec [ops]	Elap time [s]
7	31 CPU-14	2	2	1	0	0	0	100	5.217E+07	184
	32 CPU-14	2	4	1	1	0	0	99	1.043E+08	184
	33 CPU-14	2	8	1	1	1	0	99	2.087E+08	184
	34 CPU-14	2	16	1	2	2	0	98	4.174E+08	184
	35 CPU-14	2	32	1	3	3	0	97	8.303E+08	185
	36 CPU-14	2	64	1	6	6	0	94	1.643E+09	187
	37 CPU-14	2	128	1	11	11	0	89	2.683E+09	229
	38 CPU-14	2	256	1	24	24	0	76	3.485E+09	315
	39 CPU-14	2	512	1	47	46	0	53	3.427E+09	330
	40 CPU-14	2	1024	1	86	85	0	14	3.117E+09	368

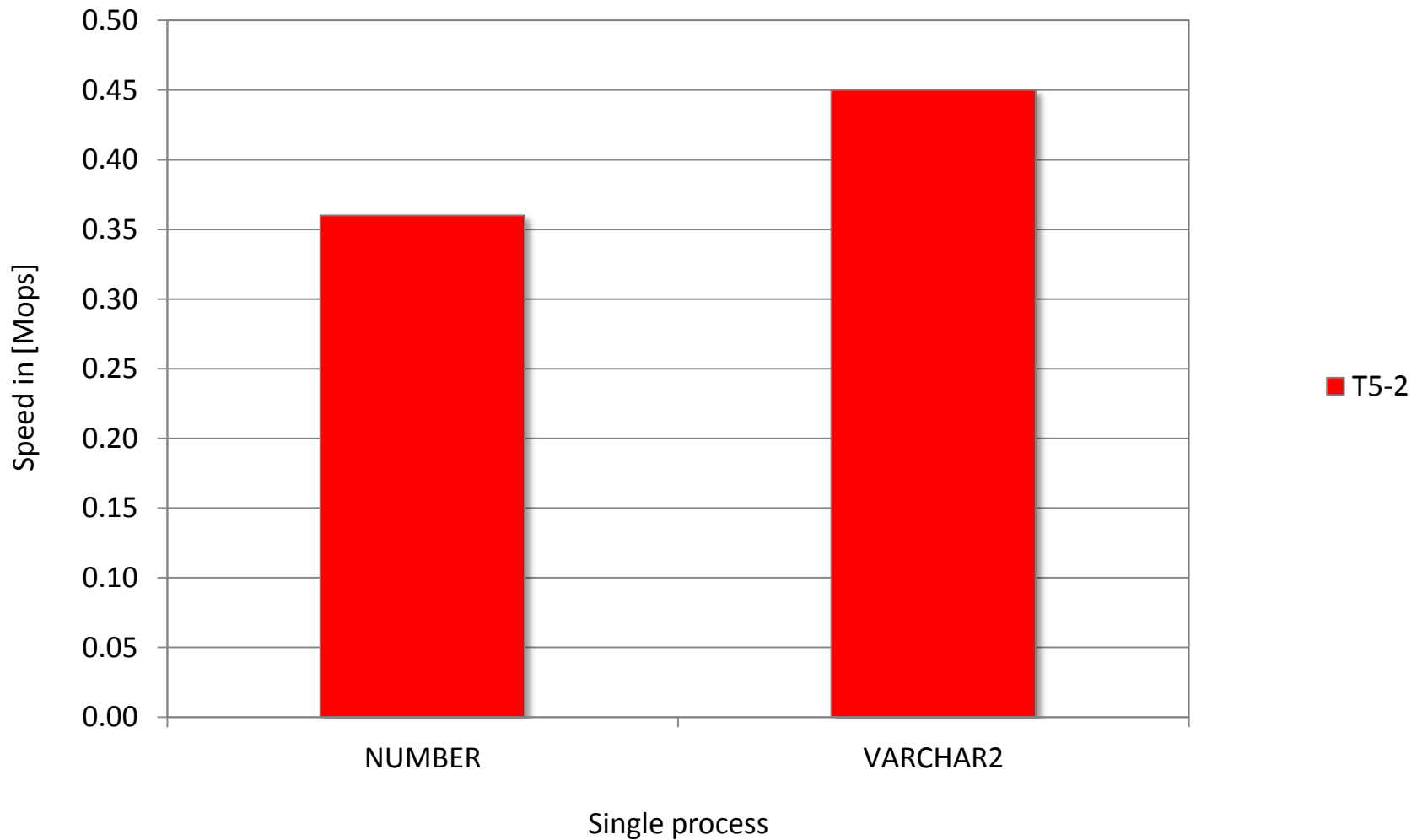


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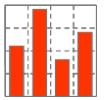
# CPU Performance



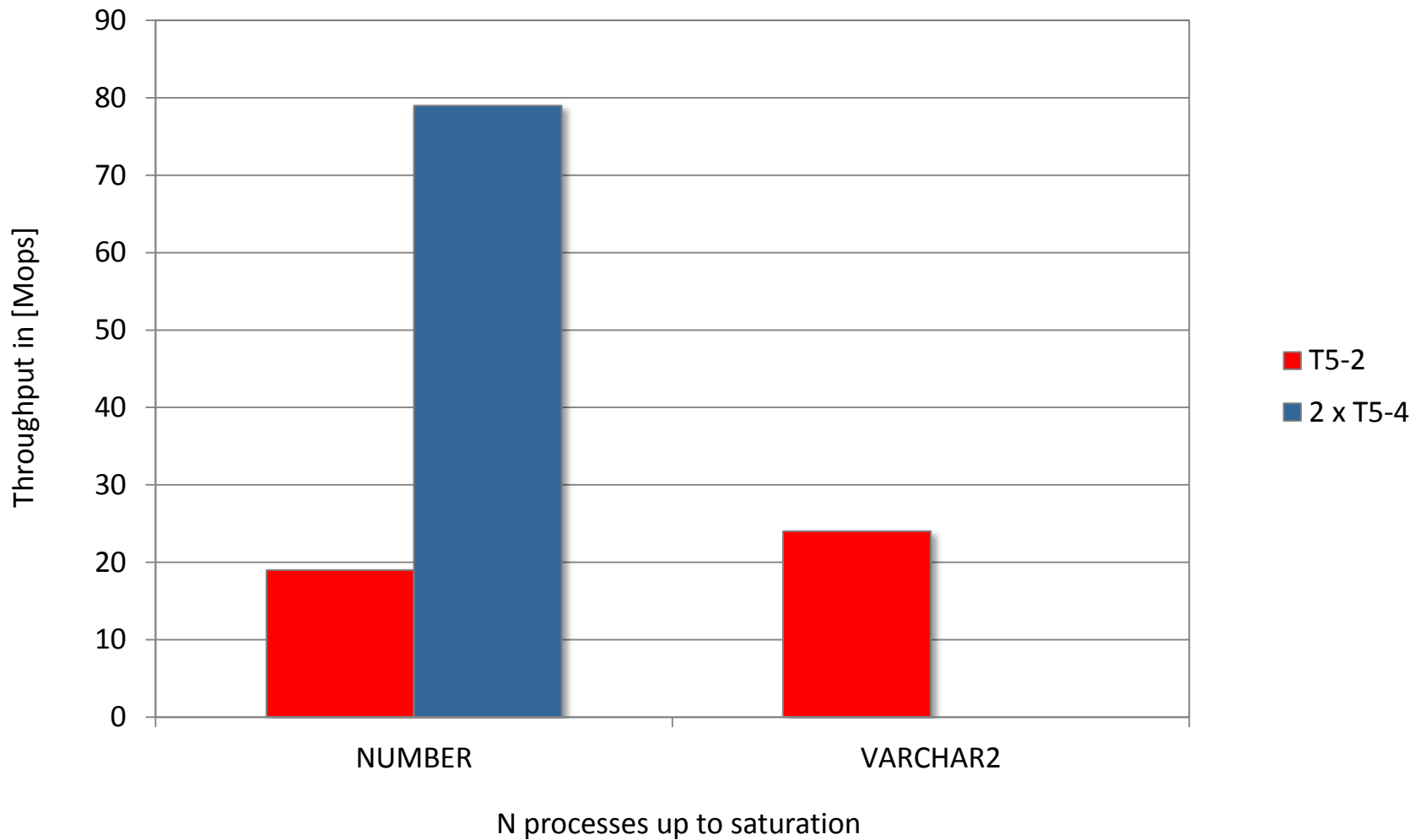
Single process speed of mixed operations, different Oracle data types



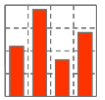
# CPU Performance



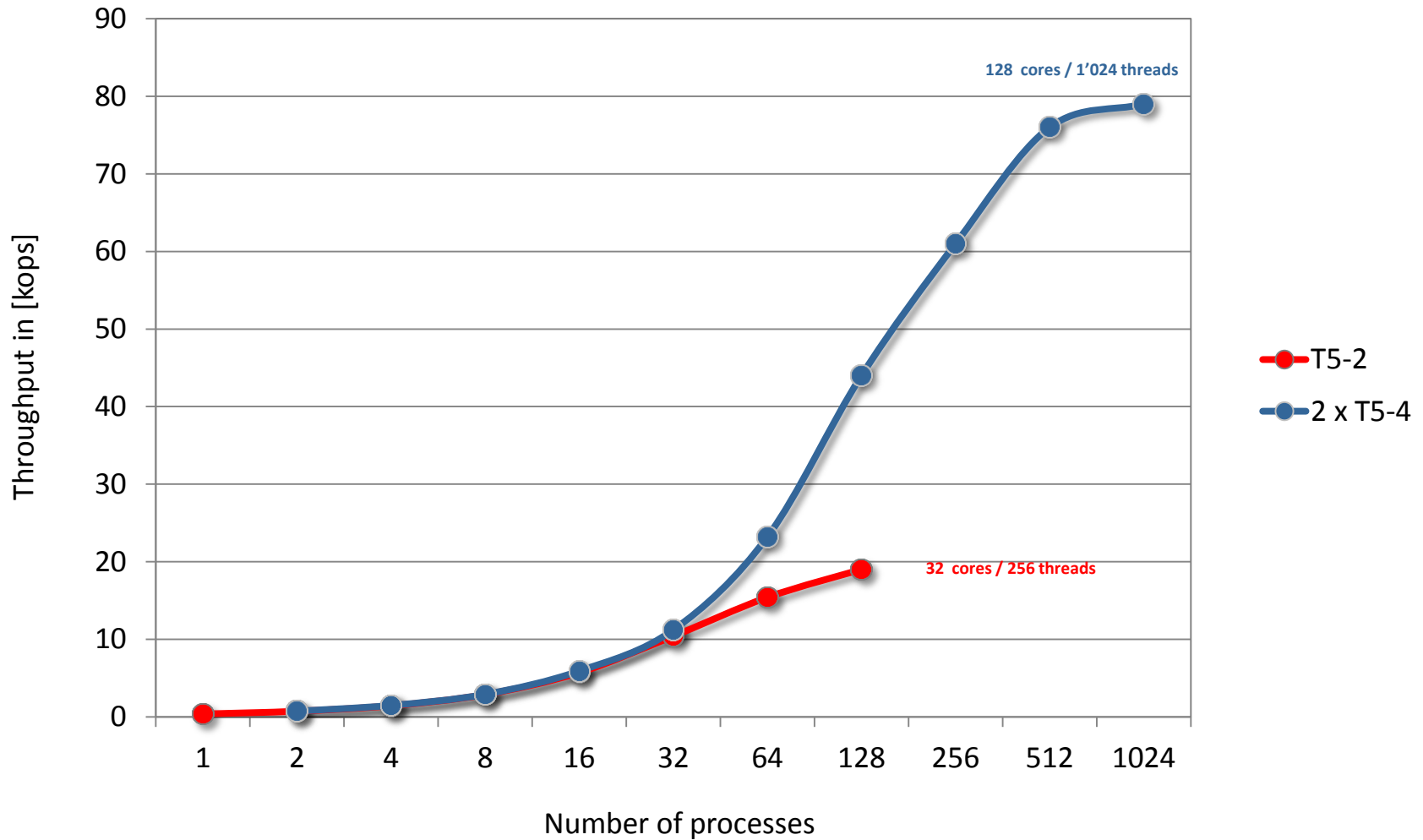
Throughput of mixed operations, different Oracle data types



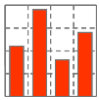
# CPU Performance



Oracle CPU performance on data type NUMBER mixed operations



# CPU Performance



Oracle CPU performance on data type NUMBER mixed operations

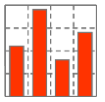
SPARC  
T5-2

Run	Tst	Code	#N	#J	#T	CPU busy [%]	CPU user [%]	CPU sys [%]	CPU idle [%]	Throughput ops/sec [ops]	Elap time [s]
2	60	CPU-24	1	1	1	0	0	0	100	3.577E+05	123
	61	CPU-24	1	2	1	1	1	0	99	7.154E+05	123
	62	CPU-24	1	4	1	2	2	0	98	1.431E+06	123
	63	CPU-24	1	8	1	3	3	0	97	2.862E+06	123
	64	CPU-24	1	16	1	6	6	0	94	5.691E+06	123
	65	CPU-24	1	32	1	12	12	0	88	1.040E+07	126
	66	CPU-24	1	64	1	24	24	0	76	1.545E+07	127
	67	CPU-24	1	128	1	48	48	0	52	1.902E+07	132

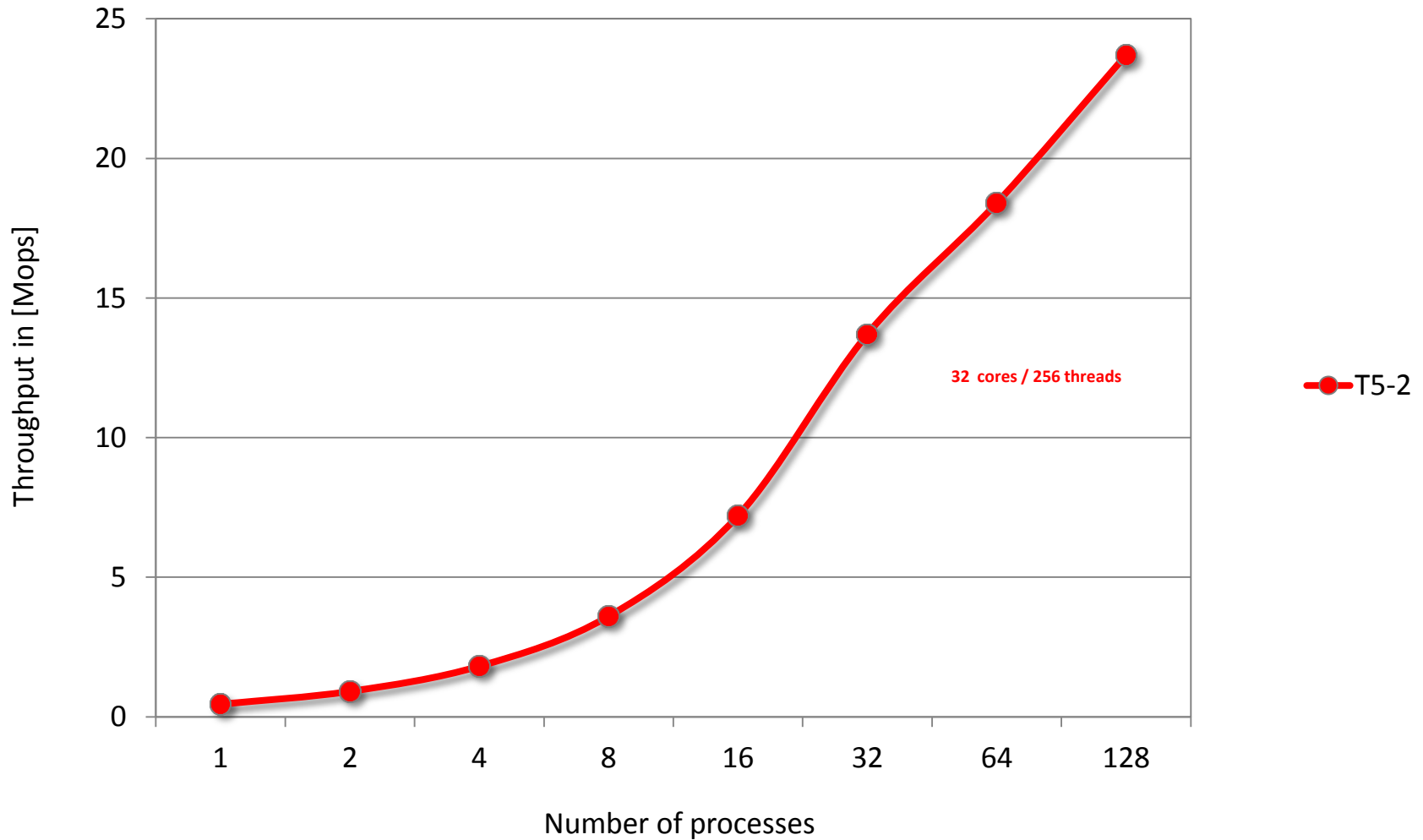
SPARC Cluster  
2 x T5-4

Run	Tst	Code	#N	#J	#T	CPU busy [%]	CPU user [%]	CPU sys [%]	CPU idle [%]	Throughput ops/sec [ops]	Elap time [s]
7	61	CPU-24	2	2	1	0	0	0	100	7.320E+05	306
	62	CPU-24	2	4	1	1	0	0	99	1.469E+06	305
	63	CPU-24	2	8	1	1	1	0	99	2.928E+06	306
	64	CPU-24	2	16	1	2	2	0	98	5.856E+06	306
	65	CPU-24	2	32	1	3	3	0	97	1.170E+07	306
	66	CPU-24	2	64	1	6	6	0	94	2.316E+07	308
	67	CPU-24	2	128	1	13	12	0	87	4.444E+07	308
	68	CPU-24	2	256	1	24	24	0	76	6.105E+07	315
	69	CPU-24	2	512	1	47	46	0	53	7.635E+07	330
	70	CPU-24	2	1024	1	85	85	0	15	7.902E+07	361

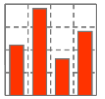
# CPU Performance



Oracle CPU performance on data type VARCHAR2 mixed operation



# CPU Performance



Oracle CPU performance on data type VARCHAR2 mixed operation

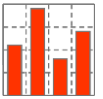
SPARC  
T5-2

Run	Tst	Code	#N	#J	#T	CPU busy [%]	CPU user [%]	CPU sys [%]	CPU idle [%]	Throughput ops/sec [ops]	Elap time [s]
2	69	CPU-25	1	1	1	0	0	0	100	4.545E+05	132
	70	CPU-25	1	2	1	1	1	0	99	9.091E+05	132
	71	CPU-25	1	4	1	2	2	0	98	1.818E+06	132
	72	CPU-25	1	8	1	3	3	0	97	3.636E+06	132
	73	CPU-25	1	16	1	6	6	0	94	7.218E+06	133
	74	CPU-25	1	32	1	12	12	0	88	1.367E+07	135
	75	CPU-25	1	64	1	23	23	0	77	1.835E+07	141
	76	CPU-25	1	128	1	46	46	0	54	2.365E+07	144

Legend:

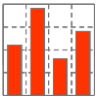
- #N number of RAC nodes
- #J number of jobs
- #T number of threads (PX)
- [s] elapsed time in seconds
- [ops] operations per second



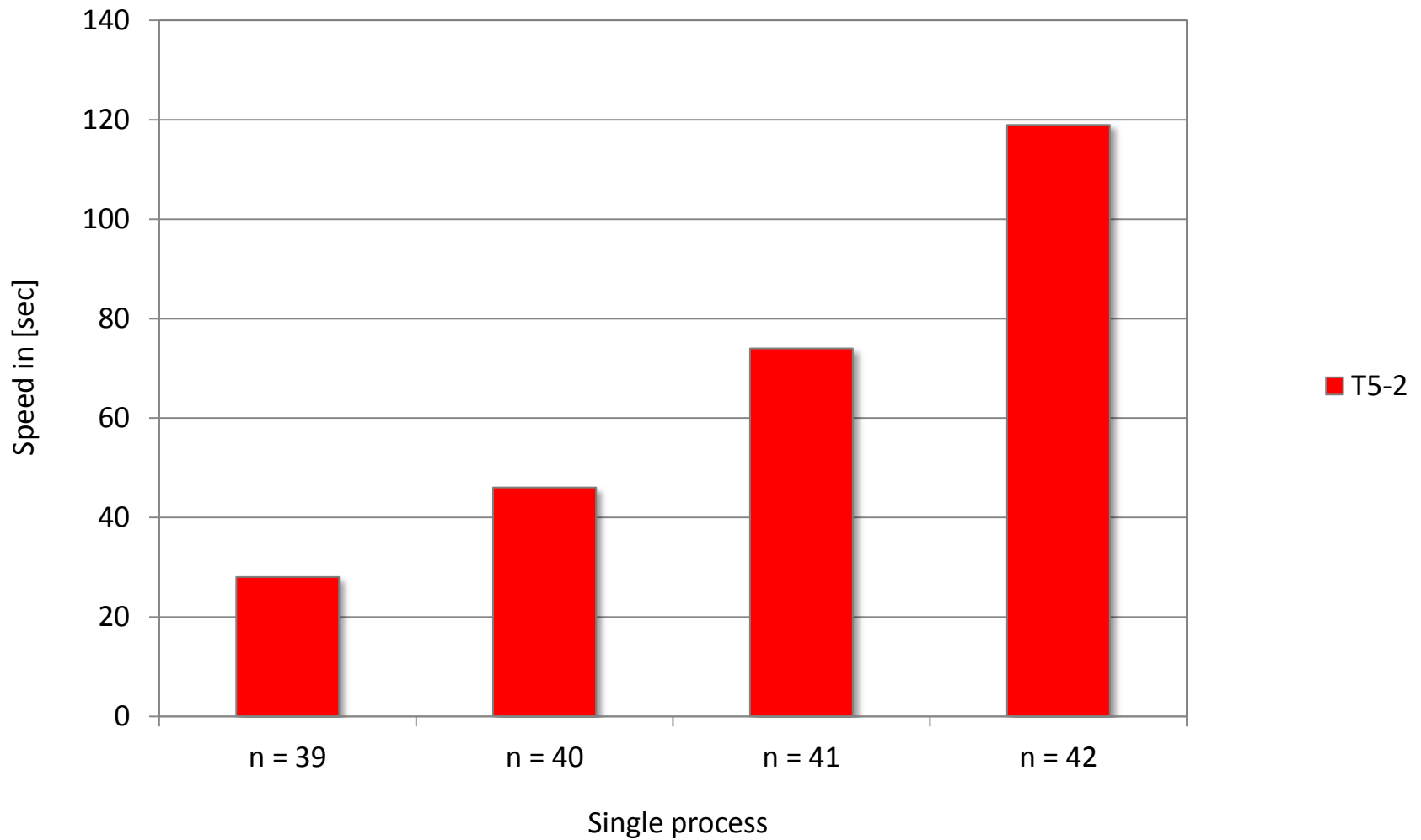


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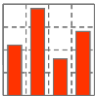
# CPU Performance



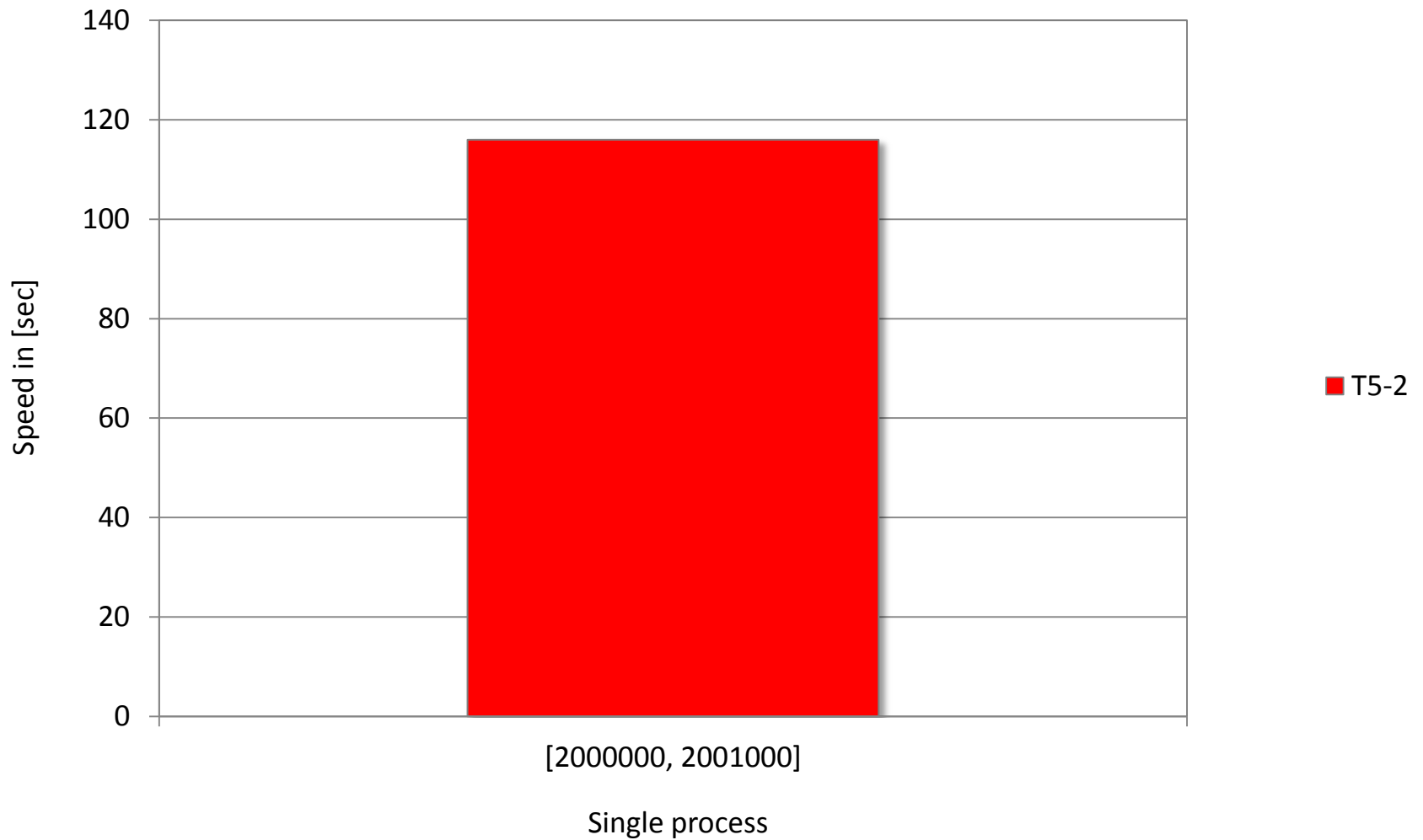
## Calculation of fibonacci numbers

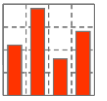


# CPU Performance



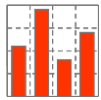
Calculation of prime numbers





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# Benchmark Results



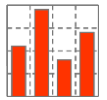
## Reviewing CPU Performance

	Metric		SPARC T5-2	SPARC T5-4 Cluster
#cores			32	128
#threads			256	1'024
Basic arithmetic ADD operation	Metric		SPARC T5-2	SPARC T5-4 Cluster
Single thread speed				
▪ SIMPLE_INTEGER	[Mops]		198	200
▪ SIMPLE_FLOAT	[Mops]		88	87
▪ PLS_INTEGER	[Mops]		136	135
▪ <b>NUMBER</b>	[Mops]		22	26
Throughput				
▪ SIMPLE_INTEGER	[Mops]		9'100	33'090
▪ SIMPLE_FLOAT	[Mops]		5'660	19'380
▪ PLS_INTEGER	[Mops]		5'872	19'560
▪ <b>NUMBER</b>	[Mops]		972	3'117

Legend:

[Mops] million operations per second

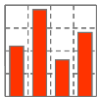
# Benchmark Results



## Reviewing CPU Performance

	Metric		SPARC T5-2	SPARC T5-4 Cluster
#cores			32	128
#threads			256	1'024
Mixed arithmetic operations	Metric		SPARC T5-2	SPARC T5-4 Cluster
Speed				
▪ SIMPLE_FLOAT	[Mops]		3.1	4.2
▪ PLS_INTEGER	[Mops]		0.4	0.4
▪ NUMBER	[Mops]		0.4	0.4
Throughput				
▪ SIMPLE_FLOAT	[Mops]		165	1'068
▪ PLS_INTEGER	[Mops]		19	78
▪ NUMBER	[Mops]		19	79
Mixed string operation	Metric		SPARC T5-2	SPARC T5-4 Cluster
Speed				
▪ VARCHAR2	[Mops]		0.5	-
Throughput				
▪ VARCHAR2	[Mops]		24	-

# Benchmark Results



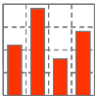
## Reviewing CPU Performance

	Metric		SPARC T5-2	SPARC T5-4 Cluster
#cores			32	128
#threads			256	1'024
Algorithms	Metric		SPARC T5-2	SPARC T5-4 Cluster
Speed, calculate fibonacci numbers				
▪ N=39	[s]		28	-
▪ N=40	[s]		46	-
▪ N=41	[s]		74	-
▪ N=42	[s]		119	-
Speed, calculate prime numbers				
▪ Interval [2000000, 2001000]	[s]		116	-

Legend:

[s] elapsed time in seconds

# Benchmark Results



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## Reviewing CPU Performance

- Chip performance is described by two characteristics
  - Speed
  - Throughput
- SPARC offers
  - Almost competitive speed within the market of scalable servers (4, 8 or more sockets)
  - Very high throughput



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