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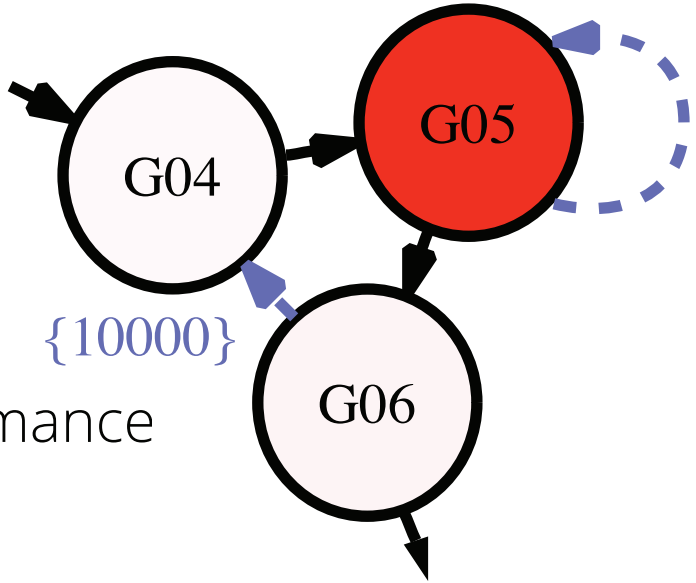

OpenPAT | The Open Performance Analysis Toolkit

Analysing Programs the Easy Way

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What is OpenPAT?

- A Toolkit to Analyse Programs to Identify:
  - Hotspot and Performance Bottlenecks
  - Dynamic Execution Trace Information
  - Code Structure
- How can this Help Me?
  - Increase Performance on Existing Hardware
  - Quantify Performance Potentials for New Approaches
  - Understand and Verify Large Programs

OpenPAT Advantage

Approach	SUIF [3]	GILK [4]	Valgrind [5]	Pin [6]	OpenPAT [1,2]
Instrumentation	Static	Dynamic	Dynamic	Dynamic	Static
Analysis	Static	Dynamic	Dynamic	Dynamic	Dynamic
Target	Source	Binary	Binary	Binary	Assembly

The OpenPAT Approach Compared with other Toolkits

Contribution	SUIF [3]	GILK [4]	Valgrind [5]	Pin [6]	OpenPAT [1,2]
Efficient	✔	✗	✗	✗	✔
Accurate	✗	✔	✔	✔	✔
Simple	✗	✗	✗	✗	✔

The Contribution for Users of Each Approach Dimension

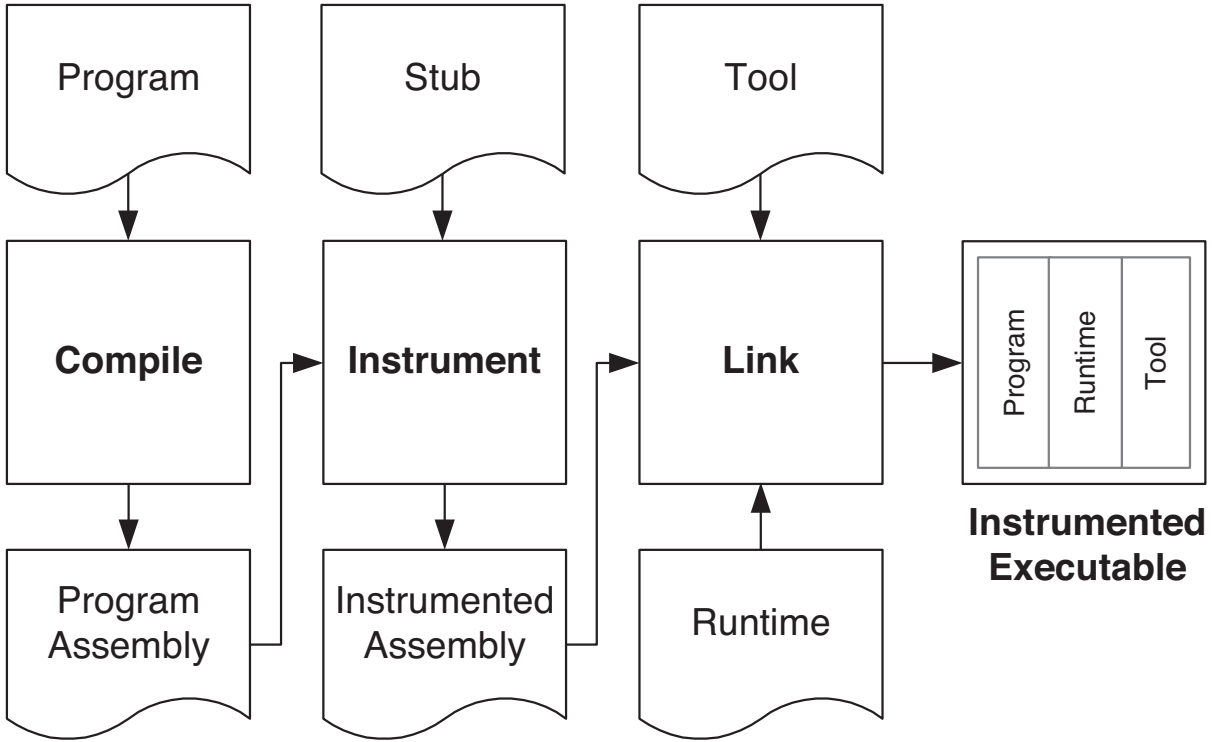
[1] S. Spacey, 3S: Program Characterisation, Imperial Tech. Paper (2006).
[2] S. Spacey, 3S Quick Start Guide, Imperial Tech. Manual (2009).
[3] G. Aigner et al., An Overview of the SUIF2 Compiler Infrastructure (2000).
[4] D.J. Pearce et al., GILK: A Dynamic Instrumentation Tool (2002).
[5] N. Nethercote et al., Valgrind: A Program Supervision Framework (2003).
[6] C. Luk et al., Pin: Building Customized Program Analysis Tools with Dyn. Instr. (2005).

OpenPAT Key Features

Feature	v0	v1	v2	v3
	3S (04/06 – 05/06)			OpenPAT
Block Traces	✔	✔	✔	✔
Block Tools		✔	✔	✔
CPU Timestamp Timings		✔	✔	✔
Instruction Level DFG Tools (Integer)			✔	✔
Instruction Level DFG Tools (x87 FPU)				✔
Static Memory Instrumentation				✔
Assembly Aspect-Oriented Programming				✔
Ranged Instrumentations				✔
Granularity and Threading Features				✔
Retargetable (CPU, OS, Language, Compiler)				✔
Community Tool Support & Site				✔
Main Toolkit Languages		Python/C		Perl/C

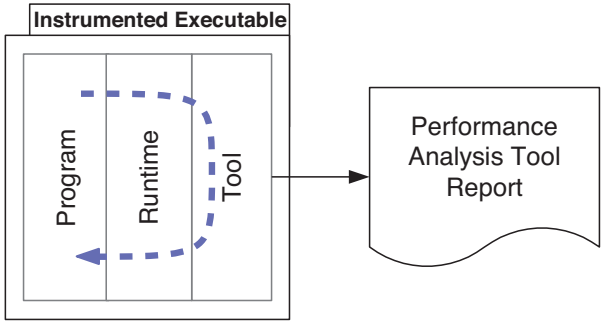
OpenPAT Version History and Key Features

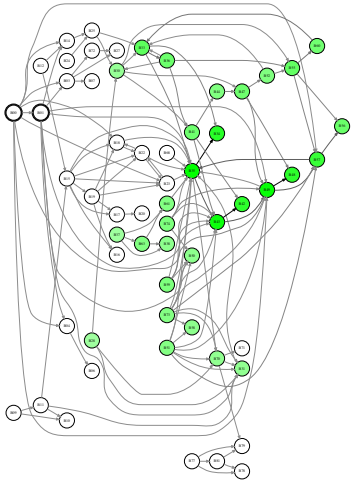
OpenPAT Approach

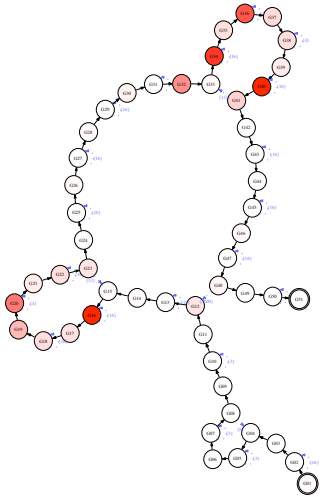


The OpenPAT Static Instrumentation and Dynamic Analysis Approach

OpenPAT Tools







```
#### OPEN PERFORMANCE ANALYSIS TOOLKIT
(OpenPAT) REGEX 2.9.1 REPORT FOR RUN
STARTED Thu Jan 24 00:16:58 2013
B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13
B14 (B15 (B16 B17 B18 B19 B20 B21 B22 B23
B24 (B25){12} B26 B27){100} B28){24} B15
(B16 B17 B18 B19 B20 B21 B22 B23 B24 (B25)
{12} B26 B27){90} B16 B17 B18 B19 B20 B21
B22 B23 B24 (B25){11} (B26 B27 B16 B17 B18
B19 B20 B21 B22 B23 B24 (B25){12} (B26 B27
B28 B15 (B16 B17 B18 B19 B20 B21 B22 B23
B24 (B25){12} B26 B27){100} B28){75} ){9}
B29 B30

* The above regular expression is written
in compressed x format with {}
representing loop counts.

#### SYMBOL TABLE
B1,main.0.0.0,15
B2,main.0.1.0,6
B3,main.0.1.call sscanf,1
B4,main.0.2.0,2
B5,main.L4.0.0,3
B6,main.L4.0.call printf,1
B7,main.L4.1.0,6
B8,main.L4.1.call calloc,1
B9,main.L4.2.0,3
B10,main.L4.2.call calloc,1
B11,main.L4.3.0,3
...
B22,main.L41.0.0,8
B23,main.L40.0.0,10
B24,main.L40.1.0,0
B25,main.L8.0.0,58
B26,main.L8.1.0,0
B27,main.L39.0.0,5
B28,main.L39.1.0,4
B29,main.L39.2.0,0
B30,main.L5.0.0,1
B31,main.L5.0.call exit,1
```

Example Tools
trace
hotspot
memory
dfg
cfg
ilp
regex
loopgraph_d
profile
cache_flow
override
simulator

Selected Tools

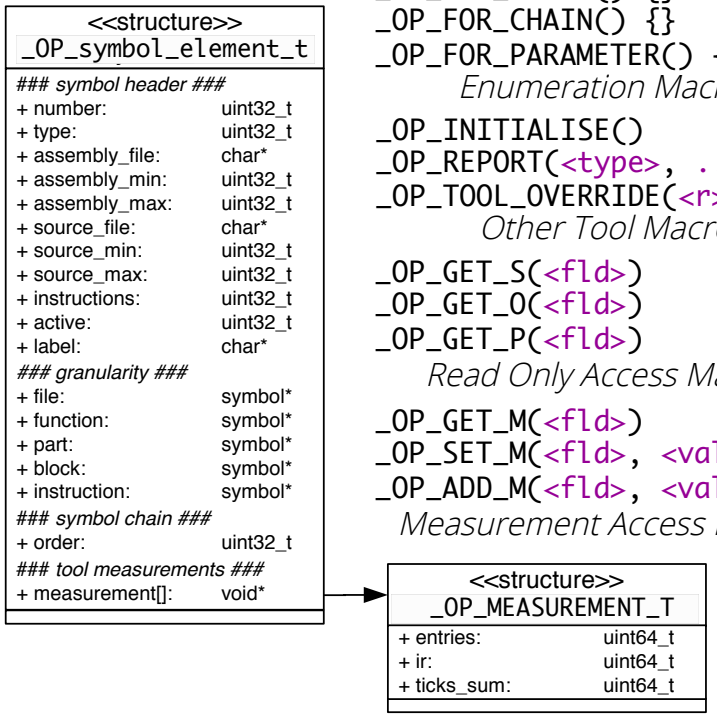
OpenPAT Tool Infrastructure

```
#define _OP_STUB        symbols_ticks
#include "../../../../_/runtime/OpenPAT.h"

typedef struct {} _OP_MEASUREMENT_T;

/* Called once before the main program starts */
void _OP_TOOL_INITIALISE(void) {}

/* Called with _OP set as code sections run */
void _OP_TOOL_ANALYSE(_OP_t *_OP) {}

/* Called once after main program exits */
void _OP_TOOL_REPORT(void) {}
```

A Runnable OpenPAT Tool

```
typedef struct {
  _OP_thread_id_t          thread_id;
  _OP_symbol_element_t*    last_symbol;
  _OP_symbol_element_t*    next_symbol;
  _OP_ticks_t              last_start;
  _OP_ticks_t              last_end;
  _OP_parameter_t          last_parameters[];
} _OP_t;
```

Analysis Information Supplied by Runtime/Stubs



OpenPAT Symbol Table and Measurement Structures

```
_OP_FOR_TABLE() {}
_OP_FOR_CHAIN() {}
_OP_FOR_PARAMETER() {}
```

Enumeration Macros

```
_OP_INITIALISE()
_OP_REPORT(<type>, ...)
_OP_TOOL_OVERRIDE(<r>, <fn>)
```

Other Tool Macros

```
_OP_GET_S(<fld>)
_OP_GET_O(<fld>)
_OP_GET_P(<fld>)
```

Read Only Access Macros

```
_OP_GET_M(<fld>)
_OP_SET_M(<fld>, <val>)
_OP_ADD_M(<fld>, <val>)
```

Measurement Access Macros

OpenPAT Summary

- The Open Performance Analysis Toolkit (OpenPAT)
  - Provides: Hotspot, Trace and Structural Information
  - Useful For: Performance Optimisation, Solution Evaluation and QA
- The OpenPAT Approach is:
  - Efficient: Statically Instruments Programs
  - Accurate: Dynamically Analyses Exact Program Execution Traces
  - Simple: Leaves (De-)Compilation to (De-)Compilers
- OpenPAT has Lots of Unique Features and Tools

More Information

[1] S. Spacey, 3S: Program Characterisation Framework, Imperial Tech. Paper (2006).

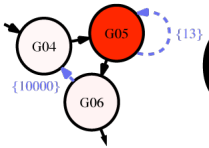
[2] S. Spacey, 3S Quick Start Guide, Imperial Tech. Manual (2009).

[3] G. Aigner, A. Diwan, D. Heine, M. Lam, D. Moore, B. Murphy, C. Sapuntzakis, An Overview of the SUIF2 Compiler Infrastructure. Stanford Tech. Paper (2000).

[4] D.J. Pearce, P.H.J. Kelly, T. Field, U. Harder, GILK: A Dynamic Instrumentation Tool for the Linux Kernel. Proceedings of the 12th International Conference on Computer Performance Evaluation, Modelling Techniques and Tools 37, pp. 220–226 (2002).

[5] N. Nethercote, J. Seward, Valgrind: A Program Supervision Framework. Electronic Notes in Theoretical Computer Science, 89(2) pp. 44-66 (2003).

[6] C-K. Luk, R. Cohn, R. Muth, H. Patil, A. Klauser, G. Lowney, S. Wallace, V.J. Reddi, K. Hazelwood, Pin: Building Customized Program Analysis Tools with Dynamic Instrumentation. Proceedings of the 2005 ACM SIGPLAN Conference on Programming Language Design and Implementation, pp. 190-200 (2005).



OpenPAT.org