Using MVCC for Clustered Databases

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Using MVCC for Clustered Databases

structure

- introduction, scope and terms
- life-cycle of a transaction in Postgres-R
- write scalability tests
- results and their analysis

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focus: cluster

- high availability, load balancing, low cost
- fast, low latency interconnect
- shared-nothing

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focus: clustered database ideals

- application transparent
- transparent data distribution and load balancing
- ACID compliant
- easy to setup and maintain

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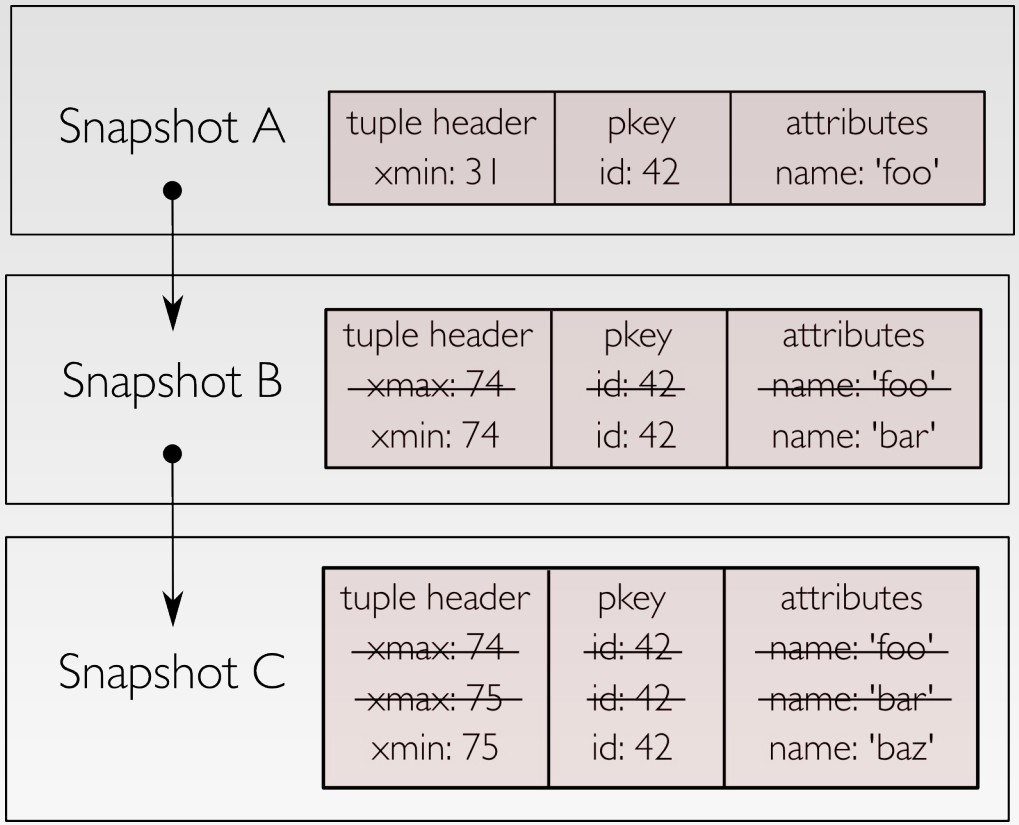
focus: multi-version concurrency control (1)



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focus: multi-version concurrency control (2)

- provides "point in time" consistent snapshots
- writes never block reads
- requires deferred background cleanup (vacuum)

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users of multi-version concurrency control

Databases: Postgres, Oracle, Microsoft SQL Server, IBM DB2, some MySQL storage engines, Ingres, Sybase SQL Anywhere, Sybase IQ, Berkeley DB, Firebird, CouchDB, HSQLDB, H2, InterBase, …

Others: JBoss Cache and Infinispan, Clojure, Subversion, Ehcache, …

Source: http://en.wikipedia.org/wiki/Multiversion_concurrency_control

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life-cycle of a transaction: overview

- collection and distribution of changes
- optimistic and parallel application
- conflict detection using MVCC
- commit independently but in congruent order

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life-cycle 1: collection of change sets

changes are collected and serialized into change sets

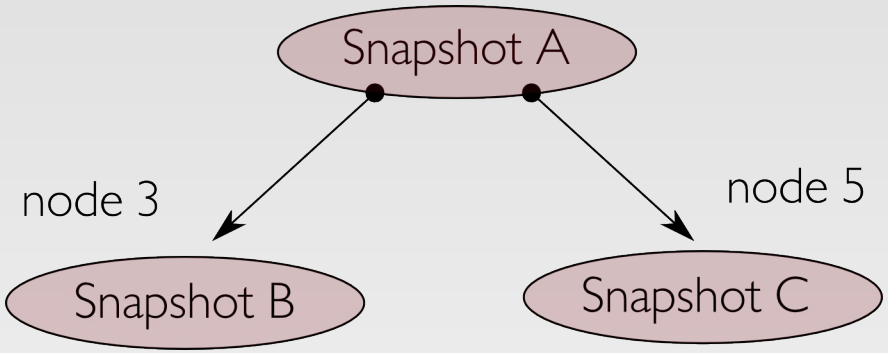
includes: primary key and origin information

tuple origin	pkey	changed atts
n:5 / xid:31	id: 42	name: 'bar'
n:2 / xid:27	id: 88	name: 'foo'

a size threshold triggers eventual broadcasts

life-cycle 2: optimistic and parallel application

background worker infrastructure allows parallel application of remote transactions



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life-cycle 3: conflict detection using MVCC

compares visible version and to-be-updated version

mismatches signal a conflict

MVCC allows identifying the conflicting transaction

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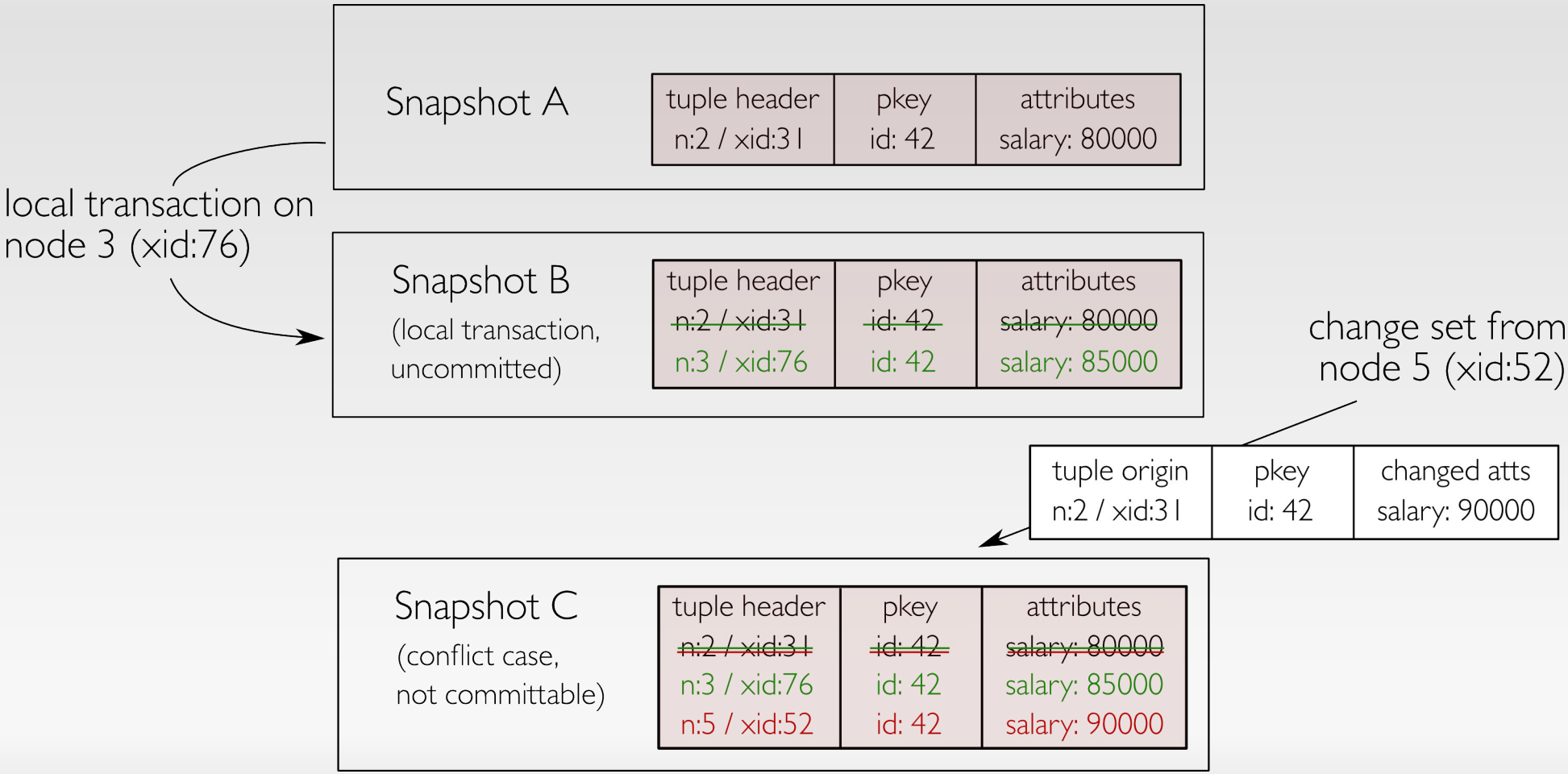
life-cycle 3: conflict detection using MVCC (example)



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life-cycle 4: congruent commit decision

before commit, an agreement on the ordering of transactions is required

nodes may progress at different speeds

applying the same changes in the same order guarantees eventual consistency

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advantages of using low-level MVCC interface

built-in support for:

- triggers
- UDFs
- rules

easy support for:

- savepoints

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write scalability

overall computing power, memory and storage capacity scale easily

the interconnect will inevitably be the bottleneck at larger scale

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write scalability: how to fight network congestion

- minimize number of nodes to replicate to (partitioning)
- minimize communication overhead between nodes
- minimize transaction runtime

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traffic test: systems tested

- PgPool-II (2.3.3)
- Postgres-XC (0.9.1)
- Postgres-R (06-2010)
- Postgres Hot-Standby (9.0 Beta 2)

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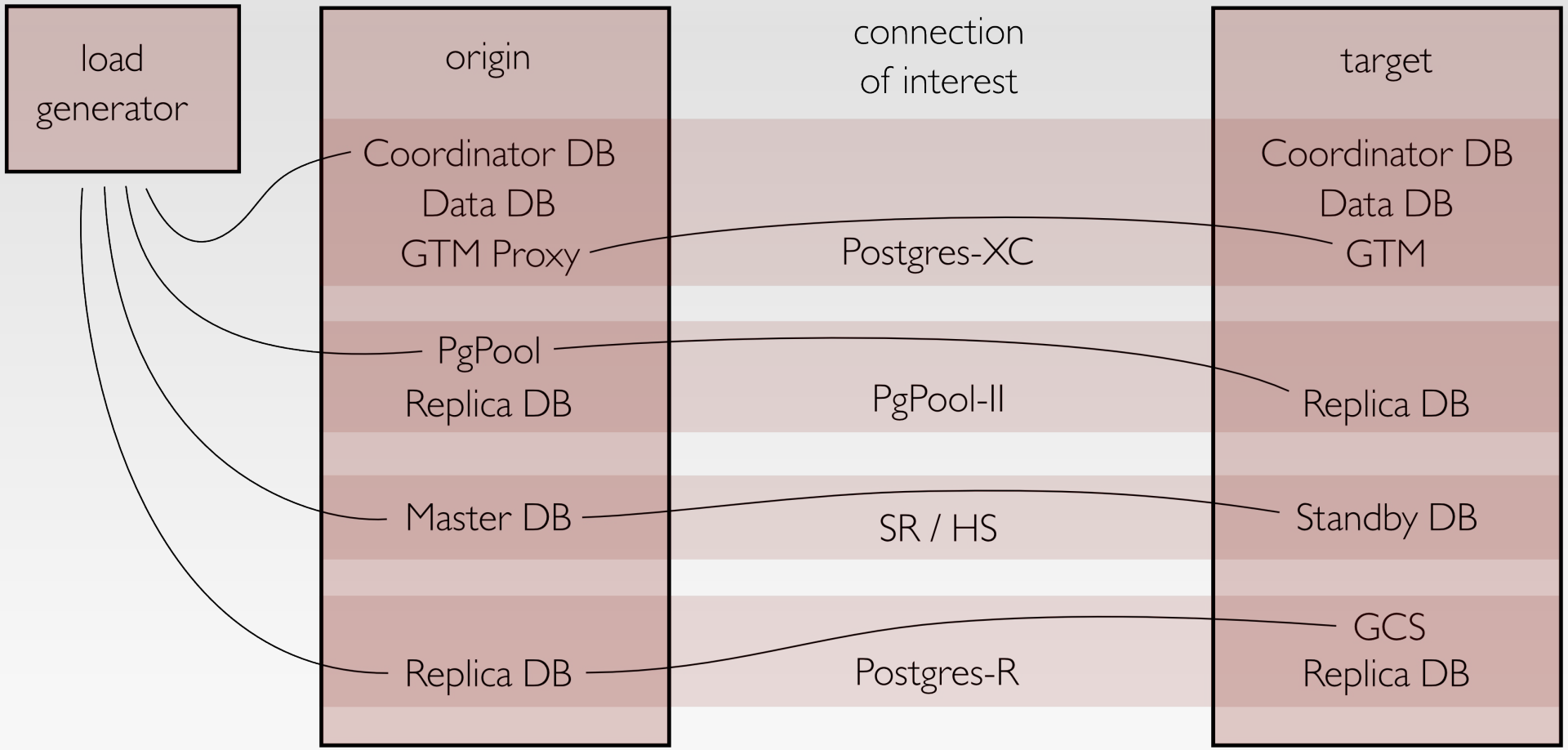
traffic test: setup



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traffic test: example transaction

new-order transaction from dbt2 (used 45% there)

- 7 - 17 row selections (no impact on replicas)
- 6 - 16 selects followed by updates
- 7 - 17 inserts

simulated avg. new-order transaction:

11 updates and 12 inserts, scripted, no UDF

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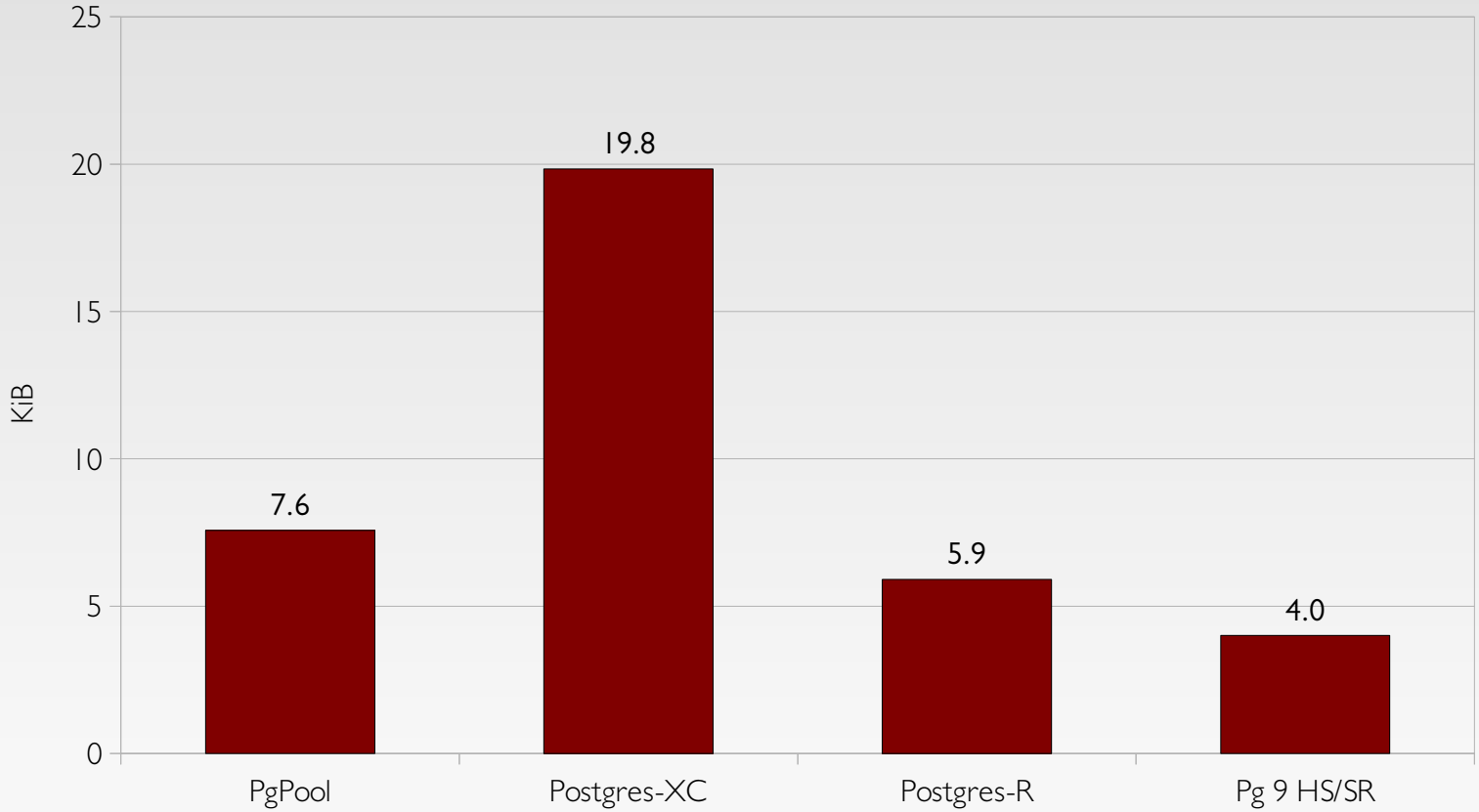
traffic test results: avg. data transmitted per txn



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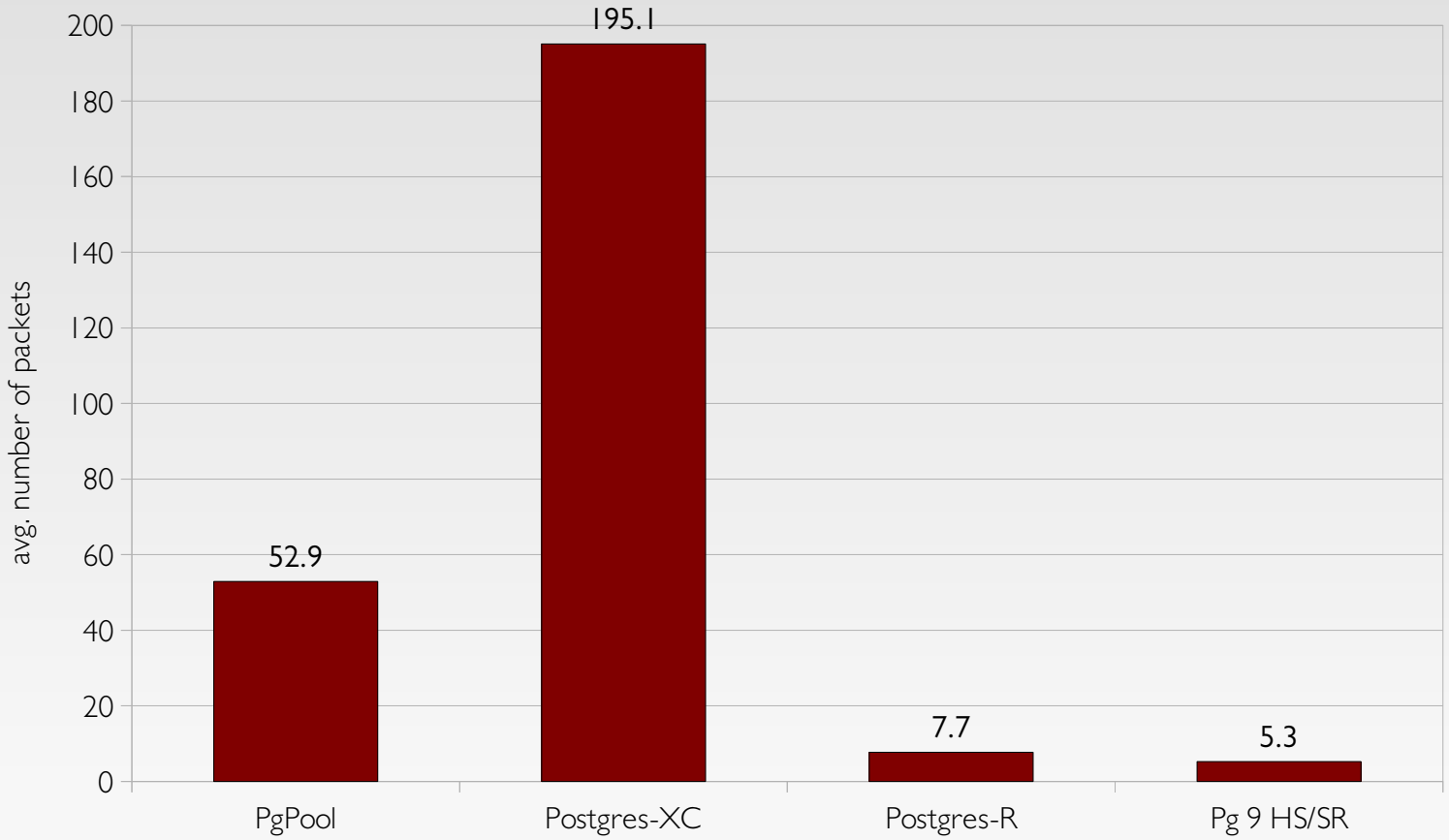
traffic test results: packets exchanged per transaction



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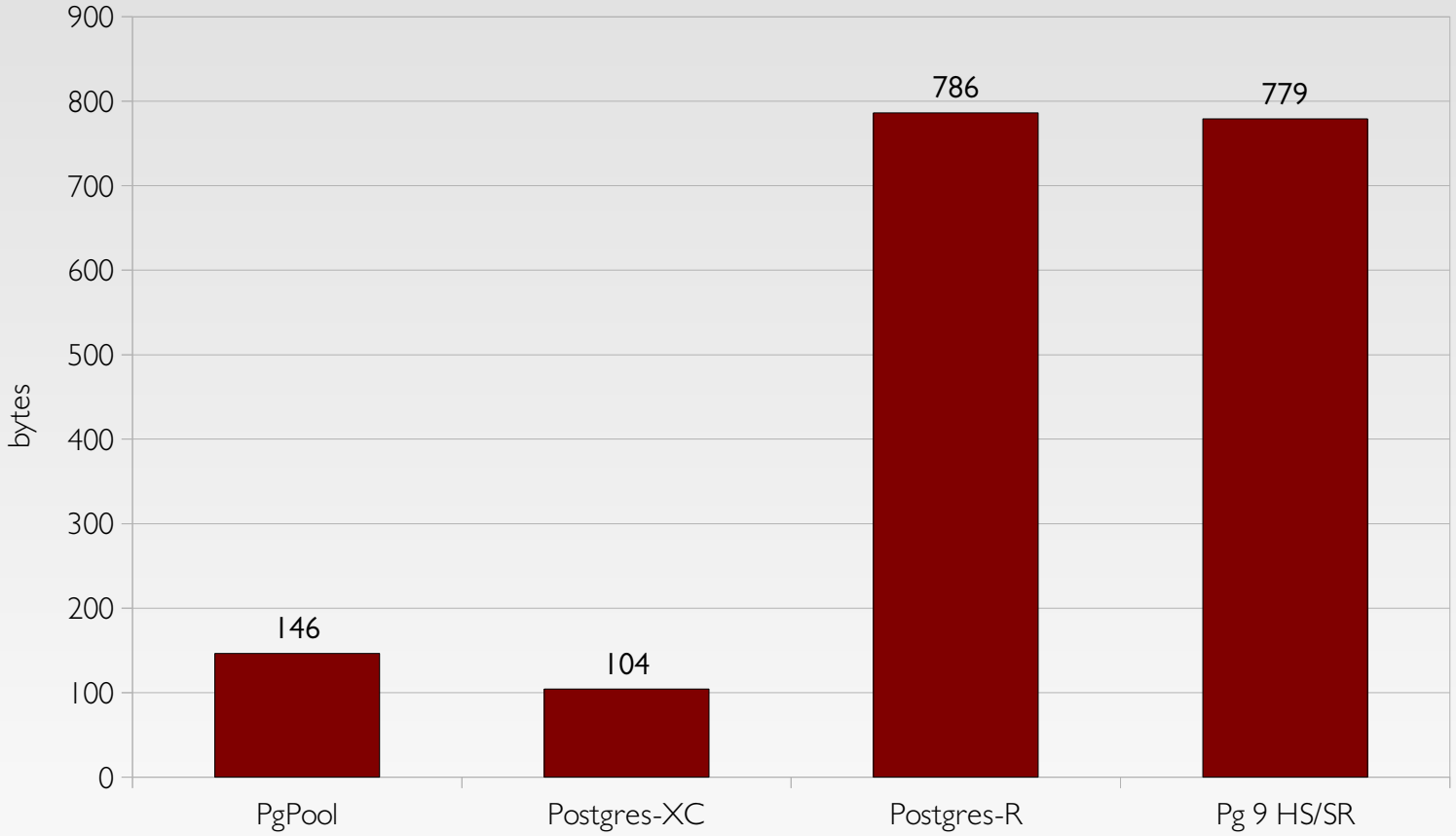
traffic test results: avg. packet size



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latency test: description

- added artificial 1000ms delay
- measured latency for single operations
- result figure: amount of round-trips required

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latency test results: round-trip count comparison

	txn start	txn commit (read-only)	txn commit (writing)	txn rollback	savepoint	release savepoint	rollback to savepoint	insert	update	delete	sequence nextval	sequence setval
PgPool-II (2.3.3)	1	1	1	1	1	1	1	1/2[1]	1	1	1	1
Postgres-XC (0.9.1)	2[2]	2	5-7	2	-	n/a	-[3]	2-3	2	2	3-5[4]	2-3
Postgres-R (2010-06)	0	0	1	0	0	0	0	0	0	0	1	1

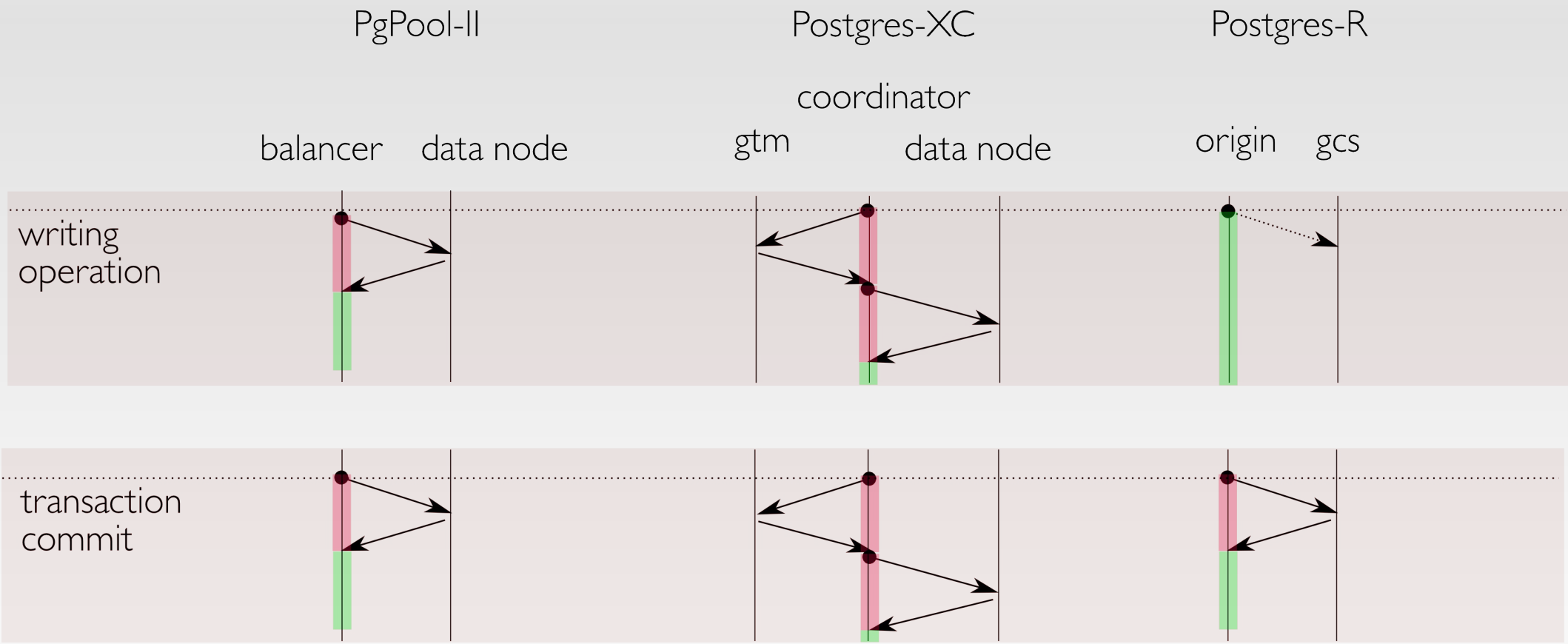
[1] 2 RTT if a SERIAL is involved and insert_lock == true

[2] deferred until a snapshot is requested

[3] savepoints are not supported in Postgres-XC 0.9.1

[4] nextval() is free if used from an INSERT

latency test analysis: time-lines



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new order transaction latency

	txn start	inserts (12)	updates (11)	txn commit		estimated total round-trips	measured runtime (at 1000ms latency)
PgPool-II (2.3.3)	1	12	11	1		25	26.25
Postgres-XC (0.9.1)	2	24	22	6		54	58.45
Postgres-R (2010-06)	0	0	0	1		1	1.19

thank you