Optimizing Linux Kernel with BOLT

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Overview

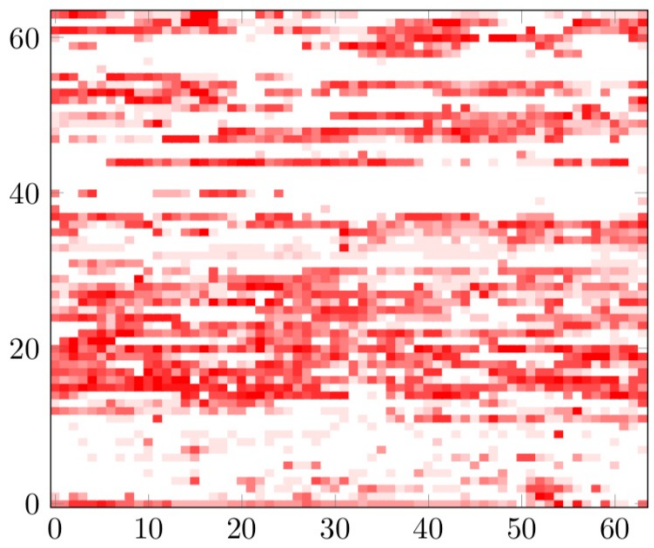
- What is BOLT
- How it works
- Linux Kernel Challenges

What is BOLT?

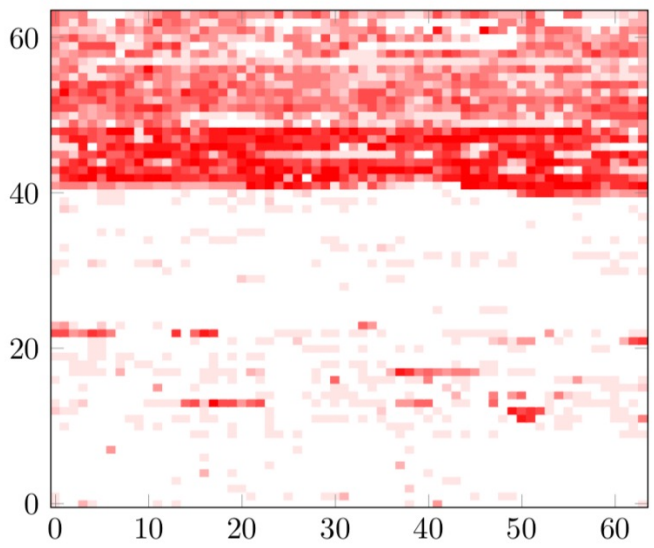
Binary Optimization and Layout Tool

- Binary
  - Compiled and linked executable or dynamic library
  - Suffers from CPU front-end stalls
- Optimization
  - Double digit speedup on top of PGO+LTO
- Layout
  - Code Layout is the main optimization

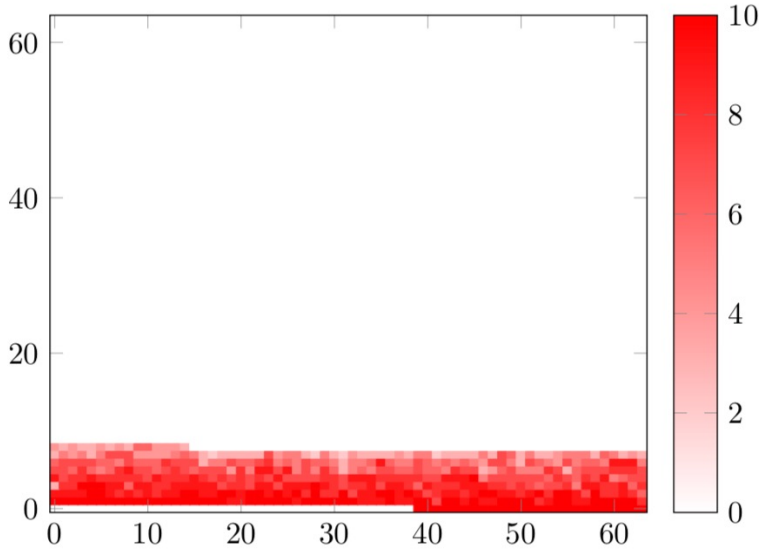
Code Layout Optimizations



Un-optimized

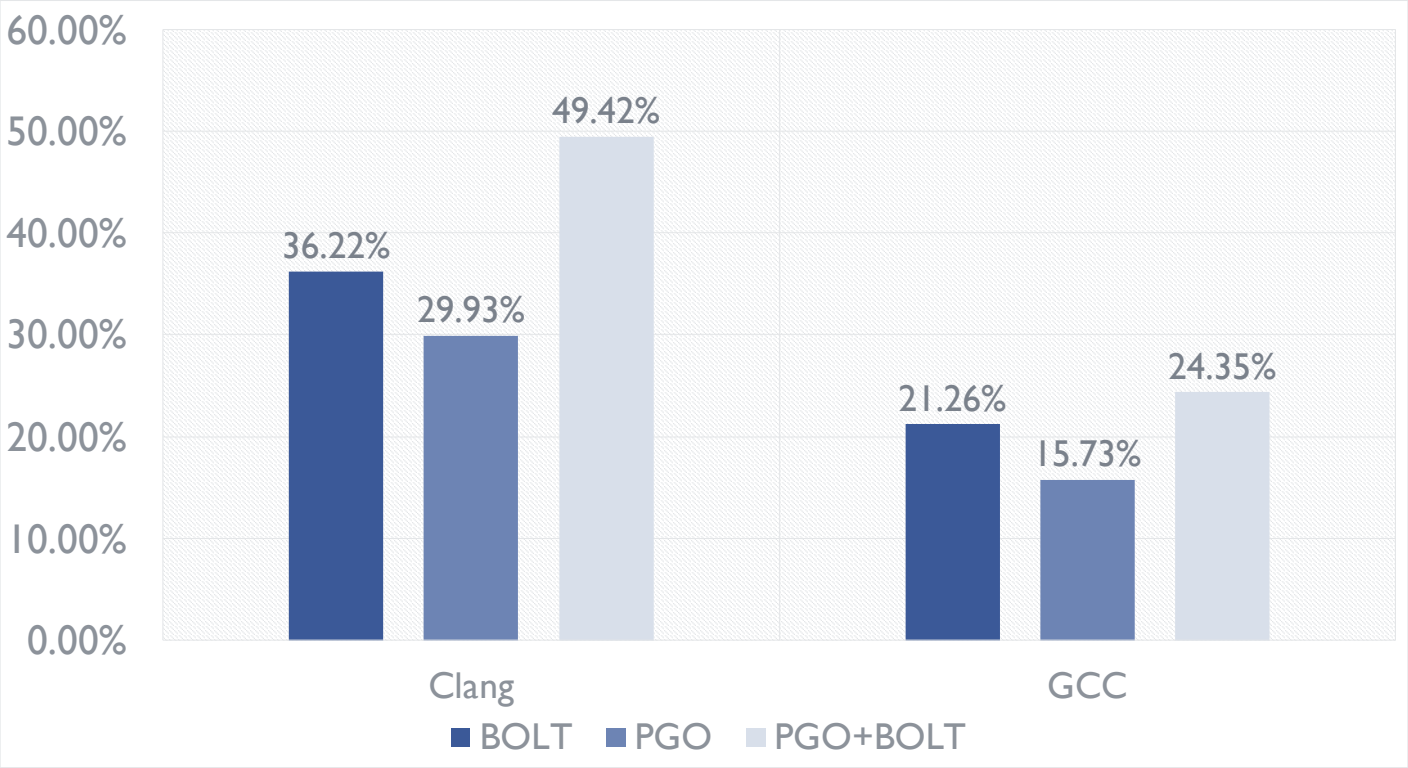


Better



Best

Clang and GCC Speedup



How to use BOLT?

- Collect profile
  - Sample run
  - Production environment
  - Methods
    - Sampling (Linux perf tool)
    - BOLT instrumentation
- Link with *–emit-relocs*
- Apply optimizations by running BOLT
  - $ llvm-bolt a.out –data perf.data –o a.out.fast <...>

VS Compiler

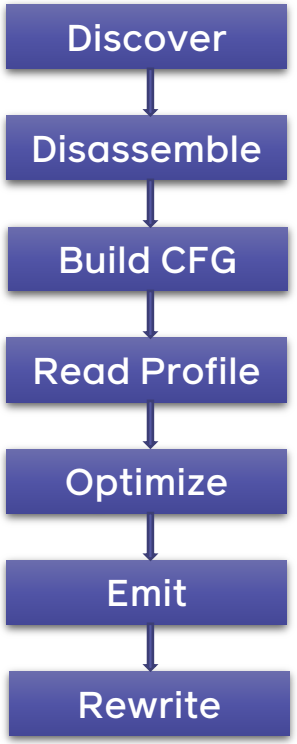
Compiler

- Uses profile for optimizations – PGO/FDO/AutoFDO
- Layout is the last step in optimization pipeline
- Profile no longer accurate

Compiler Solution

- Use two profiles
- Compile twice
- (*) Context-sensitive profiling

BOLT Pipeline



- Find functions and data in code
- Identify instructions inside functions
- Analyze instructions and build CFG
- Read profile and attribute to CFG edges
- Execute local and global optimization passes
- Generate code and process relocations
- Write code to file and update ELF

Linux Kernel Challenges for BOLT

- Self-modifying and self-patching code
- Custom unwinding and exception handling
- Re-writing the binary

Linux Kernel Challenges for BOLT

- Alternative instruction sequences
  - .altinstructions, etc.
- Exceptions
  - __ex_table, .pci_fixup
  - __bug_table
- ORC
- Possible approach: selective optimizations

Linux Kernel Challenges for BOLT

- Rewriting the binary
- Regular ELF
  - Allocate new segments(s) for code and data
- Kernel
  - Pre-allocate at link time
  - Expand existing segments

Thank you

http://github.com/facebookincubator/BOLT