PHP / HHVM Optimization for AARCH64

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PHP and HHVM

- HHVM has played a valuable role in the evolution of PHP
- Grew from an initial PHP to C++ compiler
- Released in 2011 as the Hip Hop Virtual Machine
- A just-in-time compiler generating machine code from bytecode
- Saw incentive in achieving parity and delivering compatible PHP 5 results
- Together with HHVM, Facebook also released Hack, which is a programming language specifically tailored for HHVM
- In 2017, the HHVM team announced a parting of ways recognizing the growth of PHP7 and continuing their own development in support of Hack

HHVM JIT

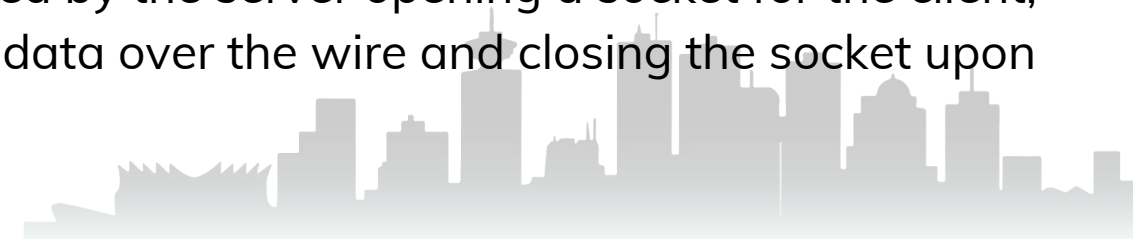
- The HHVM JIT is broken up into four components:
  - Type specialization
  - Profile-guided optimizations
  - Side exits
  - Region-based compilation
- Type specialization relates to obtaining type information either dynamically or statically and the granularity by which they are specialized
- Profile-guided optimizations are a class of optimizations that can be either enabled or enhanced by the use of runtime information.
- Side-exits are uncommon traps which give the JIT the ability to leave a compilation unit and transfer control elsewhere.
- Code generation in HHVM is based on regions (region-based compilation). These are not restricted to entire methods, single basic blocks, or straightline traces

Open Source Benchmark Suite

- The goal is to provide a benchmark suite, testing something representative of real-world situations.
- The main suite configures and runs nginx, siege, and PHP5/PHP7/HHVM over FastCGI, over a TCP socket. Configuration is as close to identical as possible.
- The script will run 300 warmup requests, then as many requests as possible in 1 minute. Statistics are only collected for the second set of data.
- Generates reliable synthetic benchmarks for purposes of profiling popular PHP5 compatible apps such as Drupal and MediaWiki using either the PHP runtime or HHVM

Siege

- Siege is an open source regression test and benchmark utility. It can stress test a single URL with a user defined number of simulated users, or it can read many URLs into memory and stress them simultaneously.
- One can run either dynamic or cached tests
- It runs its test from only one server
- Runs from the command line, relatively painless setup and install
- The program reports the total number of hits recorded, bytes transferred, response time, concurrency, and return status.
- A transaction is characterized by the server opening a socket for the client, handling a request, serving data over the wire and closing the socket upon completion.



Optimization focus

- Initial focus on OS and tools
- Added PGO
- Enabled USE_LOWPTR:
  - This allows us to compact objects with members that are guaranteed to point to low memory.
  - Some other optimizations are tied to enabling USE_LOWPTR as well.
- Enabled Hardware CRC through our compiler and via CMake flag
- Set-up pre-run optimizations
  - Flush caches
  - Give the kernel the ability to reuse TCP ports which may be in a TIME_WAIT state
  - Disable ASLR, i.e., kernel randomization of va space
  - Set cpufreq to performance
  - Etc.

Optimization focus

- Look at JEMalloc and current configuration options
- Evaluate 64KB pages with enabled Transparent Huge Page support
- Investigate memset/memcpy optimizations
- Evaluate Cache performance
- Consider branching and address range limitations

Profiling

- Enabled TC-Print for annotated perf collection
- Used perf to capture key performance coutners
- Made use of flamegraphs in combination with perf

Observations

- PHP-Zend lacked support for Aarch64 GCC Global variables. Where GCC Global variables help is that they can be substituted for arguments to the handler by storing them in global registers.
- Limitations on immediate moves into a register, three instructions versus one for example
  - ARMv8
    movz x0, #0xe8c8
    movk x0, #0x92e3, lsl #16
    movk x0, #0x3ff, lsl #32
  - x86
    mov $0x7f5caa293f08, %rax

Observations

- Limitations on conditional branch address ranges
  - Unconditional simple relative branches can branch backward or forward up to 128MB from the current program counter location.
  - Conditional simple relative branches, where a condition code is appended, have a smaller range of ±1MB.
  - That can be costly when the JIT is trying to move code blocks. In such a case, preventing the code splitting between hot/cold makes sense.
  - With x86, when hot/cold code splitting occurs, that relevant short-displacement conditional branch instructions are changed to larger displacement conditional branch instructions
- Cache topology and size

Discussion

Thank you

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