Workshop on Essential Abstractions in GCC

Introduction and Opening Remarks

GCC Resource Center
(www.cse.iitb.ac.in/grc)

Department of Computer Science and Engineering,
Indian Institute of Technology, Bombay

30 June 2012
Outline

• About GCC Resource Center

• Workshop Plan
Part 1

About GCC Resource Center
National Resource Center for F/OSS, Phase II

GCC Resource Center is a part of NRCFOSS (II)

- Sponsored by Department of Information Technology (DIT), Ministry of Information and Communication Technology
- CDAC Chennai is the coordinating agency of NRCFOSS (II)
- Participating agencies
  CDAC Chennai, CDAC Mumbai, CDAC Hyderabad, IIT Bombay, IIT Madras, Anna University,
- Project investigators of GCC Resource Center

  Uday Khedker: Professor, Dept. of CSE, IIT Bombay
  Supratim Biswas: Professor, Dept. of CSE, IIT Bombay
  Amitabha Sanyal: Professor, Dept. of CSE, IIT Bombay
Objectives of GCC Resource Center

1. **To support the open source movement**
   Providing training and technical know-how of the GCC framework to academia and industry.

2. **To include better technologies in GCC**
   Whole program optimization, Optimizer generation, Tree tiling based instruction selection.

3. **To facilitate easier and better quality deployments/enhancements of GCC**
   Restructuring GCC and devising methodologies for systematic construction of machine descriptions in GCC.

4. **To bridge the gap between academic research and practical implementation**
   Designing suitable abstractions of GCC architecture
Broad Areas of Interests

- Program Analysis and Optimization
- Translation Validation
- Retargetable compilation
- Parallelization and Vectorization for SIMD and MIMD Architectures

General explorations applied in the context of GCC
Broad Research Goals of GCC Resource Center

- Using GCC as a means
  - Adding new optimizations to GCC
  - Adding flow and context sensitive analyses to GCC
    (In particular, pointer analysis)
  - Translation validation of GCC

- Using GCC as an end in itself
  - Changing the retargetability mechanism of GCC
  - Cleaning up the machine descriptions of GCC
  - Systematic construction of machine descriptions
  - Facilitating optimizer generation in GCC
# GRC Training Programs

<table>
<thead>
<tr>
<th>Title</th>
<th>Target</th>
<th>Objectives</th>
<th>Mode</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop on Essential Abstractions in GCC</td>
<td>People interested in deploying or enhancing GCC</td>
<td>Explaining the essential abstractions in GCC to ensure a quick ramp up into GCC Internals</td>
<td>Lectures, demonstrations, and practicals (experiments and assignments)</td>
<td>Three days</td>
</tr>
<tr>
<td>Tutorial on Essential Abstractions in GCC</td>
<td>People interested in knowing about issues in deploying or enhancing GCC</td>
<td>Explaining the essential abstractions in GCC to ensure a quick ramp up into GCC Internals</td>
<td>Lectures and demonstrations</td>
<td>One day</td>
</tr>
<tr>
<td>Workshop on Compiler Construction with Introduction to GCC</td>
<td>College teachers</td>
<td>Explaining the theory and practice of compiler contraction and illustrating them with the help of GCC</td>
<td>Lectures, demonstrations, and practicals (experiments and assignments)</td>
<td>Seven days</td>
</tr>
<tr>
<td>Tutorial on Demystifying GCC Compilation</td>
<td>Students</td>
<td>Explaining the translation sequence of GCC through gray box probing (i.e. by examining the dumps produced by GCC)</td>
<td>Lectures and demonstrations</td>
<td>Half day</td>
</tr>
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</table>
GRC Training Programs

CS 715: The Design and Implementation of GNU Compiler Generation Framework

- 6 credits semester long course for M.Tech. (CSE) students at IIT Bombay
- Significant component of experimentation with GCC
- Introduced in 2008-2009
Part 2

Workshop Plan
Motivation Behind this Workshop

- To understand GCC well :-}
Motivation Behind this Workshop

- To understand GCC well :-)
- Reasonably quickly
Philosophy and Pedagogy

Twin goals of this workshop:

• **Learning how to learn GCC**
  
  Our focus will be on
  
  ▶ giving you some core information
  ▶ showing you how to discover more information

• **Striking a balance between theory and practice**
  
  Our focus will be on showing you how to
  
  ▶ discover concepts in a large code base and build abstractions
  ▶ take concepts and update a large code base
  ▶ relate the class room concepts of complilers to an industry strength compiler
Our Canvas

- Version: GCC 4.6.2
- Language: C
- Targets: i386, spim (mips simulator)
Philosophy and Pedogogy

• We will

• You will
Philosophy and Pedagogy

• We will
  ▶ Explain configuration and building of GCC
  ▶ Explain essential abstractions related to compilation
    The key intermediate representations and their manipulations
  ▶ Explain essential abstractions related to program analysis in GCC
  ▶ Explain essential abstractions related to generation of a compiler
    The machine descriptions and their influence on compilation

• You will
Philosophy and Pedagogy

• We will
  ▶ Explain configuration and building of GCC
  ▶ Explain essential abstractions related to compilation
    The key intermediate representations and their manipulations
  ▶ Explain essential abstractions related to program analysis in GCC
  ▶ Explain essential abstractions related to generation of a compiler
    The machine descriptions and their influence on compilation

• You will
  ▶ Build and run GCC
  ▶ Examine various IR dumps produced by GCC
  ▶ Add passes to GCC
  ▶ Add a new machine description and systematically enhance it
Takeaways from this Workshop

- A programmer will get a better compiler.
- A compiler professional will be able to deploy and enhance GCC much more easily.
- A compiler researcher will be able to use GCC for research much better.
- A compiler teacher will be able to strike a better balance between theory and practice.
- A compiler student will be exposed to issues in real compilers.
Schedule on All Days

- 09:30. Commencement of the pre-lunch session
- 11:00. Tea Break
- 13:00. Lunch Break
- 14:00. Commencement of the post-lunch session
- 15:30. Tea Break
- 17:15. High Tea (Formal sessions end. Participants can continue to work on the assignments)
- 20:30. Dinner
Coverage

- A day wise coverage follows
- The big picture of coverage and logical connections between the topics?
Coverage

- A day wise coverage follows
- The big picture of coverage and logical connections between the topics?

Will be clear after the technical overview
### Lecture Topics

- Introductory remarks, Workshop plan
- An overview of compilation and GCC
- Gray box probing of GCC
- Configuration and building
- (Optional) make, byobu, ctags, ddd, cscope, patch files

### Lab Topics

- Gray box probing of GCC
- Configuration and building

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**Coverage on Day 1 (Saturday 30 June 2012)**

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**Essential Abstractions in GCC**

GCC Resource Center, IIT Bombay
### Coverage on Day 2 (Sunday 1 July 2012)

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Lab Topics</th>
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</thead>
<tbody>
<tr>
<td>• Module binding mechanisms in GCC</td>
<td>Adding GIMPLE passes</td>
</tr>
<tr>
<td>• Adding passes to gcc</td>
<td>• Intraprocedural,</td>
</tr>
<tr>
<td>• gcc control flow</td>
<td>• Interprocedural</td>
</tr>
<tr>
<td>• Manipulating GIMPLE IR</td>
<td>(translation unit level)</td>
</tr>
<tr>
<td>• Link time optimization (LTO)</td>
<td>• Interprocedural</td>
</tr>
<tr>
<td>• Introduction to data flow analysis, pointer analysis</td>
<td>(program level)</td>
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</tbody>
</table>
### Coverage on Day 3 (Monday 2 July 2012)

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Lab Topics</th>
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</thead>
<tbody>
<tr>
<td>• Introduction to machine descriptions</td>
<td>Machine Descriptions</td>
</tr>
<tr>
<td>• Spim machine descriptions</td>
<td></td>
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<tr>
<td>• specRTL based machine descriptions</td>
<td></td>
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<tr>
<td>• The retargetability mechanism of GCC</td>
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</tbody>
</table>
## Coverage on Day 4 (Tuesday 3 July 2012)

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Lab Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Introduction to Parallelization and Vectorization</td>
<td>Parallelization and Vectorization</td>
</tr>
<tr>
<td>• Parallelization and Vectorization in GCC</td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>Pointer Analysis</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>Machine descriptions in specRTL</td>
</tr>
</tbody>
</table>
Lecture and Lab Schedule

- Lab and lectures will be interleaved
- Flexible schedule
- Duration, time, sequencing may be changed dynamically based on how well things are being received
- Use handouts to make notes against the slides
Video Recording of the Course

- Several requests received in past
  Last request from the GCC Developers’ Meet
- Lectures will be recorded by the *Talk to A Teacher* project of IITB
- Videos will be released in the open source free of cost
- You are requested to sign a consent form
Video Recording of the Course

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• Videos will be released in the open source free of cost
• You are requested to sign a consent form
• There are sensitive microphones near you to catch your gossip :-)
  ▶ Please do not disturb them!
  ▶ They will catch the vibrations of your mobile phones too!
Lab arrangements:

- Assignments have to be done in groups of two.
  - Please use the tea time to finalize your group
  - A sheet will be circulated after the tea for group details
  - If you need a laptop, we will issue it during lunch. You will need to return it in the evening.

- Doing the assignments.
  - Do all exercises on your laptop, or
  - Use your laptop and log into our servers,
  - Use our laptop and log into our servers.

- How to connect to server?
  Separate information sheet has been provided.

- Teaching assistants will help you in doing the assignments
Announcements and Questions

- Dinner and breakfast arrangements
  - Breakfast available in the hostels
  - Tea: Available in the foyer
  - Dinner: Sat, Sun, Mon: Available at 20:30 in foyer

- Important requirement from the security:
  Please continue to wear your name badge throughout the IITB campus
Announcements and Questions

- Receipts of payments
  - If you have sent the DD earlier, or have made electronic payment, your receipt may be ready.
  - Please collect from Nisha on Tuesday during the lunch time.
Announcements and Questions

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  ▶ If you have sent the DD earlier, or have made electronic payment, your receipt may be ready.
  ▶ Please collect from Nisha on Tuesday during the lunch time.

• Concluding session
  ▶ Informal discussions
  ▶ Brief (10 minute) presentations by participating organizations/individuals
    If you are interested, please contact me today or latest tomorrow
  ▶ Feedback forms
  ▶ Announcement of best Teaching Assistant
Two Visitors Who Could Not be Accommodated . . .

We usually are very selective but sometime some folks gate crash
Two Visitors Who Could Not be Accommodated . . .

Time: 02:00 a.m. Thursday 28 June 2012

Venue: A parking shed of a colleague’s quarter
Two Visitors Who Could Not be Accommodated . . .
Two Visitors Who Could Not be Accommodated . . .
Some Precautions: First the Caution

- Do not stray into secluded areas and deserted bylanes from evening until morning
- Trying to save yourself by hiding behind bushes and thick vegetation on the lake side or hill side may not help. Leopards (‘s’ as in plural) may be hiding there
- Evening walks by the lake are best avoided
Some Precautions: And then the Good News

- Confining yourself to the main road should not be a problem
- If possible, move out in groups
- In past forty years, only two persons were injured
  Calculate the probability by considering the number of people who have been on the campus in forty years
- Unless you bother them, the visitors would not bother you
Some Precautions: Further Information . . .

- Snakes are regular residents, don’t bother them
- So are monkeys and cattle
# The Support Team

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<tr>
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<tbody>
<tr>
<td>3.</td>
<td>Anup Naik</td>
<td>12.</td>
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<tr>
<td>6.</td>
<td>Deepak Jayanth</td>
<td>15.</td>
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<tr>
<td>8.</td>
<td>Gaurav Bhagwat</td>
<td>17.</td>
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<tr>
<td>19.</td>
<td>Rahul Asati</td>
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<td>20.</td>
<td>Raj Agrawal</td>
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<tr>
<td>21.</td>
<td>Rohan Padhye</td>
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<tr>
<td>22.</td>
<td>Sreenivas M N</td>
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<tr>
<td>23.</td>
<td>Swati Rathi</td>
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<tr>
<td>24.</td>
<td>Senthilkumaran N</td>
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<tr>
<td>25.</td>
<td>Sudakshina Das</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Sumit Jamgade</td>
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</tr>
<tr>
<td>27.</td>
<td>Vini Kanvar</td>
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