Improving build times

Setup

Use a clang stdenv:

`nix develop .#native-clangStdenvPackages`

Then delete `build/` if you were using gcc before. Enable build-time profiling with:

`just setup; meson configure build -Dprofile-build=enabled`

Then run the build: `just compile`.

Enabling build-time profiling itself costs about 10% of compile time but has no other disadvantage.

Build time reports

Use `maintainers/buildtime_report.sh build/` to generate a build time report. This will tell you where all our build time went by looking at the trace files and producing a badness summary.

Sample report

Build-time report sample

```
lix/lix2 » ClangBuildAnalyzer --analyze buildtimeold.bin
Analyzing build trace from 'buildtimeold.bin'...
**** Time summary:
Compilation (551 times):
  Parsing (frontend):         1465.3 s
  Codegen & opts (backend):   1110.9 s

**** Files that took longest to parse (compiler frontend):
 10478 ms: build/src/libstore/liblixstore.so.p/build_local-derivation-goal.cc.o
 10319 ms: build/src/libexpr/liblixexpr.so.p/primops.cc.o
  9947 ms: build/src/nix/nix.p/flake.cc.o
  9850 ms: build/src/libexpr/liblixexpr.so.p/eval.cc.o
```

```
  9751 ms: build/src/nix/nix.p/profile.cc.o
  9643 ms: build/src/nix/nix.p/develop.cc.o
  9296 ms: build/src/libcmd/liblixcmd.so.p/installable-attr-path.cc.o
  9286 ms: build/src/libstore/liblixstore.so.p/build_derivation-goal.cc.o
  9208 ms: build/src/libcmd/liblixcmd.so.p/installables.cc.o
  9007 ms: build/src/nix/nix.p/..._nix-env_nix-env.cc.o

**** Files that took longest to codegen (compiler backend):
 24226 ms: build/src/libexpr/liblixexpr.so.p/primops_fromTOML.cc.o
 24019 ms: build/src/libexpr/liblixexpr.so.p/primops.cc.o
 21102 ms: build/src/libstore/liblixstore.so.p/build_local-derivation-goal.cc.o
 16246 ms: build/src/libstore/liblixstore.so.p/store-api.cc.o
 14586 ms: build/src/nix/nix.p/..._nix-build_nix-build.cc.o
 13746 ms: build/src/libexpr/liblixexpr.so.p/eval.cc.o
 13287 ms: build/src/libstore/liblixstore.so.p/binary-cache-store.cc.o
 13263 ms: build/src/nix/nix.p/profile.cc.o
 12970 ms: build/src/nix/nix.p/develop.cc.o
 12621 ms: build/src/libfetchers/liblixfetchers.so.p/github.cc.o

**** Templates that took longest to instantiate:
 42922 ms: nlohmann::basic_json<>::parse<const char *> (69 times, avg 622 ms)
 32180 ms: nlohmann::detail::parser<nlohmann::basic_json<>, nlohmann::detail::i... (69
times, avg 466 ms)
 27337 ms: nix::HintFmt::HintFmt<nix::Uncolored<std::basic_string<char>>> (246 times, avg
111 ms)
 25338 ms: nlohmann::basic_json<>::basic_json (293 times, avg 86 ms)
 23641 ms: nlohmann::detail::parser<nlohmann::basic_json<>, nlohmann::detail::i... (69
times, avg 342 ms)
 20203 ms: boost::basic_format<char>::basic_format (492 times, avg 41 ms)
 17174 ms: nlohmann::basic_json<>::json_value::json_value (368 times, avg 46 ms)
 15603 ms: boost::basic_format<char>::parse (246 times, avg 63 ms)
 13268 ms: std::basic_regex<char>::_M_compile (28 times, avg 473 ms)
 12757 ms: std::__detail::_Compiler<std::regex_traits<char>>::_Compiler (28 times, avg 455
ms)
 10813 ms: std::__detail::_Compiler<std::regex_traits<char>>::_M_disjunction (28 times,
avg 386 ms)
 10719 ms: std::__detail::_Compiler<std::regex_traits<char>>::_M_alternative (28 times,
avg 382 ms)
 10508 ms: std::__detail::_Compiler<std::regex_traits<char>>::_M_term (28 times, avg 375
```

```
ms)
  9516 ms: nlohmann::detail::json_sax_dom_callback_parser<nlohmann::basic_json<... (69
times, avg 137 ms)
  9112 ms: std::__detail::_Compiler<std::regex_traits<char>>::_M_atom (28 times, avg 325
ms)
  8683 ms: std::basic_regex<char>::basic_regex (18 times, avg 482 ms)
  8241 ms: std::operator<=> (438 times, avg 18 ms)
  7561 ms: std::vector<boost::io::detail::format_item<char, std::char_traits<ch... (246
times, avg 30 ms)
  7475 ms: std::vector<boost::io::detail::format_item<char, std::char_traits<ch... (246
times, avg 30 ms)
  7309 ms: std::reverse_iterator<std::_Bit_iterator> (268 times, avg 27 ms)
  7131 ms: boost::stacktrace::basic_stacktrace<>::basic_stacktrace (246 times, avg 28 ms)
  6868 ms: boost::stacktrace::basic_stacktrace<>::init (246 times, avg 27 ms)
  6518 ms: std::reverse_iterator<std::_Bit_const_iterator> (268 times, avg 24 ms)
  5716 ms: std::__detail::_Synth3way::operator()<std::variant<nix::OutputsSpec:... (182
times, avg 31 ms)
  5303 ms: nix::make_ref<nix::SingleDerivedPath, nix::DerivedPathOpaque> (178 times, avg
29 ms)
  5244 ms: std::__uninitialized_move_a<boost::io::detail::format_item<char, std... (246
times, avg 21 ms)
  4857 ms: std::make_shared<nix::SingleDerivedPath, nix::DerivedPathOpaque> (178 times,
avg 27 ms)
  4813 ms: std::__detail::_Synth3way::operator()<std::variant<nix::TextIngestio... (158
times, avg 30 ms)
  4648 ms: nlohmann::detail::json_sax_dom_callback_parser<nlohmann::basic_json<... (69
times, avg 67 ms)
  4597 ms: std::basic_regex<char>::basic_regex<std::char_traits<char>, std::all... (10
times, avg 459 ms)

**** Template sets that took longest to instantiate:
 55715 ms: std::__do_visit<$> (3603 times, avg 15 ms)
 47739 ms: std::__detail::__variant::__gen_vtable_impl<$>::__visit_invoke (11132 times,
avg 4 ms)
 43338 ms: nlohmann::basic_json<$>::parse<$> (85 times, avg 509 ms)
 43097 ms: std::__detail::__variant::__raw_idx_visit<$> (2435 times, avg 17 ms)
 32390 ms: nlohmann::detail::parser<$>::parse (83 times, avg 390 ms)
 30986 ms: nix::HintFmt::HintFmt<$> (1261 times, avg 24 ms)
 30255 ms: std::__and_<$> (25661 times, avg 1 ms)
```

```
 29762 ms: std::unique_ptr<$> (2116 times, avg 14 ms)
 28609 ms: std::__tuple_compare<$>::__eq (2978 times, avg 9 ms)
 27560 ms: nlohmann::detail::parser<$>::sax_parse_internal<$> (167 times, avg 165 ms)
 27239 ms: std::variant<$> (1959 times, avg 13 ms)
 26837 ms: std::__invoke_result<$> (10782 times, avg 2 ms)
 25972 ms: std::tuple<$> (5714 times, avg 4 ms)
 24247 ms: std::__uniq_ptr_data<$> (2116 times, avg 11 ms)
 24061 ms: std::__result_of_impl<$> (9029 times, avg 2 ms)
 23949 ms: std::__uniq_ptr_impl<$> (2116 times, avg 11 ms)
 21185 ms: std::optional<$> (2502 times, avg 8 ms)
 21044 ms: std::pair<$> (4989 times, avg 4 ms)
 20852 ms: std::__or_<$> (24005 times, avg 0 ms)
 20203 ms: boost::basic_format<$>::basic_format (492 times, avg 41 ms)
 20184 ms: std::tie<$> (2895 times, avg 6 ms)
 19938 ms: nlohmann::basic_json<$>::create<$> (668 times, avg 29 ms)
 19798 ms: std::allocator_traits<$>::construct<$> (5720 times, avg 3 ms)
 19182 ms: std::__detail::__variant::_Variant_base<$> (1959 times, avg 9 ms)
 19151 ms: std::_Rb_tree<$>::_M_erase (2320 times, avg 8 ms)
 19094 ms: std::_Rb_tree<$>::~_Rb_tree (2022 times, avg 9 ms)
 18735 ms: nlohmann::basic_json<$>::basic_json (243 times, avg 77 ms)
 18546 ms: std::__detail::_Synth3way::_S_noexcept<$> (2542 times, avg 7 ms)
 17174 ms: nlohmann::basic_json<$>::json_value::json_value (368 times, avg 46 ms)
 17111 ms: nlohmann::detail::conjunction<$> (907 times, avg 18 ms)

**** Functions that took longest to compile:
  2091 ms: _GLOBAL__sub_I_primops.cc (../src/libexpr/primops.cc)
  1799 ms: nix::fetchers::GitInputScheme::fetch(nix::ref<nix::Store>, nix::fetc...
(../src/libfetchers/git.cc)
  1388 ms: nix::Settings::Settings() (../src/libstore/globals.cc)
  1244 ms: main_nix_build(int, char**) (../src/nix-build/nix-build.cc)
  1021 ms: nix::LocalDerivationGoal::startBuilder() (../src/libstore/build/local-
derivation-goal.cc)
   918 ms: nix::LocalStore::LocalStore(std::map<std::__cxx11::basic_string<char...
(../src/libstore/local-store.cc)
   835 ms: opQuery(Globals&, std::__cxx11::list<std::__cxx11::basic_string<char...
(../src/nix-env/nix-env.cc)
   733 ms: nix::daemon::performOp(nix::daemon::TunnelLogger*, nix::ref<nix::Sto...
(../src/libstore/daemon.cc)
   589 ms: _GLOBAL__sub_I_tests.cc (../tests/unit/libutil/tests.cc)
```

```
   578 ms: main_build_remote(int, char**) (../src/build-remote/build-remote.cc)
   522 ms: nix::fetchers::MercurialInputScheme::fetch(nix::ref<nix::Store>, nix...
(../src/libfetchers/mercurial.cc)
   521 ms: nix::LocalDerivationGoal::registerOutputs[abi:cxx11]()
(../src/libstore/build/local-derivation-goal.cc)
   461 ms: nix::getNameFromURL_getNameFromURL_Test::TestBody() (../tests/unit/libutil/url-
name.cc)
   440 ms: nix::Installable::build2(nix::ref<nix::Store>, nix::ref<nix::Store>,...
(../src/libcmd/installables.cc)
   392 ms: nix::prim_fetchClosure(nix::EvalState&, nix::PosIdx, nix::Value**, n...
(../src/libexpr/primops/fetchClosure.cc)
   390 ms: nix::NixArgs::NixArgs() (../src/nix/main.cc)
   388 ms: update(std::set<std::__cxx11::basic_string<char, std::char_traits<ch...
(../src/nix-channel/nix-channel.cc)
   340 ms: _GLOBAL__sub_I_primops.cc (../tests/unit/libexpr/primops.cc)
   332 ms: nix::flake::lockFlake(nix::EvalState&, nix::FlakeRef const&, nix::fl...
(../src/libexpr/flake/flake.cc)
   305 ms: _GLOBAL__sub_I_lockfile.cc (../src/libexpr/flake/lockfile.cc)
   300 ms: nix_store::opQuery(std::__cxx11::list<std::__cxx11::basic_string<cha...
(../src/nix-store/nix-store.cc)
   296 ms: nix::parseFlakeRefWithFragment(std::__cxx11::basic_string<char, std:...
(../src/libexpr/flake/flakeref.cc)
   289 ms: _GLOBAL__sub_I_error_traces.cc (../tests/unit/libexpr/error_traces.cc)
   278 ms: nix::ErrorTraceTest_genericClosure_Test::TestBody()
(../tests/unit/libexpr/error_traces.cc)
   274 ms: CmdDevelop::run(nix::ref<nix::Store>, nix::ref<nix::Installable>)
(../src/nix/develop.cc)
   269 ms: nix::flake::lockFlake(nix::EvalState&, nix::FlakeRef const&, nix::fl...
(../src/libexpr/flake/flake.cc)
   257 ms: nix::NixRepl::processLine(std::__cxx11::basic_string<char, std::char...
(../src/libcmd/repl.cc)
   251 ms: nix::derivationStrictInternal(nix::EvalState&, std::__cxx11::basic_s...
(../src/libexpr/primops.cc)
   249 ms: toml::result<toml::basic_value<toml::discard_comments, std::unordere...
(../src/libexpr/primops/fromTOML.cc)
   238 ms: nix::LocalDerivationGoal::runChild() (../src/libstore/build/local-derivation-
goal.cc)

**** Function sets that took longest to compile / optimize:
```

```
 10243 ms: std::vector<$>::_M_fill_insert(__gnu_cxx::__normal_iterator<$>, unsi... (190
times, avg 53 ms)
  9752 ms: bool boost::io::detail::parse_printf_directive<$>(__gnu_cxx::__norma... (190
times, avg 51 ms)
  8377 ms: void boost::io::detail::put<$>(boost::io::detail::put_holder<$> cons... (191
times, avg 43 ms)
  5863 ms: boost::basic_format<$>::parse(std::__cxx11::basic_string<$> const&) (190 times,
avg 30 ms)
  5660 ms: std::vector<$>::_M_fill_insert(std::_Bit_iterator, unsigned long, bo... (190
times, avg 29 ms)
  4264 ms: non-virtual thunk to boost::wrapexcept<$>::~wrapexcept() (549 times, avg 7 ms)
  4023 ms: std::_Rb_tree<$>::_M_erase(std::_Rb_tree_node<$>*) (1238 times, avg 3 ms)
  3715 ms: boost::stacktrace::detail::to_string_impl_base<boost::stacktrace::de... (166
times, avg 22 ms)
  3705 ms: std::vector<$>::_M_fill_assign(unsigned long, boost::io::detail::for... (190
times, avg 19 ms)
  3326 ms: boost::basic_format<$>::str[abi:cxx11]() const (144 times, avg 23 ms)
  3070 ms: void boost::io::detail::mk_str<$>(std::__cxx11::basic_string<$>&, ch... (191
times, avg 16 ms)
  2839 ms: boost::basic_format<$>::make_or_reuse_data(unsigned long) (190 times, avg 14
ms)
  2321 ms: std::__cxx11::basic_string<$>::_M_replace(unsigned long, unsigned lo... (239
times, avg 9 ms)
  2213 ms: std::_Rb_tree<$>::_M_get_insert_hint_unique_pos(std::_Rb_tree_const_... (203
times, avg 10 ms)
  2200 ms: boost::wrapexcept<$>::~wrapexcept() (549 times, avg 4 ms)
  2093 ms: std::vector<$>::~vector() (574 times, avg 3 ms)
  1894 ms: bool std::__detail::_Compiler<$>::_M_expression_term<$>(std::__detai... (112
times, avg 16 ms)
  1871 ms: int boost::io::detail::upper_bound_from_fstring<$>(std::__cxx11::bas... (190
times, avg 9 ms)
  1867 ms: boost::wrapexcept<$>::clone() const (549 times, avg 3 ms)
  1824 ms: std::_Rb_tree_iterator<$> std::_Rb_tree<$>::_M_emplace_hint_unique<$... (244
times, avg 7 ms)
  1821 ms: toml::result<$> toml::detail::sequence<$>::invoke<$>(toml::detail::l... (93
times, avg 19 ms)
  1814 ms: nlohmann::json_abi_v3_11_2::detail::serializer<$>::dump(nlohmann::js... (39
times, avg 46 ms)
  1799 ms: nix::fetchers::GitInputScheme::fetch(nix::ref<$>, nix::fetchers::Inp... (1
```

```
times, avg 1799 ms)
  1771 ms: boost::io::detail::format_item<char, std::char_traits<char>, std::al... (190
times, avg 9 ms)
  1762 ms: std::__detail::_BracketMatcher<$>::_BracketMatcher(std::__detail::_B... (112
times, avg 15 ms)
  1760 ms: std::_Function_handler<$>::_M_manager(std::_Any_data&, std::_Any_dat... (981
times, avg 1 ms)
  1733 ms: std::__detail::_Compiler<$>::_M_quantifier() (28 times, avg 61 ms)
  1694 ms: std::__cxx11::basic_string<$>::_M_mutate(unsigned long, unsigned lon... (251
times, avg 6 ms)
  1650 ms: std::vector<$>::vector(std::vector<$> const&) (210 times, avg 7 ms)
  1650 ms: boost::io::basic_altstringbuf<$>::overflow(int) (190 times, avg 8 ms)

**** Expensive headers:
178153 ms: ../src/libcmd/installable-value.hh (included 52 times, avg 3426 ms), included
via:
  40x: command.hh
  5x: command-installable-value.hh
  3x: installable-flake.hh
  2x: <direct include>
  2x: installable-attr-path.hh

176217 ms: ../src/libutil/error.hh (included 246 times, avg 716 ms), included via:
  36x: command.hh installable-value.hh installables.hh derived-path.hh config.hh
experimental-features.hh
  12x: globals.hh config.hh experimental-features.hh
  11x: file-system.hh file-descriptor.hh
  6x: serialise.hh strings.hh
  6x: <direct include>
  6x: archive.hh serialise.hh strings.hh
  ...

173243 ms: ../src/libstore/store-api.hh (included 152 times, avg 1139 ms), included via:
  55x: <direct include>
  39x: command.hh installable-value.hh installables.hh
  7x: libexpr.hh
  4x: local-store.hh
  4x: command-installable-value.hh installable-value.hh installables.hh
  3x: binary-cache-store.hh
```

```
  ...

170482 ms: ../src/libutil/serialise.hh (included 201 times, avg 848 ms), included via:
  37x: command.hh installable-value.hh installables.hh built-path.hh realisation.hh
hash.hh
  14x: store-api.hh nar-info.hh hash.hh
  11x: <direct include>
  7x: primops.hh eval.hh attr-set.hh nixexpr.hh value.hh source-path.hh archive.hh
  7x: libexpr.hh value.hh source-path.hh archive.hh
  6x: fetchers.hh hash.hh
  ...

169397 ms: ../src/libcmd/installables.hh (included 53 times, avg 3196 ms), included via:
  40x: command.hh installable-value.hh
  5x: command-installable-value.hh installable-value.hh
  3x: installable-flake.hh installable-value.hh
  2x: <direct include>
  1x: installable-derived-path.hh
  1x: installable-value.hh
  ...

159740 ms: ../src/libutil/strings.hh (included 221 times, avg 722 ms), included via:
  37x: command.hh installable-value.hh installables.hh built-path.hh realisation.hh
hash.hh serialise.hh
  19x: <direct include>
  14x: store-api.hh nar-info.hh hash.hh serialise.hh
  11x: serialise.hh
  7x: primops.hh eval.hh attr-set.hh nixexpr.hh value.hh source-path.hh archive.hh
serialise.hh
  7x: libexpr.hh value.hh source-path.hh archive.hh serialise.hh
  ...

156796 ms: ../src/libcmd/command.hh (included 51 times, avg 3074 ms), included via:
  42x: <direct include>
  7x: command-installable-value.hh
  2x: installable-attr-path.hh

150392 ms: ../src/libutil/types.hh (included 251 times, avg 599 ms), included via:
  36x: command.hh installable-value.hh installables.hh path.hh
```

```
  11x: file-system.hh
  10x: globals.hh
  6x: fetchers.hh
  6x: serialise.hh strings.hh error.hh
  5x: archive.hh
  ...

133101 ms: /nix/store/644b90j1vms44nr18yw3520pzkrg4dd1-boost-1.81.0-
dev/include/boost/lexical_cast.hpp (included 226 times, avg 588 ms), included via
:
  37x: command.hh installable-value.hh installables.hh built-path.hh realisation.hh
hash.hh serialise.hh strings.hh
  19x: file-system.hh
  11x: store-api.hh nar-info.hh hash.hh serialise.hh strings.hh
  7x: primops.hh eval.hh attr-set.hh nixexpr.hh value.hh source-path.hh archive.hh
serialise.hh strings.hh
  7x: libexpr.hh value.hh source-path.hh archive.hh serialise.hh strings.hh
  6x: eval.hh attr-set.hh nixexpr.hh value.hh source-path.hh archive.hh serialise.hh
strings.hh
  ...

132887 ms: /nix/store/h2abv2l8irqj942i5rq9wbrj42kbsh5y-gcc-
12.3.0/include/c++/12.3.0/memory (included 262 times, avg 507 ms), included via:
  36x: command.hh installable-value.hh installables.hh path.hh types.hh ref.hh
  16x: gtest.h
  11x: file-system.hh types.hh ref.hh
  10x: globals.hh types.hh ref.hh
  10x: json.hpp
  6x: serialise.hh
  ...

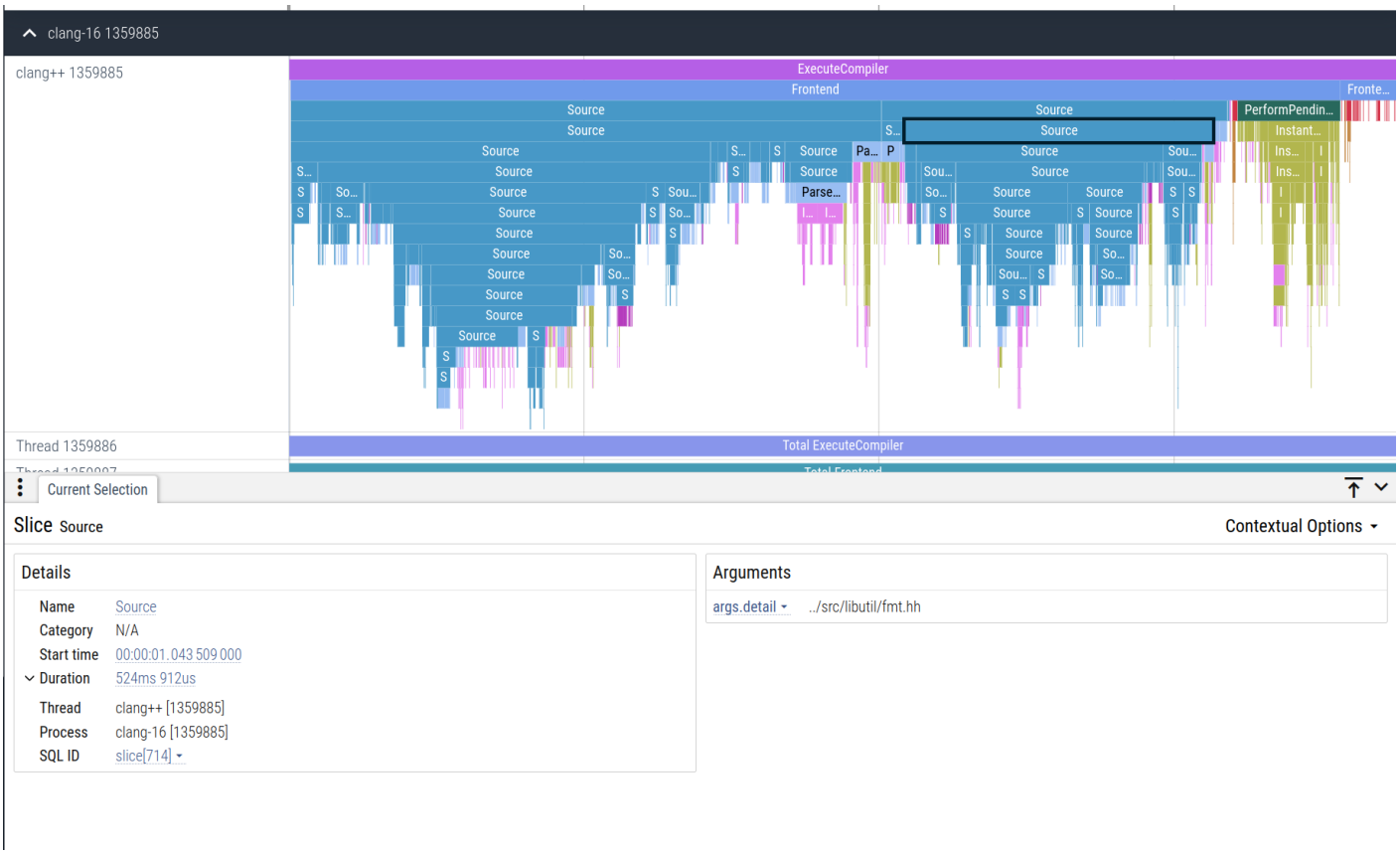
  done in 0.6s.
```

Manually looking at traces

Note that the summary in the report can miss details like *why* one particular header is bad; to find that out, use a trace viewer to inspect the JSON trace file; we suggest `rg -t json -uu error\.hh build/ | less` to find some `.cc` trace that the bad header (in this example, `error.hh`) appears in.

You can look at individual file traces by opening some file like `build/src/libcmd/liblixcmd.so.p/command.cc.json` in https://ui.perfetto.dev or another Chrome-trace-json compatible trace viewer like Speedscope.

This will produce a flamegraph of the trace (screenshot shows Perfetto):



The most general spans of compile time are at the top, and the constituent spans are shown as you go down.

Successful build time reduction CLs

- cl/588: 15%
- cl/1351: 10%

See the build-time-optimisation Gerrit topic for more related things.

Revision #3
Created 2024-03-25 10:32:43 UTC by jade
Updated 2024-06-07 04:07:24 UTC by jade