

SYRMIA

MILOŠ STOJANOVIĆ

RAZVOJ I ODŽAVANJE KVALITETA SOFTVERA U LLVM-U

Syrmia LLC

MART 2020.

Predstavljanje

SYRMIA

Miloš Stojanović

ETF

3,5 godine

Praksa: QEMU

LLVM:

- Buildbot
- Backend
- llvm-exegesis

Kompanija koja se bavi razvojem programskih prevodilaca, alata i sistemskog softvera za Linuks.

Prisutni u Zajednici otvorenog koda više od 10 godina. Najmanje jedna izmena sedmično bude prihvaćena u nekom od projekata.

Ključni projekti kojima se bavi Sirmija su:

- Jezgro Linuksa (kernel)
- Programski prevodioci (LLVM, GCC, Go lang, Lua JIT, V8 JavaScript)
- Emulatori (QEMU)
- Alati i debageri (Valgrind, gdb)
- Sistemski softver (libc, itd)

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

llvm-exegesis

Objavljivanje nove verzije

Linkovi

Kontakt informacije



SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

llvm-exegesis

Objavljivanje nove verzije

Linkovi

Kontakt informacije

Osnove

Poređenje sa gcc-om

Ospeg



Kolekcija modularnih kompajlerskih alata za višestruku upotrebu:

- clang, lld, lldb, libc++, compiler-rt

Clang diagnostika:

```
$ clang t.c
t.c:5:28: warning: use of GNU old-style field designator extension
struct point origin = { x: 0.0, y: 0.0 };
                ~~ ^
                .x =
t.c:5:36: warning: use of GNU old-style field designator extension
struct point origin = { x: 0.0, y: 0.0 };
                ~~ ^
                .y =
```

```
$ cat t.cc
template<class T>
class a {};
struct b {}
a<int> c;

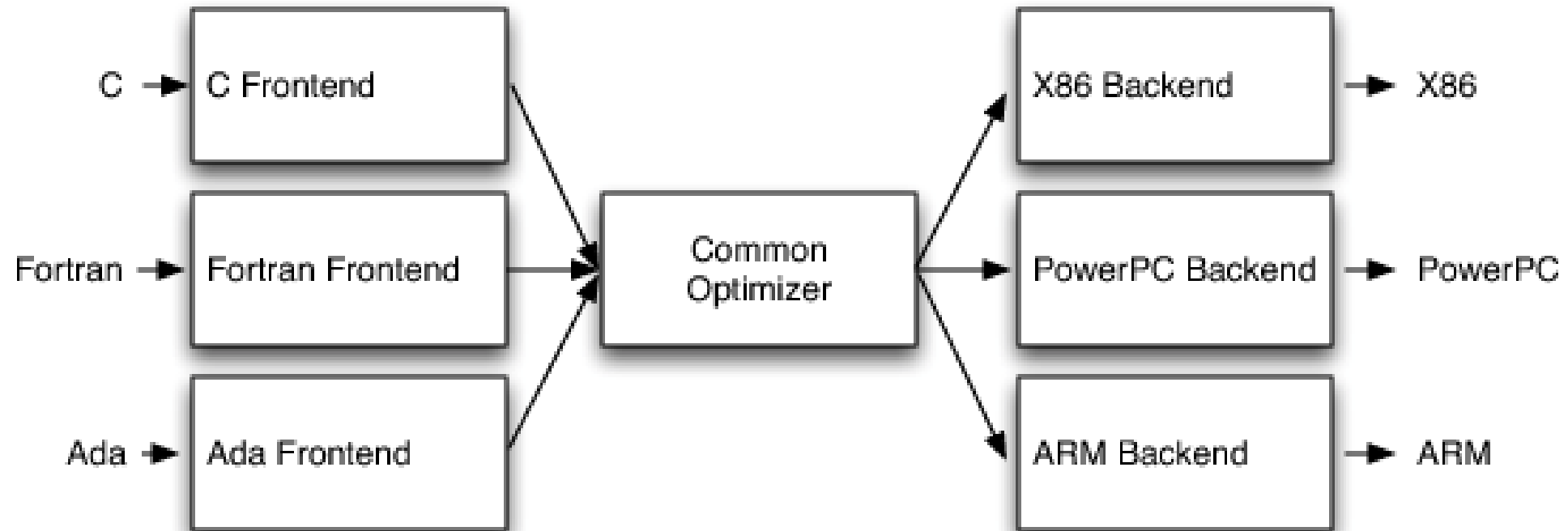
$ gcc-4.9 t.cc
t.cc:4:8: error: invalid declarator before 'c'
  a<int> c;
        ^

$ clang t.cc
t.cc:3:12: error: expected ';' after struct
struct b {}
           ^
;
```

```
$ clang -fsyntax-only format-strings.c
format-strings.c:91:13: warning: '.*' specified field precision is missing a matching 'int' argument
printf("%.*d");
           ^
```



Struktura LLVM-a:



LLVM

Osnove



SYRMIA

Dobitnik „ACM Software System“ nagrade 2012.

Još neki dobitnici nagrade:

UNIX
(1983)

TEX
(1986)

TCP/IP
(1991)

A globe icon with the letters "WWW" in the center.
(1995)

The Java logo, featuring a blue coffee cup with orange steam rising from it.
Java
(2002)

Make
(2003)

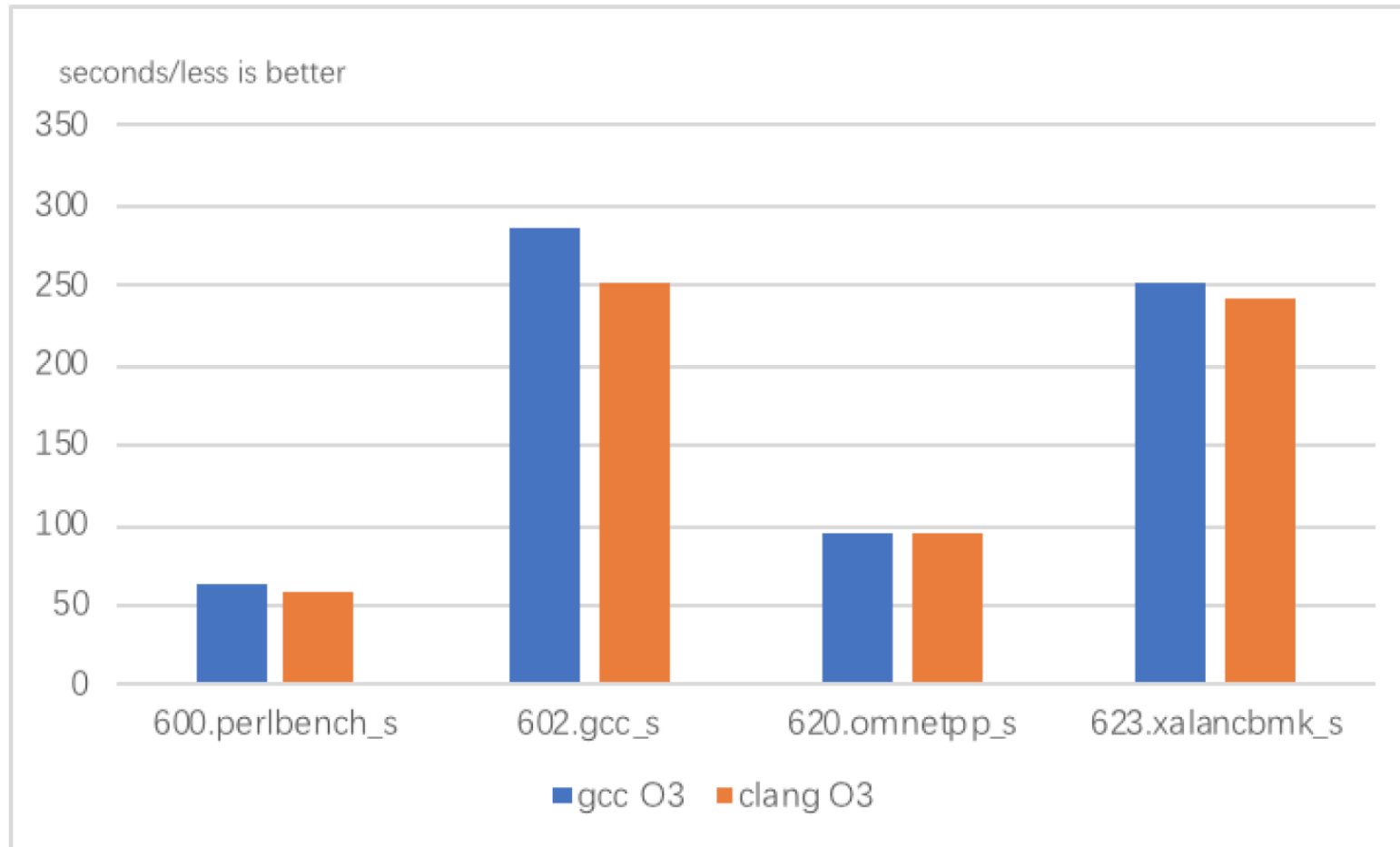


eclipse
(2011)

The GCC logo, featuring a cartoon cow's head inside an orange oval with the letters "GCC" below it.
GCC
(2015)



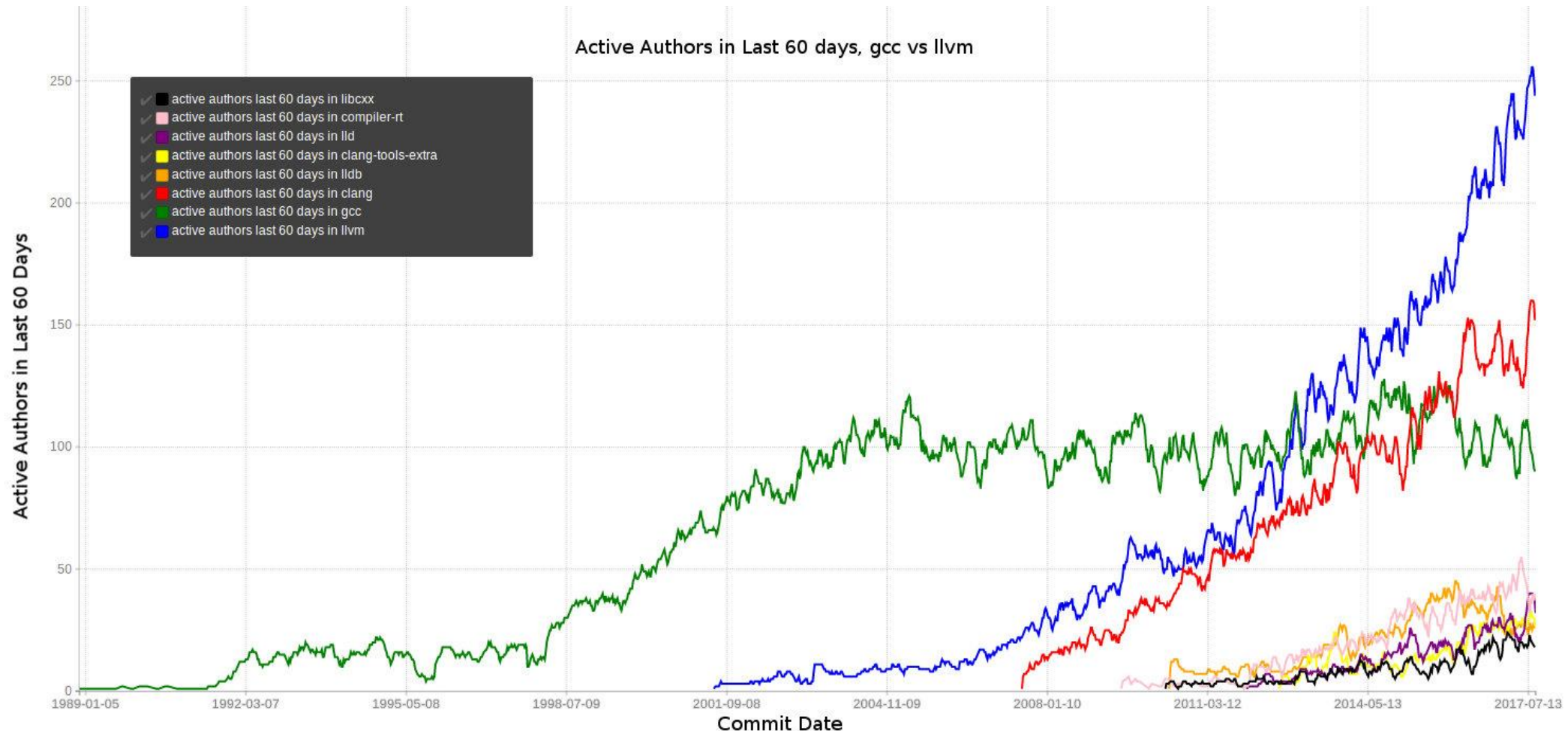
Poređenje clang-a i gcc-a u brzini prevođenja



https://medium.com/@alitech_2017/gcc-vs-clang-llvm-an-in-depth-comparison-of-c-c-compilers-899ede2be378



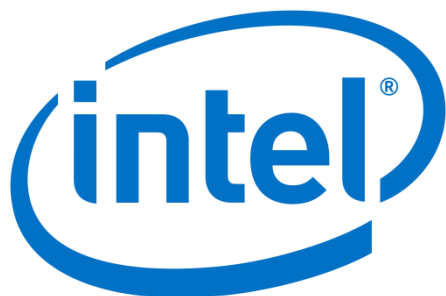
Poređenje aktivnosti u razvoju LLVM-a i gcc-a



<http://nickdesaulniers.github.io/blog/2017/09/05/gcc-vs-llvm-q3-2017-commit-rates-and-active-developer-counts/>



Kompanije koje su dale doprinose LLVM-u:





Arhitekture podržane u LLVM-u:



ARM

MIPS

PowerPC™

SPARC



RISC-V

AVR®

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

llvm-exegesis

Objavljivanje nove verzije

Linkovi

Kontakt informacije

Standardi kodiranja

Prevođenje

Testiranje

Osnovni koraci

Standardi kodiranja

SYRMIA

Zlatno pravilo: prati stil okružujućeg koda

Standard jezika (C++14)

Širina linije (80 kolona)

Tip i veličina uvlačenja (tab, n spaces)

Velika i mala slova (snake_case, CamelCase)

Komentarisanje i dokumentacija

Imenovanje funkcija i promenljivih

Osnovni koraci

Prevođenje

SYRMIA

Upozorenja:

- -Wall -Wextra -Wpedantic (-Weverything)
- -Werror

Izuzeci?

Informacije o tipovima u toku izvršavanja (RTTI)?

Standardi

- LLVM: <https://llvm.org/docs/CodingStandards.html>
- Linux Kernel: <https://www.kernel.org/doc/html/v4.10/process/coding-style.html>
- C++ Core Guidelines: <https://isocpp.github.io/CppCoreGuidelines/CppCoreGuidelines>

Osnovni koraci

Testiranje

Regresioni testovi (`llvm/test`)

- Kratak kod koji testira tačno određenu grešku ili svojstvo
- `make check-llvm`

Jedinični (unit) testovi (`llvm/unittest`)

- [Googletest](#)
- `make check-unittest`

Dodatno testiranje (`llvm-testsuite`)

- Prevođenje i izvršavanje
- Tačnost i performanse

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

llvm-exegesis

Objavljivanje nove verzije

Linkovi

Kontakt informacije

Pripremanje patch-a

Slanje na pregled

Podizanje izmene

Pregledanje koda

Pripremanje patch-a

SYRMIA

Git

Komanda za pregled stanja: `git status`

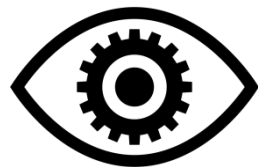
Komanda za dodavanje: `git add <ime_fajla>`

Komanda za prikazivanje izmena: `git diff`

Komanda za pravljenje patch-a: `git diff -U999999 > patch.diff`

Pregledanje koda

Slanje na pregled



SYRMIA

Phabricator

Dodavanje izmene

Pisanje naslova i opisa izmene

Podešavanje recenzenata (reviewers)





Podešavanje pretplatnika (subscribers)


Pregledanje koda

Slanje na pregled






SYRMIA

Phabricator    Search 

 Differential > D75510

[X86][llvm-exegesis] Exploring vector insert/extract

 Needs Review  Public

 Authored by [lebedev.ri](#) on Tue, Mar 3, 11:26 AM.

Details












Reviewers gchatelet
 courbet
 RKSimon

SUMMARY


This is proof-of-concept, i'm not sure if we want this so i didn't spend much time on this. If we do i can improve this.

It's not very useful without something like `D60000`, but even now i'm seeing somewhat confusing results:

```
---
mode:          latency
key:
instructions:
- 'PEXTRDrr R9D XMM6 i_0x0'
- 'MOV64toPQIrr XMM6 R9'
config:       ''
register_initial_values:
```

-  Edit Revision
-  Update Diff
-  Download Raw Diff
-  Edit Related Revisions... 
-  Edit Related Objects... 
-  Unsubscribe
-  Mute Notifications
-  Award Token
-  Flag For Later

Tags

 LLVM

Subscribers

[tschuett](#), [mstojanovic](#), [llvm-commits](#)

Pregledanje koda

Slanje na pregled



SYRMIA

Revision Contents ☰ Changeset List

Files	History	Commits
-------	---------	---------

Path ⊞ Packages

M [llvm/tools/llvm-exegesis/lib/X86/Target.cpp](#) (250 lines)

Diff 247980 ☰ View Options

[llvm/tools/llvm-exegesis/lib/X86/Target.cpp](#)

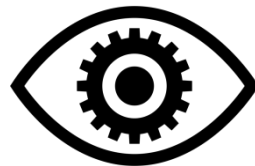
Show First 20 Lines • Show All 756 Lines • ▼ Show 20 Line(s)

754		754	
	<pre>std::vector<InstructionTemplate> ExegesisX86Target::generateInstructionVariants(SmallVector<SmallVector<MCOperand, 1>, 4> VariableChoices; VariableChoices.resize(Instr.Variables.size()); for (auto I : llvm::zip(Instr.Variables, VariableChoices)) { const Variable &Var = std::get<0>(I); SmallVectorImpl<MCOperand> &Choices = std::get<1>(I); switch (Instr.getPrimaryOperand(Var).getExplicitOperandInfo().OperandType) { default: // We don't wish to explicitly explore this variable. Choices.emplace_back(); // But add invalid MCOperand to simplify logic. continue;</pre>		<pre>std::vector<InstructionTemplate> ExegesisX86Target::generateInstructionVariants(SmallVector<SmallVector<MCOperand, 1>, 4> VariableChoices; VariableChoices.resize(Instr.Variables.size()); for (auto I : llvm::zip(Instr.Variables, VariableChoices)) { const Variable &Var = std::get<0>(I); SmallVectorImpl<MCOperand> &Choices = std::get<1>(I); switch (Instr.getPrimaryOperand(Var).getExplicitOperandInfo().OperandType) { default: break; case MCOI::OperandType::OPERAND_IMMEDIATE: { int NumElts = 0; switch (Instr.Description.getOpcode()) { default: break; // Extract Byte from XMM case X86::PEXTRBmr: case X86::PEXTRBrr:</pre>

21 / 42

Pregledanje koda

Podizanje izmene



SYRMIA

Komentarisanje koda

- Suštinski komentari
- Komentari vezani za standard kodiranja

Odobrenje: „LGTM“ (Looks Good To Me)

Podizanje izmene

- sinhronizacija repozitorijuma
 - `git pull`
- pravljenje lokalnog commit-a
 - `git commit`
- podizanje na glavni repozitorijum
 - `git push`

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

llvm-exegesis

Objavljivanje nove verzije

Linkovi

Kontakt informacije

O procesu

Buildbot

Testiranje na serveru

Kontinualna integracija

O procesu

SYRMIA

Continuous Integration (CI)

Proces spajanja radnih verzija svih programera u deljeni repozitorijum više puta dnevno

Kodiranje

Lokalno testiranje

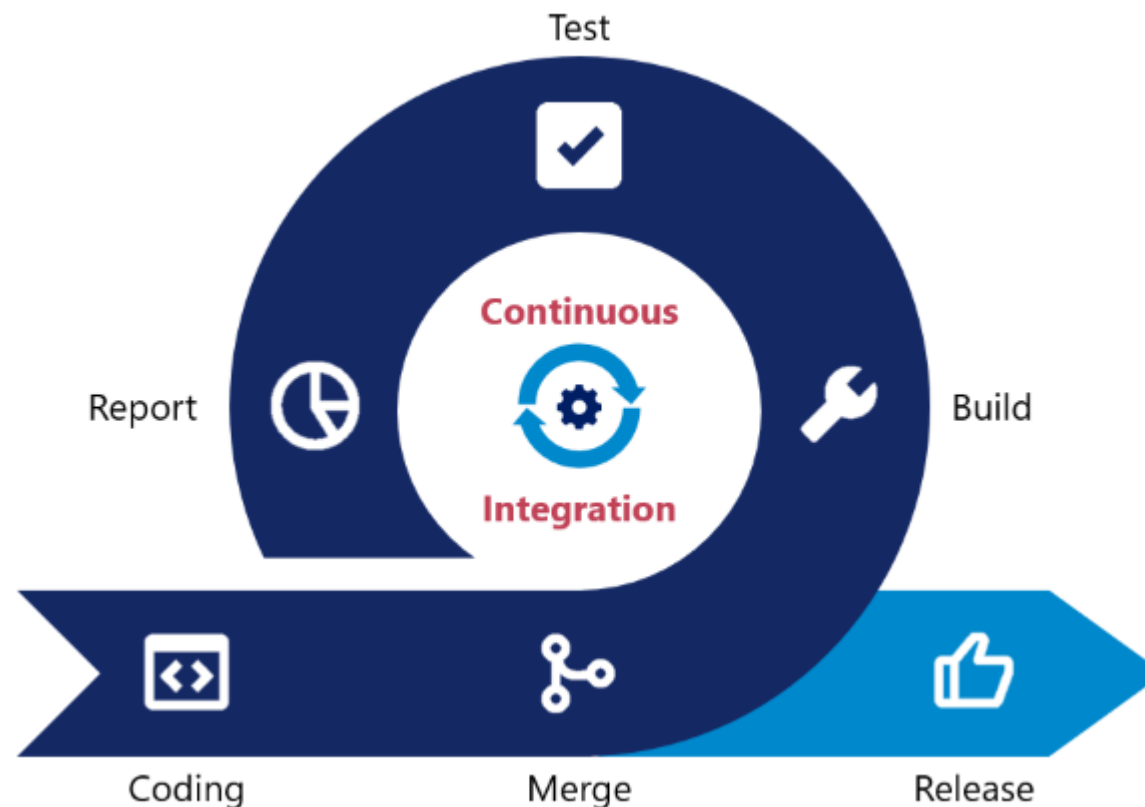
Spajanje

Izgradnja

Testiranje na serveru

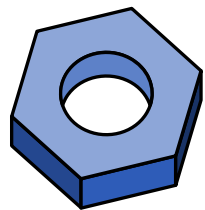
Izveštavanje

Objavljanje nove verzije



Kontinualna integracija

Buildbot

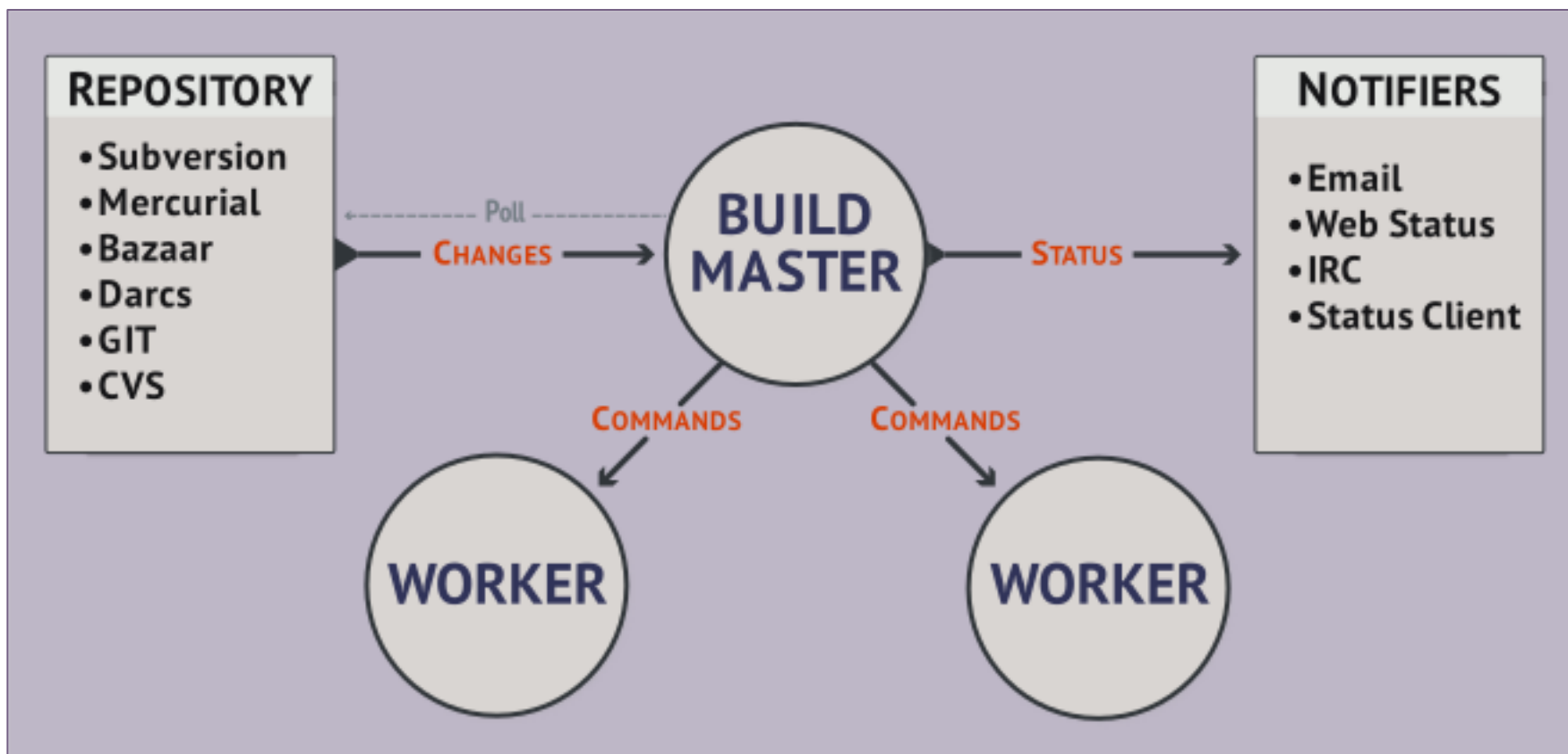


SYRMIA

Raspoređivanje poslova

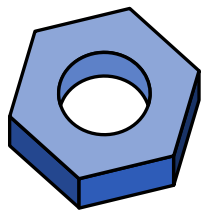
Izvršavanje poslova

Izveštavanje rezultata



Kontinualna integracija

Buildbot



SYRMIA

Automatizacija procesa

Provlačenje izmena

Build

Test

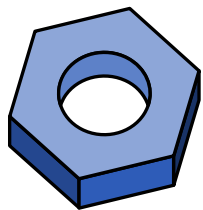
Release

Waterfall	
Builder group	
Endian format	
last build	
current activity	
CEST	changes
	Clement Courbet
13:09:16	Simon Pilgrim
13:01:11	
13:00:52	
13:00:33	

make-4-sde-2-linux-build successful	clang-armv7-linux-build-cache build successful	clang-aarch64-linux-build-cache build successful	llvm-avr-linux-build successful	clang-solaris11-amd64 build successful exception slave lost	clang-solaris11-sparcv9 build successful exception slave lost	clang-x64-ninja-win7 failed ninja check 1 ninja check 2	polly-arm-linux-build successful	polly-x86_64-linux-build successful
	building ETA in ~ 3 mins at 06:54	building ETA in ~ 24 mins at 07:15	building ETA in ~ 17 mins at 07:08 2 pending	offline 136 pending	offline 136 pending	building 5 pending	building ETA in ~ 19 mins at 07:10	idle
g-ke-1-sde-12-ix	clang-armv7-linux-build-cache	clang-aarch64-linux-build-cache	llvm-avr-linux	clang-solaris11-amd64	clang-solaris11-sparcv9	clang-x64-ninja-win7	polly-arm-linux	polly-x86_64-linux
	packaging stage 1... stdio	cmake stage 1 stdio	checking stage 1 stdio			ninja all stdio	build stdio	
		clean stdio						
		update stdio						
		Build 22993						
		uploading stage 1 to storage bucket ...						

Kontinualna integracija

Buildbot



SYRMIA

Home - Waterfall Grid T-Grid Console Builders Recent Builds Buildslaves Changesources - [JSON API] - About

Builder llvm Build #25363

Results:

Build successful

SourceStamp:

Repository	http://llvm.org/git/llvm.git
Branch	master
Revision	912ef7aa018c672beb208b6169813925dbe845c9
Changes	1 change

BuildSlave:

[LLVM](#)

Reason:

The Nightly scheduler named 'llvm_nightly' triggered this build

Steps and Logfiles:

- [shell Creating package directory](#) (0 secs)
 - [stdio](#)
- [shell_1 Cloning LNT](#) (6 secs)
 - [stdio](#)
- [shell_2 Removing old builds](#) (17 secs)
 - [stdio](#)
- [shell_3 Cleaning llvm directory](#) (7 secs)
 - [stdio](#)
- [shell_4 Cleaning clang directory](#) (3 secs)
 - [stdio](#)
- [shell_5 Cleaning lld directory](#) (0 secs)
 - [stdio](#)
- [shell_6 Cleaning test-suite directory](#) (3 secs)
 - [stdio](#)
- [shell_7 Updating llvm](#) (3 secs)
 - [stdio](#)

Build Properties:

Name	Value	Source
branch	master	Build
builddir	/home/compiler-qa/Buildbot/slaves/LLVM/llvm	slave
buildername	llvm	Builder
buildnumber	25363	Build
codebase		Build
project		Build
repository	http://llvm.org/git/llvm.git	Build
revision	912ef7aa018c672beb208b6169813925dbe845c9	Build
scheduler	llvm_nightly	Scheduler
slavename	LLVM	BuildSlave
workdir	/home/compiler-qa/Buildbot/slaves/LLVM/llvm	slave (deprecated)

Forced Build Properties:

Name	Label	Value
------	-------	-------

Responsible Users:

- Craig Topper

Timing:

Start	Tue Jun 5 08:40:00 2018
End	Tue Jun 5 08:56:47 2018
Elapsed	16 mins, 47 secs

Resubmit Build:

To force a build, fill out the following fields and push the 'Force Build' button

Reason for re-running build:

All Changes:

1. Change #94917

Changed by	Igor Kudrin <ikudrin@accesssoftek.com>
Changed at	Fri 06 Mar 2020 06:46:04
Repository	https://github.com/llvm/llvm-project
Project	llvm
Branch	master
Revision	3a1bc41a8948a2952eb2ab2b8f1480f2eb83192c

Comments

[DebugInfo] Print the actual value of an unknown section identifier. This is a follow-up for D75609. As @dblaikie suggested, it prints the actual number for an unknown section identifier when dumping unit index sections.

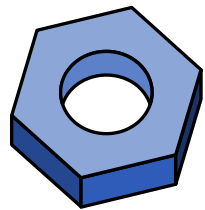
Differential Revision: <https://reviews.llvm.org/D75668>

Changed files

- ◊ [llvm/lib/DebugInfo/DWARF/DWARFUnitIndex.cpp](#)
- ◊ [llvm/test/DebugInfo/X86/debug-cu-index-unknown-section.s](#)

Kontinualna integracija

Testiranje na serveru



SYRMIA

Testiranje na različitim arhitekturama: x86_64, arm, Aarch64, sparc, avr

Testiranje na različitim operativnim sistemima: Debian, Ubuntu, Windows

Prosečno vreme: ~117 min (~32-96 niti)

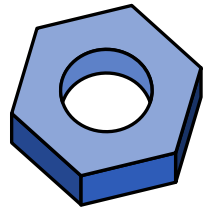
Broj buildbot-ova: 118

Procena ukupnog vremena: 230 h (~9,5 dana)

Nemoguće praktično testirati lokalno (prosečan računar sa 8 niti ~2,5 meseca)

Kontinualna integracija

Testiranje na serveru



SYRMIA

Home - [Waterfall](#) [Grid](#) [T-Grid](#) [Console](#) [Builders](#) [Recent Builds](#) [Buildslaves](#) [Changesources](#) - [JSON API](#) - [About](#)

Console View

Categories: aosp clang clang.exp clang_fast doc libc libcxx libunwind lld lldb llvm mlir openmp polly rev_iter sanitizer toolchain

Legend: Passed Failed Failed Again Running Exception Offline No data

Personalized for...

	aosp	clang	clang.exp	clang_fast	doc	libc	libcxx	libunwind
467969161d94... Shu Anzai								
[lldb/Core] Minor code cleanup in Editline.cpp (NFC) Simplify the code a bit. Differential revision: https://reviews.llvm.org/D75294								
dcba401a39d7... Nathan James								
Fix 45129: Incorrect generated configuration modernize-make-shared.IncludeStyle								
1962bc1dfb72... Alex Brachet								
[libc] [UnitTest] Add Matchers Summary: This patch adds gtest-like matchers and `EXPECT ASSERT_THAT` macros. It also adds matchers `Succeeds` and `Fails` and has examples using these in test/src/signal/sigaddset_test.cpp. Reviewers: sivachandra, gchatelet, PaulkaToast Reviewed By: sivachandra, PaulkaToast Subscribers: mgorny, MaskRay, tschuett, libc-commits Differential Revision: https://reviews.llvm.org/D75487								
cfff4851acc5... Arthur Eubanks								
Add warnings for casting ptr -> smaller int for C++ in Microsoft mode Adds warnings to groups recently added in https://reviews.llvm.org/D72231 .								

Prijavljivanje grešaka

Skidanje lošeg commit-a

Prijavljivanje greške odgovornom korisniku

Prijavljivanje bug-a

- [Bugzilla](#)

Product: tools Resolution: --- Component: llvm-exegesis

26 bugs found.

ID	Product	Comp	Assignee ▲	Status ▲	Resolution	Summary	Changed
36725	tools	llvm-exe	courbet	NEW	---	[llvm-exegesis] Evaluate Intel X86 register-register move scheduling info	2019-02-03
37049	tools	llvm-exe	courbet	NEW	---	[llvm-exegesis] Improve error and verbose reporting	2018-10-18
37565	tools	llvm-exe	courbet	NEW	---	[llvm-exegesis] Wrong serial chain generated.	2018-10-18
37602	tools	llvm-exe	courbet	NEW	---	[llvm-exegesis] Ignore unsupported instructions via UnsupportedFeatures	2018-10-18
37697	tools	llvm-exe	courbet	NEW	---	[llvm-exegesis] Idealized Resource Pressure misinterprets ProcResGroups	2019-07-27
36905	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Add support for instructions with memory operands (latency mode)	2019-02-03
37176	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Improve unit tests running on the build bots	2018-10-18
37177	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Output the jit asm snippet	2018-10-18
37193	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Support latency mode for targets without a scheduler model	2018-10-18
37448	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Include specific EFLAGS in the test code	2018-10-18
37563	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Latency varies depending on selected register.	2019-02-03
37615	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Weird results for LD_F0	2018-10-18
37734	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Set initial value registers.	2018-10-18
39038	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] Exploration of MCInstr predicates	2018-10-18
39918	tools	llvm-exe	gchatelet	NEW	---	[llvm-exegesis] DIV64r "snippet crashed while running"	2019-06-12
37568	tools	llvm-exe	unassignedbugs	NEW	---	[llvm-exegesis] Latency test code breaking register dependencies	2018-10-18
38951	tools	llvm-exe	unassignedbugs	NEW	---	[llvm-exegesis] PfmIssueCounter for uops in amdfam15h	2018-10-18
39082	tools	llvm-exe	unassignedbugs	NEW	---	[llvm-exegesis] Cleanup the yaml schema	2018-10-18

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljivanje grešaka

[llvm-exegesis](#)

Objavljivanje nove verzije

Linkovi

Kontakt informacije

O alatu

Primer slanja izmene

Alat za merenje karakteristika instrukcija kroz izvršavanje

```
llvm-exegesis -mode=latency -opcode-name=ADD64rr
```

```
---
key:
  opcode_name:  ADD64rr
  mode:        latency
  config:      ''
cpu_name:     haswell
llvm_triple:  x86_64-unknown-linux-gnu
num_repetitions: 10000
measurements:
  - { key: latency, value: 1.0058, debug_string: '' }
error:      ''
info:      'explicit self cycles, selecting one aliasing configuration.'
Snippet:
ADD64rr R8, R8, R10
'
...

```

llvm-exegesis

O alatu

SYRMIA

Projekat iz Google-a

Režimi rada:

- latency
- μ ops / inverse_throughput
- Analysis

Generisanje velikog broja instrukcija


Merenje pomoću hardverskih brojača

llvm-exegesis

Primer slanja izmene

[llvm-exegesis] Improve error reporting in Assembler.cpp

Closed Public

Author:  mstojanovic on Mon, Feb 10, 4:41 PM.

Details

Reviewers: courbet, gchatelet, petarj

Commits: rG79c7d34dcca: Recommit: "[llvm-exegesis] Improve error reporting in Assembler.cpp", rG63bb9fee525f: [llvm-exegesis] Improve error reporting in Assembler.cpp

SUMMARY


Followup to [D74085](#).

Replace the use of `report_fatal_error()` with returning the error to `llvm-exegesis.cpp` and handling it there.


Diff Detail

Repository: [rG LLVM Github Monorepo](#)


Changes from before your most recent comment are hidden. [Show Older Changes](#)


 mstojanovic added a comment. Tue, Feb 18, 11:49 AM


Ping.

 gchatelet accepted this revision. Tue, Feb 18, 2:20 PM

LGTM

 This revision is now accepted and ready to land. Tue, Feb 18, 2:20 PM

 Closed by commit rG63bb9fee525f: [llvm-exegesis] Improve error reporting in Assembler.cpp (authored by mstojanovic). · Explain Why Tue, Feb 18, 2:32 PM

 This revision was automatically updated to reflect the committed changes.

- Edit Revision
- Update Diff
- Download Raw Diff
- Edit Related Revisions...
- Edit Related Objects...
- Automatically Subscribed
- Mute Notifications
- Award Token
- Flag For Later

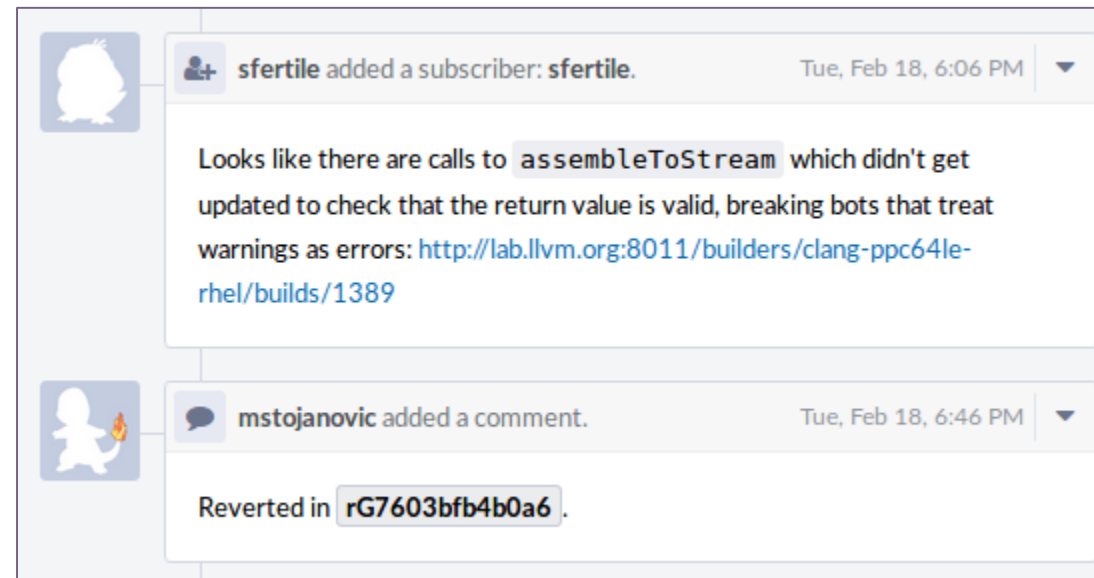
Tags

- LLVM

Subscribers

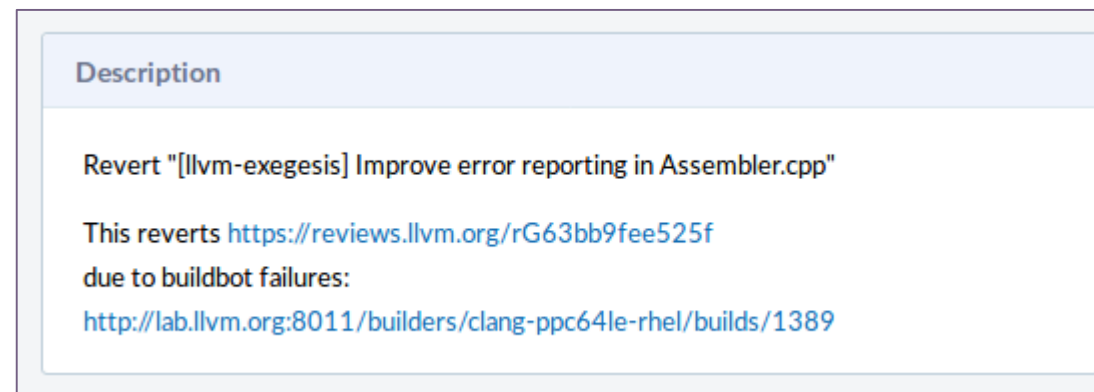
tschuett, llvm-commits

Poruka o padu



Revert

- `git revert`



Reprodukovanje greške

Popravljanje nedostatka

Podizanje ispravke

Description

Recommit: "[llvm-exegesis] Improve error reporting in Assembler.cpp"

Summary: Commit `63bb9fee525f8f29fd9c2174fa7f15573c3d1fd7` was reverted in

`7603bfb4b0a6a90137d47f0182a490fe54bf7ca3` because it broke builds that treat

warnings as errors.

This commit updates the calls to `assembleToStream()` in tests to check that the return value is valid.

Original commit message:

Followup to `D74084`.

Replace the use of `report_fatal_error()` with returning the error to `llvm-exegesis.cpp` and handling it there.

Differential Revision: <https://reviews.llvm.org/D74325>

SYRMIA

LLVM

Osnovni koraci

Pregledanje koda

Kontinualna integracija

Prijavljanje grešaka

llvm-exegesis

Objavljanje nove verzije

Linkovi

Kontakt informacije

Koraci za objavljanje

Testiranje

Build faze

Objavljivanje nove verzije

Koraci za objavljivanje

SYRMIA

Glavni release ~svakih 6 meseci (10.0.0)

Najava release-a

Zaleđivanje koda i pravljenje grane

Prva runda testiranja - release candidate 1 (**rc1**)

- Traje 7-10 dana
- Rešavanje pronađenih kritičnih regresija
- Dovošavanje izmena, izbacivanje nedovršениh

Druga runda testiranja (**rc2**)

- Ponovno testiranje
- Rešavanje grešaka nastalih pri spajanju sa glavnom granom
- Ako ih je bilo ide se u treću rundu testiranja (**rc3**)

Pisanje beleški o novoj verziji

Objavljivanje

Objavljivanje nove verzije

Testiranje

SYRMIA

Prijavljivanje dobrovoljaca koji će vršiti testiranje

Svako od njih dobija uloge da:

- Testira korektnost i performanse prethodne verzije
- Testira korektnost i performanse svakog kandidata za objavu (rcX)
- Poredi sa prethodnim verzijama i kandidatima
- Identifikuje, prijavljuje i rešavaja regresije pronađene u toku testiranja
- Stara se o tome da svaki kritičan problem bude rešen u novoj verziji

Objavljivanje nove verzije

Build faze

SYRMIA

Tri build faze:

- 1) Prevođenje sa nezavisnim prevodiocem
- 2) Prevođenje sa prevodiocem iz druge faze
- 3) Prevođenje sa prevodiocem iz treće faze

Instalacija (prevodioca iz treće faze)

Testiranje (llvm-testsuite)

Linkovi

Miloš Stojanović <Milos.Stojanovic@rt-rk.com>, <mc.cm.mail@gmail.com>

SYRMIA

Prezentacija: [Razvoj_i_odrzavanje_kvaliteta_softvera_u_LLVM-u.pdf](#)

LLVM glavni sajt: <https://llvm.org/>

LLVM izvorni kod <https://github.com/llvm/llvm-project/>

LLVM Discord grupa: <https://discord.gg/xS7Z362>

Prvi koraci sa LLVM-om: <https://llvm.org/docs/GettingStarted.html>

Politika razvoja u LLVM-u: <https://llvm.org/docs/DeveloperPolicy.html>

Testiranje LLVM-a: <https://llvm.org/docs/TestingGuide.html>

Phabricator: <https://reviews.llvm.org/>

Buildbot: <https://buildbot.net/>

LLVM buildbot: <http://lab.llvm.org:8011/console>

llvm-exegesis: <https://llvm.org/docs/CommandGuide/llvm-exegesis.html>

Objavljivanje nove verzije: <https://llvm.org/docs/HowToReleaseLLVM.html>

SYRMIA

Kontaktirajte nas

SYRMIA
Belgrade Office Park
Đorđa Stanojevića 12
Beograd 11070
Srbija