拍案惊奇——软件调试实战训练营

张银奎

2017/4/21-23 庐山秀峰中正行营


Chihu Lake
赤湖
FENLUZHEN
分路镇
东港
JIANGZHOUZHEN
江洲镇
HUANGCUNXIANG
屋村乡
YONG'ANXIANG
永安乡
Xingfugang
幸福港
XIAOCHIZHEN
小池镇
JINJIPO RESIDENTIAL DISTRICT
金鸡坡
XINGANGZHEN
新港镇
Yangtze River
DALONGXIA
大垅乡
HUKOU
湖口县
MAYINGZHEN
马影镇
GANGKOUJIEZHEN
港口街镇
Donghu Lake
东湖
QILIHU RESIDENTIAL DISTRICT
七里湖
Jiujiang
九江市
Saihu Lake
赛湖
RUICHANG
瑞昌市
Dachengmen Lake
大城门湖
YUJIAHEXIANG
虞家河乡
LUSHAN
庐山区
WEIJIAZHEN
威家镇
FULONGXIANG
付垅乡
Jiangqiaogang
江桥港
CHENGMENXIANG
城门乡
LIANHUAZHEN
莲花镇
GUTANGZHEN
姑塘镇
XINTANGXIANG
新塘乡
XINHEZHEN
新合镇
JIUJIANG
九江县
SHIZIZHEN
狮子镇
CHENGSHANZHEN
城山镇
SHUNDEXIANG
舜德乡
WUSHANZHEN
武山镇
SAIYANGZHEN
赛阳镇
GULINGZHEN
钴岭镇
HAIHUIZHEN
海会镇
CHUNQIAOXIANG
春桥乡
Xiaoguigang
小桂港
SUSHANXIANG
苏山乡
MINSHANXIANG
岷山乡
Linquan Reservoir
林泉水库
BAILUZHEN
白鹿镇
秀峰寺
XUBUZHEN
徐埠镇
LINQUANXIANG
林泉乡
XINGZI
星子县
MAHUILINGZHEN
马回岭镇
Hougang
后港
G105
G70
G56
S303
S304
S213
S212
S37
S301
S20
3D

李白

- 李白（701年—762年）
- 公元756年春，避安史之乱带妻宗氏一起来到庐山，在五老峰东侧之九叠坪筑堂读书
- 12月下山投奔永王李璘幕府
- 757年，永王和哥哥李亨干戈相见，永王兵败，李白被抓，囚于浔阳狱中，8、9月间判处流放夜郎
- 758年，到白帝城时遇到大赦，“千里江陵一日还”，又上庐山，作《望庐山瀑布》和《庐山遥寄卢侍御虚舟》

望庐山五老峰
李白
庐山东南五老峰，
青天削出金芙蓉。
九江秀色可揽结，
吾将此地巢云松。

望庐山瀑布二首
其一
西登香炉峰，南见瀑布水。
挂流三百丈，喷壑数十里。
欻如飞电来，隐若白虹起。
初惊河汉落，半洒云天里。
仰观势转雄，壮哉造化功。
海风吹不断，江月照还空。
空中乱潨射，左右洗青壁；
飞珠散轻霞，流沫沸穹石。
而我乐名山，对之心益闲；
无论漱琼液，还得洗尘颜。
且谐宿所好，永愿辞人间。
其二
日照香炉生紫烟，遥看瀑布挂前川。
飞流直下三千尺，疑是银河落九天。

庐山谣寄卢侍御虚舟
李白
我本楚狂人， 凤歌笑孔丘。
手持绿玉杖， 朝别黄鹤楼。
五岳寻仙不辞远， 一生好入名山游。
庐山秀出南斗旁， 屏风九叠云锦张， 影落明湖青黛光。
金阙前开二峰长， 银河倒挂三石梁。
香炉瀑布遥相望， 回崖沓嶂凌苍苍。
翠影红霞映朝日， 鸟飞不到吴天长。
登高壮观天地间， 大江茫茫去不还。
黄云万里动风色， 白波九道流雪山。
好为庐山谣， 兴因庐山发。
闲窥石镜清我心， 谢公行处苍苔没。
早服还丹无世情， 琴心三叠道初成。
遥见仙人彩云里， 手把芙蓉朝玉京。
先期汗漫九垓上， 愿接卢敖游太清。

白居易

- 白居易（772年—846年），字乐天，号香山居士，又号醉吟先生，祖籍太原，到其曾祖父时迁居下邽，生于河南新郑。
- 815年10月，被贬职为江州司马的白居易就职
- 816年，江边送客，遇琵琶女，作《琵琶行》
- 3267言的《与元九书》
- 《访陶公旧宅》
- 816年秋天，第一次登上庐山
- 817年春天（3/27），草堂落成入住，《庐山草堂记》
- 818年，改任忠州刺史，离开庐山，822年，改任杭州刺史

香爐峯下新卜山居草堂初成偶題東壁
白居易

日高睡足猶慵起，小閤重衾不怕寒
遺愛寺鐘欹枕聽，香鑪峯雪撥簾看
匡廬便是逃名地，司馬仍爲送老官
心泰身寧是歸處，故鄉可獨在長安

苏轼

- 苏轼（1037年1月8日—1101年8月24日）
- 漱玉亭
- 青玉峡，龙潭

开先漱玉亭
高岩下赤日，深谷来悲风。
擘开青玉峡，飞出两白龙。
乱沫散霜雪，古潭摇清空。
余流滑无声，快泻双石砌。
我来不忍去，月出飞桥东。
荡荡白银阙，沉沉水精宫。
愿随琴高生，脚踏赤鲤公。
手持白芙蕖，跳下清泠中。

米芾

米芾（1051-1107），初名黻，后改芾，字元章，时人号海岳外史 ，又号鬻熊后人、火正后人。北宋书法家、画家、书画理论家，与蔡襄、苏轼、黄庭坚合称“宋四家”。曾任校书郎、书画博士、礼部员外郎。。能诗文，擅书画，精鉴别，书画自成一家，创立了“米点山水”。集书画家、鉴定家、收藏家于一身。其个性怪异，举止颠狂，遇石称“兄”，膜拜不已，因而人称“米颠”。宋徽宗诏为书画学博士，又称“米襄阳”、“米南宫”。

开仙寺观龙潭

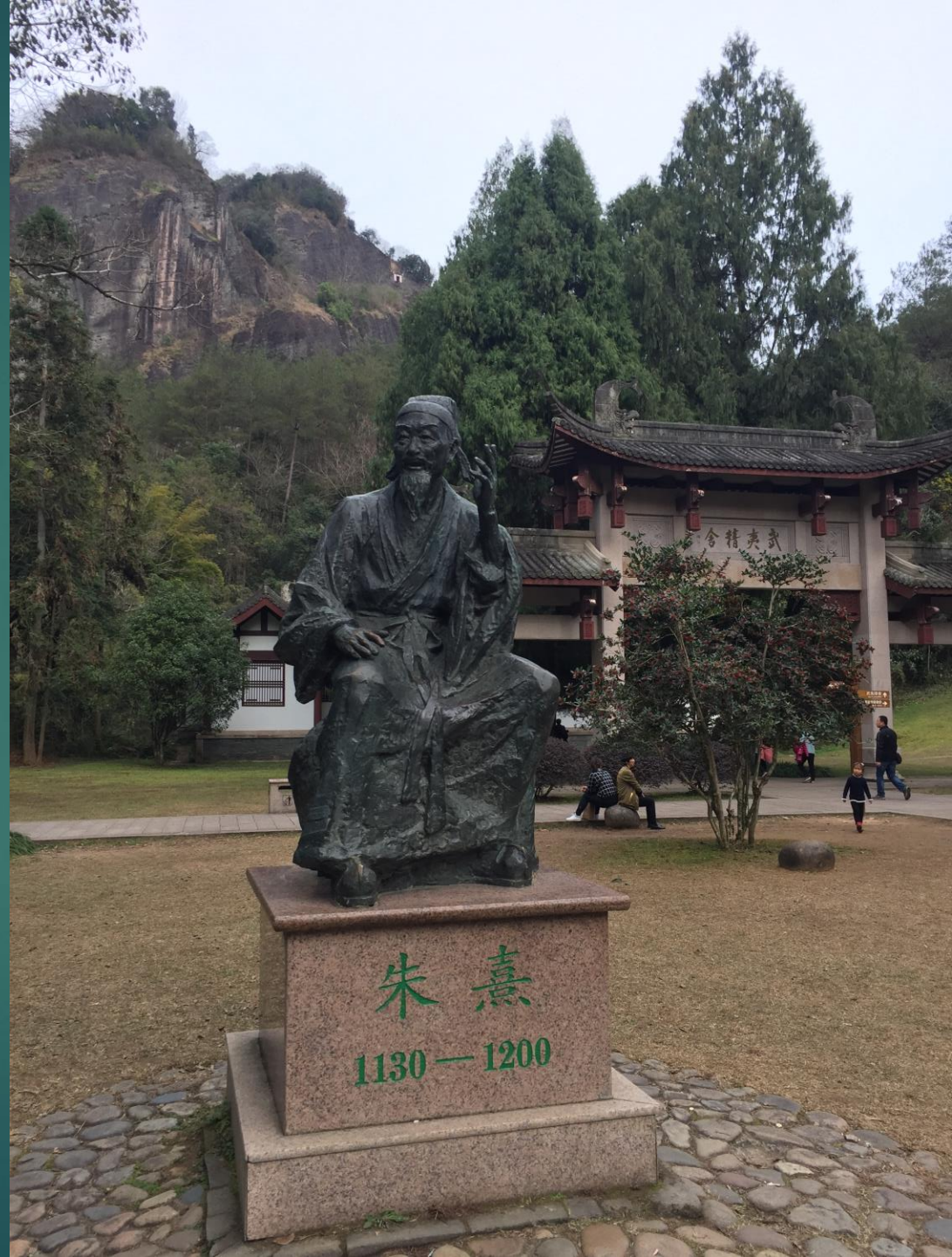
度峡扪青玉，临深坐绿苔。
水从双剑下，山挟两龙来。
春暖花惊雪，林空石迸雷。
尘缨聊此濯，却去首重回。

朱熹

朱熹（1130.9.15—1200.4.23），字元晦，又字仲晦，号晦庵，晚称晦翁，谥文，世称朱文公

鹤鸣峰
不见山头夜鹤鸣，空遗山下瀑泉声。
野人惆怅空无寐，一曲瑶琴分外清。

奉同尤延之提舉廬山雜詠十四篇 其八 開先漱玉亭
在萬杉西二里，亭舊在橋上，今廢
奇哉康山陽，雙劍屹對起。上有橫飛雲，下有瀑布水。
崩騰復璀璨，佳麗更雄偉。勢從三梁外，影落明湖裏。
平生兩仙句，詠嘆深仰止。三年落星灣，悵望眼空眯。
今朝隨杖屨，得此弄清泚。更誦玉虹篇，塵襟諒昭洗。



唐寅

唐寅（1470年3月6日-1524年1月7日），字伯虎，后改字子畏，号六如居士、桃花庵主、鲁国唐生、逃禅仙吏等，南直隶苏州府吴县人，明代画家、书法家、诗人。

登庐山

匡庐山高高几重，山雨山烟浓复浓。
移家未住屏风叠，骑驴来看香炉峰。
江上乌帽谁涉水，岩际白衣人采松。
古句摩崖留岁月，读之漫灭为修容。

龙潭夜坐

明·王守仁

何处花香入夜清，石林茅屋隔溪声。
幽人月出每孤往，栖鸟山空时一鸣。
草露不辞芒屨湿，松风偏与葛衣轻。
临流欲写猗兰意，江北江南无限情。

王阳明

- 王守仁（1472年10月31日—1529年1月9日），幼名云，字伯安，别号阳明。因曾筑室于会稽山阳明洞，自号阳明子，学者称之为阳明先生，亦称王阳明。
- 屯兵鄱阳湖边，“以列郡之兵平定”宁王朱宸濠叛乱
- 安仁铺内倚栏杆，遥望孤牛俯在山。
- 乡村郭氏：任是牧童鞭不起，田园荒芜至今闲。

又重游题壁

中丞不解了公事，到处看山复寻寺。
尚为妻孥守俸钱，至今未得休官去。
三月开先两度来，寺僧倦客门未开。
山灵似嫌俗士驾，溪风拦路吹人回。
君不见富贵中入如中酒，折腰解醒须五斗。
未妨适意山水间，浮名于我亦何有。

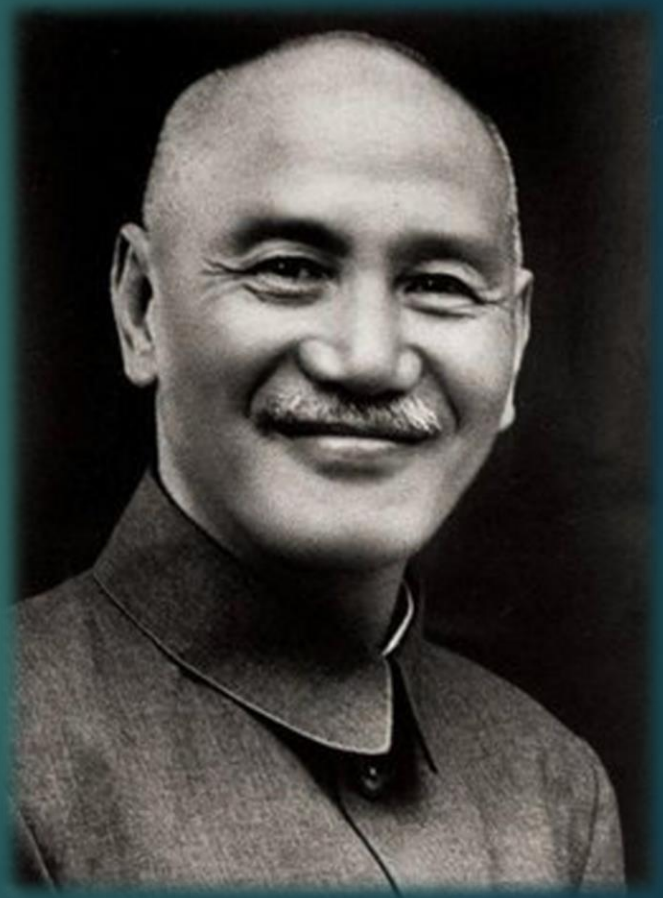
徐霞客庐山游记

- 徐霞客（1587—1641），名弘祖，字振之，号霞客，南直隶江阴（今江苏江阴市）人
- 1618年八月十八，与族兄雷门、白夫到九江，换小船进入龙开河，行二十里水路后在李裁缝堰登陆，经西林寺到东林寺
- 二十二日经白鹿洞、栖贤寺、万松寺到开先寺，赏庐山瀑布，夜宿开先寺
- 二十三日游马尾瀑布，登文殊台，黄岩寺，攀登黄石岩，远眺鄱阳湖
- 仍在开先寺用饭，饭后告别而去

徐霞客（1587—1641），名弘祖，字振之，号霞客，南直隶江阴（今江苏江阴市）人。明代地理学家、旅行家和文学家，他经30年考察撰成的60万字地理名著《徐霞客游记》，被称为“千古奇人”。

蒋介石

- 蒋介石（1887年10月31日－1975年4月5日），名中正，字介石。幼名瑞元、谱名周泰、学名志清。祖籍江苏宜兴，生于浙江奉化，是近代中国著名政治人物及军事家，历任黄埔军校校长、国民革命军总司令、国民政府主席、行政院院长、国民政府军事委员会委员长、中华民国特级上将、中国国民党总裁、三民主义青年团团长、第二次世界大战同盟国中国战区最高统帅、中华民国总统等职。
- 蒋中正受孙中山赏识而崛起於民国政坛，在孙去世后长期领导中国国民党达半世纪；其於国民政府时代一直居於军政核心，领导中国渡过对日抗战与二次大战，行宪后又连续担任第一至五任中华民国总统长达27年，但其政治手腕与独裁统治亦遭受批评。
- 1932年，任国民政府军事委员会委员长时来到秀峰，下榻中正行营。



WHO AM I

凡凡一书农，深居都市中
工作写代码，闲来爱捉虫
都言此道苦，我觉乐无穷
如不遇软件，此身何所用

张银奎，Raymond Zhang，格蠹老雷，《软件调试》和《格蠹汇编》作者
http://advdbg.org http://weibo.com/dbgger 格友公众号

大纲

前言

热身篇：双剑合璧——WinDBG与GDB之理一分殊

1. 堆损毁导致的随机崩溃和挂死
2. 后台服务因段错误崩溃
3. 与驱动程序间通信时的数据混乱
4. 应用程序挂死之陷在内核态
5. .Net程序调试之SDK安装程序死循环
6. 多线程调试之死锁和死循环
7. 转储分析之双重错误
8. 系统挂死在DPC
9. 缓冲区溢出之系统服务崩溃
10. C++程序中的堆错乱
11. 混合调试之右键菜单异常缓慢
12. 调试加过壳的软件

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双剑合璧——WinDBG与GDB之理一分殊

张银奎

2017/4/21 庐山秀峰中正行营

David Cutler

- NT内核之父——NT内核和执行体的最主要设计者，NT“部落”的领导核心
- 1942年出生密歇根州兰辛市
- 1971年（29岁）加入DEC
- 1988.10.31加入微软
- KD的主要设计者和实现者
- 微软Sr. Technical Fellow

David Cutler

- 2016 Fellow
- For his fundamental contributions to computer architecture, compilers, operating systems and software engineering.
- He is an avid cyclist and enjoys golfing and skiing. On weekends he can often be found at Microsoft, writing code for the next critical current project or his own pet project.
- http://www.computerhistory.org/fellowawards/hall/david-cutler/

/*++

Copyright (c) 1990 Microsoft Corporation

Module Name:

    kdbreak.c

Abstract:

    This module implements machine dependent functions to add and delete
    breakpoints from the kernel debugger breakpoint table.

Author:

    David N. Cutler 2-Aug-1990

Revision History:

--*/

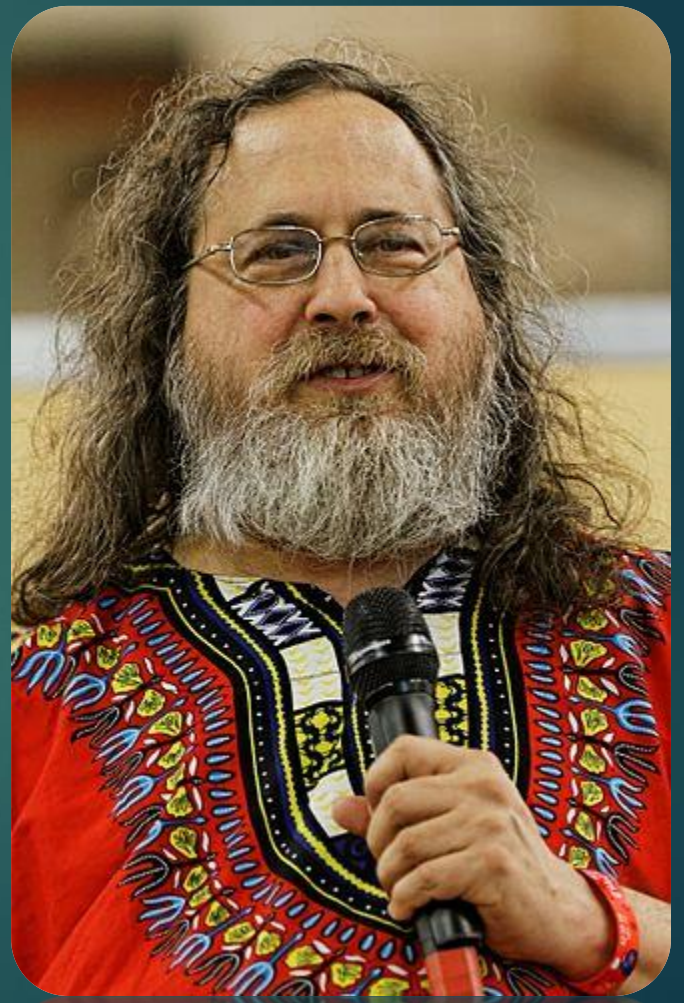

I've always been a very hands-on person.

Richard Matthew Stallman

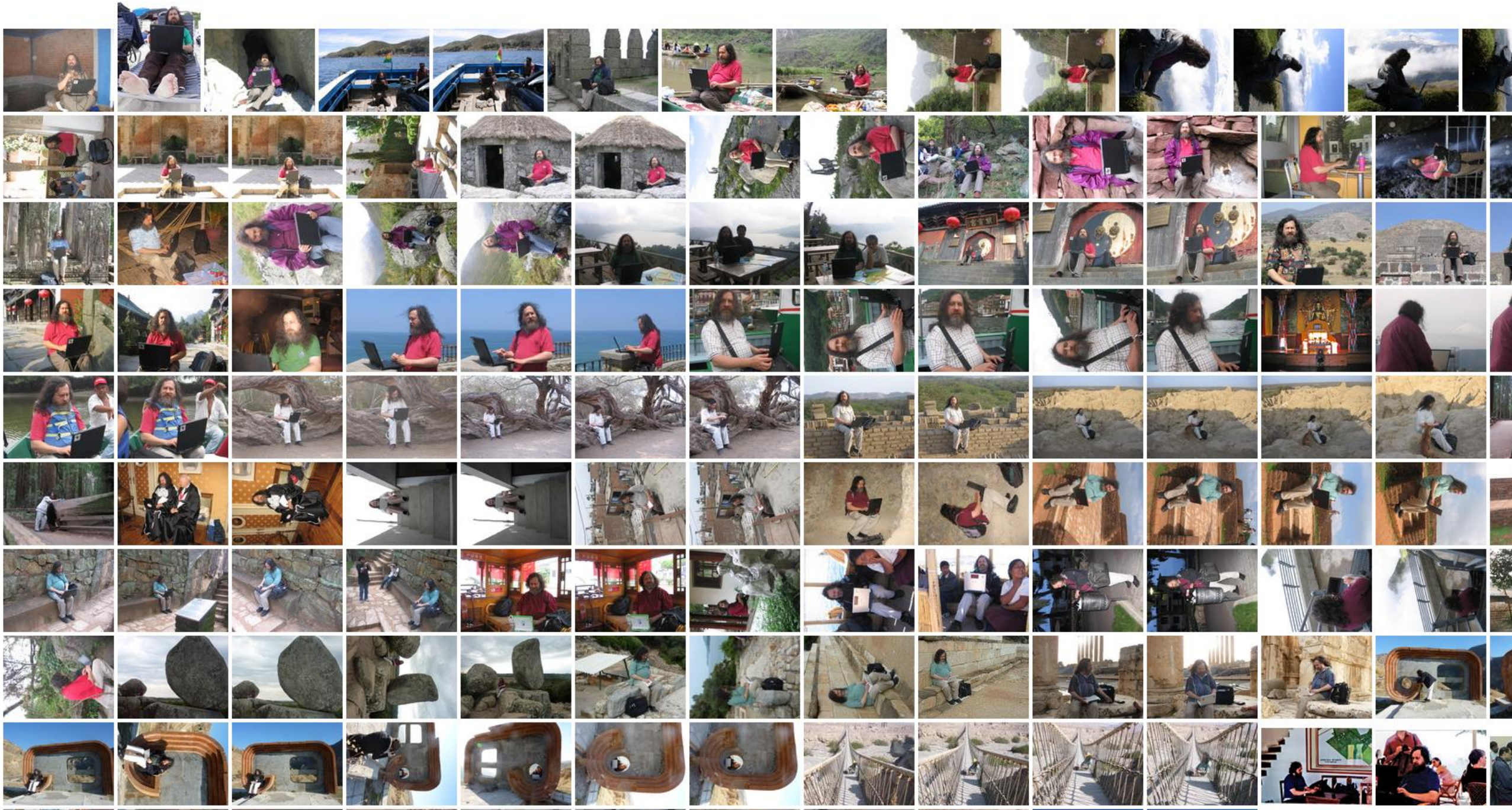
"Richard Matthew Stallman is a software developer and software freedom activist. Born in 1953, he attended Harvard starting in 1970 and graduated in 1974 with a Bachelor of Arts in physics. From September 1974 to June 1975 he was a graduate student in physics at MIT."

Stallman developed a number of widely used software components of the GNU system: the GNU Compiler Collection, the GNU symbolic debugger (gdb), GNU Emacs, and various others.

- https://www.stallman.org/



https://www.stallman.org/photos/rms-working/



RMS in China, 2000

Beijing -> Chengdu -> JiuZhaiGou -> Wuhan and to Shanghai"

Richard Stallman using his Lemote machine at Indian Institute of Technology Madras, Chennai before his lecture on 'Free Software, Freedom and Education' organized by Free Software Foundation, Tamil Nadu.

https://en.wikipedia.org/wiki/Richard_Stallman

What hardware do you use?
I am using a Lemote Yeelong, a netbook with a Loongson chip and a 9-inch display. This is my only computer, and I use it all the time. I chose it because I can run it with 100% free software even at the BIOS level.

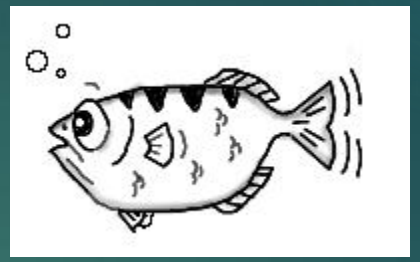
https://usesthis.com/interviews/richard.stallman/

GNU Projects

- Stallman announced the plan for the GNU operating system in September 1983 on several ARPANET mailing lists and USENET.
- Stallman was responsible for contributing many necessary tools, including a text editor (Emacs), compiler (GCC), debugger (GNU Debugger), and a build automator (GNU make).
- In 1991, Linus Torvalds, a Finnish student, used the GNU's development tools to produce the free monolithic Linux kernel.

- Man ls
  - AUTHOR
- Written by Richard M. Stallman and David MacKenzie.

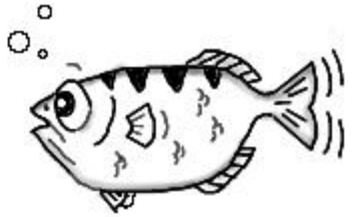
GDB



- GNU Debugger
  - 1986年，Richard Stallman创建
  - 1900-1993，John Gilmore维护
  - 目前在GDB Steering Committee
  - It was modeled after the DBX debugger, which came with Berkeley Unix distributions
  - 支持很多种CPU architecture
  - A29K, ARC, ETRAX CRIS, D10V, D30V, FR-30, FR-V, Intel i960, M32R, 68HC11, Motorola 88000, MCORE, MN10200, MN10300, NS32K, Stormy16, V850, Z8000 and many more
  - 默认为命令行界面,有很多GUI的前端(Add-on)

官网

GDB: The GNU Project Debugger



[bugs] [GDB Maintainers] [contributing] [current git] [documentation] [download] [home] [irc] [links] [mailing lists] [news] [schedule] [song] [wiki]

GDB: The GNU Project Debugger

What is GDB?

GDB, the GNU Project debugger, allows you to see what is going on `inside' another program while it executes -- or what another program was doing at the moment it crashed.

GDB can do four main kinds of things (plus other things in support of these) to help you catch bugs in the act:

- Start your program, specifying anything that might affect its behavior.
- Make your program stop on specified conditions.
- Examine what has happened, when your program has stopped.
- Change things in your program, so you can experiment with correcting the effects of one bug and go on to learn about another.

The program being debugged can be written in Ada, C, C++, Objective-C, Pascal (and many other languages). Those programs might be executing on the same machine as GDB (native) or on another machine (remote). GDB can run on most popular UNIX and Microsoft Windows variants.

GDB version 7.11.1

Version 7.11.1 of GDB, the GNU Debugger, is now available for download. See the ANNOUNCEMENT for details including changes in this release.

- https://www.gnu.org/software/gdb/

Contributors to gdb

Contributors to GDB

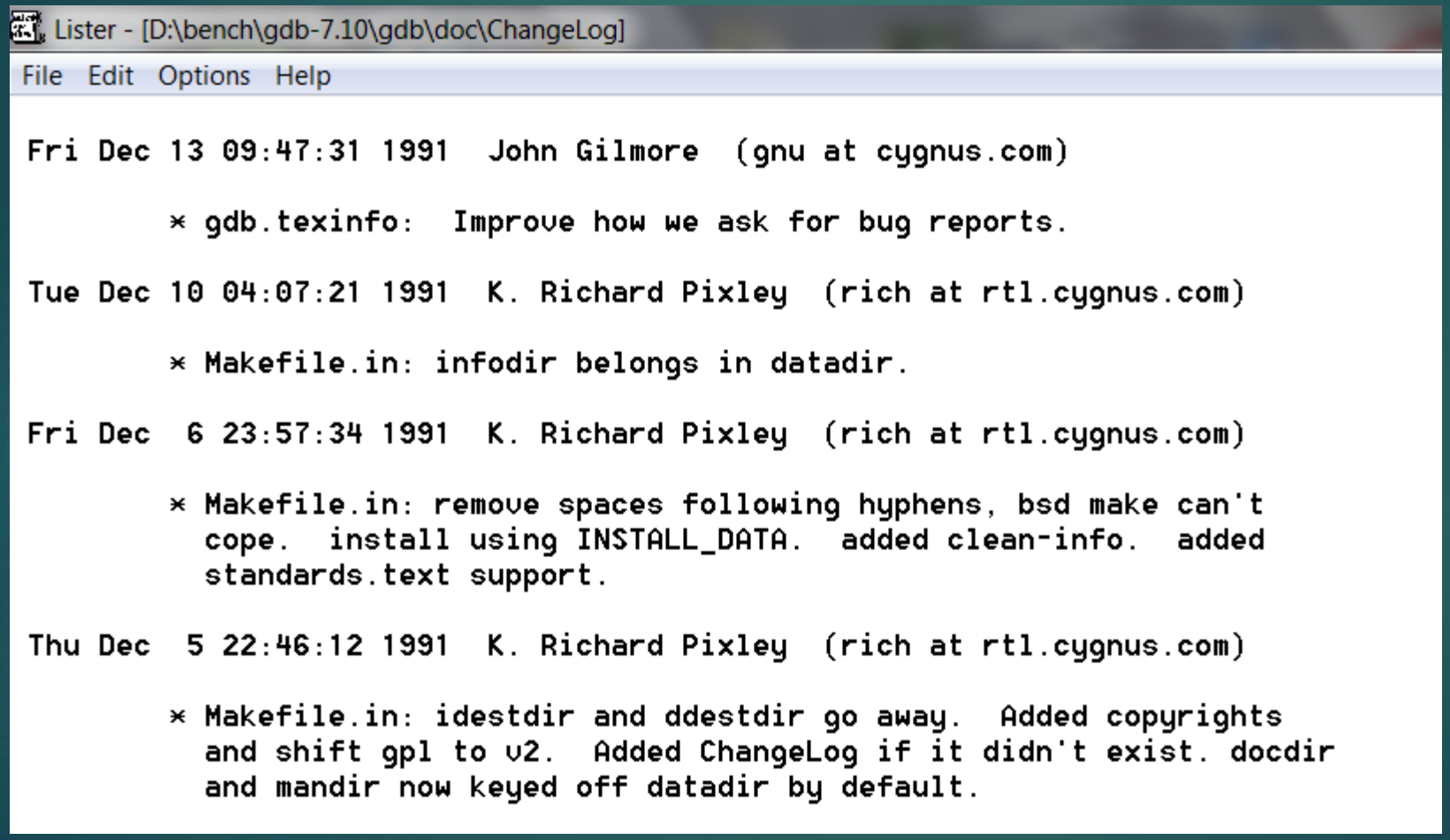
Richard Stallman was the original author of GDB, and of many other GNU programs. Many others have contributed to its development. This section attempts to credit major contributors. One of the virtues of free software is that everyone is free to contribute to it; with regret, we cannot actually acknowledge everyone here. The file 'ChangeLog' in the GDB distribution approximates a blow-by-blow account.

Changes much prior to version 2.0 are lost in the mists of time.

> *Plea:* Additions to this section are particularly welcome. If you or your friends (or enemies, to be evenhanded) have been unfairly omitted from this list, we would like to add your names!

So that they may not regard their many labors as thankless, we particularly thank those who shepherded GDB through major releases: Andrew Cagney (releases 6.3, 6.2, 6.1, 6.0, 5.3, 5.2, 5.1 and 5.0); Jim Blandy (release 4.18); Jason Molenda (release 4.17); Stan Shebs (release 4.14); Fred Fish (releases 4.16, 4.15, 4.13, 4.12, 4.11, 4.10, and 4.9); Stu Grossman and John Gilmore (releases 4.8, 4.7, 4.6, 4.5, and 4.4); John Gilmore (releases 4.3, 4.2, 4.1, 4.0, and 3.9); Jim Kingdon (releases 3.5, 3.4, and 3.3); and Randy Smith (releases 3.2, 3.1, and 3.0).

ChangeLog


Lister - [D:\bench\gdb-7.10\gdb\doc\ChangeLog]
File Edit Options Help
Fri Dec 13 09:47:31 1991 John Gilmore (gnu at cygnus.com)
* gdb.texinfo: Improve how we ask for bug reports.
Tue Dec 10 04:07:21 1991 K. Richard Pixley (rich at rtl.cygnus.com)
* Makefile.in: infodir belongs in datadir.
Fri Dec 6 23:57:34 1991 K. Richard Pixley (rich at rtl.cygnus.com)
* Makefile.in: remove spaces following hyphens, bsd make can't
cope. install using INSTALL_DATA. added clean-info. added
standards.text support.
Thu Dec 5 22:46:12 1991 K. Richard Pixley (rich at rtl.cygnus.com)
* Makefile.in: idestdir and ddestdir go away. Added copyrights
and shift gpl to v2. Added ChangeLog if it didn't exist. docdir
and mandir now keyed off datadir by default.

/gdb/README

README for GDB release

This is GDB, the GNU source-level debugger.

A summary of new features is in the file `gdb/NEWS'.

Check the GDB home page at http://www.gnu.org/software/gdb/ for up to date release information, mailing list links and archives, etc.

The file `gdb/PROBLEMS' contains information on problems identified late in the release cycle. GDB's bug tracking data base at http://www.gnu.org/software/gdb/bugs/ contains a more complete list of bugs.

Debugging in Assembly Mode

If you have C or C++ source files for your application, you can use the debugger much more powerfully if you debug in source mode.

However, there are many times you cannot perform source debugging. You might not have the source files for your application. You might be debugging someone else's code. You might not have built your executable files with full *.pdb* symbols. And even if you can do source debugging on your application, you might have to trace Microsoft Windows routines that your application calls or that are used to load your application.

In these situations, you have to debug in assembly mode. Moreover, assembly mode has many useful features that are not present in source debugging. The debugger automatically displays the contents of memory locations and registers as they are accessed and displays the address of the program counter. This display makes assembly debugging a valuable tool that you can use together with source debugging.

Disassembly Code

The debugger primarily analyzes binary executable code. Instead of displaying this code in raw format, the debugger *disassembles* this code. That is, the debugger converts the code from machine language to assembly language.

You can display the resulting code (known as *disassembly code*) in several different ways:

- The **u (Unassemble)** command disassembles and displays a specified section of machine language.
- The **uf (Unassemble Function)** command disassembles and displays a function.
- The **up (Unassemble from Physical Memory)** command disassembles and displays a specified section of machine language that has been stored in physical memory.
- The **ur (Unassemble Real Mode BIOS)** command disassembles and displays a specified 16-bit real-mode code.
- The **ux (Unassemble x86 BIOS)** command disassembles and displays the x86-based BIOS code instruction set at a specified address.
- *(WinDbg only)* The Disassembly window disassembles and displays a specified section of machine language. This window is automatically active if you select the **Automatically Open Disassembly** command on the **Window** menu. You can also open this window by clicking **Disassembly** on the **View** menu, pressing ALT+7, or pressing the **Disassembly (Alt+7)** button () on the WinDbg toolbar.

The disassembly display appears in four columns: address offset, binary code, assembly language mnemonic, and assembly language details. The following example shows this display.

```
0040116b    45          inc         ebp
0040116c    fc          cld
0040116d    8945b0      mov         eax,[ebp-0x1c]
```

To the right of the line that represents the current program counter, the display shows the values of any memory locations or registers that are being accessed. If this line contains a branch instruction, the notation **[br=1]** or **[br=0]** appears. This notation indicates a branch that is or is not taken, respectively.

!Review Note: We should give more details about this.

You can use the **.asm (Change Disassembly Options)** command to change how the disassembled instructions are displayed.

In WinDbg's Disassembly window, the line that represents the current program counter is highlighted. Lines where breakpoints are set are also

RMS's gdb Debugger Tutorial

RMS's gdb Debugger Tutorial

"Don't worry if it doesn't work right. If everything did, you'd be out of a job."

Unknown

gdb Debugger Frequently Asked Questions

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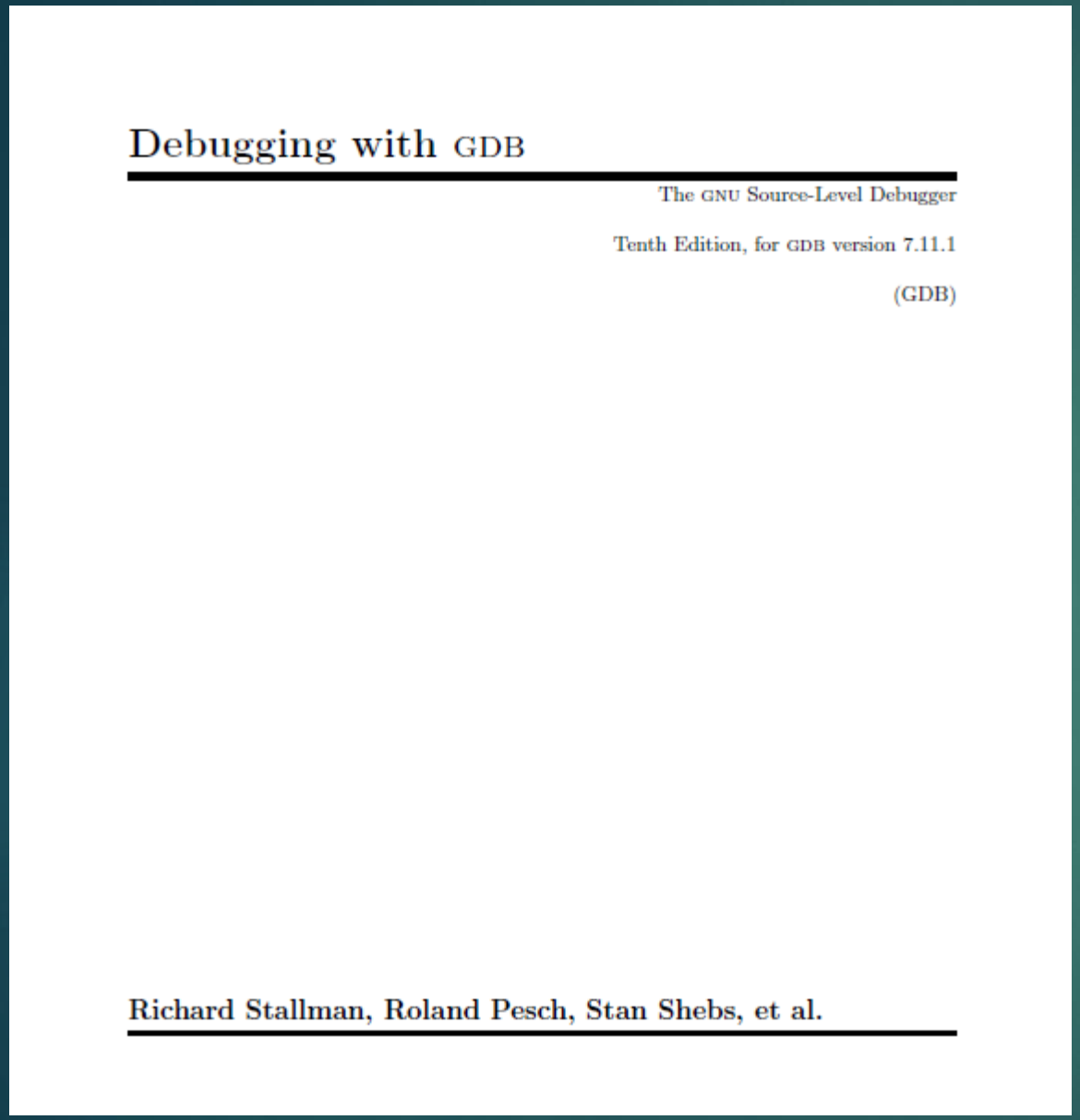
- http://www.unknownroad.com/rtfm/gdbtut/gdbtoc.html



Document

- 学习GDB的最好教材
- Tenth Edition, for gdb version 7.11.1
- 33章，多个附录，790页

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概览

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高级技巧

Syntax

- A command is a single line of input. There is no limit on how long it can be.
- You can repeat certain commands by typing just **RET**.
- **GDB:** You can also use the TAB key to get gdb to fill out the rest of a word in a command
- Comment: # (GDB), * (WinDBG)

```
(gdb) b make_ TAB
GDB sounds bell; press TAB again, to see:
make_a_section_from_file     make_environ
make_abs_section             make_function_type
make_blockvector             make_pointer_type
make_cleanup                 make_reference_type
make_command                 make_symbol_completion_list
(gdb) b make_
```

缩写和别名

- You can abbreviate a gdb command to the first few letters of the command name, if that abbreviation is unambiguous;
  - (GDB) info > I
  - (GDB) continue > c
- 很多命令有简单的别名
  - (GDB) backtrace > bt
  - (GDB) ptype > pt

Convenience Variables

- GDB维护的违变量
- 以$开头
- $ most recent displayed value
- $n nth displayed value
- $$ displayed value previous to $
- $$n nth displayed value back from $
- 可以使用set命令定义

```
(gdb) p argv[0]
$4 = 0xbffff567 "/home/ge/work/llaolao3/baner"
(gdb) p $
$5 = 0xbffff567 "/home/ge/work/llaolao3/baner"
```

set $foo = *object_ptr

```
(gdb) show conv
$_thread = 2
$_siginfo = {si_signo = 19, si_errno = 0, si_code = 0, _sifields = {_pad = {0,
      0, 135725706, 162241784, -1220761920, 0, 0, 162241784, 138194409,
      -1248857920, -1220759564, -1220756960, 1, 1, -1222068232, -1220756960,
      -1080018849, 1, 134858900, 160600224, 152099856, -1248857920,
      -1224747328, -1220759564, -1, 152244240, -1080018072, -1080017996,
      -1080018184}, _kill = {si_pid = 0, si_uid = 0}, _timer = {si_tid = 0,
      si_overrun = 0, si_sigval = {sival_int = 135725706,
        sival_ptr = 0x817028a}}, _rt = {si_pid = 0, si_uid = 0, si_sigval = {
        sival_int = 135725706, sival_ptr = 0x817028a}}, _sigchld = {si_pid = 0,
      si_uid = 0, si_status = 135725706, si_utime = 162241784,
      si_stime = -1220761920}, _sigfault = {si_addr = 0x0}, _sigpoll = {
      si_band = 0, si_fd = 0}}}
$_sdata = void
```

$_和$__

- The variable $_ is automatically set by the x command to the last address examined.
- The variable $__ is automatically set by the x command to the value found in the last address examined. Its type is chosen to match the format in which the data was printed

```
(gdb) x argv
0xbffff7f4:     0x24
(gdb) p $__
$22 = 36
(gdb) p $_
$23 = (int8_t *) 0xbffff7f4
```

$_thread

- Gdb provides two convenience variables, $_thread and $_gthread (the latter being pretty new), which can be used in conditions to refer to the current thread.
- So, once the worker thread has started, you can use info thread to find its number. Then you can change your breakpoint (supposing for this example that it is breakpoint 2) like:
- (gdb) cond 2 $_thread != 57

Gdb variables

- (gdb) set $foo = 4
- (gdb) p $foo
- $3 = 4

Register Variables

- (gdb) break write if $rsi == 2

表达式归纳

- expr an expression in C, C++, or Modula-2(including function calls), or:
- addr@len an array of len elements beginning at addr
- file::nm a variable or function nm defined in file
- **{type}addr** read memory at addr as specied type
- $ most recent displayed value
- $n nth displayed value
- $$ displayed value previous to $
- $$n nth displayed value back from $
- $_ last address examined with x
- $__ value at address $_
- $var convenience variable; assign any value
- show values [n] show last 10 values [or surrounding $n]
- show conv display all convenience variables

```
(gdb) p argv[0]@2
$7 = {0xbffff567 "/home/ge/work/llaolao3/baner", 0xbffff584 "0"}
(gdb) p $$
$8 = 0xbffff567 "/home/ge/work/llaolao3/baner"
```

```
(gdb) p {int}argv
$14 = -1073744537
(gdb) p /x {int}argv
$15 = 0xbffff567
```

Shell Commands

- shell command-string
- !command-string

```
(gdb) !dir
 Volume in drive C is OSDisk
 Volume Serial Number is 1E62-585F

 Directory of C:\TEMP\ge

10/08/2016  07:25 AM    <DIR>          .
10/08/2016  07:25 AM    <DIR>          ..
09/01/2016  10:12 PM    <DIR>          cmos
08/15/2016  08:30 PM            28,175 dev.txt
09/21/2016  11:16 AM        11,587,305 fedcore.ko
09/30/2016  12:01 PM         3,936,768 fedtest.frames.txt
09/30/2016  09:55 AM         1,169,286 fedtest.ko
08/12/2016  05:42 PM        18,934,392 gdb-7.11.tar.xz
08/12/2016  05:40 PM         4,993,536 gdb.exe
01/13/2015  10:00 AM         2,650,119 gdb.zip
08/22/2016  09:59 PM     5,326,498,816 ge32.ova
08/17/2016  10:01 PM           107,779 laolao.elf.txt
09/28/2016  01:04 PM    <DIR>          lib
08/14/2016  12:15 PM    <DIR>          linux-3.12.2
09/20/2016  11:21 AM     2,680,575,786 linux_dwarf.txt
09/01/2016  10:12 PM    <DIR>          llaolao
09/07/2016  08:09 PM    <DIR>          llaolao2
09/18/2016  10:50 PM    <DIR>          llaolao3
10/08/2016  07:25 AM                 0 readme.txt
08/18/2016  04:57 PM    <DIR>          syseye
09/28/2016  10:53 AM             2,778 vdso.frames
08/14/2016  12:15 PM       217,010,778 vmlinuz-3.12.2.ko
              13 File(s)  8,267,495,518 bytes
               9 Dir(s)   3,873,128,448 bytes free
```

Info and show

- info -- Generic command for showing things about the program being debugged
- show -- Generic command for showing things about the debugger

```
(gdb) show version
GNU gdb (GDB) 7.9
Copyright (C) 2015 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "i686-pc-mingw32".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word".
This binary was built by Equation Solution <http://www.Equation.com>.
```

Debug the debugger

```
(gdb) show debug
arch:  Architecture debugging is 0.
check-physname:  Whether to check "physname" is off.
displaced:  Displace stepping debugging is off.
dwarf2-die:  Debugging of the dwarf2 DIE reader is 0.
entry-values:  Entry values and tail call frames debugging is 0.
expression:  Expression debugging is 0.
frame:  Frame debugging is 0.
infrun:  Inferior debugging is 0.
jit:  JIT debugging is 0.
libthread-db:  libthread-db debugging is 0.
lin-lwp:  Debugging of GNU/Linux lwp module is 0.
observer:  Observer debugging is 0.
overload:  Debugging of C++ overloading is 0.
parser:  Parser debugging is off.
record:  Debugging of process record target is 0.
remote:  Debugging of remote protocol is 0.
serial:  Serial debugging is 0.
target:  Target debugging is 0.
timestamp:  Timestamping debugging messages is off.
xml:  XML debugging is off.
```

- set debug -- Generic command for setting gdb debugging flags

Logging Output

`set logging on`
: Enable logging.

`set logging off`
: Disable logging.

`set logging file` *`file`*
: Change the name of the current logfile. The default logfile is '`gdb.txt`'.

`set logging overwrite [on|off]`
: By default, GDB will append to the logfile. Set `overwrite` if you want `set logging on` to overwrite the logfile instead.

`set logging redirect [on|off]`
: By default, GDB output will go to both the terminal and the logfile. Set `redirect` if you want output to go only to the log file.

`show logging`
: Show the current values of the logging settings.

常用调试命令对照表

WinDBG命令	GDB命令	功能
bp	break或b	设置软件断点
ba	watch	设置硬件断点
k	backtrace或bt	显示函数调用序列（栈回溯）
g	continue或c	恢复执行
p/t	next/step或n/s	单步跟踪
d	x	观察内存
dv	info locals	观察局部变量
dt	pt	观察数据类型（结构）
gu	finish	执行到函数返回
.frame	frame	切换当前栈帧
lm	i shared	列模块

更多常用命令

- 命令行
  - run xxx
  - set args xx xx
  - show args
- 观察类型
  - ptype
  - whatis
  - print v@10
- 管理断点
  - info/disable/delete break
- 源代码
  - list 3,8
  - info line/source/sources
- show conv

GDB QUICK REFERENCE GDB Version 4

Essential Commands

`gdb` *program* [*core*]	debug *program* [using coredump *core*]
`b` [*file*`:`]*function*	set breakpoint at *function* [in *file*]
`run` [*arglist*]	start your program [with *arglist*]
`bt`	backtrace: display program stack
`p` *expr*	display the value of an expression
`c`	continue running your program
`n`	next line, stepping over function calls
`s`	next line, stepping into function calls

Starting GDB

`gdb`	start GDB, with no debugging files
`gdb` *program*	begin debugging *program*
`gdb` *program core*	debug coredump *core* produced by *program*
`gdb --help`	describe command line options

Stopping GDB

`quit`	exit GDB; also `q` or `EOF` (eg `C-d`)
`INTERRUPT`	(eg `C-c`) terminate current command, or send to running process

Getting Help

`help`	list classes of commands
`help` *class*	one-line descriptions for commands in *class*
`help` *command*	describe *command*

Executing your Program

`run` *arglist*	start your program with *arglist*
`run`	start your program with current argument list
`run ... <`*inf* `>`*outf*	start your program with input, output redirected
`kill`	kill running program
`tty` *dev*	use *dev* as stdin and stdout for next `run`
`set args` *arglist*	specify *arglist* for next `run`
`set args`	specify empty argument list
`show args`	display argument list
`show env`	show all environment variables
`show env` *var*	show value of environment variable *var*
`set env` *var string*	set environment variable *var*
`unset env` *var*	remove *var* from environment

Shell Commands

`cd` *dir*	change working directory to *dir*
`pwd`	Print working directory
`make ...`	call "`make`"
`shell` *cmd*	execute arbitrary shell command string

[ ] surround optional arguments ... show one or more arguments

Breakpoints and Watchpoints

`break` [*file*`:`]*line* `b` [*file*`:`]*line*	set breakpoint at *line* number [in *file*] eg: `break main.c:37`
`break` [*file*`:`]*func*	set breakpoint at *func* [in *file*]
`break +`*offset*	set break at *offset* lines from current stop
`break -`*offset*	
`break *`*addr*	set breakpoint at address *addr*
`break`	set breakpoint at next instruction
`break ... if` *expr*	break conditionally on nonzero *expr*
`cond` *n* [*expr*]	new conditional expression on breakpoint *n*; make unconditional if no *expr*
`tbreak ...`	temporary break; disable when reached
`rbreak` *regex*	break on all functions matching *regex*
`watch` *expr*	set a watchpoint for expression *expr*
`catch` *event*	break at *event*, which may be `catch`, `throw`, `exec`, `fork`, `vfork`, `load`, or `unload`.
`info break`	show defined breakpoints
`info watch`	show defined watchpoints
`clear`	delete breakpoints at next instruction
`clear` [*file*`:`]*fun*	delete breakpoints at entry to *fun*()
`clear` [*file*`:`]*line*	delete breakpoints on source line
`delete` [*n*]	delete breakpoints [or breakpoint *n*]
`disable` [*n*]	disable breakpoints [or breakpoint *n*]
`enable` [*n*]	enable breakpoints [or breakpoint *n*]
`enable once` [*n*]	enable breakpoints [or breakpoint *n*]; disable again when reached
`enable del` [*n*]	enable breakpoints [or breakpoint *n*]; delete when reached
`ignore` *n count*	ignore breakpoint *n*, *count* times
`commands` *n* [`silent`] *command-list*	execute GDB *command-list* every time breakpoint *n* is reached. [`silent` suppresses default display]
`end`	end of *command-list*

Program Stack

`backtrace` [*n*] `bt` [*n*]	print trace of all frames in stack; or of *n* frames—innermost if *n*>0, outermost if *n*<0
`frame` [*n*]	select frame number *n* or frame at address *n*; if no *n*, display current frame
`up` *n*	select frame *n* frames up
`down` *n*	select frame *n* frames down
`info frame` [*addr*]	describe selected frame, or frame at *addr*
`info args`	arguments of selected frame
`info locals`	local variables of selected frame
`info reg` [*rn*]...	register values [for regs *rn*] in selected frame; `all-reg` includes floating point

Execution Control

`continue` [*count*] `c` [*count*]	continue running; if *count* specified, ignore this breakpoint next *count* times
`step` [*count*] `s` [*count*]	execute until another line reached; repeat *count* times if specified
`stepi` [*count*] `si` [*count*]	step by machine instructions rather than source lines
`next` [*count*] `n` [*count*]	execute next line, including any function calls
`nexti` [*count*] `ni` [*count*]	next machine instruction rather than source line
`until` [*location*]	run until next instruction (or *location*)
`finish`	run until selected stack frame returns
`return` [*expr*]	pop selected stack frame without executing [setting return value]
`signal` *num*	resume execution with signal *s* (none if 0)
`jump` *line*	resume execution at specified *line* number or *address*
`jump *`*address*	
`set var=`*expr*	evaluate *expr* without displaying it; use for altering program variables

Display

`print` [*/f*] [*expr*] `p` [*/f*] [*expr*]	show value of *expr* [or last value `$`] according to format *f*:
`x`	hexadecimal
`d`	signed decimal
`u`	unsigned decimal
`o`	octal
`t`	binary
`a`	address, absolute and relative
`c`	character
`f`	floating point
`call` [*/f*] *expr*	like `print` but does not display `void`
`x` [*/Nuf*] *expr*	examine memory at address *expr*; optional format spec follows slash
N	count of how many units to display
u	unit size; one of `b` individual bytes `h` halfwords (two bytes) `w` words (four bytes) `g` giant words (eight bytes)
f	printing format. Any `print` format, or `s` null-terminated string `i` machine instructions
`disassem` [*addr*]	display memory as machine instructions

Automatic Display

`display` [*/f*] *expr*	show value of *expr* each time program stops [according to format *f*]
`display`	display all enabled expressions on list
`undisplay` *n*	remove number(s) *n* from list of automatically displayed expressions
`disable disp` *n*	disable display for expression(s) number *n*
`enable disp` *n*	enable display for expression(s) number *n*
`info display`	numbered list of display expressions

Expressions

expr	an expression in C, C++, or Modula-2 (including function calls), or:
addr`@`*len*	an array of *len* elements beginning at *addr*
file`::`*nm*	a variable or function *nm* defined in *file*
{*type*}*addr*	read memory at *addr* as specified *type*
`$`	most recent displayed value
`$`*n*	*n*th displayed value
`$$`	displayed value previous to `$`
`$$`*n*	*n*th displayed value back from `$`
`$_`	last address examined with `x`
`$__`	value at address `$_`
`$`*var*	convenience variable; assign any value
`show values` [*n*]	show last 10 values [or surrounding `$`*n*]
`show conv`	display all convenience variables

Symbol Table

`info address` *s*	show where symbol *s* is stored
`info func` [*regex*]	show names, types of defined functions (all, or matching *regex*)
`info var` [*regex*]	show names, types of global variables (all, or matching *regex*)
`whatis` [*expr*]	show data type of *expr* [or `$`] without evaluating; `ptype` gives more detail
`ptype` [*expr*]	
`ptype` *type*	describe type, struct, union, or enum

GDB Scripts

`source` *script*	read, execute GDB commands from file *script*
`define` *cmd*	create new GDB command *cmd*; execute
command-list	script defined by *command-list*
`end`	end of *command-list*
`document` *cmd*	create online documentation for new GDB
help-text	command *cmd*
`end`	end of *help-text*

Signals

`handle` *signal act*	specify GDB actions for *signal*:
`print`	announce signal
`noprint`	be silent for signal
`stop`	halt execution on signal
`nostop`	do not halt execution
`pass`	allow your program to handle signal
`nopass`	do not allow your program to see signal
`info signals`	show table of signals, GDB action for each

Debugging Targets

`target` *type param*	connect to target machine, process, or file
`help target`	display available targets
`attach` *param*	connect to another process
`detach`	release target from GDB control

Controlling GDB

`set` *param value*	set one of GDB's internal parameters
`show` *param*	display current setting of parameter

Parameters understood by `set` and `show`:

`complaint` *limit*	number of messages on unusual symbols
`confirm` *on/off*	enable or disable cautionary queries
`editing` *on/off*	control `readline` command-line editing
`height` *lpp*	number of lines before pause in display
`language` *lang*	Language for GDB expressions (`auto`, `c` or `modula-2`)
`listsize` *n*	number of lines shown by `list`
`prompt` *str*	use *str* as GDB prompt
`radix` *base*	octal, decimal, or hex number representation
`verbose` *on/off*	control messages when loading symbols
`width` *cpl*	number of characters before line folded
`write` *on/off*	Allow or forbid patching binary, core files (when reopened with `exec` or `core`)
`history` ...	groups with the following options:
`h` ...	
`h exp` *off/on*	disable/enable `readline` history expansion
`h file` *filename*	file for recording GDB command history
`h size` *size*	number of commands kept in history list
`h save` *off/on*	control use of external file for command history
`print` ...	groups with the following options:
`p` ...	
`p address` *on/off*	print memory addresses in stacks, values
`p array` *off/on*	compact or attractive format for arrays
`p demangl` *on/off*	source (demangled) or internal form for C++ symbols
`p asm-dem` *on/off*	demangle C++ symbols in machine-instruction output
`p elements` *limit*	number of array elements to display
`p object` *on/off*	print C++ derived types for objects
`p pretty` *off/on*	struct display: compact or indented
`p union` *on/off*	display of union members
`p vtbl` *off/on*	display of C++ virtual function tables
`show commands`	show last 10 commands
`show commands` *n*	show 10 commands around number *n*
`show commands +`	show next 10 commands

Working Files

`file` [*file*]	use *file* for both symbols and executable; with no arg, discard both
`core` [*file*]	read *file* as coredump; or discard
`exec` [*file*]	use *file* as executable only; or discard
`symbol` [*file*]	use symbol table from *file*; or discard
`load` *file*	dynamically link *file* and add its symbols
`add-sym` *file addr*	read additional symbols from *file*, dynamically loaded at *addr*
`info files`	display working files and targets in use
`path` *dirs*	add *dirs* to front of path searched for executable and symbol files
`show path`	display executable and symbol file path
`info share`	list names of shared libraries currently loaded

Source Files

`dir` *names*	add directory *names* to front of source path
`dir`	clear source path
`show dir`	show current source path
`list`	show next ten lines of source
`list -`	show previous ten lines
`list` *lines*	display source surrounding *lines*, specified as:
[*file*`:`]*num*	line number [in named file]
[*file*`:`]*function*	beginning of function [in named file]
`+`*off*	*off* lines after last printed
`-`*off*	*off* lines previous to last printed
`*`*address*	line containing *address*
`list` *f*`,`*l*	from line *f* to line *l*
`info line` *num*	show starting, ending addresses of compiled code for source line *num*
`info source`	show name of current source file
`info sources`	list all source files in use
`forw` *regex*	search following source lines for *regex*
`rev` *regex*	search preceding source lines for *regex*

GDB under GNU Emacs

`M-x gdb`	run GDB under Emacs
`C-h m`	describe GDB mode
`M-s`	step one line (`step`)
`M-n`	next line (`next`)
`M-i`	step one instruction (`stepi`)
`C-c C-f`	finish current stack frame (`finish`)
`M-c`	continue (`cont`)
`M-u`	up *arg* frames (`up`)
`M-d`	down *arg* frames (`down`)
`C-x &`	copy number from point, insert at end
`C-x SPC`	(in source file) set break at point

GDB License

`show copying`	Display GNU General Public License
`show warranty`	There is NO WARRANTY for GDB. Display full no-warranty statement.

Get help

- help(h)
- help class
- apropos args
- complete args

```
(gdb) apropos  file
add-auto-load-safe-path -- Add entries to the list of directories from which it
is safe to auto-load files
add-inferior -- Add a new inferior
add-symbol-file -- Load symbols from FILE
append -- Append target code/data to a local file
append binary -- Append target code/data to a raw binary file
append binary memory -- Append contents of memory to a raw binary file
append binary value -- Append the value of an expression to a raw binary file
append memory -- Append contents of memory to a raw binary file
append value -- Append the value of an expression to a raw binary file
attach -- Attach to a process or file outside of GDB
break-range -- Set a breakpoint for an address range
compare-sections -- Compare section data on target to the exec file
compile file -- Evaluate a file containing source code
core-file -- Use FILE as core dump for examining memory and registers
detach -- Detach a process or file previously attached
directory -- Add directory DIR to beginning of search path for source files
disassemble -- Disassemble a specified section of memory
dump -- Dump target code/data to a local file
dump binary -- Write target code/data to a raw binary file
dump binary memory -- Write contents of memory to a raw binary file
dump binary value -- Write the value of an expression to a raw binary file
dump ihex -- Write target code/data to an intel hex file
```

```
(gdb) complete b
backtrace
bookmark
break
break-range
bt
(gdb) help complete
List the completions for the rest of the line as a command.
```

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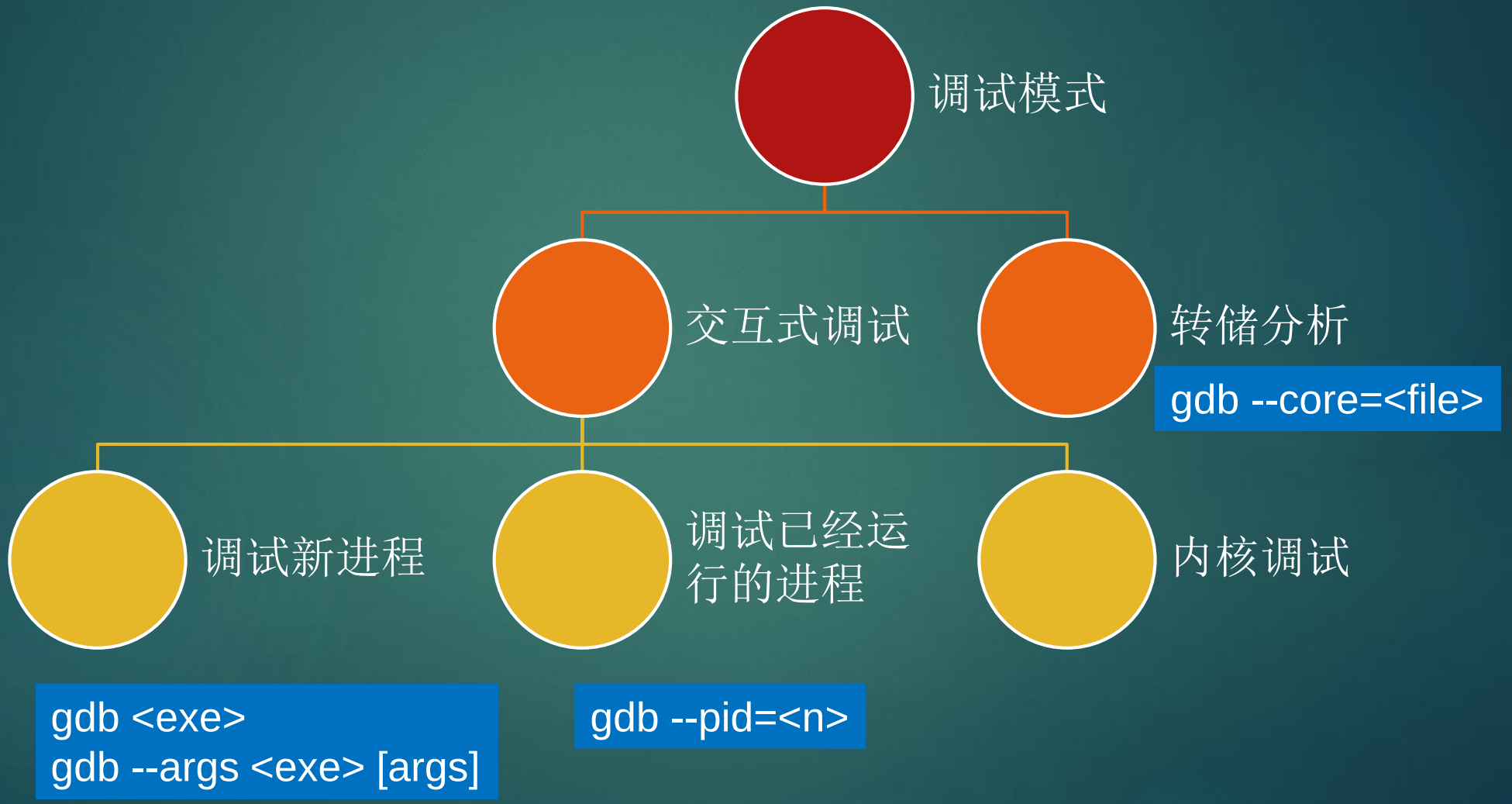
调试模式


调试模式
交互式调试
转储分析
gdb --core=<file>
调试新进程
调试已经运行的进程
内核调试
gdb <exe>
gdb --args <exe> [args]
gdb --pid=<n>

调试新进程

命令行指定exe

- gdb <exe>

命令行指定exe和参数

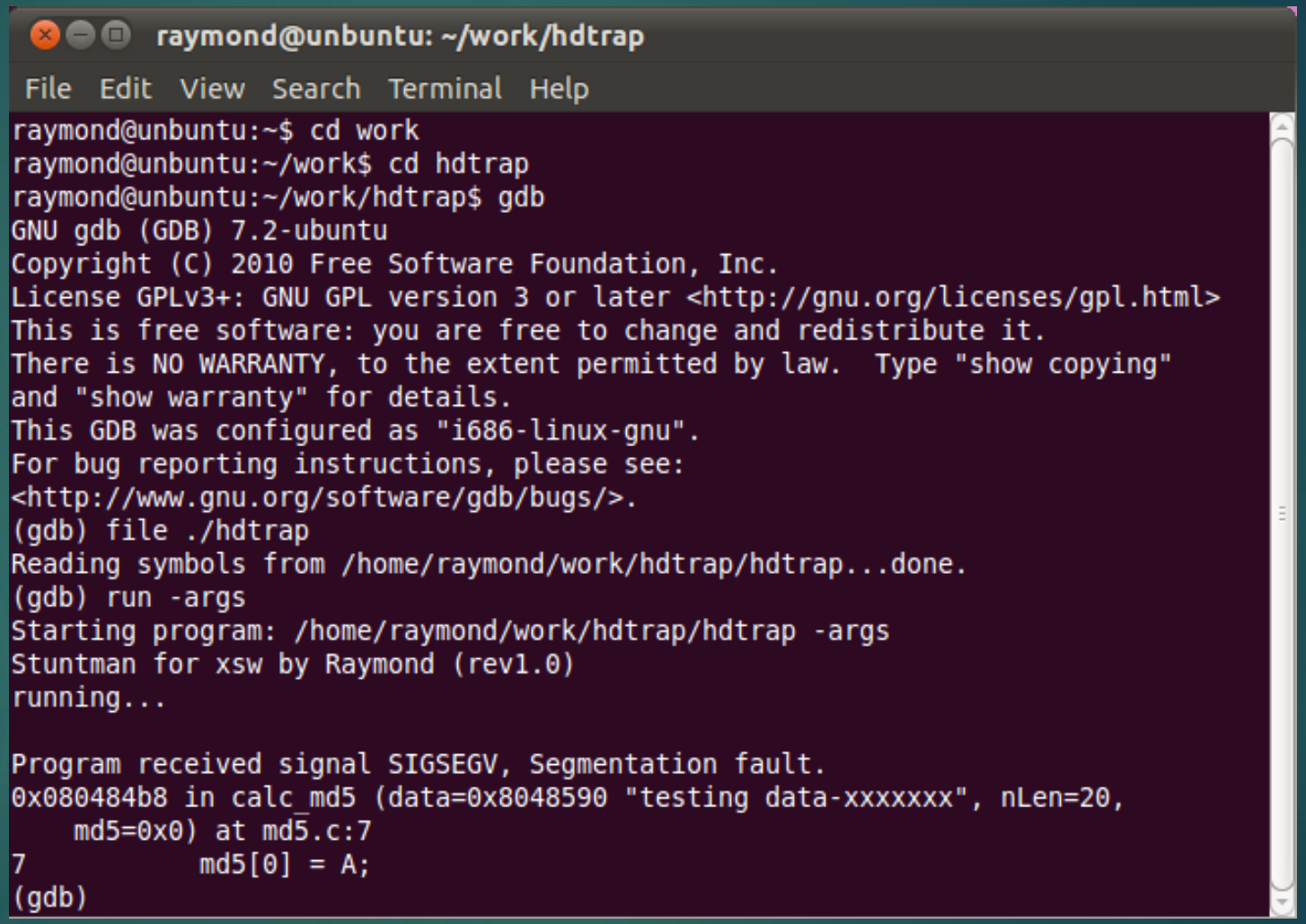
- gdb --args <exe> [args]

使用命令

- gdb
- file <exe>
- run [args]

示例1

- gdb
- file <exe>
- run [args]



示例2

- gdb --args gcc -O2 -c foo.c

args

- [~]$ gdb --args pizzamaker --deep-dish --toppings=pepperoni
- ...
- (gdb) **show args**
- Argument list to give program being debugged when it is started is
- " --deep-dish --toppings=pepperoni".
- (gdb) b main
- Breakpoint 1 at 0x45467c: file oven.c, line 123.
- (gdb) run
- ...

设置和显示程序参数

- set args
  - Specify the arguments to be used the next time your program is run. If set args has no arguments, run executes your program with no arguments. Once you have run your program with arguments, using set args before the next run is the only way to run it again without arguments.
- show args
  - Show the arguments to give your program when it is started.

环境变量

- path directory
- show paths
- show environment [varname]
- set environment varname [=value]

```
(gdb) show path
Executable and object file path: /usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/b
in:/sbin:/bin
(gdb) show environment
TERM=xterm
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd
=40;33;01:or=40;31;01:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=0
1;32:*.tar=01;31:*.tgz=01;31:*.arj=01;31:*.taz=01;31:*.lzh=01;31:*.lzma=01;31:*.
tlz=01;31:*.txz=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz=01;31:*.lz
=01;31:*.xz=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.d
eb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31
```

工作目录

- 继承GDB的当前目录
- cd [directory]
  - Set the gdb working directory to directory. If not given, directory uses ~.
- pwd
  - Print the gdb working directory.

输入输出

- info terminal
- run > outfile
- tty /dev/ttyb

```
(gdb) info terminal
Inferior's terminal status (currently saved by GDB):
File descriptor flags = O_RDWR
Process group = 3341
c_iflag = 0x6d02, c_oflag = 0x5,
c_cflag = 0x4bf, c_lflag = 0x8a3b
c_cc: 0x3 0x1c 0x7f 0x15 0x4 0x0 0x1 0xff 0x11 0x13 0x1a 0xff 0x12 0xf 0x17 0x1
 0xff 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0 0x0
```

inferior

- n.部下， 下属;次品;晚辈;[印]下角码 [ɪn'fɪrɪə(r)]
- gdb represents the state of each program execution with an object called an inferior.
- An inferior typically corresponds to a process, but is more general and applies also to targets that do not have processes.
- Inferiors may be created before a process runs, and may be retained after a process exits.
- 下程

显示下程信息

```
(gdb) info inferiors
  Num  Description       Executable
* 1    <null>            /home/ge/work/llaolao3/baner
```

```
(gdb) info inferiors
  Num  Description       Executable
  7    <null>            /home/ge/work/llaolao3/a.out
  6    <null>
  5    <null>            /home/ge/work/llaolao3/baner
  4    <null>            /home/ge/work/llaolao3/baner
  3    <null>            /home/ge/work/llaolao3/baner
* 2    process 3341      /home/ge/work/llaolao3/baner
  1    <null>            /home/ge/work/llaolao3/baner
```

- 描述部分的null表示进程退出或者没有运行，或者已经detach

克隆下程

```
(gdb) clone-inferior -copies 2
Added inferior 2.
Added inferior 3.
(gdb) info inferiors
  Num  Description       Executable
  3    <null>            /home/ge/work/llaolao3/baner
  2    <null>            /home/ge/work/llaolao3/baner
* 1    <null>            /home/ge/work/llaolao3/baner
```

切换下程

- inferior infno
  - Make inferior number infno the current inferior. The argument infno is the inferior number assigned by gdb, as shown in the first field of the ‘info inferiors’ display.

```
(gdb) inferior 2
[Switching to inferior 2 [process 0] (/home/ge/work/llaolao3/baner)]
(gdb) run
Starting program: /home/ge/work/llaolao3/baner
baner <devno> r/w/s/i <value>
[Inferior 2 (process 2851) exited with code 0377]
```

增加下程

- add-inferior [-copies n] [-exec executable]

```
(gdb) add-inferior -copies 1 -exec a.out
Added inferior 7
Reading symbols from /home/ge/work/llaolao3/a.out...(no debugging symbols found)
...done.
(gdb) info inferiors
  Num  Description       Executable
  7    <null>            /home/ge/work/llaolao3/a.out
  6    <null>
  5    <null>            /home/ge/work/llaolao3/baner
  4    <null>            /home/ge/work/llaolao3/baner
  3    <null>            /home/ge/work/llaolao3/baner
* 2    <null>            /home/ge/work/llaolao3/baner
  1    <null>            /home/ge/work/llaolao3/baner
```

更多关于下程的命令

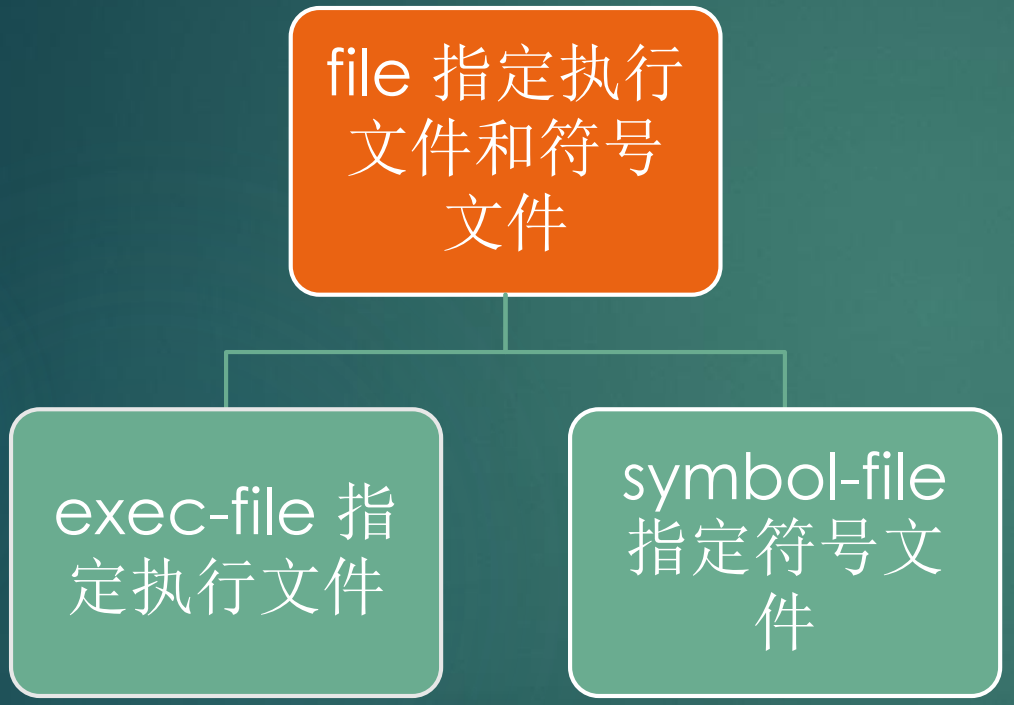
- remove-inferiors infno...
- detach inferior infno...
- kill inferiors infno...

file命令

- Use FILE as program to be debugged.
- It is read for its symbols, for getting the contents of pure memory, and it is the program executed when you use the `run' command.
- If FILE cannot be found as specified, your execution directory path ($PATH) is searched for a command of that name.
- No arg means to have no executable file and no symbols.

```
(gdb) file notepad.exe
Reading symbols from notepad.exe...(no debugging symbols found)...done.
(gdb) r
Starting program: C:\windows\system32\notepad.exe
[New Thread 26604.0x529c]
[Inferior 1 (process 26604) exited normally]
```

文件命令



文件名作为参数，不带参数则清除此类信息

18 GDB Files

GDB needs to know the file name of the program to be debugged, both in order to read its symbol table and in order to start your program. To debug a core dump of a previous run, you must also tell GDB the name of the core dump file.

18.1 Commands to Specify Files

You may want to specify executable and core dump file names. The usual way to do this is at start-up time, using the arguments to GDB's start-up commands (see Chapter 2 [Getting In and Out of GDB], page 11).

开始运行

- run
- Start debugged program. You may specify arguments to give it.
- Args may include "*", or "[...]"; they are expanded using "sh".
- Input and output redirection with ">", "<", or ">>" are also allowed.

- With no arguments, uses arguments last specified (with "run" or "set args").
- To cancel previous arguments and run with no arguments,
- use "set args" without arguments.

附加到已经运行的进程

命令行参数

- gdb --pid=<n>

使用attach命令

- attach process-id

终止调试会话

- 分离 - detach
- 杀死 - quit

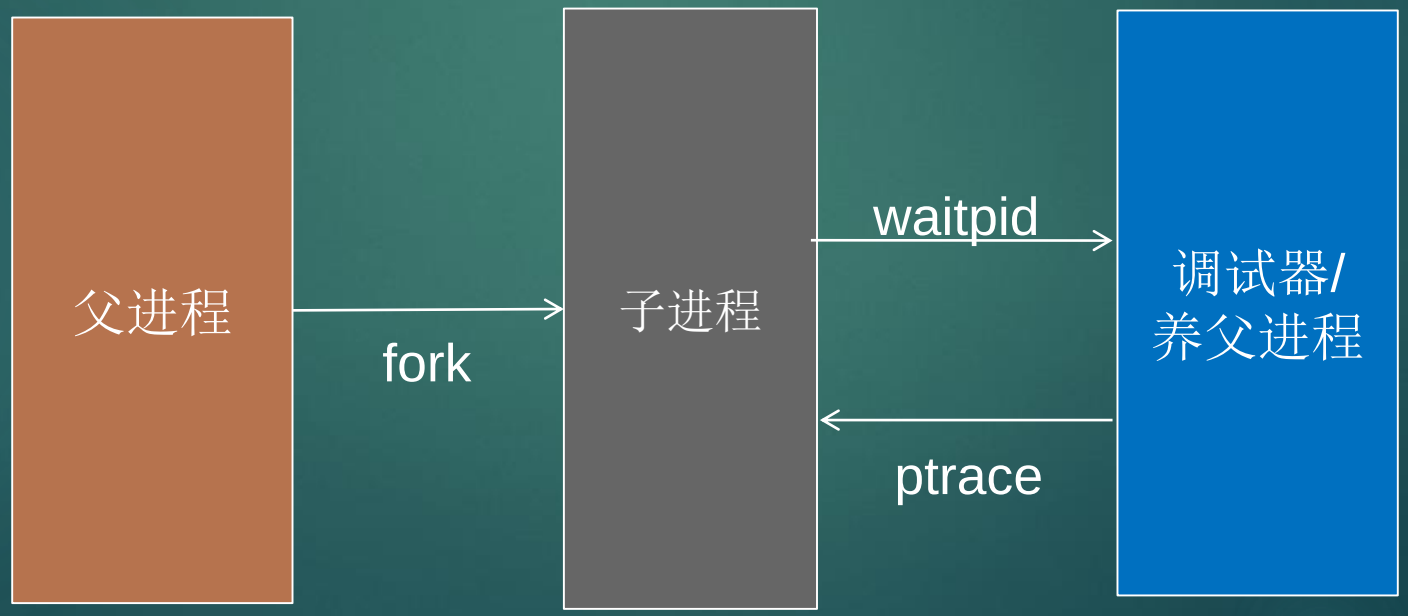
```
(gdb) detach
Detaching from program: /home/ge/work/llaolao3/baner, process 3341
baner <devno> r/w/s/i <value>
(gdb) info inferiors
  Num  Description       Executable
  7    <null>            /home/ge/work/llaolao3/a.out
  6    <null>
  5    <null>            /home/ge/work/llaolao3/baner
  4    <null>            /home/ge/work/llaolao3/baner
  3    <null>            /home/ge/work/llaolao3/baner
* 2    <null>            /home/ge/work/llaolao3/baner
  1    <null>            /home/ge/work/llaolao3/baner
```

Quit gdb

- use the quit command (abbreviated q)
- type an end-of-file character (usually Ctrl-d)

进程跟踪

- Process Trace，Ptrace
- **最早实现在1979发布的Unix V7**
- Unix/Linux用户态调试的主要依据



ptrace

- #include <sys/ptrace.h>
- long int ptrace(enum __ptrace_request request, pid_t pid, void * addr, void * data)
  - **PTRACE_ATTACH/ PTRACE_DETACH**
  - PTRACE_PEEKTEXT, PTRACE_PEEKDATA, PTRACE_PEEKUSER
  - PTRACE_POKETEXT, PTRACE_POKEDATA, PTRACE_POKEUSER
  - **PTRACE_SINGLESTEP**
  - **PTRACE_KILL**
- 系统调用

waitpid

- **#include <sys/types.h>**
  #include <sys/wait.h>
- **pid_t waitpid(pid_t** *pid*, **int** ***status*, **int** *options*);**
- WIFEXITED(status): 子进程正常退出
  - WEXITSTATUS(status): 子进程的退出码
- WIFSIGNALED(status): SIGINT, CTRL-C
  - WTERMSIG(status): 终止信号编号
- WIFSTOPPED(status): SIGSTOP, CTRL-Z
  - WSTOPSIG(status): 停止信号编号

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设置代码断点

软件断点	break 普通
	tbreak 一次性
	rbreak 接受正则表达式成批设置
硬件断点	hbreak
	thbreak 一次性

两类断点

软件断点

- 基于CPU的断点指令，如x86的INT 3（机器码0xCC）
- 替换断点位置的指令
- CPU执行到此时触发断点异常
- 没有数量限制

硬件断点

- 基于CPU的调试寄存器，如x86的DR0 – DR7
- 不需要修改程序代码，可以针对EEPROM上的代码设置
- 有数量限制

指定位置(Location)

Linespec locations

- 行号
- -/+偏移行
- 文件名：行号
- 函数名
- 函数：标号
- 文件名：函数名
- 标号

Explicit locations

- -source filename
- -function function
- -label label
- -line number

Address locations

- *address

示例 – 对函数名和地址设断点

```
(gdb) file baner
Reading symbols from /home/ge/work/llaolao3/baner...(no debugging symbols found)
...done.
(gdb) b main
Breakpoint 1 at 0x804876e
(gdb) info function usage
All functions matching regular expression "usage":

Non-debugging symbols:
0x080485e4  usage
(gdb) b *0x80485e4
Breakpoint 2 at 0x80485e4
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804876e <main+4>
2       breakpoint     keep y   0x080485e4 <usage>
```

示例 – 对源代码行设断点

```
(gdb) list usage
5       #include <errno.h>
6       #include <string.h>
7       #include "hdioctl.h"
8
9       int usage()
10      {
11          printf("baner <devno> r/w/s/i <value>\n");
12          return -1;
13      }
14      void hd_ioctl(int fd, char * cmd, char *arg)
(gdb) b baner.c:11
Breakpoint 1 at 0x80485ea: file baner.c, line 11.
(gdb) b +2
Breakpoint 2 at 0x804860a: file baner.c, line 17.
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x080485ea in usage at baner.c:11
2       breakpoint     keep y   0x0804860a in hd_ioctl at baner.c:17
```

- 第二个断点+2意为相对当前代码行之后（after）2行，上个list命令会影响当前代码行的位置
- For the list command, the current line is the last one printed; for the breakpoint commands, this is the line at which execution stopped

硬件断点

- VBOX虚拟机中设置失败

```
(gdb) hbreak hd_ioctl
No hardware breakpoint support in the target.
```

```
(gdb) info b
Num     Type           Disp Enb Address    What
1       hw breakpoint  keep y   <PENDING>  main
```

管理断点

- info b
- delete 1 #Delete breakpoint 1
- disable 1 # Disable the breakpoint 1
- enable 1 # Enable breakpoint 1
- delete #Delete all breakpoints
- clear sum #Clear any breakpoints at the entry to function sum

扩展断点

监视点

- 监视表达式，值变化时中断
  - The expression may be as simple as the value of a single variable, or as complex as many variables combined by operators.
  - watch a*b + c/d
  - watch *(int *)0x12345678
  - watch *global_ptr
- 数据断点（data breakpoint）

监视点示例

```
(gdb) file baner
Reading symbols from /home/ge/work/llaolao3/baner...done.
(gdb) b main
Breakpoint 1 at 0x804877b: file baner.c, line 53.
(gdb) run 0 w abcdefg
Starting program: /home/ge/work/llaolao3/baner 0 w abcdefg

Breakpoint 1, main (argc=4, argv=0xbffff7f4) at baner.c:53
53      {
(gdb) watch fd
Hardware watchpoint 2: fd
(gdb) c
Continuing.
Hardware watchpoint 2: fd

Old value = 134513733
New value = 7
main (argc=4, argv=0xbffff7f4) at baner.c:62
62          if(fd < 0)
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
2       hw watchpoint  keep y              fd
        breakpoint already hit 1 time
```

实现

```
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
2       hw watchpoint  keep y              fd
        breakpoint already hit 1 time
3       hw watchpoint  keep y              n
4       watchpoint     keep y              name
5       hw watchpoint  keep y              buffer[0]
6       hw watchpoint  keep y              buffer[10]
(gdb) watch buffer[5]
Hardware watchpoint 7: buffer[5]
(gdb) c
Continuing.
Warning:
Could not insert hardware watchpoint 6.
Could not insert hardware breakpoints:
You may have requested too many hardware breakpoints/watchpoints.
```

- 硬件平台相关
- X86上是使用硬件寄存器，数量有限制，最多4个

Depending on your system, watchpoints may be implemented in software or hardware. GDB does software watchpointing by single-stepping your program and testing the variable's value each time, which is hundreds of times slower than normal execution. (But this may still be worth it, to catch errors where you have no clue what part of your program is the culprit.)

On some systems, such as most PowerPC or x86-based targets, GDB includes support for hardware watchpoints, which do not slow down the running of your program.

自动删除

```
Continuing.
Watchpoint 2 deleted because the program has left the block
in which its expression is valid.
Watchpoint 3 deleted because the program has left the block
in which its expression is valid.
Watchpoint 5 deleted because the program has left the block
in which its expression is valid.
Watchpoint 7 deleted because the program has left the block
in which its expression is valid.
write 7 bytes:
 abcdefg
[Inferior 1 (process 2625) exited normally]
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
```

访问监视点

- rwatch [-l|-location] expr [thread thread-id] [mask maskvalue]
  - Set a watchpoint that will break when the value of expr is read by the program.
- awatch [-l|-location] expr [thread thread-id] [mask maskvalue]
  - Set a watchpoint that will break when expr is either read from or written into by the program.

访问监视点示例

```
(gdb) awatch fd
Hardware access (read/write) watchpoint 10: fd
(gdb) rwatch n
Hardware read watchpoint 11: n
```

```
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
10      acc watchpoint keep y               fd
11      read watchpoint keep y              n
(gdb) c
Continuing.
Hardware access (read/write) watchpoint 10: fd

Old value = 134513733
New value = 7
main (argc=4, argv=0xbffff7f4) at baner.c:62
62          if(fd < 0)
(gdb) c
Continuing.
Hardware access (read/write) watchpoint 10: fd

Value = 7
0x080487d6 in main (argc=4, argv=0xbffff7f4) at baner.c:62
62          if(fd < 0)
(gdb) c
Continuing.
Hardware access (read/write) watchpoint 10: fd

Value = 7
0x080488c4 in main (argc=4, argv=0xbffff7f4) at baner.c:82
82              if((n = write(fd, argv[3], strlen(argv[3])))>0)
(gdb) c
Continuing.
Hardware read watchpoint 11: n

Value = 6
0x080488d5 in main (argc=4, argv=0xbffff7f4) at baner.c:82
82              if((n = write(fd, argv[3], strlen(argv[3])))>0)
```

写fd触发
实际上是61行的写操作触发硬件断点，事后报告，导致gdb行号报告为62行

```
fd = open(name, O_RDWR);
```

读fd触发

读fd触发

读n做比较时触发，写时没有触发

线程约束

- thread <threadno>
- 进档指定线程遇到断点时才中断
- 适用于各类断点

`watch [-l|-location] expr [thread thread-id] [mask maskvalue]`

Set a watchpoint for an expression. GDB will break when the expression *expr* is written into by the program and its value changes. The simplest (and the most popular) use of this command is to watch the value of a single variable:

```
(gdb) watch foo
```

If the command includes a [`thread thread-id`] argument, GDB breaks only when the thread identified by *thread-id* changes the value of *expr*. If any other threads change the value of *expr*, GDB will not break. Note that watchpoints restricted to a single thread in this way only work with Hardware Watchpoints.

线程约束示例

- (gdb) b hd_ioctl thread 1
- Breakpoint 10 at 0x8048603: file baner.c, line 16.

```
(gdb) run 0 i s 1
Starting program: /home/ge/work/llaolao3/baner 0 i s 1

Breakpoint 1, main (argc=5, argv=0xbffff7f4) at baner.c:53
53      {
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
10      breakpoint     keep y   0x08048603 in hd_ioctl at baner.c:16 thread 1
        stop only in thread 1
(gdb) c
Continuing.

Breakpoint 10, hd_ioctl (fd=7, cmd=0xbffff945 "s", arg=0xbffff947 "1")
    at baner.c:16
16          int val = 0;
(gdb) info threads
  Id   Target Id         Frame
* 1    process 2637 "baner" hd_ioctl (fd=7, cmd=0xbffff945 "s",
    arg=0xbffff947 "1") at baner.c:16
```

附加条件

- 直接使用if关键字附加在断点命令后
- 或者 condition bnum expression

- condition bnum 没有参数则删除之前设置的条件

条件断点示例

```
(gdb) b hd_ioctl thread 1 if fd>0
Unknown thread 1.
(gdb) run 0 i s 1
Starting program: /home/ge/work/llaolao3/baner 0 i s 1

Breakpoint 1, main (argc=5, argv=0xbffff7f4) at baner.c:53
53      {
(gdb) b hd_ioctl thread 1 if fd>0
Breakpoint 12 at 0x8048603: file baner.c, line 16.
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
12      breakpoint     keep y   0x08048603 in hd_ioctl at baner.c:16 thread 1
        stop only if fd>0
        stop only in thread 1
(gdb) c
Continuing.

Breakpoint 12, hd_ioctl (fd=7, cmd=0xbffff945 "s", arg=0xbffff947 "1")
    at baner.c:16
16          int val = 0;
```

5.1.7 Breakpoint Command Lists

You can give any breakpoint (or watchpoint or catchpoint) a series of commands to execute when your program stops due to that breakpoint. For example, you might want to print the values of certain expressions, or enable other breakpoints.

`commands` [*range*...]
... *command-list* ...
`end`

Specify a list of commands for the given breakpoints. The commands themselves appear on the following lines. Type a line containing just `end` to terminate the commands.

To remove all commands from a breakpoint, type `commands` and follow it immediately with `end`; that is, give no commands.

With no argument, `commands` refers to the last breakpoint, watchpoint, or catchpoint set (not to the breakpoint most recently encountered). If the most recent breakpoints were set with a single command, then the `commands` will apply to all the breakpoints set by that command. This applies to breakpoints set by `rbreak`, and also applies when a single `break` command creates multiple breakpoints (see Section 10.2 [Ambiguous Expressions], page 116).

附件命令示例

```
(gdb) commands 12
Type commands for breakpoint(s) 12, one per line.
End with a line saying just "end".
>silent
>printf "fd is %d\n",fd
>continue
>end
```

```
(gdb) info b
Num     Type           Disp Enb Address    What
1       breakpoint     keep y   0x0804877b in main at baner.c:53
        breakpoint already hit 1 time
12      breakpoint     keep y   0x08048603 in hd_ioctl at baner.c:16 thread 1
        stop only if fd>0
        stop only in thread 1
        breakpoint already hit 1 time
        silent
        printf "fd is %d\n",fd
        continue
```

```
(gdb) c
Continuing.
fd is 7
ioctl cmd s value 1
[Inferior 1 (process 2640) exited normally]
(gdb)
```

例2

```
(gdb) b do_mmap_pgoff
Breakpoint 1 at 0xffffffff8111a441: file mm/mmap.c, line 940.
(gdb) command 1
Type commands for when breakpoint 1 is hit, one per line.
End with a line saying just "end".
>print addr
>print len
>print prot
>end
(gdb)
```

WinDBG的断点命令

- 软件断点
  - bp 设置断点
    - **bp ntdll!RtlRaiseException "r eax; dt MyVar; g"**
  - bu 设置延迟的断点
  - bm 模式匹配
    - bm /a nt!Dbgk*
- 硬件断点
  - ba i|w|r|e*n* 地址
- 控制和显示
  - be bd bl bc

demo

使用WinDBG“挖地雷”

硬件断点示例

```
kd> ba w4 0x011b0000
kd> g
Breakpoint 2 hit
cdd!memcpy+0x33:
912b7a83 f3a5            rep movs dword ptr es:[edi],dword ptr [esi]
kd> r
eax=fdc01200 ebx=00001200 ecx=0000047f edx=00000000 esi=fdc00004 edi=011b0004
eip=912b7a83 esp=8cdeb3bc ebp=8cdeb3c4 iopl=0         nv up ei pl nz ac pe nc
cs=0008  ss=0010  ds=0023  es=0023  fs=0030  gs=0000             efl=00010216
cdd!memcpy+0x33:
912b7a83 f3a5            rep movs dword ptr es:[edi],dword ptr [esi]
```

- 陷阱类异常——命中时，访问指令已经执行完毕
- EIP指向下一条指令，串指令例外

数据监视断点

- 监视变量访问
  - 内存中数据段
- 基于调试寄存器的方法
  - ba r1 xxx 读写中断
  - ba w2 xxx 写中断
  - 个数有限
- VC6的方法
  - 单步执行所有指令
  - 速度慢，没有个数限制

00 — Break on instruction execution only.
01 — Break on data writes only.
10 — Break on I/O reads or writes.
11 — Break on data reads or writes but not instruction fetches.

条件断点

- Bp hal!x86BiosWriteIoSpace+0x5 ".if poi(@ebp+0xc)=ec00 {} .else {.echo Entered hal!x86BiosWriteIoSpace port;dd (@ebp+0xc) l1; .echo data; dd (@ebp+0x10) l1; kpL 15; gc}"

- 相当于IDE调试器中的追踪点（Tracing Point）

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单步跟踪

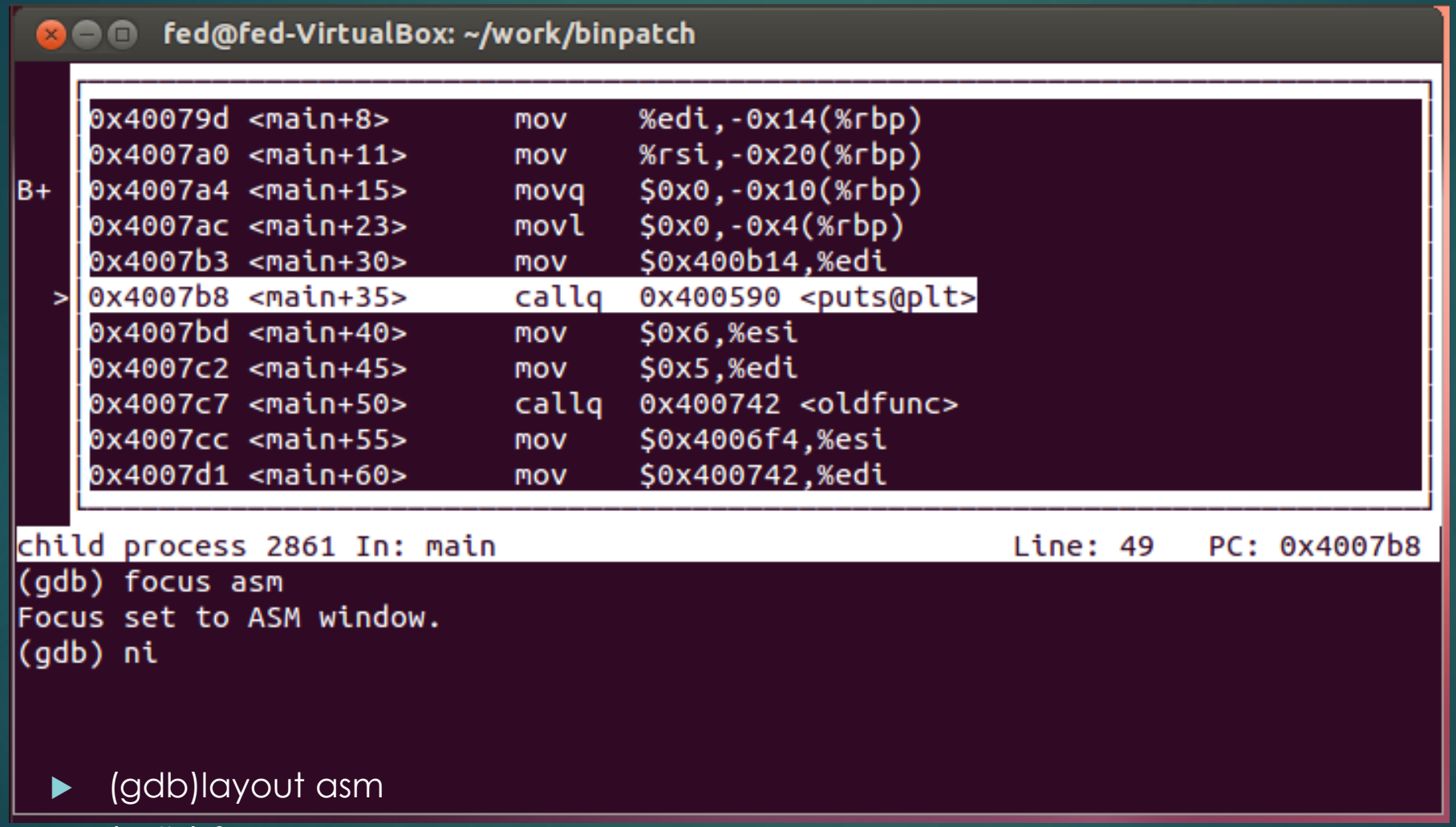
- stepi #Execute one instruction
- stepi 4 # Execute four instructions
- nexti # Like stepi, but proceed through function calls without stopping
- step # Execute one C statement

汇编级跟踪

- set disassemble-next-line on

```
(gdb) si
0x00000000004007c2      52          oldfunc(5,6);
   0x00000000004007bd <main+40>:        be 06 00 00 00  mov    $0x6,%esi
=> 0x00000000004007c2 <main+45>:        bf 05 00 00 00  mov    $0x5,%edi
   0x00000000004007c7 <main+50>:        e8 76 ff ff ff  callq  0x400742 <oldfunc>
(gdb)
0x00000000004007c7      52          oldfunc(5,6);
   0x00000000004007bd <main+40>:        be 06 00 00 00  mov    $0x6,%esi
   0x00000000004007c2 <main+45>:        bf 05 00 00 00  mov    $0x5,%edi
=> 0x00000000004007c7 <main+50>:        e8 76 ff ff ff  callq  0x400742 <oldfunc>
(gdb)
oldfunc (n=32767, m=-139936230) at binpatch.c:29
29      {
=> 0x0000000000400742 <oldfunc+0>:      55      push   %rbp
   0x0000000000400743 <oldfunc+1>:      48 89 e5        mov    %rsp,%rbp
   0x0000000000400746 <oldfunc+4>:      48 83 ec 20     sub    $0x20,%rsp
   0x000000000040074a <oldfunc+8>:      89 7d ec        mov    %edi,-0x14(%rbp)
   0x000000000040074d <oldfunc+11>:     89 75 e8        mov    %esi,-0x18(%rbp)
(gdb)
0x0000000000400743      29      {
   0x0000000000400742 <oldfunc+0>:      55      push   %rbp
=> 0x0000000000400743 <oldfunc+1>:      48 89 e5        mov    %rsp,%rbp
   0x0000000000400746 <oldfunc+4>:      48 83 ec 20     sub    $0x20,%rsp
   0x000000000040074a <oldfunc+8>:      89 7d ec        mov    %edi,-0x14(%rbp)
   0x000000000040074d <oldfunc+11>:     89 75 e8        mov    %esi,-0x18(%rbp)
(gdb)
```

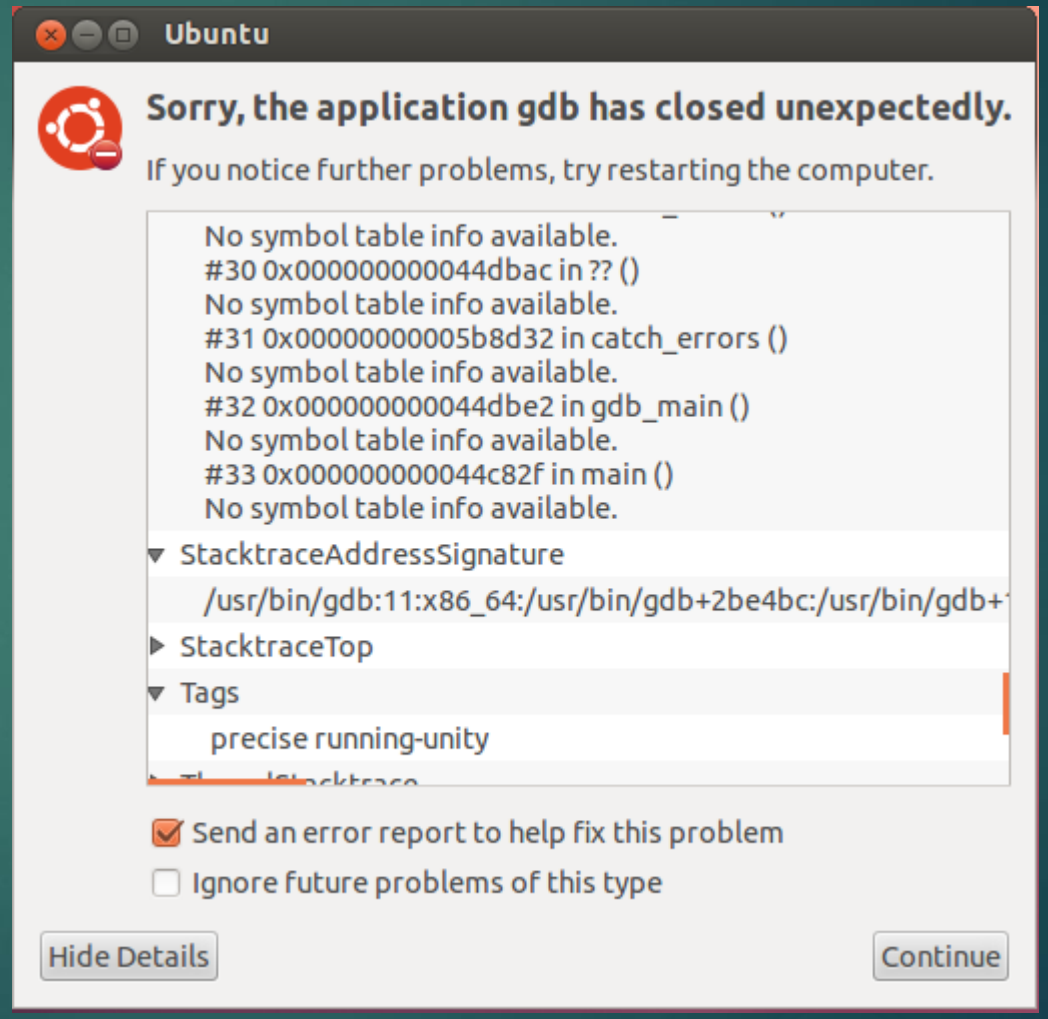
汇编'窗口'



- (gdb)layout asm
- (gdb) focus asm
- (gdb) ni

Oops

- (gdb) show version
- GNU gdb (Ubuntu/Linaro 7.4-2012.04-0ubuntu2.1) 7.4-2012.04
- Copyright (C) 2012 Free Software Foundation, Inc.
- License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
- This is free software: you are free to change and redistribute it.
- There is NO WARRANTY, to the extent permitted by law. Type "show copying"
- and "show warranty" for details.
- This GDB was configured as "x86_64-linux-gnu".



观察机器码

- echo 'asm("mov $400835, %rax\n jmp *%rax\n");' > test.c
- gcc -c test.c
- objdump -d test.o

- display /3i $pc

```
0000000000400742 <oldfunc>:
  400742:       55                      push   %rbp
  400743:       48 89 e5                mov    %rsp,%rbp
  400746:       48 83 ec 20             sub    $0x20,%rsp
  40074a:       89 7d ec                mov    %edi,-0x14(%rbp)
  40074d:       89 75 e8                mov    %esi,-0x18(%rbp)
  400750:       c7 45 f4 08 00 00 00    movl   $0x8,-0xc(%rbp)
  400757:       c7 45 f8 e7 03 00 00    movl   $0x3e7,-0x8(%rbp)
  40075e:       8b 45 f4                mov    -0xc(%rbp),%eax
  400761:       0f af 45 f8             imul   -0x8(%rbp),%eax
  400765:       0f af 45 e8             imul   -0x18(%rbp),%eax
  400769:       89 45 fc                mov    %eax,-0x4(%rbp)
  40076c:       bf d3 0a 40 00          mov    $0x400ad3,%edi
  400771:       e8 1a fe ff ff          callq  400590 <puts@plt>
  400776:       b8 e8 0a 40 00          mov    $0x400ae8,%eax
  40077b:       8b 55 e8                mov    -0x18(%rbp),%edx
  40077e:       8b 4d ec                mov    -0x14(%rbp),%ecx
  400781:       89 ce                   mov    %ecx,%esi
  400783:       48 89 c7                mov    %rax,%rdi
  400786:       b8 00 00 00 00          mov    $0x0,%eax
  40078b:       e8 20 fe ff ff          callq  4005b0 <printf@plt>
  400790:       8b 45 fc                mov    -0x4(%rbp),%eax
  400793:       c9                      leaveq
  400794:       c3                      retq
```

恢复执行

- continue # Resume execution until the next breakpoint
- until 3 # Continue executing until program hits breakpoint 3
- finish # Resume execution until current function returns

调用函数

- call sum(1, 2) # Call sum(1,2) and print return value

```
(gdb) run 0 i s 1
Starting program: /home/ge/work/llaolao3/baner 0 i s 1

Breakpoint 1, main (argc=5, argv=0xbffff7f4) at baner.c:53
53      {
(gdb) call usage()
baner <devno> r/w/s/i <value>
$2 = -1
```

强制返回

- return expression
- You can cancel execution of a function call with the return command. If you give an expression argument, its value is used as the function's return value.

```
Breakpoint 1, Reading in symbols for libc-start.c...done.
main (argc=3, argv=0xbffff3f4) at baner.c:53
53      {
(gdb) return 1
Make main return now? (y or n) y
#0  __libc_start_main (main=0x804876a <main>,
    argc=3, ubp_av=0xbffff3f4, init=0x8048990 <__libc_csu_init>,
    fini=0x8048a00 <__libc_csu_fini>,
    rtld_fini=Reading in symbols for dl-fini.c...done.
0xb7fed230 <_dl_fini>, stack_end=0xbffff3ec) at libc-start.c:258
258     libc-start.c: No such file or directory.
(gdb)
Make __libc_start_main return now? (y or n) n
Not confirmed
(gdb) bt
#0  __libc_start_main (main=0x804876a <main>, argc=3, ubp_av=0xbffff3f4,
    init=0x8048990 <__libc_csu_init>, fini=0x8048a00 <__libc_csu_fini>,
    rtld_fini=0xb7fed230 <_dl_fini>, stack_end=0xbffff3ec) at libc-start.c:258
#1  0x08048551 in _start ()
```

触发中断

- CTRL + C

Suspending execution is done with the interrupt command when running in the background,or Ctrl-c during foreground execution.

反向单步

6 Running programs backward

When you are debugging a program, it is not unusual to realize that you have gone too far, and some event of interest has already happened. If the target environment supports it, GDB can allow you to "rewind" the program by running it backward.

A target environment that supports reverse execution should be able to "undo" the changes in machine state that have taken place as the program was executing normally. Variables, registers etc. should revert to their previous values. Obviously this requires a great deal of sophistication on the part of the target environment; not all target environments can support reverse execution.

- # reverse-step, reverse-next, reverse-continue (rc)
- # target record
- # target record-full
- http://stackoverflow.com/questions/1206872/go-to-previous-line-in-gdb

利用RTIT反向单步

- Real time instruction trace,又叫 intel processor trace
- Gdb 7.10 supports PT for “backwards debugging” (reverse-step)
- Uses perf interface, works as non root

```
(gdb) reverse-step
do_crash () at src/stack.c:59
59          return comp(&arg);
(gdb) record instruction-history -
67          0x0000000000400623 <do_crash+20>:       mov     -0x8(%rbp),%rax
68          0x0000000000400627 <do_crash+24>:       test    %rax,%rax
69          0x000000000040062a <do_crash+27>:       jne     0x400635
70          0x0000000000400635 <do_crash+38>:       mov     -0x8(%rbp),%rax
71          0x0000000000400639 <do_crash+42>:       mov     -0x8(%rbp),%rdx
72          0x000000000040063d <do_crash+46>:       mov     0x8(%rdx),%rdx
73          0x0000000000400641 <do_crash+50>:       add     (%rax),%rdx
74          0x0000000000400644 <do_crash+53>:       mov     %rdx,%rax
75          0x0000000000400647 <do_crash+56>:       leaveq
76          0x0000000000400648 <do_crash+57>:       retq
```

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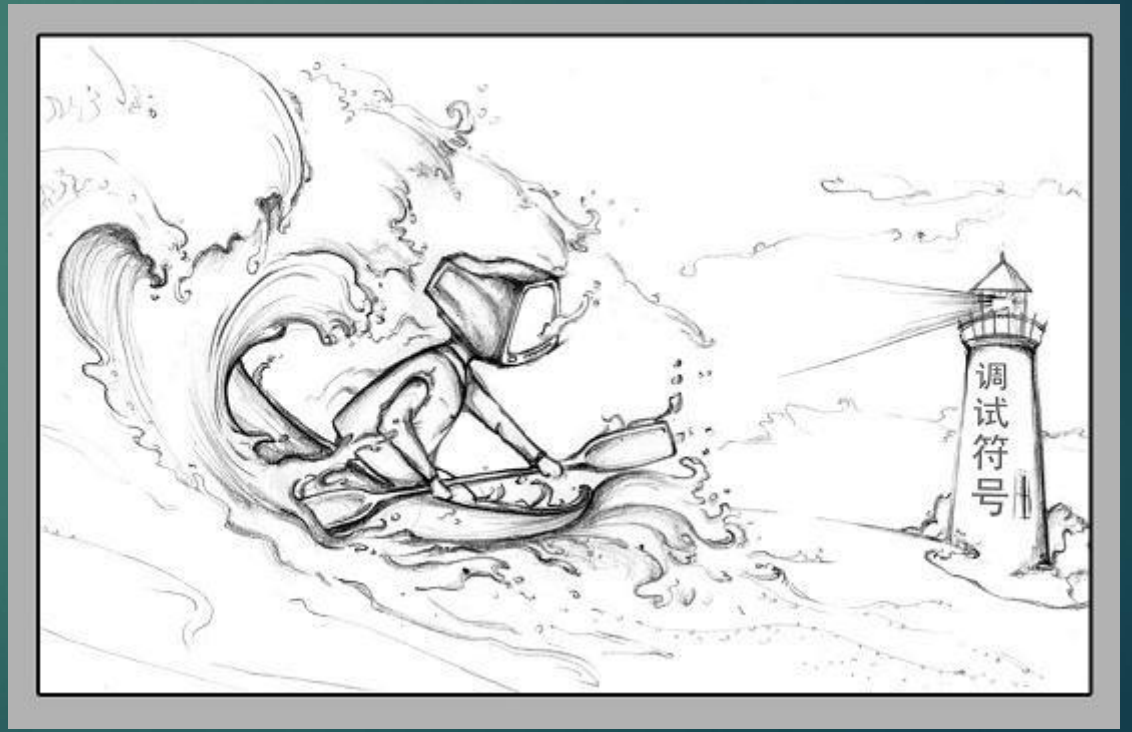
调试符号

- 编译器对调试的重大贡献
  - 编译过程的副产品
- 衔接二进制程序与源程序的桥梁
- 对调试有着重要意义
- 源代码级调试必须
- 二进制跟踪时的灯塔



DWARF

- DWARF Debugging Information Format
- http://www.dwarfstd.org
- 功莫大焉

再看ELF

```
ge@gewubox:~/work/llaolao3$ readelf -h baner
ELF Header:
  Magic:   7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF32
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              EXEC (Executable file)
  Machine:                           Intel 80386
  Version:                           0x1
  Entry point address:               0x8048530
  Start of program headers:          52 (bytes into file)
  Start of section headers:          5824 (bytes into file)
  Flags:                             0x0
  Size of this header:               52 (bytes)
  Size of program headers:           32 (bytes)
  Number of program headers:         9
  Size of section headers:           40 (bytes)
  Number of section headers:         36
  Section header string table index: 33
```

段表

```
Section Headers:
  [Nr] Name              Type            Addr     Off    Size   ES Flg Lk Inf Al
  [ 0]                   NULL            00000000 000000 000000 00      0   0  0
  [ 1] .interp           PROGBITS        08048154 000154 000013 00   A  0   0  1
  [ 2] .note.ABI-tag     NOTE            08048168 000168 000020 00   A  0   0  4
  [ 3] .note.gnu.build-i NOTE            08048188 000188 000024 00   A  0   0  4
  [ 4] .gnu.hash         GNU_HASH        080481ac 0001ac 000020 04   A  5   0  4
  [ 5] .dynsym           DYNSYM          080481cc 0001cc 0000f0 10   A  6   1  4
  [ 6] .dynstr           STRTAB          080482bc 0002bc 00009f 00   A  0   0  1
  [ 7] .gnu.version      VERSYM          0804835c 00035c 00001e 02   A  5   0  2
  [ 8] .gnu.version_r    VERNEED         0804837c 00037c 000030 00   A  6   1  4
  [ 9] .rel.dyn          REL             080483ac 0003ac 000008 08   A  5   0  4
  [10] .rel.plt          REL             080483b4 0003b4 000068 08   A  5  12  4
  [11] .init             PROGBITS        0804841c 00041c 00002e 00  AX  0   0  4
  [12] .plt              PROGBITS        08048450 000450 0000e0 04  AX  0   0 16
  [13] .text             PROGBITS        08048530 000530 00050c 00  AX  0   0 16
  [14] .fini             PROGBITS        08048a3c 000a3c 00001a 00  AX  0   0  4
  [15] .rodata           PROGBITS        08048a58 000a58 00013b 00   A  0   0  4
  [16] .eh_frame_hdr     PROGBITS        08048b94 000b94 000044 00   A  0   0  4
  [17] .eh_frame         PROGBITS        08048bd8 000bd8 000108 00   A  0   0  4
  [18] .ctors            PROGBITS        08049f14 000f14 000008 00  WA  0   0  4
  [19] .dtors            PROGBITS        08049f1c 000f1c 000008 00  WA  0   0  4
  [20] .jcr              PROGBITS        08049f24 000f24 000004 00  WA  0   0  4
  [21] .dynamic          DYNAMIC         08049f28 000f28 0000c8 08  WA  6   0  4
  [22] .got              PROGBITS        08049ff0 000ff0 000004 04  WA  0   0  4
  [23] .got.plt          PROGBITS        08049ff4 000ff4 000040 04  WA  0   0  4
  [24] .data             PROGBITS        0804a034 001034 000008 00  WA  0   0  4
  [25] .bss              NOBITS          0804a03c 00103c 000008 00  WA  0   0  4
  [26] .comment          PROGBITS        00000000 00103c 00002a 01  MS  0   0  1
  [27] .debug_aranges    PROGBITS        00000000 001066 000020 00      0   0  1
  [28] .debug_info       PROGBITS        00000000 001086 0001e8 00      0   0  1
  [29] .debug_abbrev     PROGBITS        00000000 00126e 000110 00      0   0  1
  [30] .debug_line       PROGBITS        00000000 00137e 000091 00      0   0  1
  [31] .debug_str        PROGBITS        00000000 00140f 0000bf 01  MS  0   0  1
  [32] .debug_loc        PROGBITS        00000000 0014ce 0000a8 00      0   0  1
  [33] .shstrtab         STRTAB          00000000 001576 000147 00      0   0  1
  [34] .symtab           SYMTAB          00000000 001c60 000530 10     35  51  4
  [35] .strtab           STRTAB          00000000 002190 0002ca 00      0   0  1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings)
```

感受DWARF – 编译单元

```
Contents of the .debug_info section:

  Compilation Unit @ offset 0x0:
   Length:        0x1e4 (32-bit)
   Version:       2
   Abbrev Offset: 0
   Pointer Size:  4
 <0><b>: Abbrev Number: 1 (DW_TAG_compile_unit)
    <c>   DW_AT_producer    : (indirect string, offset: 0x38): GNU C 4.6.3
    <10>   DW_AT_language    : 1    (ANSI C)
    <11>   DW_AT_name        : (indirect string, offset: 0x0): baner.c
    <15>   DW_AT_comp_dir    : (indirect string, offset: 0xa8): /home/ge/work/llaolao3
    <19>   DW_AT_low_pc      : 0x80485e4
    <1d>   DW_AT_high_pc     : 0x804898f
    <21>   DW_AT_stmt_list   : 0x0
 <1><25>: Abbrev Number: 2 (DW_TAG_base_type)
    <26>   DW_AT_byte_size   : 1
    <27>   DW_AT_encoding    : 8    (unsigned char)
    <28>   DW_AT_name        : (indirect string, offset: 0x11): unsigned char
```

TAG(标签)

```
<1><a0>: Abbrev Number: 8 (DW_TAG_subprogram)
   <a1>   DW_AT_external    : 1
   <a2>   DW_AT_name        : (indirect string, offset: 0x8): hd_ioctl
   <a6>   DW_AT_decl_file   : 1
   <a7>   DW_AT_decl_line   : 14
   <a8>   DW_AT_prototyped  : 1
   <a9>   DW_AT_low_pc      : 0x80485fd
   <ad>   DW_AT_high_pc     : 0x804876a
   <b1>   DW_AT_frame_base  : 0x38 (location list)
   <b5>   DW_AT_sibling     : <0x11d>
<2><b9>: Abbrev Number: 9 (DW_TAG_formal_parameter)
   <ba>   DW_AT_name        : fd
   <bd>   DW_AT_decl_file   : 1
   <be>   DW_AT_decl_line   : 14
   <bf>   DW_AT_type        : <0x4f>
   <c3>   DW_AT_location    : 2 byte block: 91 0   (DW_OP_fbreg: 0)
<2><c6>: Abbrev Number: 9 (DW_TAG_formal_parameter)
   <c7>   DW_AT_name        : cmd
   <cb>   DW_AT_decl_file   : 1
   <cc>   DW_AT_decl_line   : 14
   <cd>   DW_AT_type        : <0x6b>
   <d1>   DW_AT_location    : 2 byte block: 91 4   (DW_OP_fbreg: 4)
<2><d4>: Abbrev Number: 9 (DW_TAG_formal_parameter)
   <d5>   DW_AT_name        : arg
   <d9>   DW_AT_decl_file   : 1
   <da>   DW_AT_decl_line   : 14
   <db>   DW_AT_type        : <0x6b>
   <df>   DW_AT_location    : 2 byte block: 91 8   (DW_OP_fbreg: 8)
<2><e2>: Abbrev Number: 10 (DW_TAG_variable)
   <e3>   DW_AT_name        : val
   <e7>   DW_AT_decl_file   : 1
   <e8>   DW_AT_decl_line   : 16
   <e9>   DW_AT_type        : <0x4f>
   <ed>   DW_AT_location    : 2 byte block: 91 6c  (DW_OP_fbreg: -20)
<2><f0>: Abbrev Number: 11 (DW_TAG_lexical_block)
   <f1>   DW_AT_low_pc      : 0x8048628
   <f5>   DW_AT_high_pc     : 0x804874d
```

产生符号

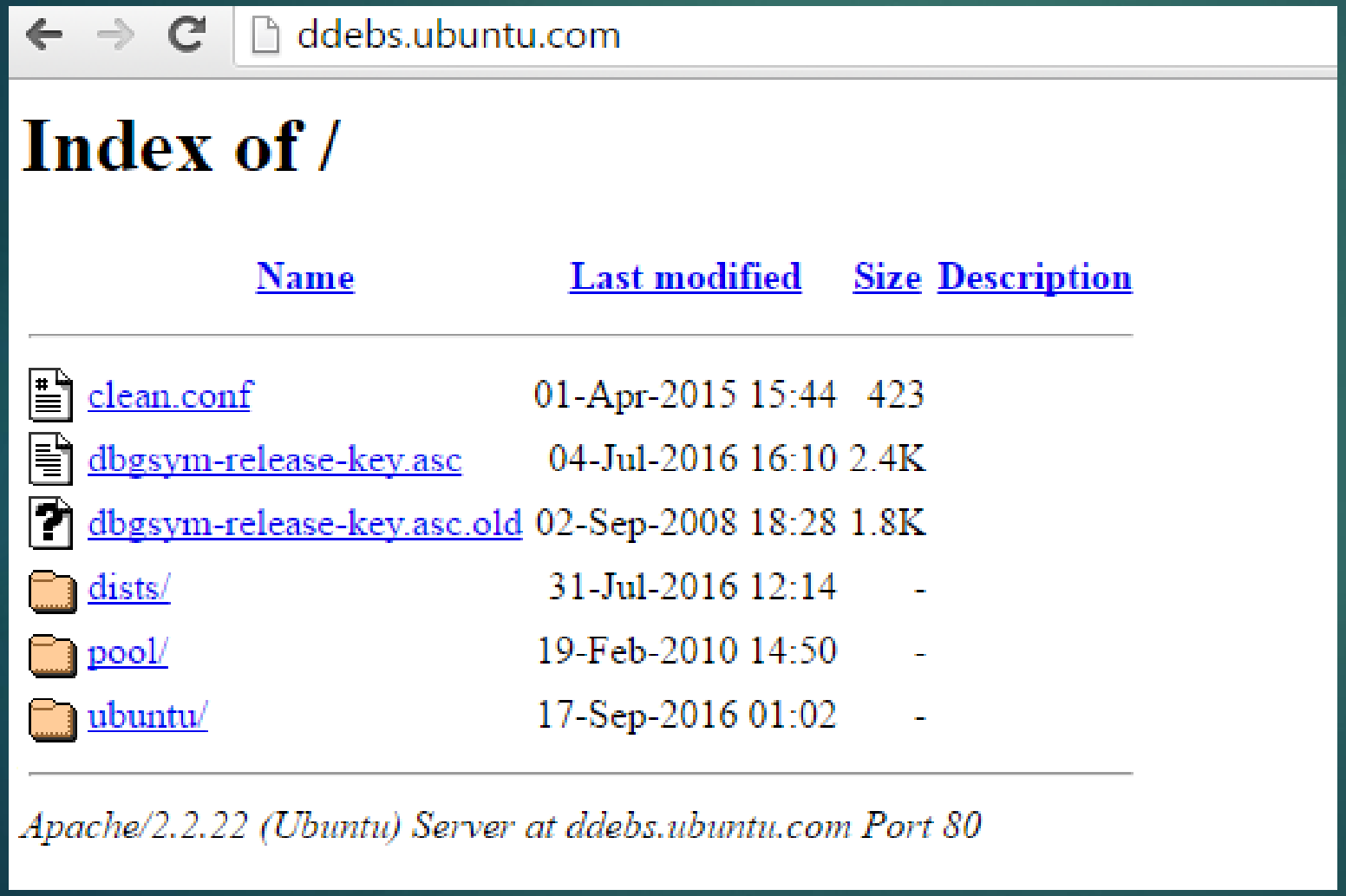
- $ gcc –g –o baner baner.c
- -g --gen-debug generate debugging information

```
--debug-prefix-map OLD=NEW
                           map OLD to NEW in debug information
--defsym SYM=VAL           define symbol SYM to given value
--execstack                require executable stack for this object
--noexecstack              don't require executable stack for this object
--size-check=[error|warning]
                           ELF .size directive check (default --size-check=error)
-f                         skip whitespace and comment preprocessing
-g --gen-debug             generate debugging information
--gstabs                   generate STABS debugging information
--gstabs+                  generate STABS debug info with GNU extensions
--gdwarf-2                 generate DWARF2 debugging information
--hash-size=<value>        set the hash table size close to <value>
--help                     show this message and exit
```

Ubuntu的符号服务器

- http://ddebs.ubuntu.com/pool/main/l/linux/

服务器的根目录


ddebs.ubuntu.com
Index of /
Name
Last modified
Size
Description
clean.conf 01-Apr-2015 15:44 423
dbgsym-release-key.asc 04-Jul-2016 16:10 2.4K
dbgsym-release-key.asc.old 02-Sep-2008 18:28 1.8K
dists/ 31-Jul-2016 12:14 -
pool/ 19-Feb-2010 14:50 -
ubuntu/ 17-Sep-2016 01:02 -
Apache/2.2.22 (Ubuntu) Server at ddebs.ubuntu.com Port 80

下载内核符号文件

17

1. First create a `ddebs.list` using:

```
echo "deb http://ddebs.ubuntu.com $(lsb_release -cs) main restricted universe multiverse
```

2. Then add the GPG key for `ddebs.ubuntu.com`:

```
wget -O - http://ddebs.ubuntu.com/dbgsym-release-key.asc | sudo apt-key add -
```

3. Then run:

```
sudo apt-get update
```

4. Then install the symbols package using:

```
sudo apt-get install linux-image-`uname -r`-dbgsym
```

This is rather huge (>680MB), so prepare for a wait while you download it.

http://askubuntu.com/questions/197016/how-to-install-a-package-that-contains-ubuntu-kernel-debug-symbols

示例2

```
fed@fed-VirtualBox:~/work$ sudo apt-get -c aptproxy.conf install linux-image-`uname -r`-dbgsym
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  linux-image-3.8.0-29-generic-dbgsym
0 upgraded, 1 newly installed, 0 to remove and 458 not upgraded.
Need to get 770 MB of archives.
After this operation, 2,532 MB of additional disk space will be used.
Get:1 http://ddebs.ubuntu.com/ precise-updates/main linux-image-3.8.0-29-generic-dbgsym amd64 3.8.0-29.42~precise1
[770 MB]
Fetched 770 MB in 1h 21min 54s (157 kB/s)
Selecting previously unselected package linux-image-3.8.0-29-generic-dbgsym.
(Reading database ... 142486 files and directories currently installed.)
Unpacking linux-image-3.8.0-29-generic-dbgsym (from .../linux-image-3.8.0-29-generic-dbgsym_3.8.0-29.42~precise1_am
d64.ddeb) ...
Setting up linux-image-3.8.0-29-generic-dbgsym (3.8.0-29.42~precise1) ...
```

libc

```
fed@fed-VirtualBox:~/work$ dpkg -S /lib/x86_64-linux-gnu/libc-2.15.so
libc6: /lib/x86_64-linux-gnu/libc-2.15.so
fed@fed-VirtualBox:~/work$ dpkg -S libc.so.6
libc6: /lib/x86_64-linux-gnu/libc.so.6
fed@fed-VirtualBox:~/work$ sudo apt-get -c aptproxy.conf install libc6-dbg
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  libc-bin libc-dev-bin libc6 libc6-dev
Suggested packages:
  glibc-doc
The following NEW packages will be installed:
  libc6-dbg
The following packages will be upgraded:
  libc-bin libc-dev-bin libc6 libc6-dev
4 upgraded, 1 newly installed, 0 to remove and 454 not upgraded.
Need to get 11.7 MB of archives.
After this operation, 19.9 MB of additional disk space will be used.
Do you want to continue [Y/n]? Y
Get:1 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc6-dev amd64 2.15-0ubuntu10.15 [2,943 kB]
Get:2 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc-dev-bin amd64 2.15-0ubuntu10.15 [84.7 kB]
Get:3 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc-bin amd64 2.15-0ubuntu10.15 [1,177 kB]
Get:4 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc6 amd64 2.15-0ubuntu10.15 [4,636 kB]
Get:5 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc6-dbg amd64 2.15-0ubuntu10.15 [2,888 kB]
Fetched 11.7 MB in 11s (1,055 kB/s)
Preconfiguring packages ...
(Reading database ... 146947 files and directories currently installed.)
Preparing to replace libc6-dev 2.15-0ubuntu10.4 (using .../libc6-dev_2.15-0ubuntu10.15_amd64.deb) ...
Unpacking replacement libc6-dev ...
Preparing to replace libc-dev-bin 2.15-0ubuntu10.4 (using .../libc-dev-bin_2.15-0ubuntu10.15_amd64.deb) ...
Unpacking replacement libc-dev-bin ...
Preparing to replace libc-bin 2.15-0ubuntu10.4 (using .../libc-bin_2.15-0ubuntu10.15_amd64.deb) ...
Unpacking replacement libc-bin ...
Processing triggers for man-db ...
Setting up libc-bin (2.15-0ubuntu10.15) ...
(Reading database ... 146946 files and directories currently installed.)
Preparing to replace libc6 2.15-0ubuntu10.4 (using .../libc6_2.15-0ubuntu10.15_amd64.deb) ...
Unpacking replacement libc6 ...
Setting up libc6 (2.15-0ubuntu10.15) ...
```

学习用虚拟机- gebox

```
ge@gewubox:~$ sudo apt-get install libc6-dbg
[sudo] password for ge:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  libc-bin libc-dev-bin libc6 libc6-dev
Suggested packages:
  glibc-doc
The following NEW packages will be installed:
  libc6-dbg
The following packages will be upgraded:
  libc-bin libc-dev-bin libc6 libc6-dev
4 upgraded, 1 newly installed, 0 to remove and 357 not upgraded.
Need to get 12.8 MB of archives.
After this operation, 25.6 MB of additional disk space will be used.
Do you want to continue [Y/n]? Y
Get:1 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc6-dev i386 2
.15-0ubuntu10.15 [5,099 kB]
Get:2 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc-dev-bin i38
6 2.15-0ubuntu10.15 [77.7 kB]
Get:3 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main libc-bin i386 2.
```

加载符号文件

- file或者symbol-file [filename]
- Read symbol table information from file filename. PATH is searched when necessary.
- Use the file command to get both symbol table and program to run from the same file.

案例

```
(gdb) i shared
From        To          Syms Read   Shared Object Library
0xb7fde820  0xb7ff6baf  Yes (*)     /lib/ld-linux.so.2
0xb7e37f10  0xb7f6d44c  Yes (*)     /lib/i386-linux-gnu/libc.so.6
(*): Shared library is missing debugging information.
```

```
(gdb) inf shared
From        To          Syms Read   Shared Object Library
0xb7fde820  0xb7ff6b5f  Yes         /lib/ld-linux.so.2
0xb7e38f70  0xb7f6d35c  Yes         /lib/i386-linux-gnu/libc.so.6
```

符号文件信息

```
(gdb) info files
Symbols from "/home/ge/work/llaolao3/baner".
Unix child process:
        Using the running image of child process 3807.
        While running this, GDB does not access memory from...
Local exec file:
        `/home/ge/work/llaolao3/baner', file type elf32-i386.
        Entry point: 0x8048530
        0x08048154 - 0x08048167 @ 0x00000154 is .interp
        0x08048168 - 0x08048188 @ 0x00000168 is .note.ABI-tag
        0x08048188 - 0x080481ac @ 0x00000188 is .note.gnu.build-id
        0x080481ac - 0x080481cc @ 0x000001ac is .gnu.hash
        0x080481cc - 0x080482bc @ 0x000001cc is .dynsym
        0x080482bc - 0x0804835b @ 0x000002bc is .dynstr
        0x0804835c - 0x0804837a @ 0x0000035c is .gnu.version
        0x0804837c - 0x080483ac @ 0x0000037c is .gnu.version_r
        0x080483ac - 0x080483b4 @ 0x000003ac is .rel.dyn
        0x080483b4 - 0x0804841c @ 0x000003b4 is .rel.plt
        0x0804841c - 0x0804844a @ 0x0000041c is .init
        0x08048450 - 0x08048530 @ 0x00000450 is .plt
        0x08048530 - 0x08048a3c @ 0x00000530 is .text
        0x08048a3c - 0x08048a56 @ 0x00000a3c is .fini
        0x08048a58 - 0x08048b93 @ 0x00000a58 is .rodata
        0x08048b94 - 0x08048bd8 @ 0x00000b94 is .eh_frame_hdr
        0x08048bd8 - 0x08048ce0 @ 0x00000bd8 is .eh_frame
        0x08049f14 - 0x08049f1c @ 0x00000f14 is .ctors
        0x08049f1c - 0x08049f24 @ 0x00000f1c is .dtors
        0x08049f24 - 0x08049f28 @ 0x00000f24 is .jcr
---Type <return> to continue, or q <return> to quit---
```

两阶段读取

- 对于大多数符号文件，GDB先是快速扫描符号文件，然后根据需要读取详细数据
- 可以使用readnow选项来强制读取所有符号信息

`symbol-file` [`-readnow`] *filename*
`file` [`-readnow`] *filename*

You can override the GDB two-stage strategy for reading symbol tables by using the '`-readnow`' option with any of the commands that load symbol table information, if you want to be sure GDB has the entire symbol table available.

显示符号

- info variables regexp
- info classes regexp
- info functions regexp
- info types regexp

```
(gdb) info variables errno
All variables matching regular expression "errno":

File errno.c:
int rtld_errno;
int __libc_errno;
int errno;

File herrno.c:
int __libc_h_errno;
int h_errno;
```

查找函数

- info functions regexp

```
(gdb) info functions sprintf
All functions matching regular expression "sprintf":

File sprintf.c:
int __sprintf(char *, const char *, ...);

File asprintf.c:
int ___asprintf(char **, const char *, ...);

File iovsprintf.c:
int __IO_vsprintf(char *, const char *, __gnuc_va_list);

File vasprintf.c:
int _IO_vasprintf(char **, const char *, __gnuc_va_list);

File sprintf_chk.c:
int ___sprintf_chk(char *, int, size_t, const char *, ...);

File vsprintf_chk.c:
int ___vsprintf_chk(char *, int, size_t, const char *, va_list);

File asprintf_chk.c:
int __asprintf_chk(char **, int, const char *, ...);

---Type <return> to continue, or q <return> to quit---
File vasprintf_chk.c:
int __GI___vasprintf_chk(char **, int, const char *, va_list);

Non-debugging symbols:
0x08048500  sprintf
0x08048500  sprintf@plt
```

符号命令归纳

- info address s #show where symbol s is stored
- info func [regex] #show names, types of defined functions (all, or matching regex)
- info var [regex] #show names, types of global variables (all, or matching regex)
- whatis [expr] #show data type of expr [or $] without evaluating;
- ptype [expr] #ptype gives more detail
- ptype type #describe type, struct, union, or enum

符号和地址互查

`info address` *`symbol`*

Describe where the data for *symbol* is stored. For a register variable, this says which register it is kept in. For a non-register local variable, this prints the stack-frame offset at which the variable is always stored.

Note the contrast with '`print &`*`symbol`*', which does not work at all for a register variable, and for a stack local variable prints the exact address of the current instantiation of the variable.

`info symbol` *`addr`*

Print the name of a symbol which is stored at the address *addr*. If no symbol is stored exactly at *addr*, GDB prints the nearest symbol and an offset from it:

```
(gdb) info symbol 0x54320
_initialize_vx + 396 in section .text
```

观察虚函数表

```
(gdb) x o
0x602010:       0x0000000000400b50
(gdb) x /2g $__
0x400b50 <_ZTV6Object+16>:      0x000000000040097e      0x0000000000400996
(gdb) info symbol $__
Object::InsertOrder(int, void*) in section .text of /home/fed/work/vtable/vtable
demo
(gdb) info symbol 0x000000000040097e
Object::Foo() in section .text of /home/fed/work/vtable/vtabledemo
(gdb)
```

或

```
(gdb) x o
0x602010:       0x0000000000400b50
(gdb) x o
0x602010:       0x0000000000400b50
(gdb) x /2g 0x400b50
0x400b50 <_ZTV6Object+16>:      0x000000000040097e      0x0000000000400996
(gdb) info symbol ^CQuit
(gdb) info symbol 0x000000000040097e
Object::Foo() in section .text of /home/fed/work/vtable/vtabledemo
(gdb) info symbol 0x0000000000400996
Object::InsertOrder(int, void*) in section .text of /home/fed/work/vtable/vtable
demo
```

查看源代码

`dir` *names*	add directory *names* to front of source path
`dir`	clear source path
`show dir`	show current source path
`list`	show next ten lines of source
`list -`	show previous ten lines
`list` *lines*	display source surrounding *lines*, specified as:
[*file*:]*num*	line number [in named file]
[*file*:]*function*	beginning of function [in named file]
+*off*	*off* lines after last printed
-*off*	*off* lines previous to last printed
**address*	line containing *address*
`list` *f*,*l*	from line *f* to line *l*
`info line` *num*	show starting, ending addresses of compiled code for source line *num*
`info source`	show name of current source file
`info sources`	list all source files in use
`forw` *regex*	search following source lines for *regex*
`rev` *regex*	search preceding source lines for *regex*

源文件信息

```
(gdb) info source
Current source file is ioputs.c
Compilation directory is /build/eglibc-QV9xlv/eglibc-2.15/libio
Source language is c.
Compiled with DWARF 2 debugging format.
Does not include preprocessor macro info.
(gdb) info sources
Source files for which symbols have been read in:

/home/ge/work/llaolao3/baner.c, dl-runtime.c, ../libio/stdio.h,
../nptl/pthreadP.h, ../stdio-common/_itoa.h, ../sysdeps/gnu/_G_config.h,
../iconv/gconv.h, ../wcsmbs/wchar.h, ../libio/libio.h,
../sysdeps/i386/dl-procinfo.c, ../sysdeps/i386/fpu_control.h,
../sysdeps/generic/ldsodefs.h, ../include/link.h,
../nptl/sysdeps/pthread/bits/libc-lock.h,
../nptl/sysdeps/unix/sysv/linux/internaltypes.h, ../nptl/descr.h,
../resolv/resolv.h, ../inet/netinet/in.h, ../bits/sockaddr.h,
../sysdeps/generic/unwind.h, ../nptl/../nptl_db/thread_db.h,
../nptl/sysdeps/pthread/pthread.h, ../nptl/sysdeps/pthread/list.h,
../sysdeps/i386/i686/hp-timing.h, ../sysdeps/i386/bits/setjmp.h,
../sysdeps/unix/sysv/linux/bits/sched.h, ../nptl/sysdeps/i386/i686/../tls.h,
../sysdeps/i386/bits/linkmap.h, ../elf/link.h, ../sysdeps/i386/bits/link.h,
../bits/elfclass.h, ../dlfcn/dlfcn.h,
../nptl/sysdeps/unix/sysv/linux/i386/bits/pthreadtypes.h,
../posix/sys/types.h, ../bits/types.h, ../elf/elf.h,
../sysdeps/generic/stdint.h, /usr/lib/gcc/i686-linux-gnu/4.6/include/stddef.h,
../sysdeps/i386/dl-irel.h, ../sysdeps/i386/dl-machine.h,
../sysdeps/i386/dl-trampoline.S, dl-debug.c, rtld.c, ../include/unistd.h,
../posix/unistd.h, ../include/assert.h, ../string/bits/string2.h,
../sysdeps/i386/dl-procinfo.h, ../sysdeps/i386/dl-tlsdesc.h, do-rel.h,
---Type <return> to continue, or q <return> to quit---
```

Install source files from Ubuntu

```
[~/src]$ apt-get source coreutils
[~/src]$ sudo apt-get install coreutils-dbgsym
[~/src]$ gdb /bin/ls
GNU gdb (GDB) 7.1-ubuntu
(gdb) list main
1192    ls.c: No such file or directory.
    in ls.c
(gdb) directory ~/src/coreutils-7.4/src/
Source directories searched: /home/nelhage/src/coreutils-7.4:$cdir:$cwd
(gdb) list main
1192        }
1193    }
```

安装libc源文件

- sudo apt-get source libc6-dev
- /home/ge/eglibc-2.15

```
ge@gewubox:~$ sudo apt-get source libc6-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
Picking 'eglibc' as source package instead of 'libc6-dev'
Need to get 25.4 MB of source archives.
Get:1 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main eglibc 2.15-0ubu
ntu10.15 (dsc) [5,829 B]
Get:2 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main eglibc 2.15-0ubu
ntu10.15 (tar) [23.5 MB]
Get:3 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main eglibc 2.15-0ubu
ntu10.15 (diff) [1,917 kB]
Fetched 25.4 MB in 24s (1,058 kB/s)
gpgv: Signature made Thu 26 May 2016 05:23:34 PM CST using RSA key ID 005E81F4
gpgv: Can't check signature: public key not found
dpkg-source: warning: failed to verify signature on ./eglibc_2.15-0ubuntu10.15.d
sc
dpkg-source: info: extracting eglibc in eglibc-2.15
dpkg-source: info: unpacking eglibc_2.15.orig.tar.gz
dpkg-source: info: applying eglibc_2.15-0ubuntu10.15.diff.gz
```

设置搜索路径

```
directory dirname ...
dir dirname ...
```

- Add directory dirname to the front of the source path. Several directory names may be given to this command, separated by ':' (';' on MS-DOS and MSWindows, where ':' usually appears as part of absolute file names) or whitespace.
- '$cdir' to refer to the compilation directory
- '$cwd' to refer to the current working directory

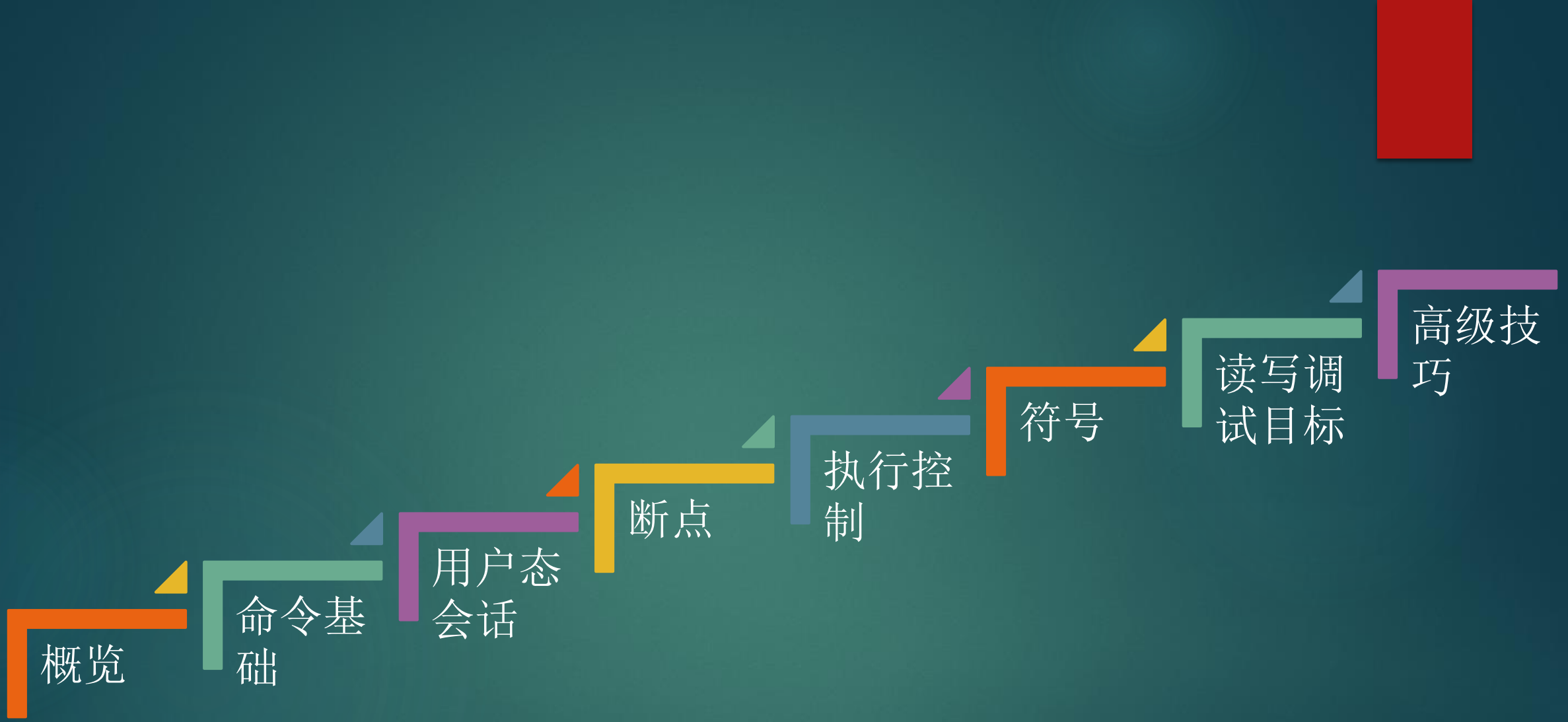
```
(gdb) directory /home/ge/eglibc-2.15/libio
Source directories searched: /home/ge/eglibc-2.15/libio:/home/ge/eglibc-2.15:/home/ge/eglibc:$cdir:$cwd
(gdb) list
30      #include <limits.h>
31
32      int
33      _IO_puts (str)
34           const char *str;
35      {
36        int result = EOF;
37        _IO_size_t len = strlen (str);
38        _IO_acquire_lock (_IO_stdout);
39
```

安装内核源文件

```
[~/src]$ apt-get source linux-image-2.6.32-25-generic
[~/src]$ sudo apt-get install linux-image-2.6.32-25-generic-dbgsym
[~/src]$ gdb /usr/lib/debug/boot/vmlinux-2.6.32-25-generic
(gdb) list schedule
5519    /build/buildd/linux-2.6.32/kernel/sched.c: No such file or directory.
    in /build/buildd/linux-2.6.32/kernel/sched.c
(gdb) set substitute-path /build/buildd/linux-2.6.32
/home/nelhage/src/linux-2.6.32/
(gdb) list schedule
5519
5520    static void put_prev_task(struct rq *rq, struct task_struct *p)
5521    {
```

常用命令

```
ge@gewubox:~$ apt-get source coreutils
Reading package lists... Done
Building dependency tree
Reading state information... Done
Need to get 12.6 MB of source archives.
Get:1 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main coreutils 8.13-3
ubuntu3.3 (dsc) [1,650 B]
Get:2 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main coreutils 8.13-3
ubuntu3.3 (tar) [11.7 MB]
Get:3 http://cn.archive.ubuntu.com/ubuntu/ precise-updates/main coreutils 8.13-3
ubuntu3.3 (diff) [930 kB]
Fetched 12.6 MB in 11s (1,114 kB/s)
gpgv: Signature made Wed 14 Jan 2015 11:32:42 AM CST using RSA key ID 9D8D2E97
gpgv: Can't check signature: public key not found
dpkg-source: warning: failed to verify signature on ./coreutils_8.13-3ubuntu3.3.
dsc
dpkg-source: info: extracting coreutils in coreutils-8.13
dpkg-source: info: unpacking coreutils_8.13.orig.tar.gz
dpkg-source: info: applying coreutils_8.13-3ubuntu3.3.diff.gz
ge@gewubox:~$ ls
coreutils-8.13                    Desktop    examples.desktop  sf.sh
coreutils_8.13-3ubuntu3.3.diff.gz dev.txt    Music             Templates
coreutils_8.13-3ubuntu3.3.dsc     Documents  Pictures          Videos
coreutils_8.13.orig.tar.gz        Downloads  Public            work
```


概览
命令基础
用户态会话
断点
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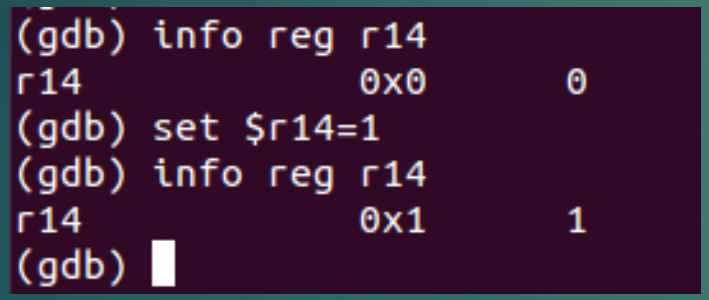
观察寄存器

```
(gdb) info reg
eax            0xbffff7f4       -1073743884
ecx            0xbffff7f4       -1073743884
edx            0xbffff784       -1073743996
ebx            0xb7fc6ff4       -1208193036
esp            0xbffff6f0       0xbffff6f0
ebp            0xbffff758       0xbffff758
esi            0x0      0
edi            0x0      0
eip            0x804877b        0x804877b <main+17>
eflags         0x286    [ PF SF IF ]
cs             0x73     115
ss             0x7b     123
ds             0x7b     123
es             0x7b     123
fs             0x0      0
gs             0x33     51
```

修改寄存器

- (gdb)set $<name>=<value>



参数和局部变量

```
(gdb) where
#0  hd_ioctl (fd=7, cmd=0xbffff945 "s", arg=0xbffff947 "1") at baner.c:16
#1  0x08048967 in main (argc=5, argv=0xbffff7f4) at baner.c:96
(gdb) info locals
val = -1073743551
(gdb) info local
val = -1073743551
(gdb) info args
fd = 7
cmd = 0xbffff945 "s"
arg = 0xbffff947 "1"
```

切换栈帧

- frame <no>

```
Breakpoint 1, Reading in symbols for libc-start.c...done.
main (argc=3, argv=0xbffff3f4) at baner.c:53
53      {
(gdb) b _IO_puts
Reading in symbols for ioputs.c...done.
Breakpoint 4 at 0xb7e88830: file ioputs.c, line 35.
(gdb) c
Continuing.

Breakpoint 2, __printf (format=0x8048b03 "open file %s failed with %d\n")
    at printf.c:30
30      printf.c: No such file or directory.
(gdb) bt
#0  __printf (format=0x8048b03 "open file %s failed with %d\n") at printf.c:30
#1  0x080487f8 in main (argc=3, argv=0xbffff3f4) at baner.c:64
(gdb) info locals
arg = <optimized out>
done = 134515459
(gdb) frame 1
#1  0x080487f8 in main (argc=3, argv=0xbffff3f4) at baner.c:64
64              printf("open file %s failed with %d\n", name, errno);
(gdb) info locals
n = -1208192028
fd = -1
name = "/dev/huadengw\000\377\377\326", <incomplete sequence \345\267>
buffer = "\364o\374\267eN\345\267\060\322\376\267\000\000\000\000\231\211\004\b"
```

观察变量和内存

`print` [*/f*] [*expr*]	show value of *expr* [or last value `$`]
`p` [*/f*] [*expr*]	according to format *f*:
`x`	hexadecimal
`d`	signed decimal
`u`	unsigned decimal
`o`	octal
`t`	binary
`a`	address, absolute and relative
`c`	character
`f`	floating point
`x` [*/Nuf*] *expr*	examine memory at address *expr*; optional format spec follows slash
N	count of how many units to display
u	unit size; one of
	`b` individual bytes
	`h` halfwords (two bytes)
	`w` words (four bytes)
	`g` giant words (eight bytes)
f	printing format. Any `print` format, or
	`s` null-terminated string
	`i` machine instructions

X

```
[~]$ grep saved_command /proc/kallsyms
ffffffff81946000 B saved_command_line
```

```
(gdb) x/s 0xffffffff81946000
ffffffff81946000 <>:     "root=/dev/sda1 quiet“
```

示例

```
(gdb) x /32bx arg
0xbffff947:     0x31    0x00    0x53    0x48    0x45    0x4c    0x4c    0x3d
0xbffff94f:     0x2f    0x62    0x69    0x6e    0x2f    0x62    0x61    0x73
0xbffff957:     0x68    0x00    0x54    0x45    0x52    0x4d    0x3d    0x78
0xbffff95f:     0x74    0x65    0x72    0x6d    0x00    0x55    0x53    0x45
```

```
(gdb) p arg[0]
$6 = 49 '1'
(gdb) p arg[1]
$7 = 0 '\000'
```

@

- (gdb) p *&a[0]@10
  $1 = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
- to view elements 550-553 in a long vector, all you do is
- 'p *&a[550]@4'

```
(gdb) p argv[0]@6
$14 = {0xbffff924 "/home/ge/work/llaolao3/baner", 0xbffff941 "0",
  0xbffff943 "i", 0xbffff945 "s", 0xbffff947 "1", 0x0}
```

修改内存

- (gdb) set <var>=<exp>

```
(gdb) set worker=2
(gdb) info locals
worker = 2
n = 0
(gdb)
```

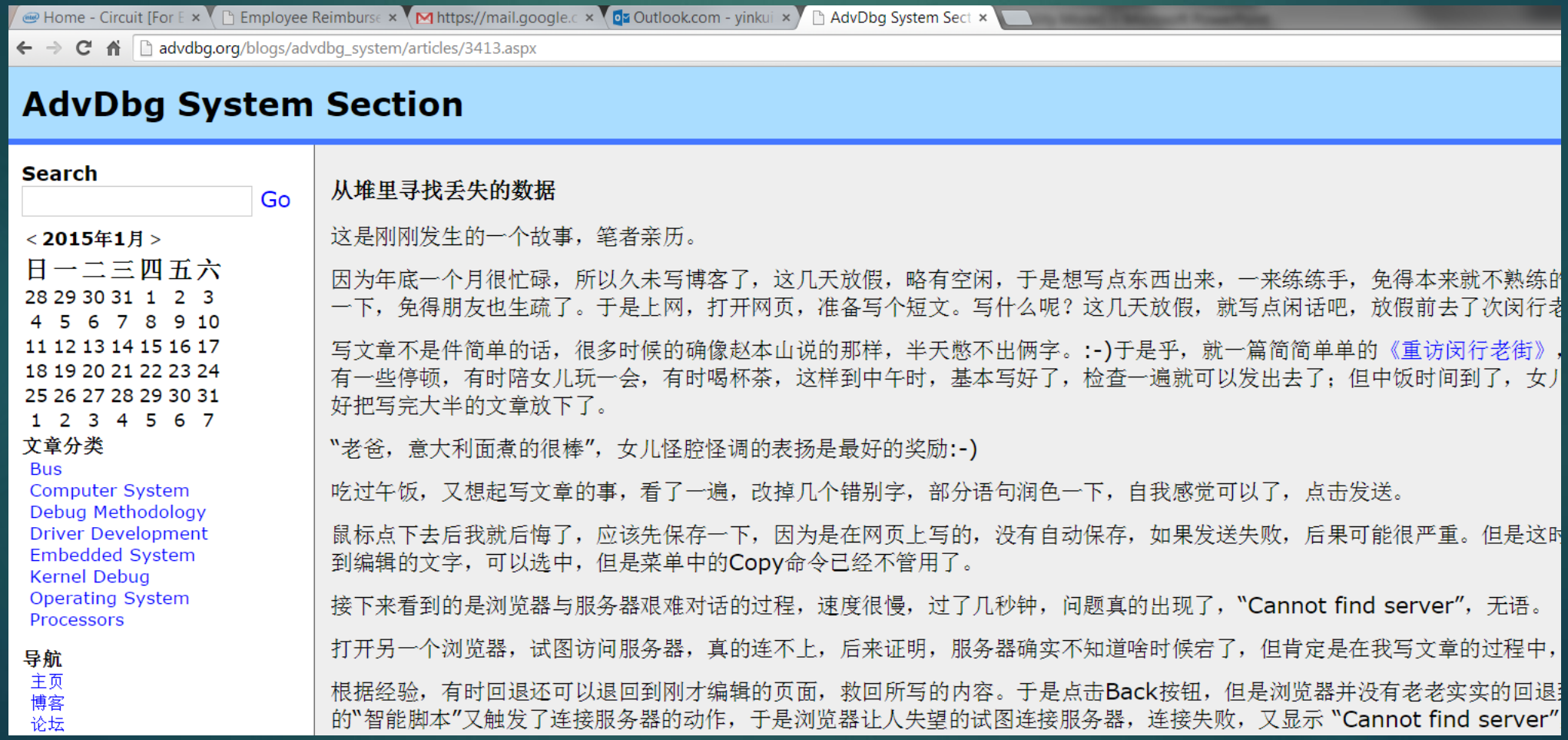
(gdb) help set variable
Evaluate expression EXP and assign result to variable VAR, using assignment syntax appropriate for the current language (VAR = EXP or VAR := EXP for example). VAR may be a debugger "convenience" variable (names starting with $), a register (a few standard names starting with $), or an actual variable in the program being debugged. EXP is any valid expression.
This may usually be abbreviated to simply "set".

WinDBG读写内存

- 显示内存d*
  - d, da, db, dc, dd, dD, df, dp, dq, du, dw, dW, dyb, dyd
  - 对于物理内存，!db, !dc, !dd, !dp, !dq, !du, !dw
  - 按类型显示：dt ds dS dl
- 编辑内存e*
  - e, ea, eb, ed, eD, ef, ep, eq, eu, ew, eza, ezu
  - 对于物理内存!eb, !ed
- 区域操作
  - 移动 m，填充 f（fp），比较c，查找s
- 局部变量
  - dv, !for_each_local

搜索内存

- s -u 10000 L8000000 "当年在交大"



GDB中搜索内存

- find [/sn] start_addr, +len, val1 [, val2, …]
- find [/sn] start_addr, end_addr, val1 [, val2, …]

```
(gdb) find &hello[0], +sizeof(hello), "hello"
0x804956d <hello.1620+6>
1 pattern found
(gdb) find &hello[0], +sizeof(hello), 'h', 'e', 'l', 'l', 'o'
0x8049567 <hello.1620>
0x804956d <hello.1620+6>
2 patterns found
(gdb) find /b1 &hello[0], +sizeof(hello), 'h', 0x65, 'l'
0x8049567 <hello.1620>
1 pattern found
(gdb) find &mixed, +sizeof(mixed), (char) 'c', (short) 0x1234, (int) 0x87654321
0x8049560 <mixed.1625>
1 pattern found
(gdb) print $numfound
$1 = 1
(gdb) print $_
$2 = (void *) 0x8049560
```

反汇编

disassem [*addr*]	display memory as machine instructions

```
(gdb) disas main
Dump of assembler code for function main:
   0x0804876a <+0>:     push   %ebp
   0x0804876b <+1>:     mov    %esp,%ebp
   0x0804876d <+3>:     push   %edi
   0x0804876e <+4>:     and    $0xfffffff0,%esp
   0x08048771 <+7>:     sub    $0x60,%esp
   0x08048774 <+10>:    mov    0xc(%ebp),%eax
   0x08048777 <+13>:    mov    %eax,0x1c(%esp)
   0x0804877b <+17>:    mov    %gs:0x14,%eax
   0x08048781 <+23>:    mov    %eax,0x5c(%esp)
   0x08048785 <+27>:    xor    %eax,%eax
   0x08048787 <+29>:    cmpl   $0x2,0x8(%ebp)
   0x0804878b <+33>:    jg     0x8048797 <main+45>
   0x0804878d <+35>:    call   0x80485e4 <usage>
   0x08048792 <+40>:    jmp    0x8048978 <main+526>
   0x08048797 <+45>:    mov    0x1c(%esp),%eax
   0x0804879b <+49>:    add    $0x4,%eax
   0x0804879e <+52>:    mov    (%eax),%edx
   0x080487a0 <+54>:    mov    $0x8048af4,%eax
   0x080487a5 <+59>:    mov    %edx,0x8(%esp)
   0x080487a9 <+63>:    mov    %eax,0x4(%esp)
   0x080487ad <+67>:    lea    0x34(%esp),%eax
   0x080487b1 <+71>:    mov    %eax,(%esp)
---Type <return> to continue, or q <return> to quit---
```

x/i

```
(gdb) x/5i schedule
   0xffffffff8154804a <schedule>:   push   %rbp
   0xffffffff8154804b <schedule+1>: mov    $0x11ac0,%rdx
   0xffffffff81548052 <schedule+8>: mov    %gs:0xb588,%rax
   0xffffffff8154805b <schedule+17>:    mov    %rsp,%rbp
   0xffffffff8154805e <schedule+20>:    push   %r15
```

x/10i sum Examine first 10 instructions of function sum

https://blogs.oracle.com/ksplice/entry/8_gdb_tricks_you_should

X86汇编语言

INTEL语法

- 先是目标，然后是源，也就是从右向左赋值
- Windows上流行

AT&T语法

- 先是源，然后是目标，也就是从左向右赋值
- Unix和Linux上流行

栈

`backtrace` [*n*]	print trace of all frames in stack; or of *n*
`bt` [*n*]	frames—innermost if *n*>0, outermost if *n*<0
`frame` [*n*]	select frame number *n* or frame at address *n*; if no *n*, display current frame
`up` *n*	select frame *n* frames up
`down` *n*	select frame *n* frames down
`info frame` [*addr*]	describe selected frame, or frame at *addr*
`info args`	arguments of selected frame
`info locals`	local variables of selected frame
`info reg` [*rn*]...	register values [for regs *rn*] in selected
`info all-reg` [*rn*]	frame; `all-reg` includes floating point

栈回溯

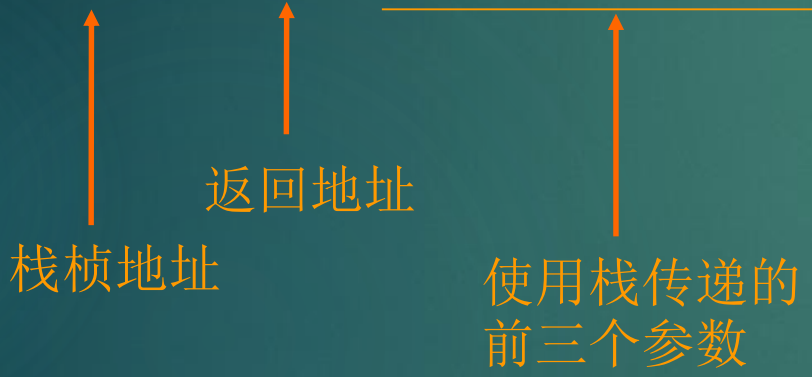
- backtrace

```
(gdb) bt
#0  hd_ioctl (fd=7, cmd=0xbffff945 "s", arg=0xbffff947 "1") at baner.c:16
#1  0x08048967 in main (argc=5, argv=0xbffff7f4) at baner.c:96
```

WinDBG观察栈

- k, kb, kv, kd, kp

```
0:001> kb
ChildEBP RetAddr  Args to Child
0052ffb4 7c80b50b 00000000 20202020 00142a78 UefSndThrd!UefThreadProc+0x25 [c:\dig\dbg\author\code\chap03\uef\uefs
0052ffec 00000000 00401005 00000000 00000000 kernel32!BaseThreadStart+0x37
```



使用栈传递的
前三个参数

```
0:001> kPL
ChildEBP RetAddr
00e5ffb4 7c80b6a3 MulThrds!DbgeeThreadProc(
                  void * lpParameter = 0x0012fe34)+0x1e
00e5ffec 00000000 kernel32!BaseThreadStart+0x37
```

概览

命令基础

用户态会话

断点

执行控制

符号

查看调试目标

高级技巧

信号

```
(gdb) info signals
Signal        Stop      Print   Pass to program Description

SIGHUP        Yes       Yes     Yes             Hangup
SIGINT        Yes       Yes     No              Interrupt
SIGQUIT       Yes       Yes     Yes             Quit
SIGILL        Yes       Yes     Yes             Illegal instruction
SIGTRAP       Yes       Yes     No              Trace/breakpoint trap
SIGABRT       Yes       Yes     Yes             Aborted
SIGEMT        Yes       Yes     Yes             Emulation trap
SIGFPE        Yes       Yes     Yes             Arithmetic exception
SIGKILL       Yes       Yes     Yes             Killed
SIGBUS        Yes       Yes     Yes             Bus error
SIGSEGV       Yes       Yes     Yes             Segmentation fault
SIGSYS        Yes       Yes     Yes             Bad system call
SIGPIPE       Yes       Yes     Yes             Broken pipe
SIGALRM       No        No      Yes             Alarm clock
SIGTERM       Yes       Yes     Yes             Terminated
SIGURG        No        No      Yes             Urgent I/O condition
SIGSTOP       Yes       Yes     Yes             Stopped (signal)
SIGTSTP       Yes       Yes     Yes             Stopped (user)
SIGCONT       Yes       Yes     Yes             Continued
SIGCHLD       No        No      Yes             Child status changed
SIGTTIN       Yes       Yes     Yes             Stopped (tty input)
```

处理规则

```
(gdb) info handle
Signal        Stop      Print   Pass to program Description

SIGHUP        Yes       Yes     Yes             Hangup
SIGINT        Yes       Yes     No              Interrupt
SIGQUIT       Yes       Yes     Yes             Quit
SIGILL        Yes       Yes     Yes             Illegal instruction
SIGTRAP       Yes       Yes     No              Trace/breakpoint trap
SIGABRT       Yes       Yes     Yes             Aborted
SIGEMT        Yes       Yes     Yes             Emulation trap
SIGFPE        Yes       Yes     Yes             Arithmetic exception
SIGKILL       Yes       Yes     Yes             Killed
SIGBUS        Yes       Yes     Yes             Bus error
SIGSEGV       Yes       Yes     Yes             Segmentation fault
SIGSYS        Yes       Yes     Yes             Bad system call
SIGPIPE       Yes       Yes     Yes             Broken pipe
SIGALRM       No        No      Yes             Alarm clock
SIGTERM       Yes       Yes     Yes             Terminated
SIGURG        No        No      Yes             Urgent I/O condition
SIGSTOP       Yes       Yes     Yes             Stopped (signal)
SIGTSTP       Yes       Yes     Yes             Stopped (user)
SIGCONT       Yes       Yes     Yes             Continued
SIGCHLD       No        No      Yes             Child status changed
SIGTTIN       Yes       Yes     Yes             Stopped (tty input)
---Type <return> to continue, or q <return> to quit---
```

改变信号处理规则

`handle` *signal act*	specify GDB actions for *signal*:
`print`	announce signal
`noprint`	be silent for signal
`stop`	halt execution on signal
`nostop`	do not halt execution
`pass`	allow your program to handle signal
`nopass`	do not allow your program to see signal
`info signals`	show table of signals, GDB action for each

- **handle SIGPIPE nostop print**

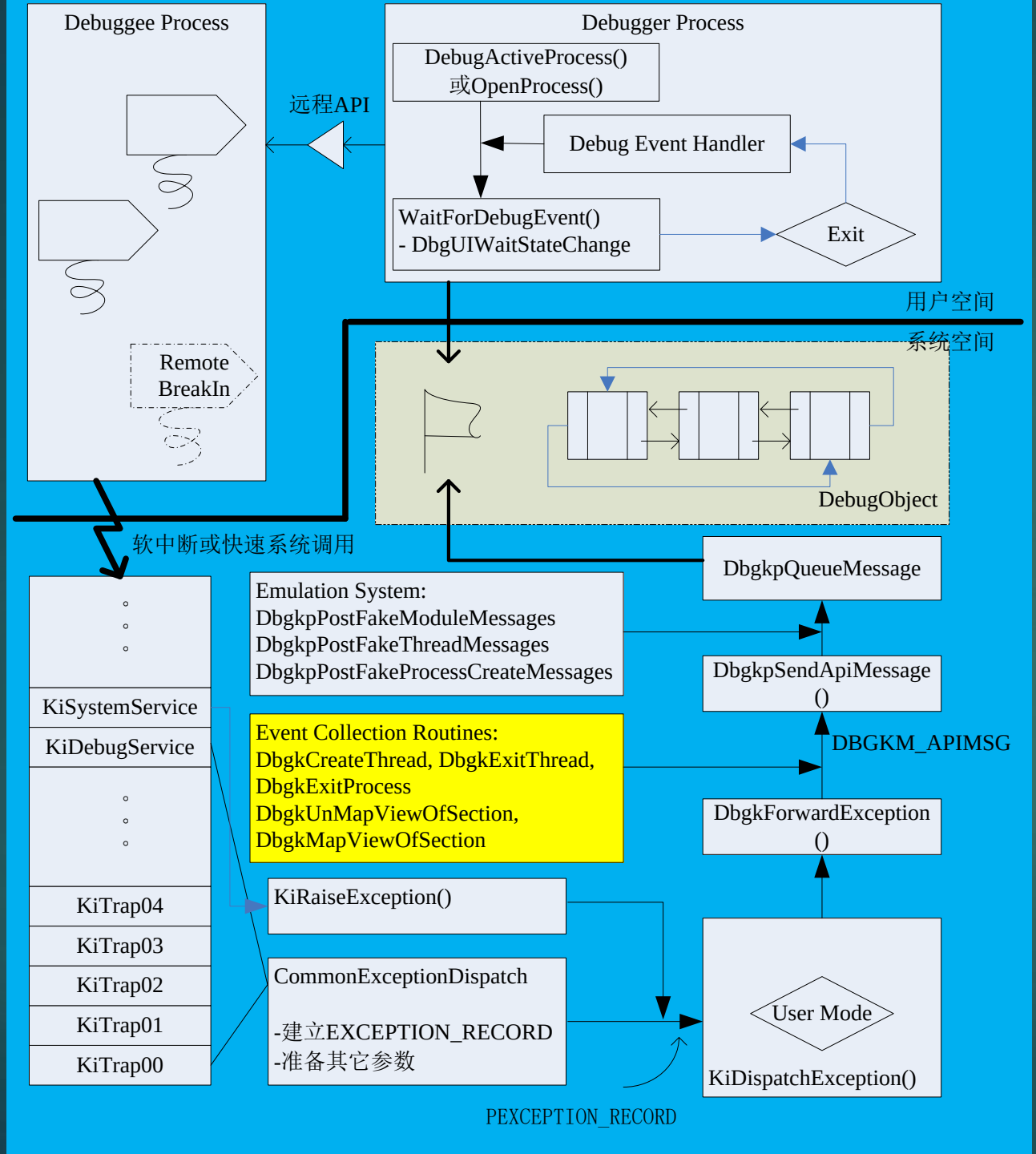
```
(gdb) handle SIGPIPE
Signal        Stop      Print   Pass to program Description
SIGPIPE       No        Yes     Yes             Broken pipe
```

Backbone of a Debugger

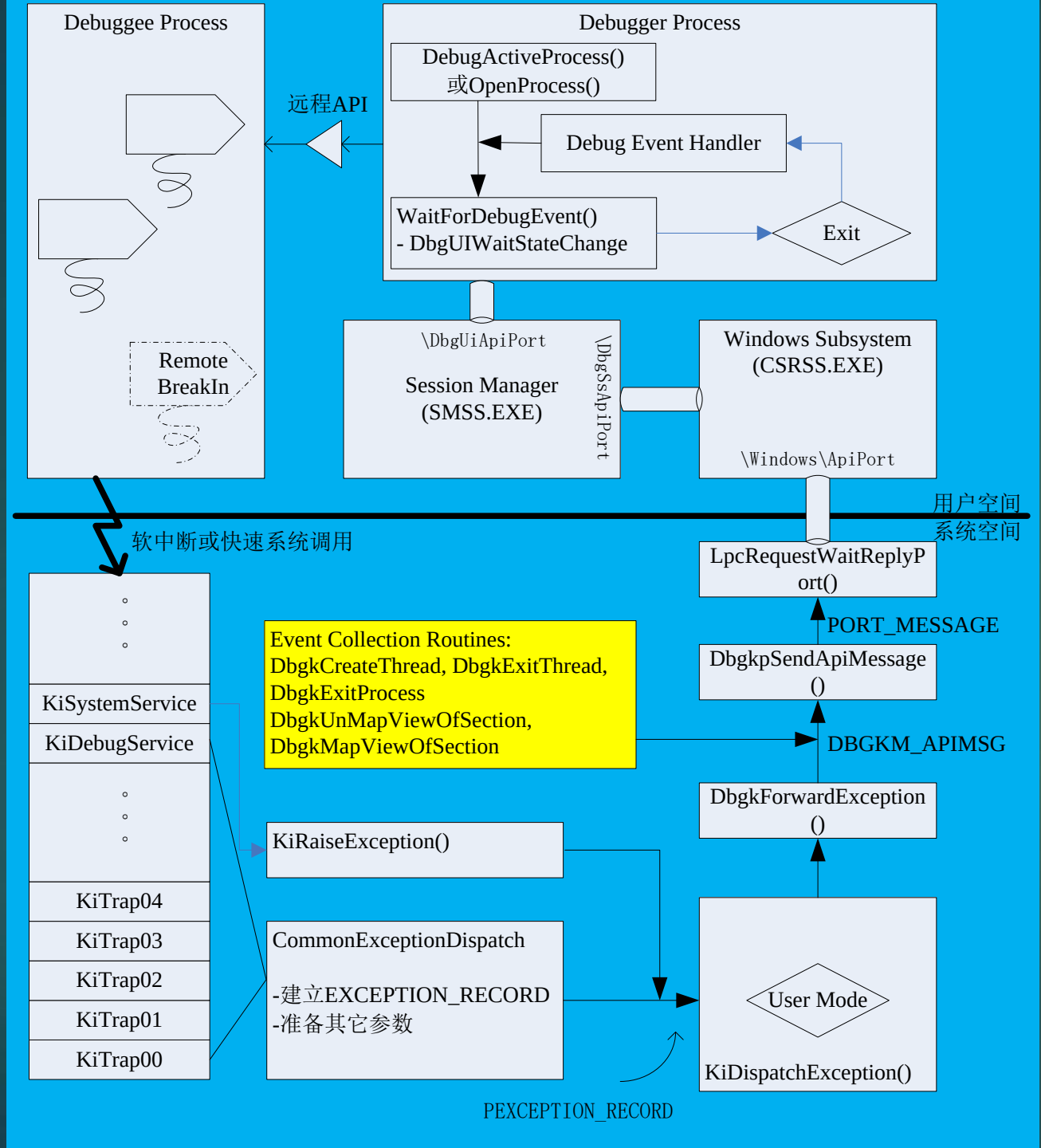
```
if(bNewProcess)
        CreateProcess ( ..., DEBUG_PROCESS ,... );
else
        DebugActiveProcess(dwPID)
while ( 1 == WaitForDebugEvent (&DbgEvt, INFINITE) )
{
         switch (DbgEvt.dwDebugEventCode)
        {
         case EXIT_PROCESS_DEBUG_EVENT:
            break;
         //other cases
        }
        ContinueDebugEvent ( ... ) ;
}
```

WaitForDebugEvent

```
BOOL WaitForDebugEvent(
  LPDEBUG_EVENT lpDebugEvent,
  DWORD dwMilliseconds);
typedef struct _DEBUG_EVENT {
    DWORD dwDebugEventCode;
    DWORD dwProcessId;
    DWORD dwThreadId;
    union {
      EXCEPTION_DEBUG_INFO Exception;
      CREATE_THREAD_DEBUG_INFO CreateThread;
      CREATE_PROCESS_DEBUG_INFO CreateProcessInfo;
      EXIT_THREAD_DEBUG_INFO ExitThread;
       EXIT_PROCESS_DEBUG_INFO ExitProcess;
      LOAD_DLL_DEBUG_INFO LoadDll;
       UNLOAD_DLL_DEBUG_INFO UnloadDll;
       OUTPUT_DEBUG_STRING_INFO DebugString;
       RIP_INFO RipInfo; } u;
    } DEBUG_EVENT, *LPDEBUG_EVENT;
```



- The model is used since Windows XP.
- All debug event will go through kernel to deliver to debugger
- Dbgk routines in kernel are the anchor points to collect debug messages



- Before Windows XP, debug message is managed by CSRSS (windows subsystem server process) and SMSS (Session Manager)
- The two models are compatible In API level. That's one debugger for Win2K still works for XP, vice versa.

调试事件

EXCEPTION_DEBUG_EVENT

CREATE_THREAD_DEBUG_EVENT

CREATE_PROCESS_DEBUG_EVENT

EXIT_THREAD_DEBUG_EVENT

EXIT_PROCESS_DEBUG_EVENT

LOAD_DLL_DEBUG_EVENT

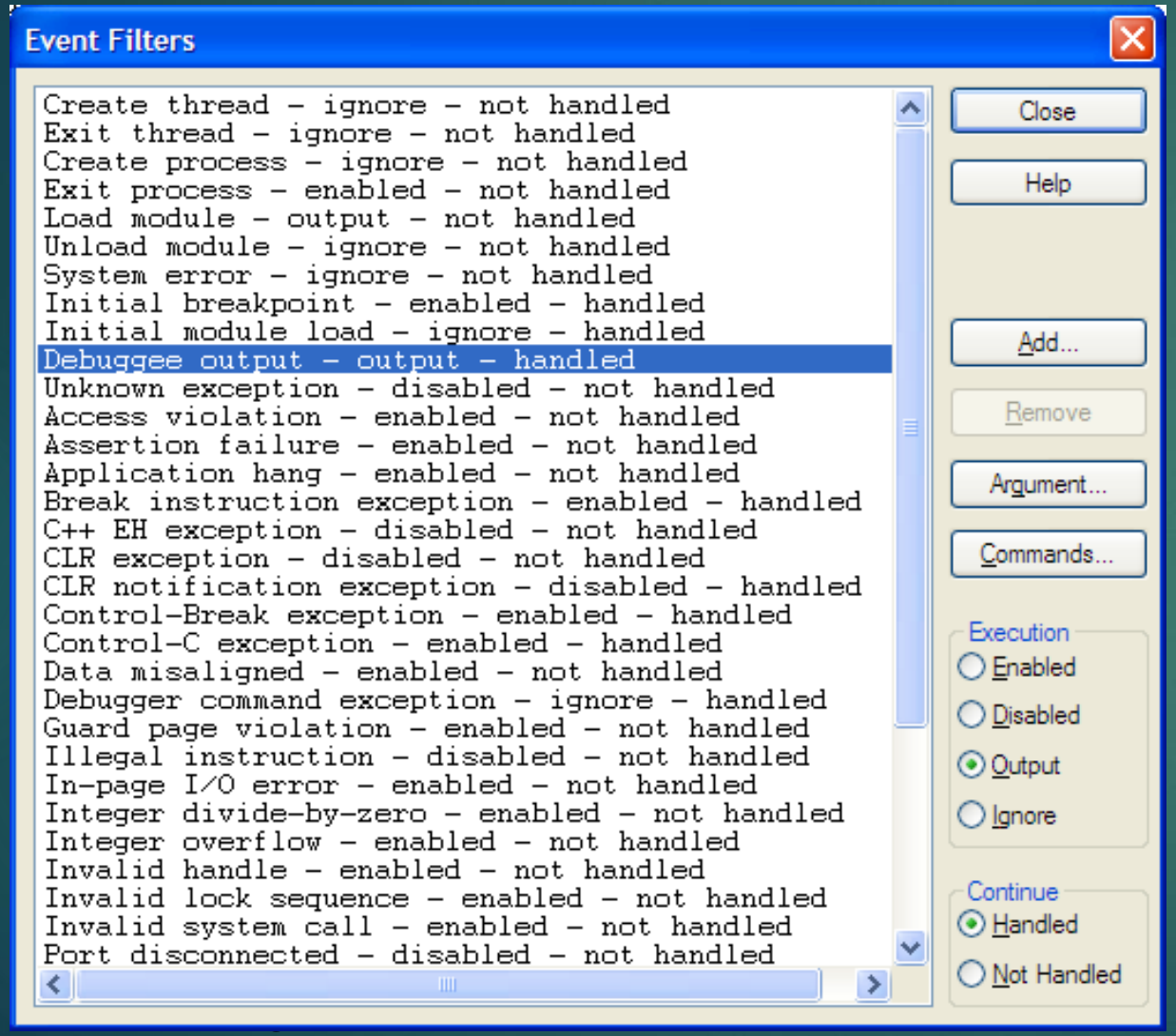
UNLOAD_DLL_DEBUG_EVENT

OUTPUT_DEBUG_STRING_EVENT

处理调试事件

- 对于不同的调试事件，调试器通常有可以配置的不同处理方法
- 对于异常，调试器会最多得到两轮处理机会
  - 第一轮机会
    - 默认不处理，返回DBG_EXCEPTION_NOT_HANDLED，让系统继续分发异常
  - 第二轮机会
    - 默认声明处理，返回DBG_CONTINUE，让系统返回到发生异常的位置继续执行

定制调试事件的处理方式(1/2)



- Debug > Event Filters
- 调试会话建立后才可使用
- 会保存到工作空间中

定制调试事件的处理方式(2/2)

Command	Status Name	Description
SXE or -xe	Break (Enabled)	第一次机会时就中断到调试器
SXD or -xd	Second chance break (Disabled)	第一次机会时不中断到调试器但是显示消息第二次机会时中断到调试器
SXN or -xn	Output (Notify)	不中断到调试器但是显示消息
SXI or -xi	Ignore	不中断到调试器，也不显示消息

加载SOS

- 不同版本的.Net运行时，需要不同版本的SOS
- 加载的最佳方法是使用.loadby命令
  - 如果不需调试进程启动早期的问题，那么可以在mscorwks加载后执行.loadby sos mscorwks
  - 如果需要调试进程启动早期的问题
    - sxe ld:mscorjit.dll &&告诉WinDBG在收到加载mscorjit模块的事件时中断下来
      - 或者sxe -c “” clrn，但是在某些环境下不工作
    - .loadby sos mscorwks
- 加载后，执行!help可看到一个命令清单

多线程调试

info threads

```
(gdb) info threads
  Id   Target Id         Frame
  3    Thread 0xb62b9b40 (LWP 2529) "dconf worker" 0xb76e4424 in __kernel_vsyscall ()
  2    Thread 0xb58ffb40 (LWP 2530) "gdbus" 0xb76e4424 in __kernel_vsyscall ()
* 1    Thread 0xb66a9840 (LWP 2523) "gnome-screensav" 0xb76e4424 in __kernel_vsyscall ()
```

*代表当前线程

切换线程

- thread thread-id

```
(gdb) bt
#0  0xb76e4424 in __kernel_vsyscall ()
#1  0xb6b66460 in poll () from /lib/i386-linux-gnu/libc.so.6
#2  0xb6dd0a3b in g_poll () from /lib/i386-linux-gnu/libglib-2.0.so.0
#3  0xb6dc306e in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#4  0xb6dc352b in g_main_loop_run () from /lib/i386-linux-gnu/libglib-2.0.so.0
#5  0xb72e5ff5 in gtk_main () from /usr/lib/i386-linux-gnu/libgtk-3.so.0
#6  0x0804eed7 in main ()
(gdb) thread 2
[Switching to thread 2 (Thread 0xb58ffb40 (LWP 2530))]
#0  0xb76e4424 in __kernel_vsyscall ()
(gdb) bt
#0  0xb76e4424 in __kernel_vsyscall ()
#1  0xb6b66460 in poll () from /lib/i386-linux-gnu/libc.so.6
#2  0xb6dd0a3b in g_poll () from /lib/i386-linux-gnu/libglib-2.0.so.0
#3  0xb6dc306e in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#4  0xb6dc352b in g_main_loop_run () from /lib/i386-linux-gnu/libglib-2.0.so.0
#5  0xb705f4aa in ?? () from /usr/lib/i386-linux-gnu/libgio-2.0.so.0
#6  0xb6de6673 in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#7  0xb764dd4c in start_thread () from /lib/i386-linux-gnu/libpthread.so.0
#8  0xb6b74bae in clone () from /lib/i386-linux-gnu/libc.so.6
```

对多个线程执行命令

- thread apply [thread-id-list | all [-ascending]] command

```
(gdb) thread apply all bt

Thread 3 (Thread 0xb62b9b40 (LWP 2529)):
#0  0xb76e4424 in __kernel_vsyscall ()
#1  0xb6b66460 in poll () from /lib/i386-linux-gnu/libc.so.6
#2  0xb6dd0a3b in g_poll () from /lib/i386-linux-gnu/libglib-2.0.so.0
#3  0xb6dc306e in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#4  0xb6dc352b in g_main_loop_run () from /lib/i386-linux-gnu/libglib-2.0.so.0
#5  0xb76db134 in ?? ()
   from /usr/lib/i386-linux-gnu/gio/modules/libdconfsettings.so
#6  0xb6de6673 in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#7  0xb764dd4c in start_thread () from /lib/i386-linux-gnu/libpthread.so.0
#8  0xb6b74bae in clone () from /lib/i386-linux-gnu/libc.so.6

Thread 2 (Thread 0xb58ffb40 (LWP 2530)):
#0  0xb76e4424 in __kernel_vsyscall ()
#1  0xb6b66460 in poll () from /lib/i386-linux-gnu/libc.so.6
#2  0xb6dd0a3b in g_poll () from /lib/i386-linux-gnu/libglib-2.0.so.0
#3  0xb6dc306e in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#4  0xb6dc352b in g_main_loop_run () from /lib/i386-linux-gnu/libglib-2.0.so.0
#5  0xb705f4aa in ?? () from /usr/lib/i386-linux-gnu/libgio-2.0.so.0
#6  0xb6de6673 in ?? () from /lib/i386-linux-gnu/libglib-2.0.so.0
#7  0xb764dd4c in start_thread () from /lib/i386-linux-gnu/libpthread.so.0
#8  0xb6b74bae in clone () from /lib/i386-linux-gnu/libc.so.6

Thread 1 (Thread 0xb66a9840 (LWP 2523)):
#0  0xb76e4424 in __kernel_vsyscall ()
```

命名

- thread name [name]

```
(gdb) info threads
  Id   Target Id         Frame
  3    Thread 0xb62b9b40 (LWP 2529) "dconf worker" 0xb76e4424 in __kernel_vsyscall ()
* 2    Thread 0xb58ffb40 (LWP 2530) "gui" 0xb76e4424 in __kernel_vsyscall ()
  1    Thread 0xb66a9840 (LWP 2523) "gnome-screensav" 0xb76e4424 in __kernel_vsyscall ()
```

WinDBG中控制进程和线程

- |显示进程信息，|s设置当前进程
- ~显示线程信息，~s设置当前线程
- 控制线程
  - ~n 挂起，~m恢复挂起，改变线程的挂起计数，相当于调用SuspendThread和ResumeThread API
  - ~f冻结，~u解冻，调试子系统的控制，脱离调试时会自动解冻
- 针对线程执行命令
  - ~* k
  - ~*e !gle 依次显示所有线程的Last Error
  - ~*e ？ $tid;.ttime

命令文件

- https://sourceware.org/gdb/onlinedocs/gdb/Command-Files.html

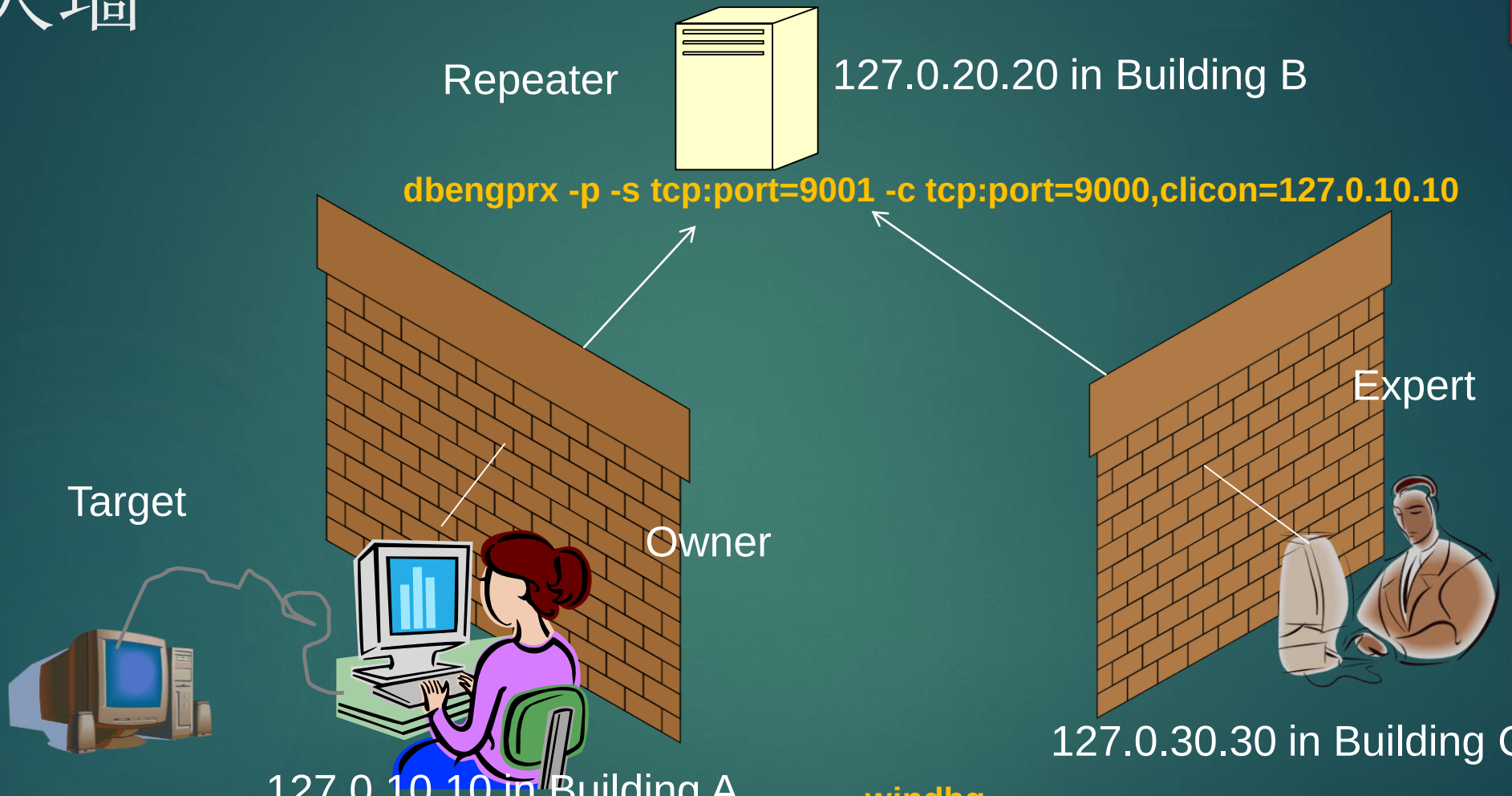
远程调试

- 调试器与被调试程序位于两台不同的机器上，通过网络连接通信
- 应用：
  - 调试全屏程序
  - 调试OnPaint方法或者其它GDI功能
  - 调试客户机器上才发生的问题
  - 多方共同调试一个问题

使用WinDBG远程调试

- 多种方案
  - 使用remote.exe (remote /c客户端，remote /s 服务器)
  - 使用服务进程（DBGSRV.EXE或KDSRV.EXE）
  - 使用调试器
- 使用调试器作为服务器
  - **服务器, WinDBG, CDB, KD, NTSD均可**
    - **cdb -server tcp:port=1025 -p 122**
  - 客户端, **WinDBG, CDB, KD均可**
    - **windbg -remote tcp:server=BOX17,port=1025**

防火墙



kdsrv -t tcp:port=9000,clicon=127.0.20.20,password=longjump
(用户态使用DbgSrv)

windbg -k kdsrv:server=@{tcp:server=127.0.20.20,port=9001,password=longjump},trans=@{1394:channel=9} -y *SymbolPath*

“Thinkers are a dime a dozen. Anyone can think and profess great ideas. Doers are more valuable because they do things and get things done. The most valuable, however, are the thinker doers. They think and they do!”

“So my advice is be a thinker doer.”

切问而近思

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Q&A

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