PostgreSQL on ARM: ecosystem, optimization & tuning

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Why ARM?

- Low cost of ownership
- All standard Linux operating systems available on ARM
- Many databases are available on ARM.
- Many powerful ARM chips available
  - Huawei: Kunpeng920
  - Amazon: AWS Graviton2
  - Ampere: Altra max 80-120 cores
  - Apple: M1 Laptop
  - Microsoft: News is that they are developing a ARM-based Chip..
- Growing adoption
- Widely available on Cloud
Speeding up PostgreSQL on ARM

- Apply Cost-performance model before comparing performance on ARM versus x86
  - [https://mysqlonarm.github.io/CPM/](https://mysqlonarm.github.io/CPM/)

- Contention: Critical to scale out with very high number of clients

- Atomic operations should be optimized (**atomic_compare_exchange**, **atomic_fetch_add**)
  - These are Hardware and compiler dependent functions to manipulate memory atomically

- Look for platform-specific conditional compilation

- Compiler options and compiler versions
  - gcc 10.1 makes use of LSE instructions for **atomic_compare_exchange**, etc
Speeding up PostgreSQL on ARM

- NUMA awareness
- SIMD Vectorization
- CPU Cache line size
- Importance of Query Parallelism on ARM
When PostgreSQL bring ARM?

PG community provides the easiest way to use PostgreSQL on ARM64 platform.

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2020.03

PostgreSQL 9.5, 9.6, 10, 11, 12, 13 versions released Deb ARM64 packages for Debian and Ubuntu in Mar, 2020.

2020.04

2020.08

aarch64 support is available on yum.postgresql.org

2020.09

PostgreSQL 9.5, 9.6, 10, 11, 12, 13 versions released RPM(YUM) ARM64 packages for RHEL, CentOS 7,8 and fedora in Aug, 2020.
2018.04 Optimize Arm64 crc32c implementation in Postgresql

2020.01 spin_delay() for ARM

2020.07 Inlining of couple of functions in pl_exec.c improves stored procedure performance

[PATCH] auto-detect and use -moutline-atomics compilation flag for aarch64

2020.09 Auto-vectorization speeds up multiplication of large-precision numerics

2020.10 Improving spin-lock implementation on ARM.

2021.01 Speeding up GIST index creation for tsvectors

ARM specific optimization

PG community provides the easiest way to use PostgreSQL on ARM64 platform.
What we gain from ARM?

1. Inline of couple of functions in pl_exec.c improves stored procedure performance (7-14%)

2. spinlock optimization (10-40%)

3. SIMD optimization for multiplication of numeric types (2.7x)

4. GiST index build optimization (30-60%)

5. -moutline-atomics compilation flag for aarch64 (3%-10%)

Adaption & optimization on ARM platform.
What we gain from ARM?

More cores, more numa nodes and challenges.

- ARM tend to have more Cores and in-turn more NUMA nodes.
- No hyper-threading support.

Challenges:
- Across Numa might bring bad/unstable performance.
- How to make a good use of these resources?
Don't access state variables/structure across NUMA nodes.
Numa Issue

Don’t access state variables/structure accross NUMA nodes.
Parallel Queries

Large scale
Resource utilization rate
Bigdata scenarios
pgbench
  -b select-only

ARM64:
  Kunpeng 920 2.6 Hz
  64 cores

x86_64:
  Intel(R) Xeon(R) Gold 6151
  3.00 Gz
  28 logical cores

Tables pre-warmed

pgbench scale=3000

Cost-performance model: Two machines with same price:
  64-CPU ARM versus 28-CPU x86 machine

**ARM optimization:**

Spinlock spins using
  atomic compare-and-exchange operation (__atomic_compare_exchange_n)
rather than atomic exchange operation (__sync_lock_test_and_set)
pgbench -b tpcb-like

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