Practical Use of BOLT

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Eighth LLVM Performance
Workshop at CGO

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Edinburgh, UK

Meta

Agenda

1. Introduction
2. Prerequisites
3. Profile collection
4. Usage of BOLT
5. Logs and debugging
6. Interaction with PGO

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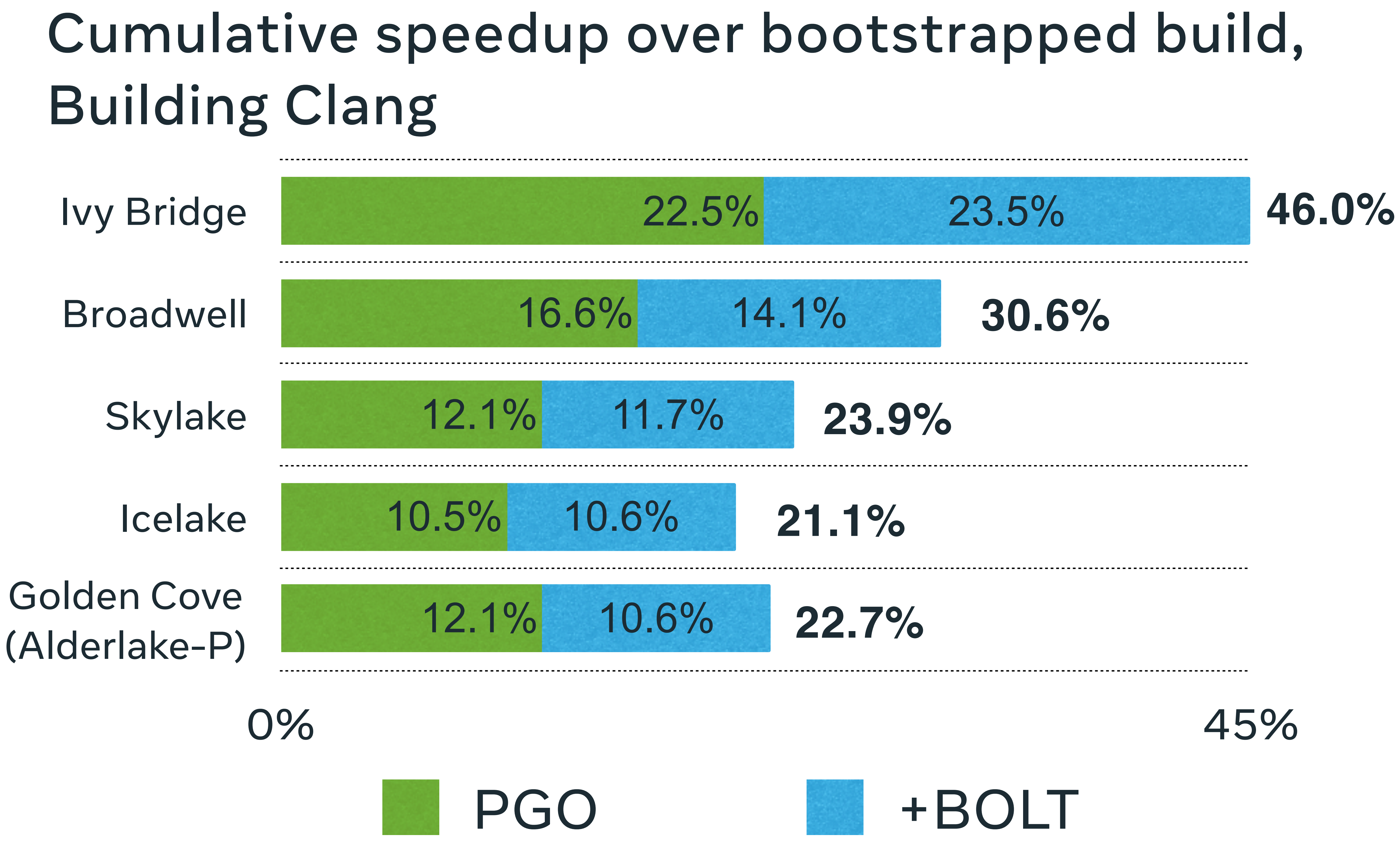

2022 LLVM Dev Meeting: Optimizing Clang with BOLT using CMake

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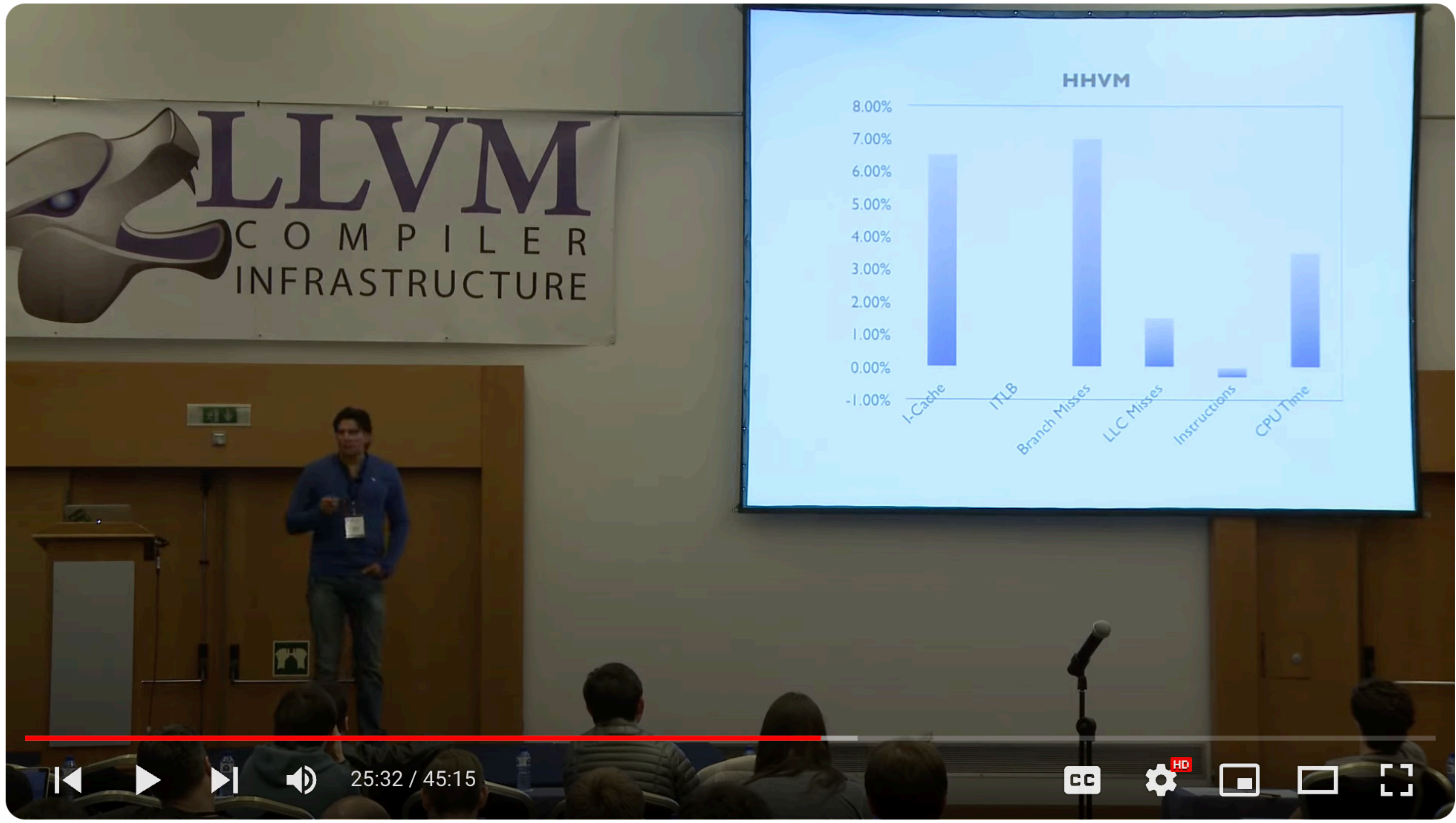

2016 EuroLLVM Developers' Meeting: M. Panchenko "Building a binary optimizer with LLVM"

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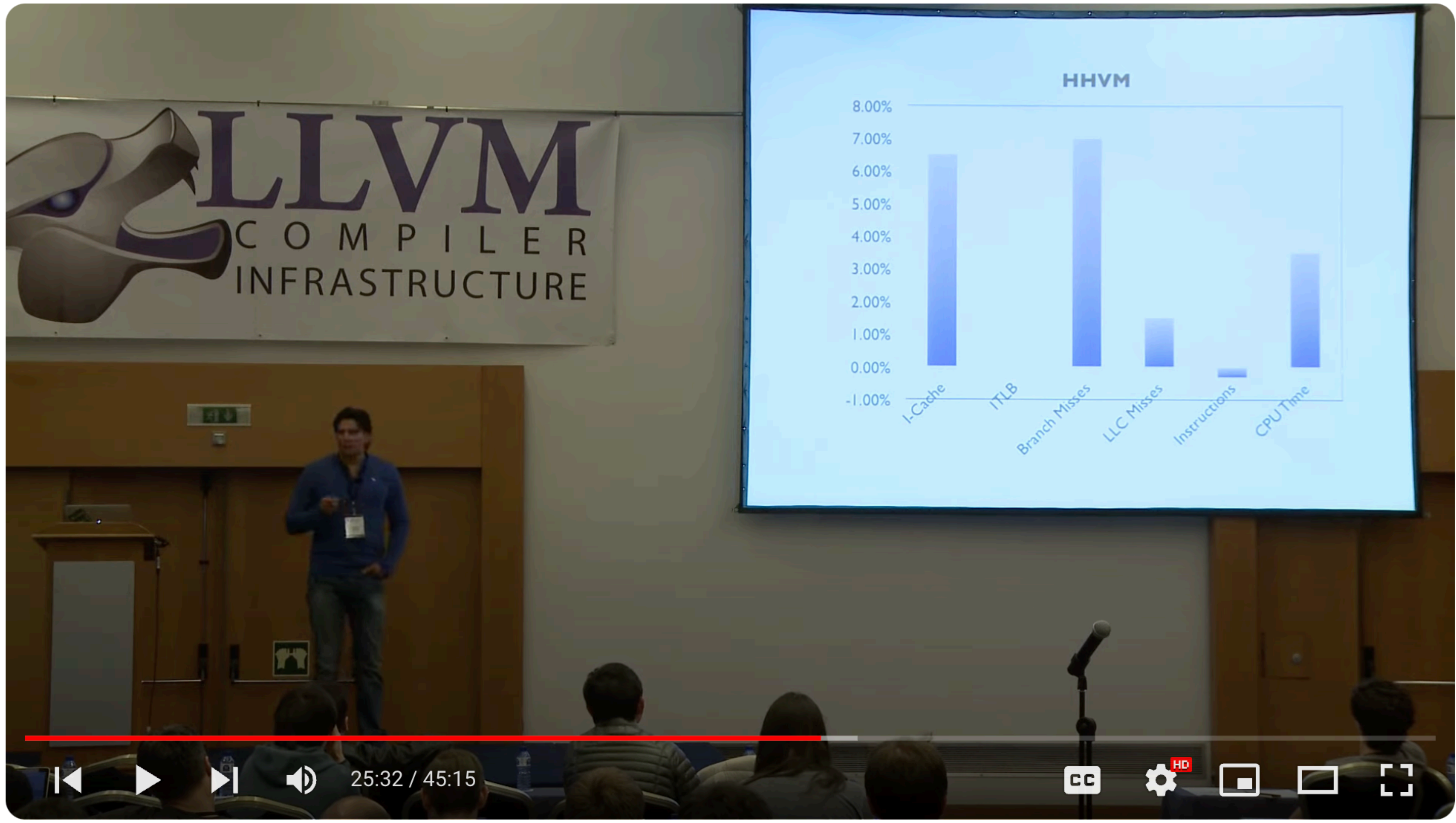

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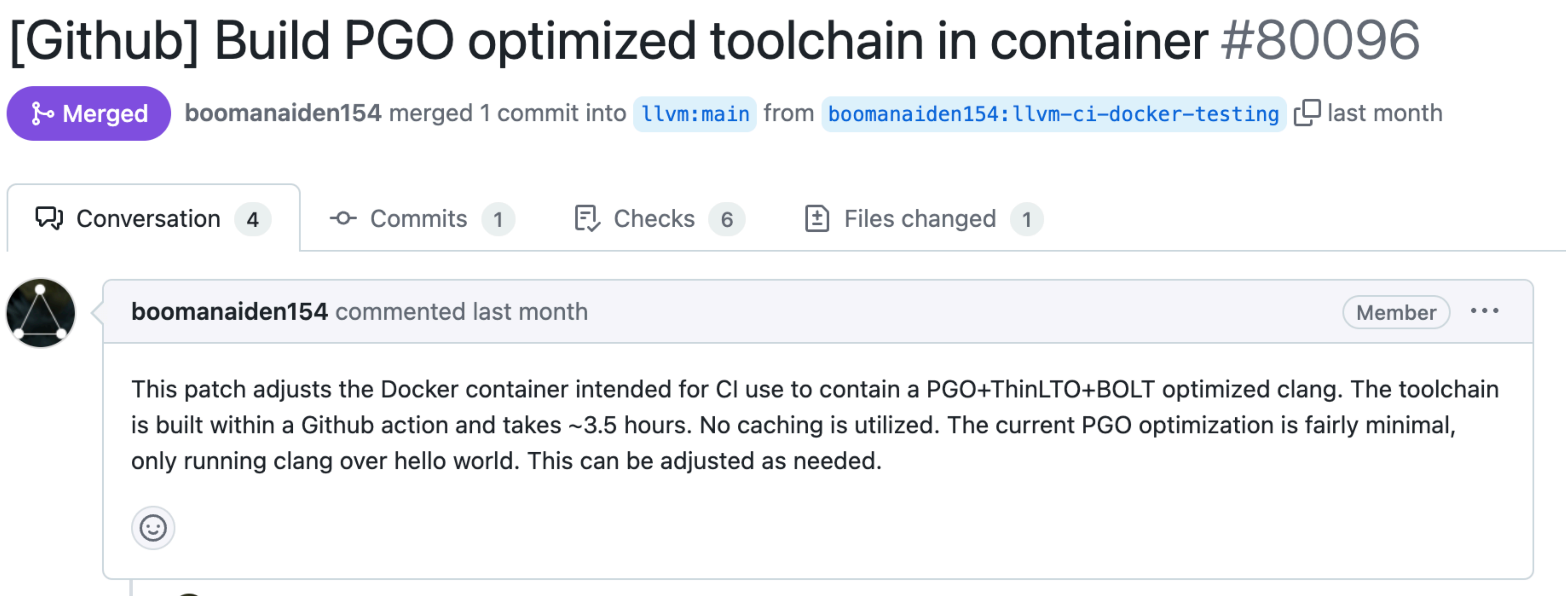

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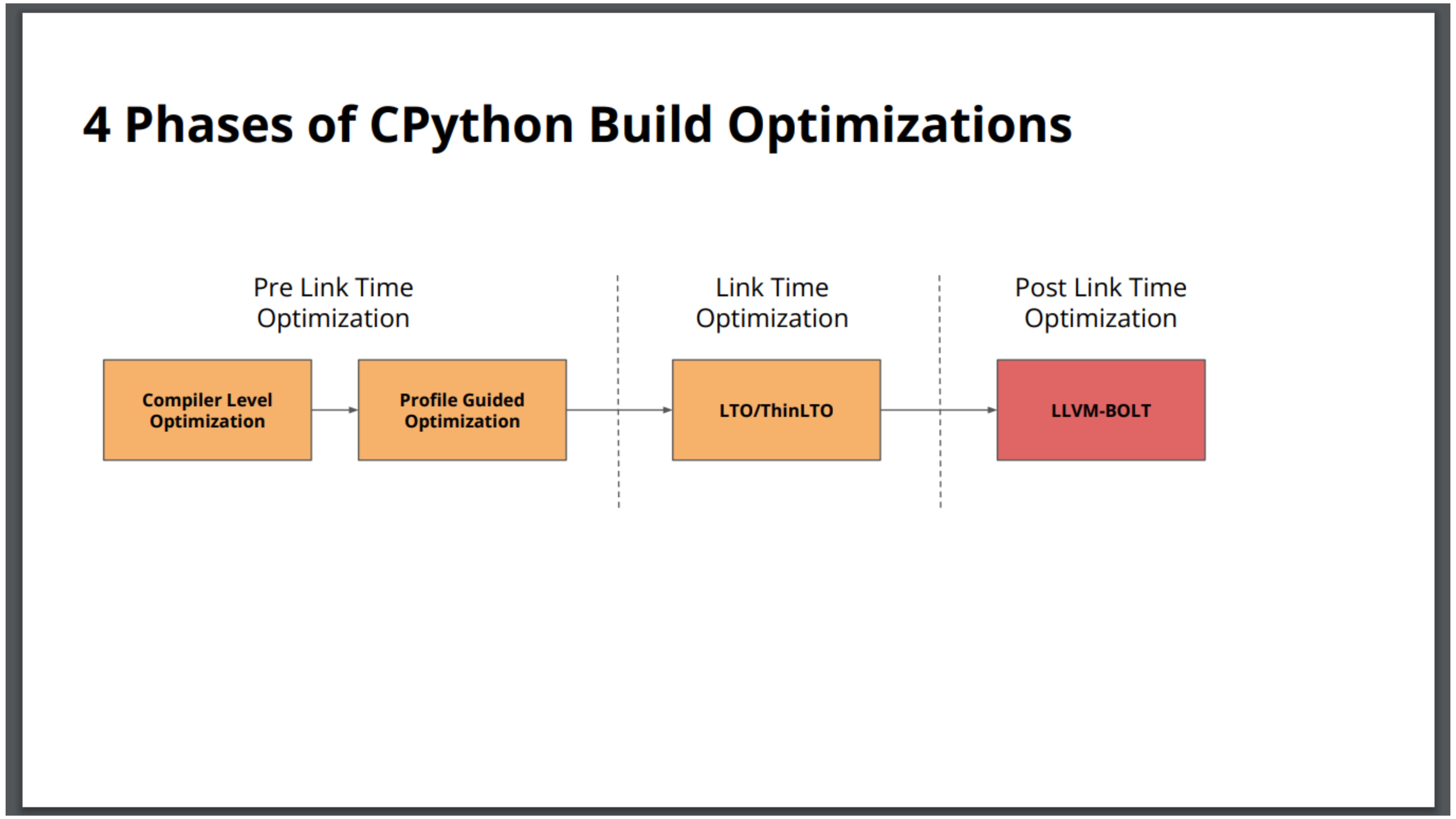

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Code layout optimizations for rustc

The Rust compiler continues to get faster, with this release including the application of BOLT to our binary releases, bringing a 2% mean wall time improvements on our benchmarks. This tool optimizes the layout of the `librustc_driver.so` library containing most of the rustc code, allowing for better cache utilization.

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Faster Rust Toolchains for Android

Posted by Chris Wailes - Senior Software Engineer

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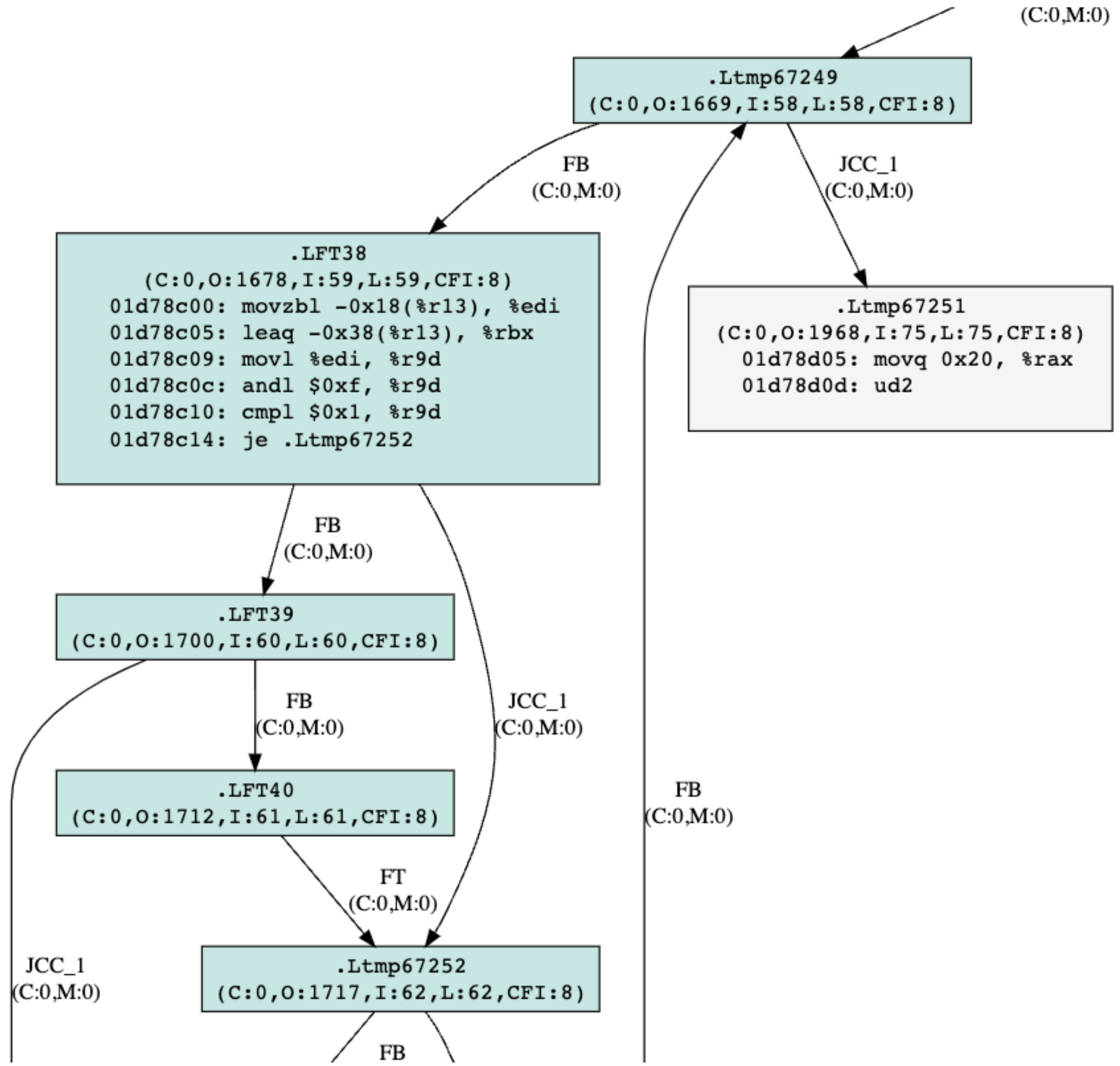

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   - >5MB of code, >10% FE bound, >10 icache MPKI

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4. Unsupported: stripped symbols + split functions (default in Linux distros)
   - GCC8+: disable `-freorder-blocks-and-partition`
   - LLVM: don't enable `-split-machine-functions`

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Optimizations

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1. State of the art:
   - Function splitting: `-split-functions -split-strategy=`**`cdsplit`**
   - Function reordering: `-reorder-functions=`**`cdsort`**
   - Block reordering: `-reorder-blocks=`**`ext-tsp`**

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    - Block reordering: `-reorder-blocks=`**`ext-tsp`**
2. Extra:
    - Use THP pages for hot text: `-hugify`
    - PLT optimization: `-plt`
    - More aggressive ICF: `-icf`
    - Indirect Call Promotion: `-indirect-call-promotion`
    - `--help`

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4. Can create accelerator tables (gdb_index, debug_names)

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2. Disable hugify (aligns to 2MB)

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3. Verbose logging if something is wrong: `-v=2`

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   - Read CFG: `-print-only=func.* -print-cfg`
   - Look at CFG: `-dump-dot-all`

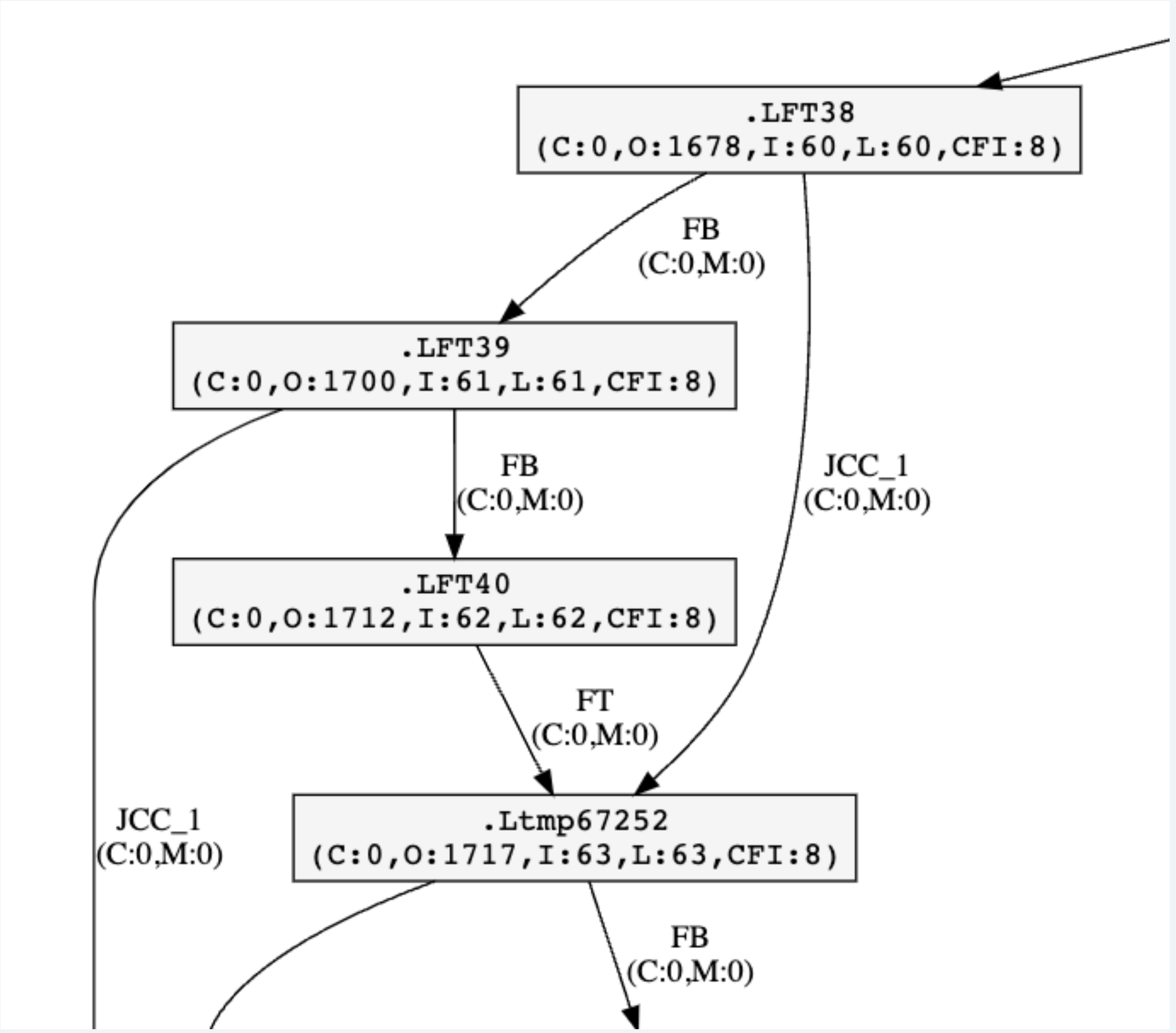
dot format

`llvm-bolt`

`  -dump-dot-all`

Outputs

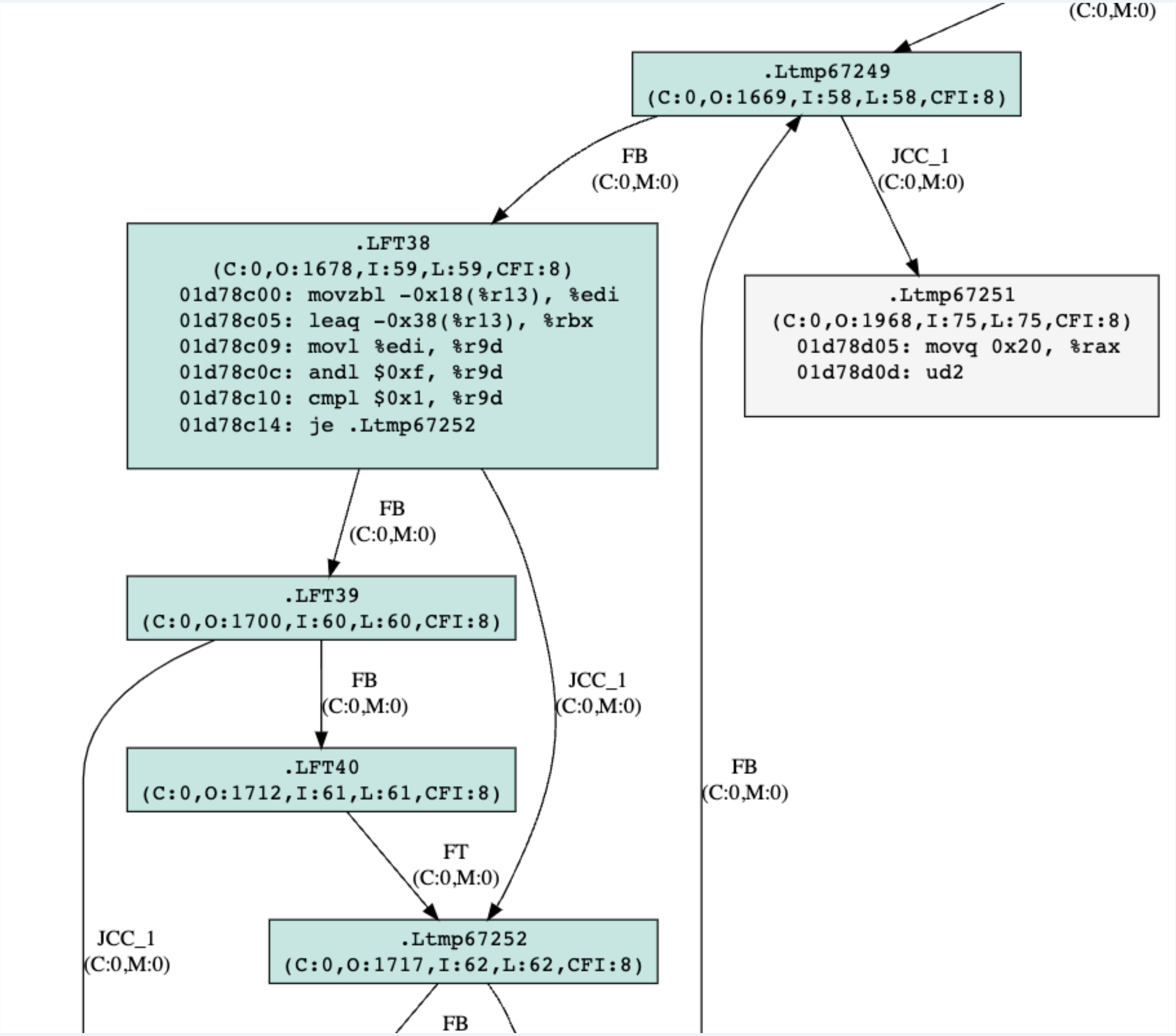
`funcname-00_build-cfg.dot`



Interactive HTML

```
llvm-bolt
  -dump-dot-all
  -print-loops -dot-tooltip-code

bolt/utils/dot2html/dot2html.py
  main-25_zero-idiom.dot{,.html}
```



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`bolt/utils/bughunter.sh`

Invocation:

```
BOLT=/build/llvm-bolt \
BOLT_OPTIONS="-v=1" \
INPUT_BINARY=/path/to/binary \
# COMMAND_LINE="--version" or
# OFFLINE=1 \
bolt/utils/bughunter.sh
```

Output:

Text file containing the culprit function.

Performance debugging

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    - Check logs!
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    - Same binary used for profiling and optimization?
    - Noise?
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   - Check logs!
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2. If it’s really the case
   - Collect perf.data from BOLTed binary
   - Run `llvm-bolt-heatmap` and check layout

Interaction with PGO

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    - Not the only one: CSSPGO, CSIR PGO, FS-AFDO, Propeller
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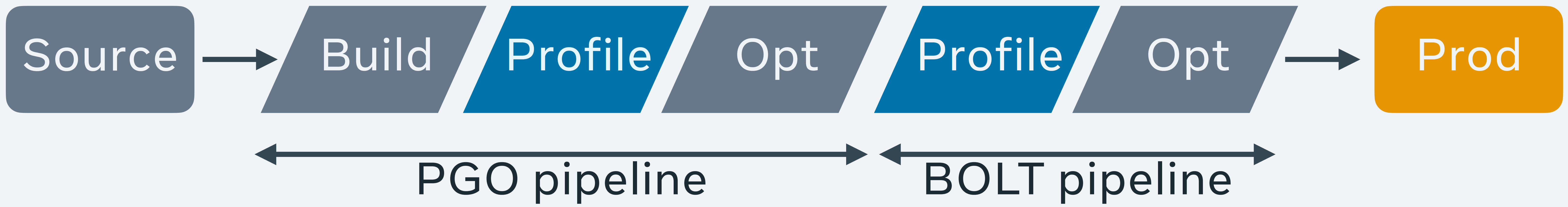
Ideal pipeline (“Zero Gap”)



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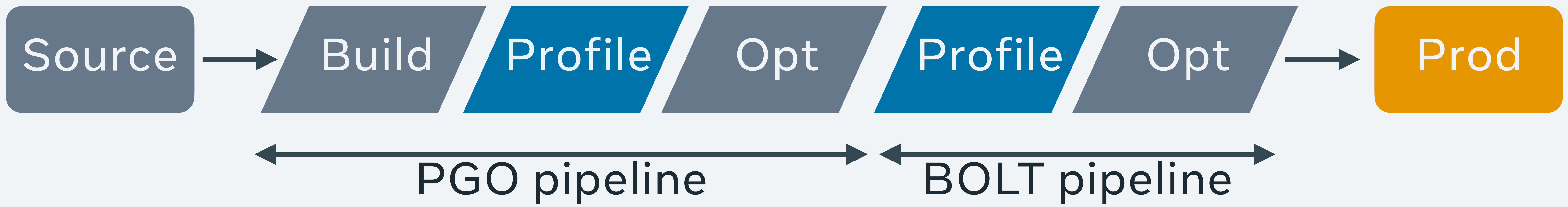

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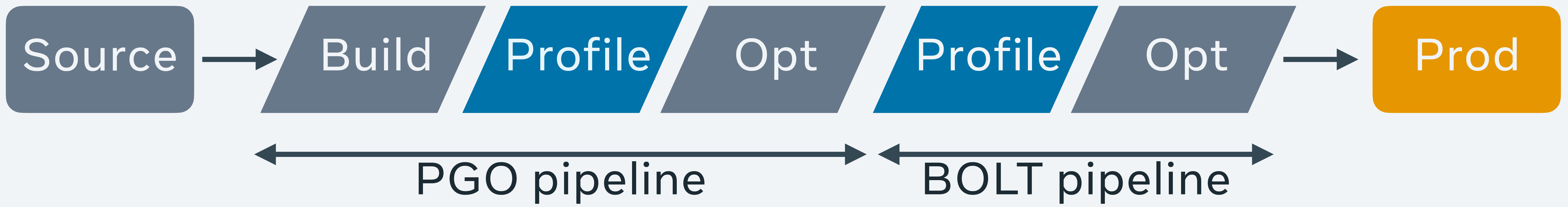

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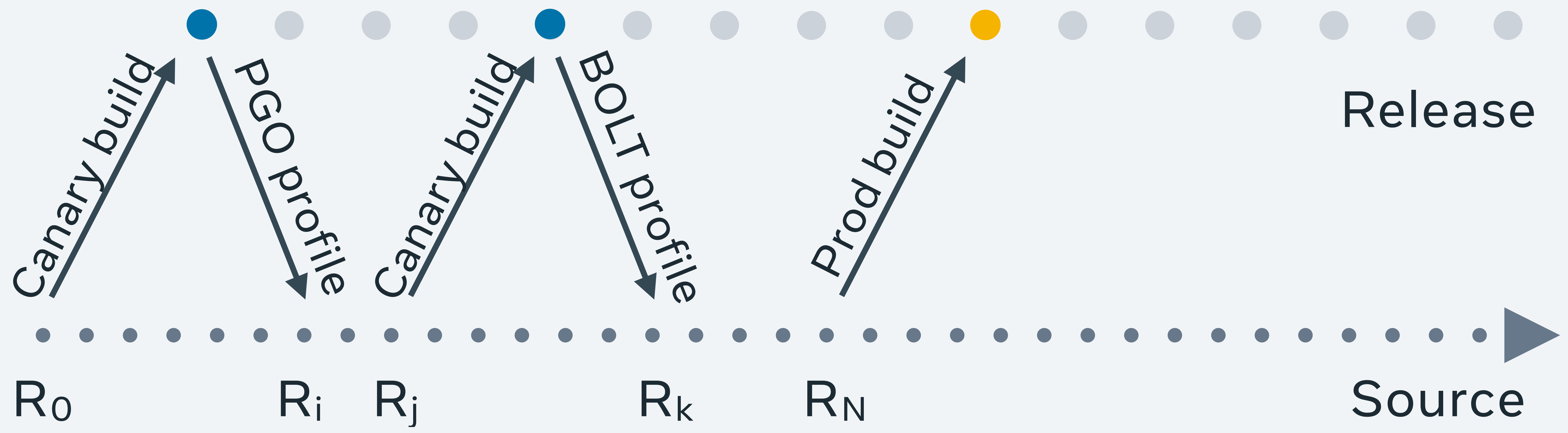

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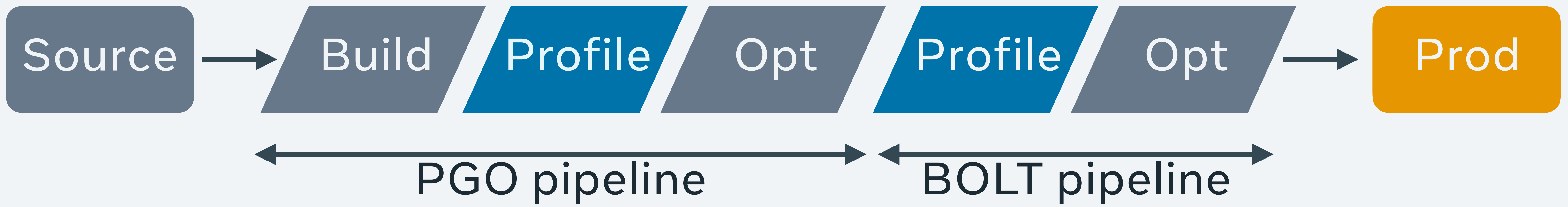

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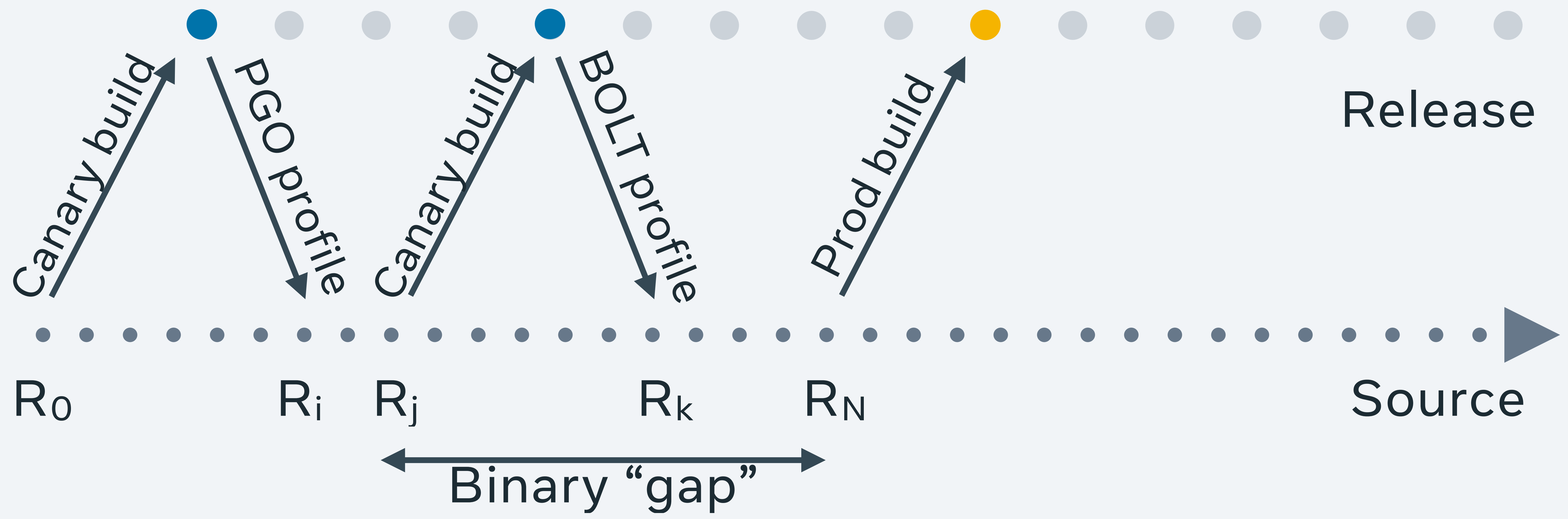

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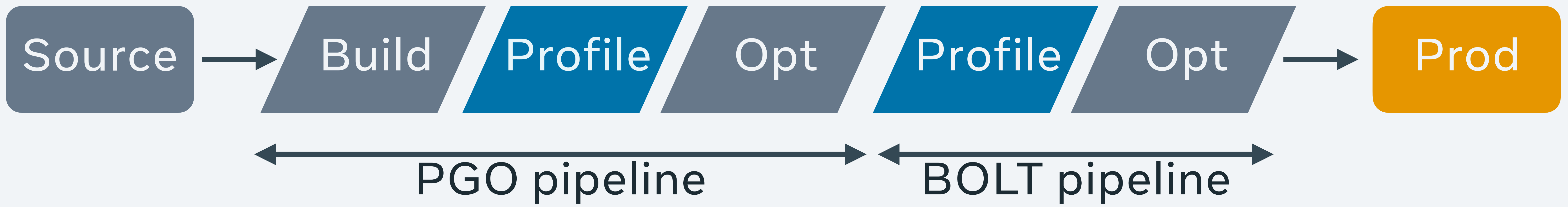

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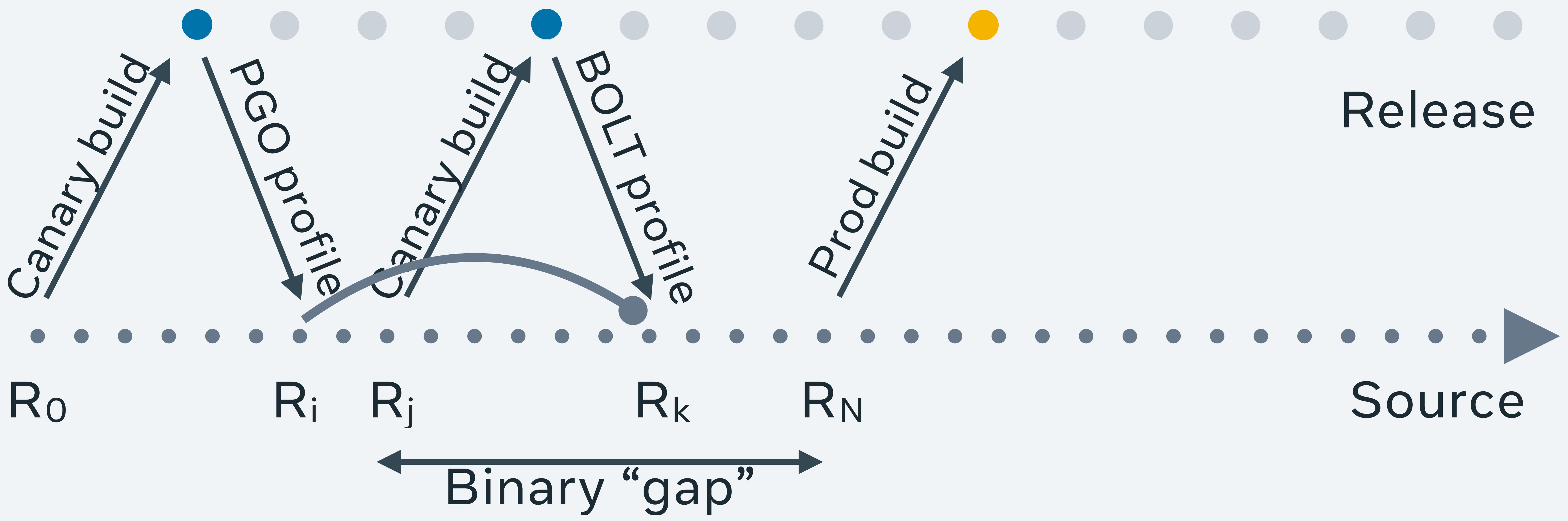

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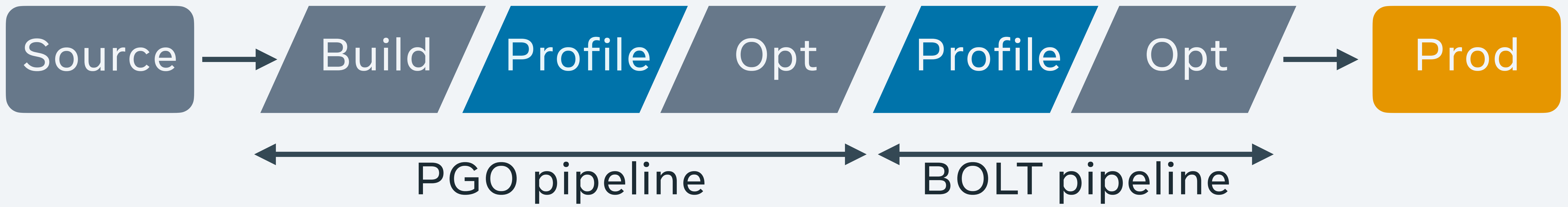

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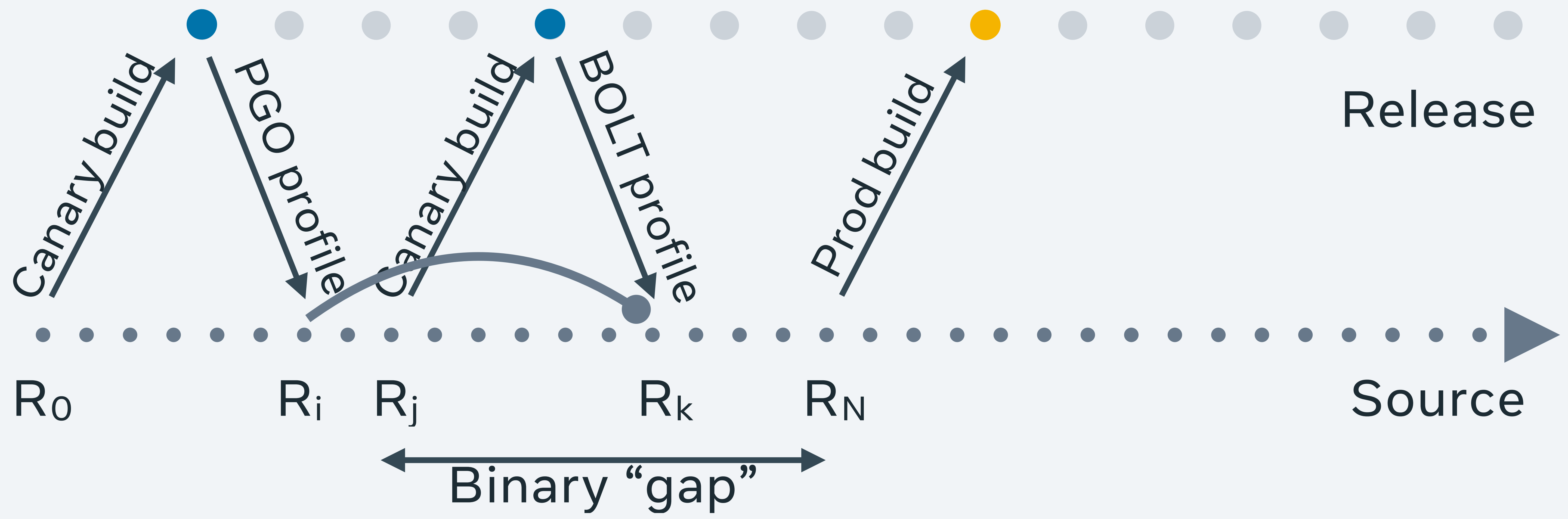

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3. Collecting BOLT profile from BOLTed binary: `-enable-bat`
    - WIP streamlining use with stale matching

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