Transaction Performance vs. Moore's Law

Meikel Poess, Oracle Corporation

Raghunath Nambiar, Cisco Systems, Inc.

SINGAPORE 2010

TPCTC 2010
Singapore

Agenda

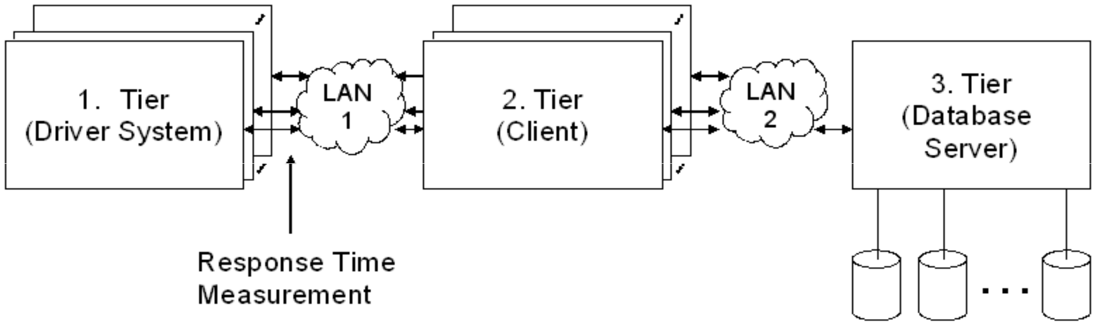
- Motivation
- TPC-C Benchmark
- Moore's Law vs. Transaction Performance
- Moore's Law vs. Cost for Transaction Performance
- Conclusion

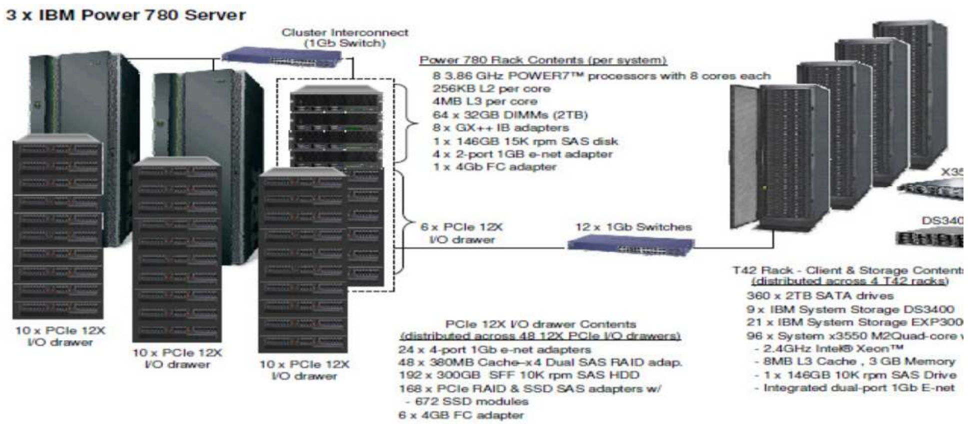
TPC-C Benchmark

- Approved in 1992 as successor of TPC-B
- Yardstick for comparing transaction processing performance
- Complete system performance
- Over 750 results
  - All major server vendors
  - All major and database platforms
  - Variety of architectures

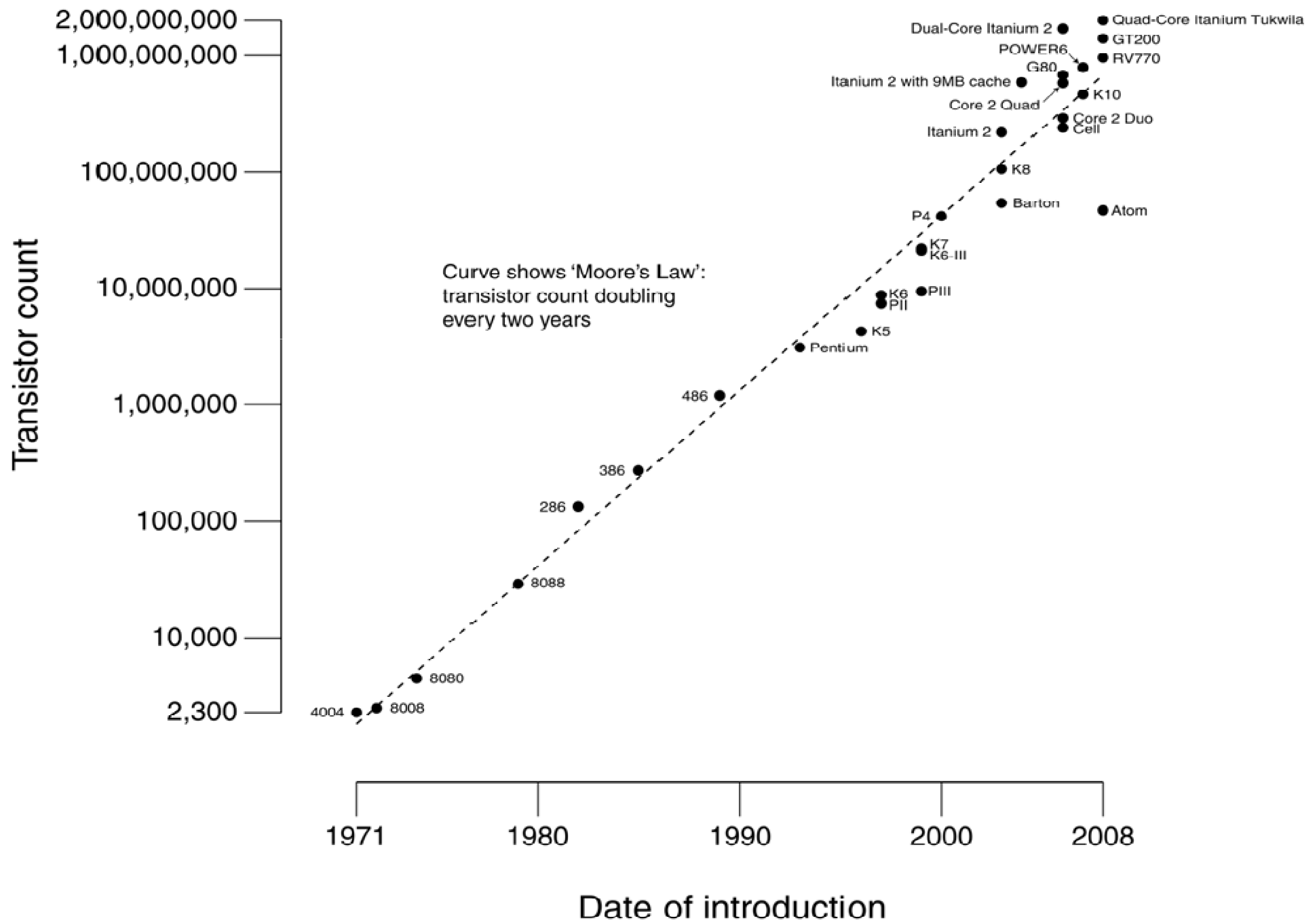
TPC-C Benchmark Configuration

- Complex configurations
- 3-tier architecture
- Powerful database server as back-end





Moore's Law



Transistor count
2,000,000,000
1,000,000,000
100,000,000
10,000,000
1,000,000
100,000
10,000
2,300
Curve shows 'Moore's Law': transistor count doubling every two years
Quad-Core Itanium Tukwila
Dual-Core Itanium 2
GT200
POWER6
RV770
G80
Itanium 2 with 9MB cache
K10
Core 2 Quad
Core 2 Duo
Cell
Itanium 2
K8
Barton
Atom
P4
K7
K6-III
K6
PIII
PII
K5
Pentium
486
386
286
8088
8080
8008
4004
1971
1980
1990
2000
2008
Date of introduction

TPC-C Revisi

- Clause to disallow "benchmark specials"
- Additional disclosures

- New rules around transaction monitor requirements

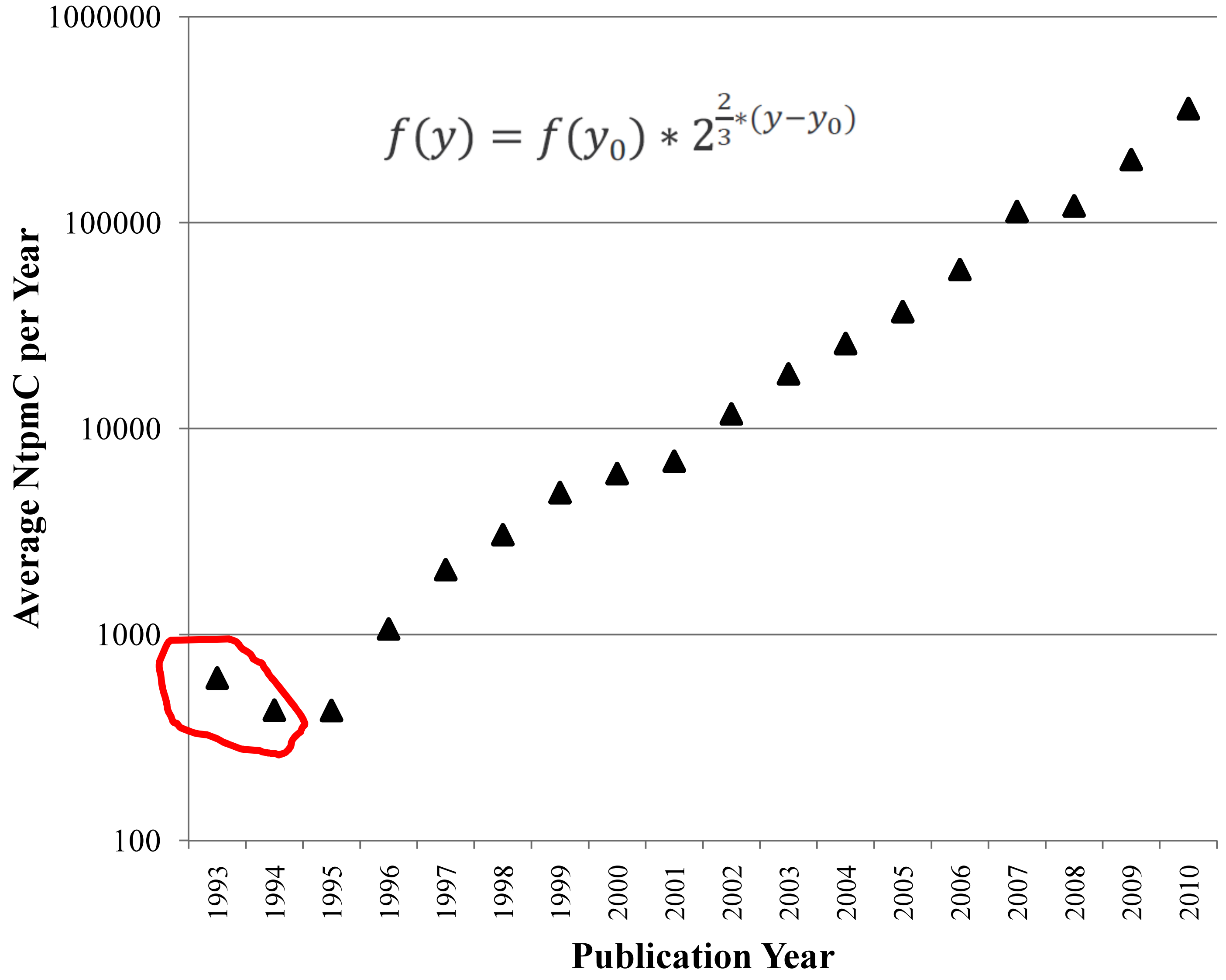
Date	Version	Description
22-Jun-92	Draft 6.6	Mail ballot version (proposed standa
13-Aug-92	Revision 1.0	Standard specification
1-Jun-93	Revision 1.1	First mino
20-Oct-93	Revision 2.0	irst major revision
15-Feb-95	Revision 3.0	Sec
4-Jun-96	Revision 3.1	Minor changes to rev 3.1.
27-Aug-96	Revision 3.2	Changed mix back to 3.0 values.
12-Sep-96	Revision 3.2.1	Fixed Member list and added index
15-Jan-97	Revision 3.2.2	Added wording for TAB Ids #197, 221 & 224
6-Feb-97	Revision 3.2.3	Added wording for TAB Ids #205, 222 & 226
8-Apr-97	Revision 3.3	New Clauses 2.3.6 & 9.2.2.3 (TAB Id #225)
9-Apr-97	Revision 3.3.1	Wording added for availability date in Clause 8.1.8.3
25-Jun-97	Revision 3.3.2	Editorial changes in Clauses 8.1.6.7 and 9.1.4
16-Apr-98	Revision 3.3.3	Editorial changes in Clauses 2.5.2.2 and 4.2.2
24-Aug-98	Revision 3.4	New Clause 5.7 and changed wording in Cl
25-Aug-99	Revision 3.5	Modify wording in Clause 7.1.3
18-Oct-00	Revision 5.0	
6-Dec-00	Revision 5.0	7x24 Maintenance,
26-Feb-01	Revision 5.0	Official Version 5.0 Specification
11-Dec-02	Revision 5.1	Clause 3.5.4, PDO Limitations, Cluster
11-Dec-03	Revision 5.2	Modified Clause 7.1.3, Clause 8.3, Claus MQTh)
22-Apr-04	Revision 5.3	Clause 8.3 (9), Executive Summary, Mod
21-Apr-05	Revision 5.4	Modified Clause 3.3.3.2, Modified Clause
20-Oct-05	Revision 5.5	Modified Clauses 8.1.1.7 and 8.1.9.1, Added Comment to Clause 8.1.1.2 and added Clause 9.2.9
8-Dec-05	Revision 5.6	Modified Clauses 5.5.1.2, 8.1.1.2. Replaced 6.6.6
21-Apr-06	Revision 5.7	Modified Clauses 1.3.1 and 1.4.9. Added Clause 1.4.14
14-Dec-06	Revision 5.8	Modified Clauses 0.2, 1.3.1, 5.2.5.4, 8.1.8.1, 9.2.8.1, 7.1.3,8.3, and 9.2.1. Added Clause 7.2.6
14-Jun-07	Revision 5.9	Modified Clause 7.2.6.1, 7.2.6.2, 8.3.1, 8.3.2 to address substitution rules
17-Apr-08	Revision 5.10	Modified Clauses 1.3.1, 3.1.5, 3.3.2, 3.5, 3.5.1, 3.5.3, 3.5.3.4, 4.3.2.2, 5.2.3, 5.2.5.6, 8.1.1.2, Added Clause 9.2.9.2.
5-Feb-09	Revision 5.10.1	Editorial changes in Clauses 3.4.2.9,3.5,5.6.4,7.2.6.1,8.1.1.3
11-Feb-10	Revision 5.11	Updated TPC Membership, Editorial change in Clause1.3.1, Modified Clause 6.6.3.7, Modified Clause 7.2.3.1, Modified/Added Clauses 0.1, 5.7.1, 8.1.1.2, and 9.2.9 to support TPC-Energy requirements.

- Revision 4 was skipped
- Pricing change
- Increased measurement interval from 20 min to 2 hours

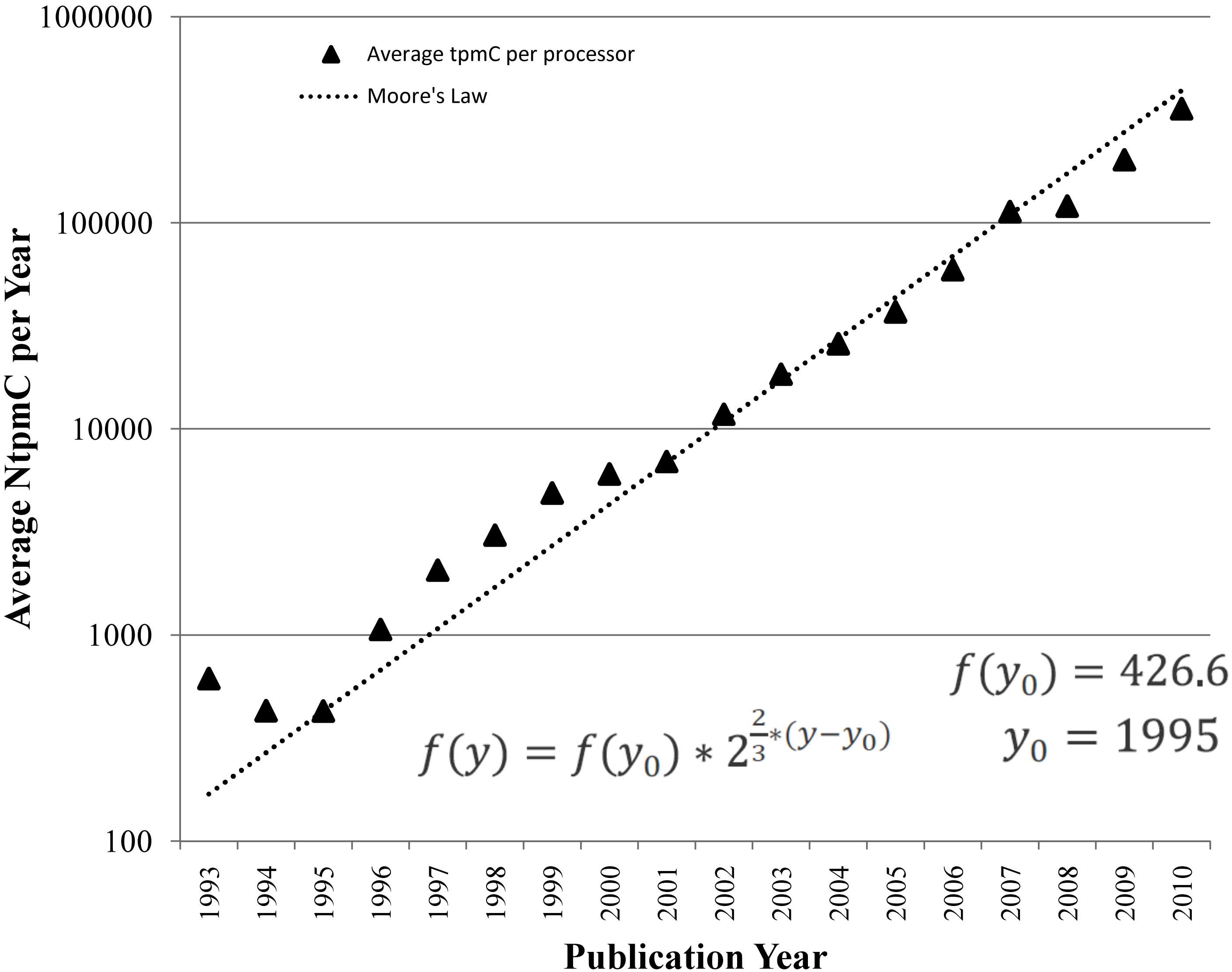
TPC-C Metric [tpmC]

- TPC-C primary performance metric: Transactions per minute [tpmC]
- TPC-C price performance metric is: System Cost + 3 year maintenance divided by transactions per minute [$/tpmC]
- System size range widely
  - Single, one processor server with few disks to large clusters with thousands of disks
  - Consequently performance varies from hundreds to millions of tpmC
- Normalized performance metric NtpmC = tpmC divided by the number of processors (sockets)

NtpmC for Years 1993 to 2010



NtpmC for Years 1993 to 2010

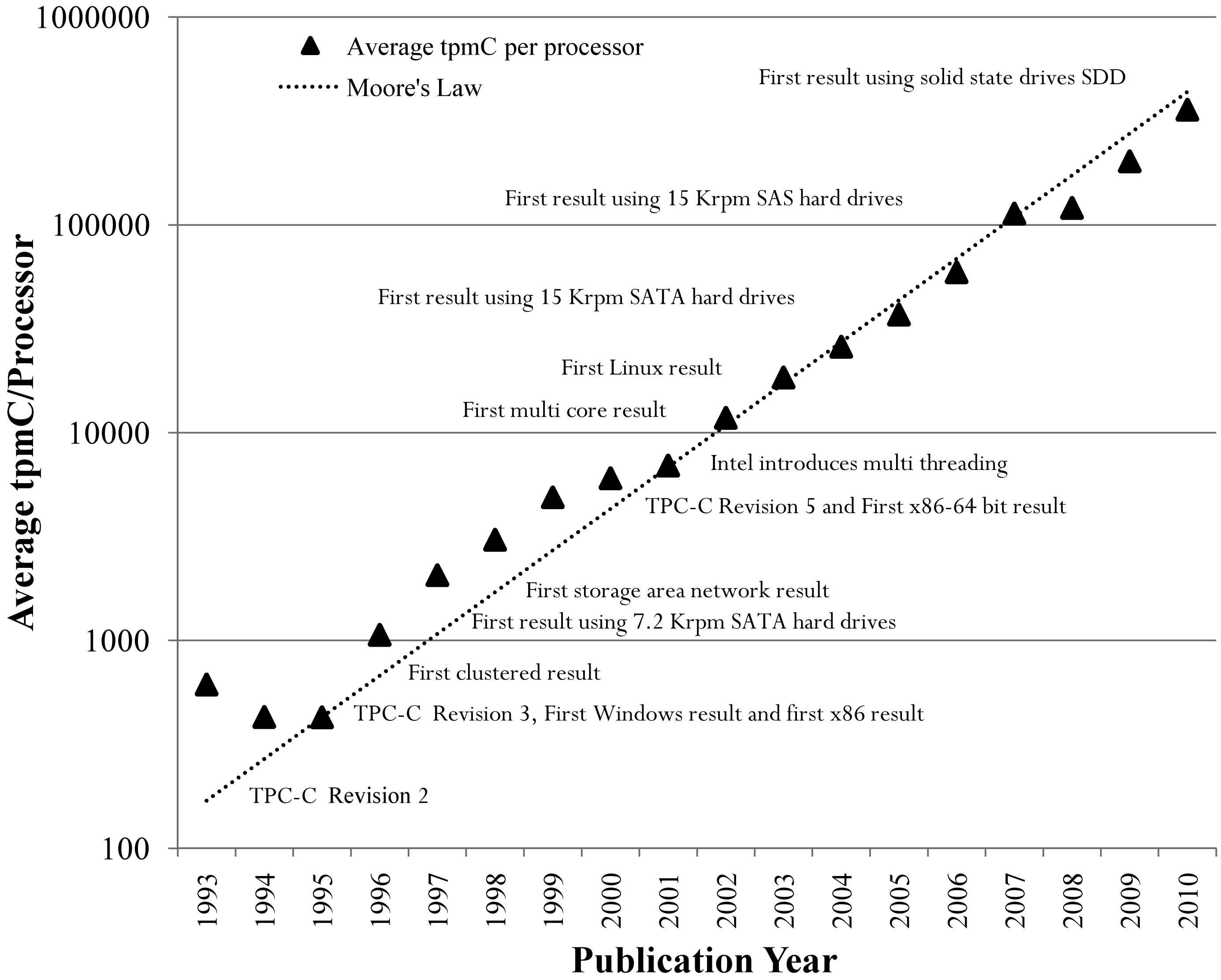


$$f(y) = f(y_0) * 2^{\frac{2}{3}*(y-y_0)}$$

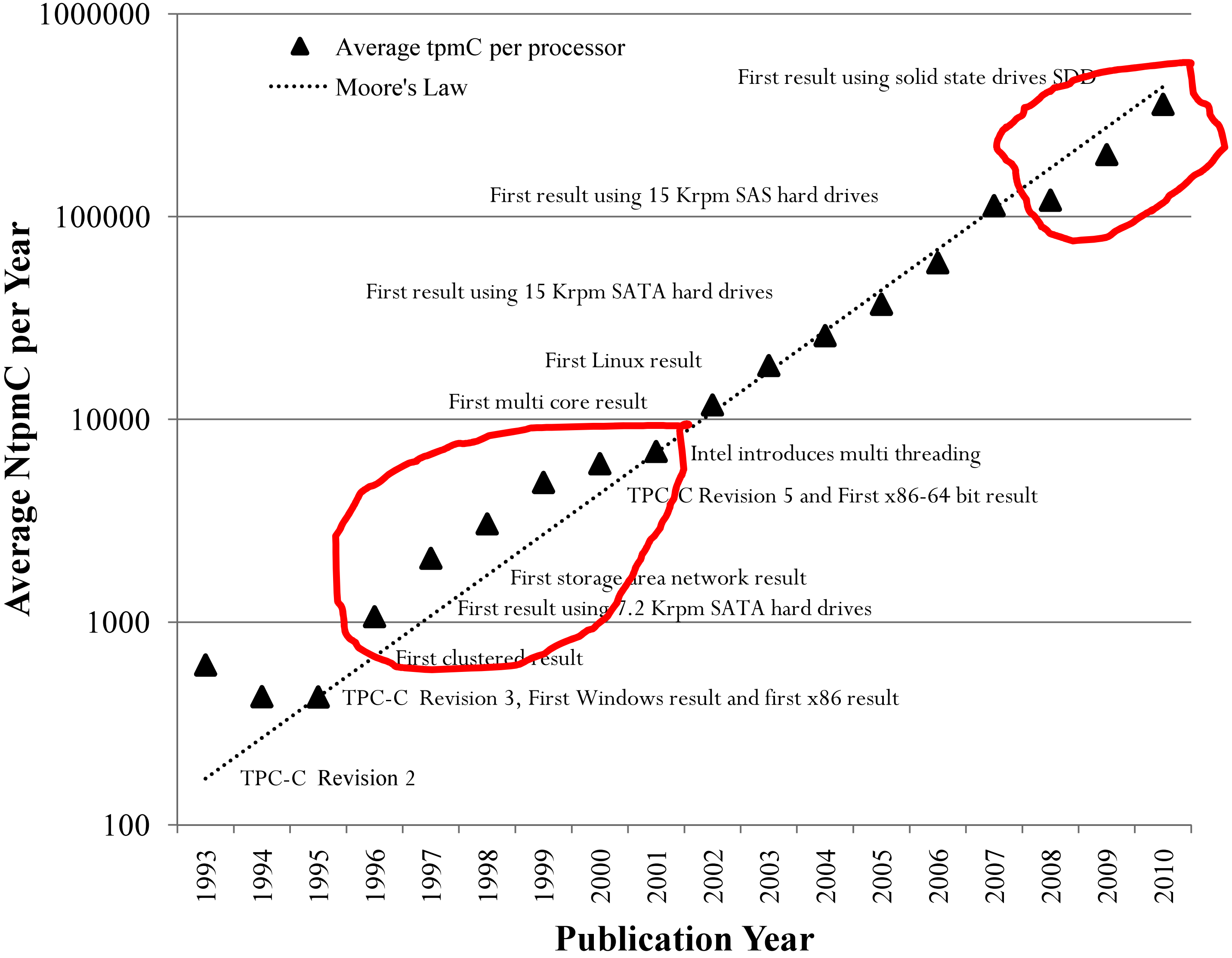
$$f(y_0) = 426.65\ NtpmC$$

$$y_0 = 1995$$

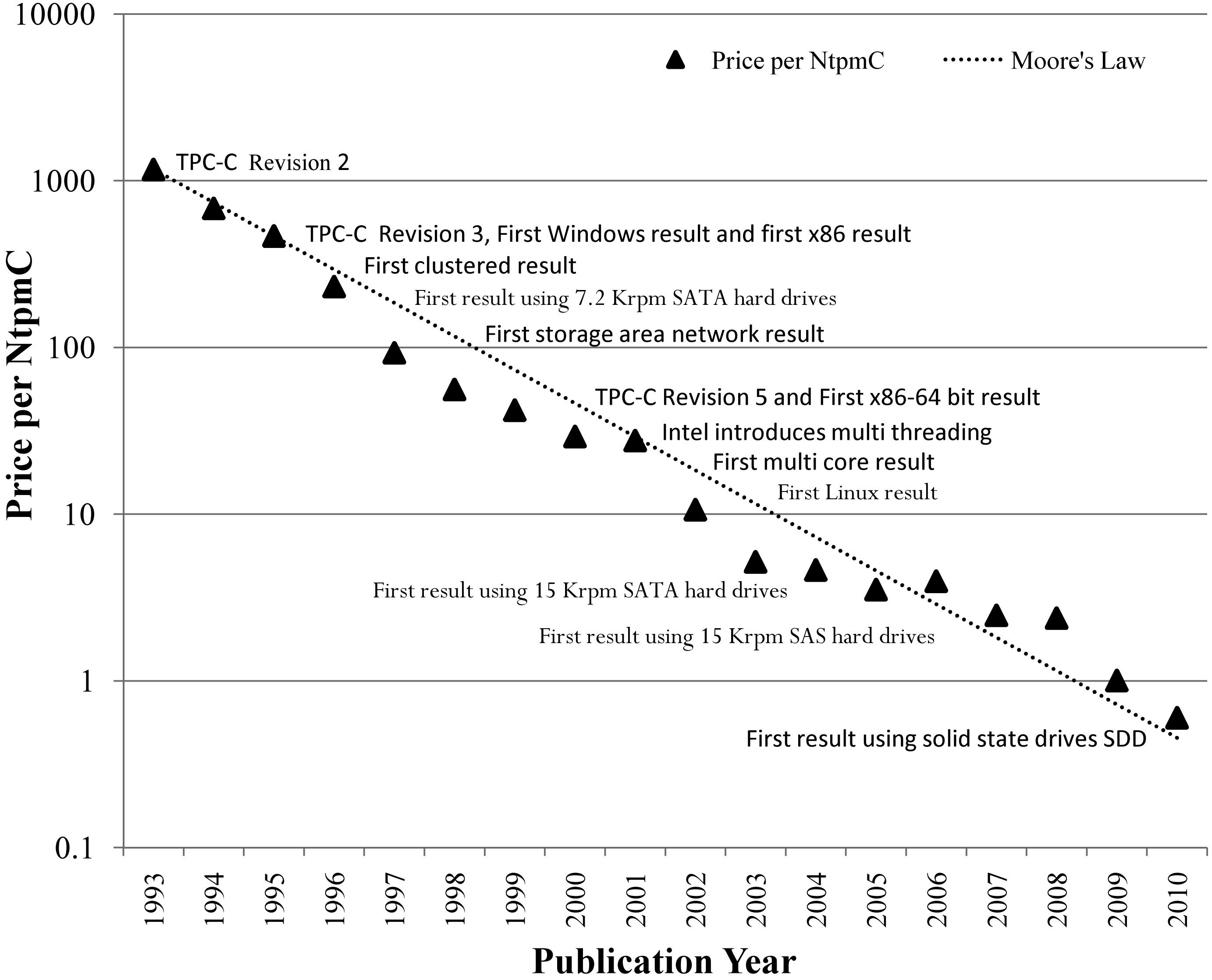
Transaction performance vs. Moore's Law, Milestones, 1993 to 2010



NTpmC for Years 1993 to 2010



TPC-C Price-Performance Trend



Conclusion

- TPC-C performance improvements over 18 years are remarkably similar to Moore's Law
- TPC-C price-performance also follows Moore's Law
- Topics of debate
  - → Can TPC-C performance be attributed solely to processor improvements?
  - → Do we need TPC-C benchmarks if performance can be predicted so easily?

Conclusion Cont'

- No, because TPC-C systems:
  - Complete systems that involve many components (Server, Storage, Network, Software)
  - The increase in processor speed causes challenges:
    1. Performance of other component needs to be increased
    2. Components whose performance lagged behind need to be replicated
    3. Software has to deal with more concurrency

Conclusion Cont'

1. Performance of other components need to be increased, e.g.
   - System BUS
   - Memory (Capacity and performance)
   - IO Subsystem (Controllers, Arrays, Disk Drives, Drivers and Firmware)
2. Components whose performance lagged behind need to be replicated, e.g.
   - Disk drives: disk per processor increased from 12 to over 100
3. Software (OS,DBMS) has to deal with more concurrency, e.g.
   - Multiple Cores
   - Large user counts
   - Semaphore contention
   - Locking