LA-UR-15-27034

Title: Byfl: Hardware-Independent Application Characterization

Author(s):   Pakin, Scott D.

Intended for: Innovation to Go

Issued: 2015-09-09

Byfl

Los Alamos NATIONAL LABORATORY — EST.1943 —

Hardware-Independent Application Characterization

BACKGROUND & MOTIVATION

Current software performance tools can say only how well an application runs on *today's* hardware

- Will your application run well on emerging architectures?

- What are the performance bottlenecks likely to be?

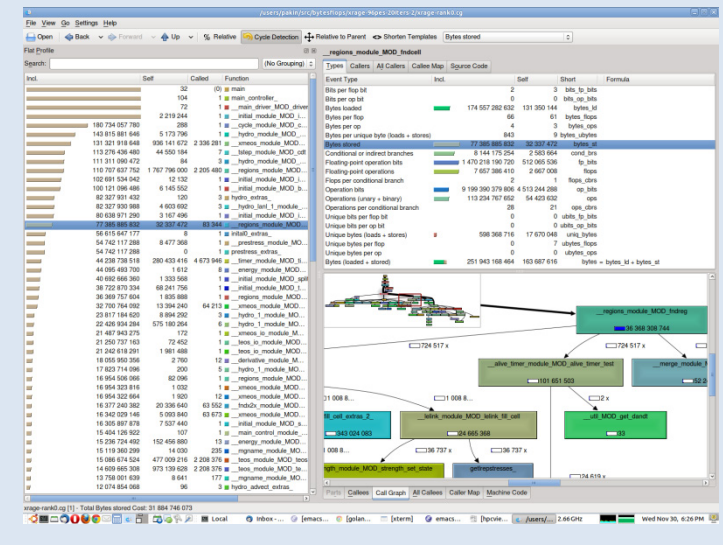App → Future CPU → **?**

INNOVATION

Identifying *fundamental* application characteristics, as separate from performance artifacts, can lead to invaluable insight

- Trends in emerging architectures are becoming apparent

- For example, high arithmetic intensity, substantial operation independence, minimal control logic, and small working-set sizes are likely to be fast

- Can we automatically identify where an application does and does not exhibit those features?

DESCRIPTION
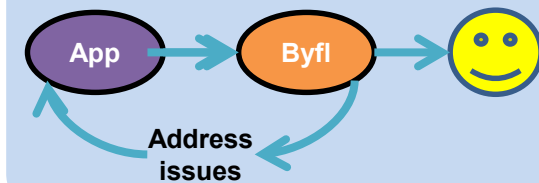
"Software performance counters"

- Analogous to hardware performance counters

- Not limited to counters provided by the hardware and not limited to scalar counters (e.g., some data is collected in histograms)

- Instrument application at compile time but gather and report data at run time

- Tool sees compiler's abstract view of execution and canonical hardware model but has access to run-time data dependencies

TRL 4. Component Prototypes Tested in a Controlled Environment
Byfl has been tested on a few large applications

ANTICIPATED IMPACT

Application readiness for exascale computing

- Determine which functions will need rethinking to exploit CPUs with high data parallelism but small per-core caches

App → Byfl → ☺
Address issues

PATH FORWARD

New features

- Based on feedback from initial users as to questions they'd like Byfl to answer

- Branch divergence, strided data accesses, branch predictability

- Run-time speed improvements

Potential end users

- Computational scientists

- Code performance specialists

Point of Contact: Scott Pakin, Computer, Computational, and Statistical Sciences Division, 505-667-5568, pakin@lanl.gov

Metadata

Byfl

Los Alamos NATIONAL LABORATORY — EST.1943 —

CONTACT INFORMATION

Please list the following contacts for the penta chart.

PI: Scott Pakin

Co PI(s):

Responsible Group: CCS-7

Division POC: Scott Pakin

Note: The Division recommended POC will be listed as the POC on the penta chart.

DISTRIBUTION RESTRICTIONS

Please select any known unclassified sensitive information that may be contained in your penta chart. If there are no sensitivities select "None" and recommend your penta chart receive an LAUR number.

Official Use Only (OUO) – Statutory

___ Export Controlled (ECI)

___ ECI – International Traffic and Arms Regulations (ITAR)

___ CRADA Protected Information

___ Company Proprietary

Official Use Only (OUO) - Discretionary

___ Program/Sponsor Sensitive

LANS Proprietary Information (LPI)

___ Patent Sensitive

___ Competition/Proposal Sensitive

___ Procurement/Technology Transfer

None

Penta chart does not contain any sensitive unclassified information and should be released for public distribution (LAUR)

Note: If your penta chart contains unclassified sensitive information please make sure it is marked appropriately.

If your penta chart contains OUO information, please use the appropriate OUO template (including cover sheet).

*Penta charts **cannot contain UCNI or classified information***

SPONSOR INFORMATION

Current Sponsor(s):
Please select current sponsors that are funding development of the technology/capability described in your penta chart.

___ ARPA-E	___ DTRA
___ CDC	___ EPA
___ DARPA	___ Industry
___ DHS	___ LDRD
___ DOD	___ NASA
___ DOE/EERE	___ NIH
___ DOE/EPSCoR	___ NSF
___ DOE/FE	___ ONR
___ DOE/NE	___ University
_X_ DOE/OSC	___ USDA
_X_ DOE – Other	___ Other
___ DoS	

Previous Sponsor(s):
Please select previous sponsors that have funded development of the technology/capability described in your penta chart.

___ ARPA-E	___ DTRA
___ CDC	___ EPA
___ DARPA	___ Industry
___ DHS	_X_ LDRD
___ DOD	___ NASA
___ DOE/EERE	___ NIH
___ DOE/EPSCoR	___ NSF
___ DOE/FE	___ ONR
___ DOE/NE	___ University
___ DOE/OSC	___ USDA
___ DOE – Other	___ Other
___ DoS	

Do NOT specify a specific sponsor if doing so will make this slide deck classified.

LDRD FUNDING

Please specify if the technology/capability described in your penta chart was the result of LDRD funding.

Resulted from LDRD Funded: Yes / **No**

If "Yes", under which LDRD project(s) was the technology/capability developed?

LDRD Project Number:

LDRD Project Name:

If "No" please delete the LDRD logo before submitting your penta chart

Metadata

Byfl

Los Alamos NATIONAL LABORATORY —EST.1943—

CAPABILITY AREAS

Please select the most relevant LANL capability area(s) for the technology/capability described in your penta chart. *(Select a maximum of 4)*

- ____ Accelerators and Electrodynamics
- ____ Astrophysics and Cosmology
- ____ Biosciences
- ____ Chemical Science
- ____ Computational Physics and Applied Math
- _X_ Computer and Computational Sciences
- ____ Earth and Space Sciences
- ____ Engineering
- ____ High-Energy Density Plasmas and Fluids
- ____ Information Science and Technology
- ____ Materials
- ____ Nuclear and Particle Physics
- ____ Nuclear Engineering and Technology
- ____ Science of Signatures - In Situ Measurements
- ____ Science of Signatures - Remote and Standoff Sensing

APPLICATION SPACE

Please select the most relevant application space(s) for the technology/capability described in your penta chart. *(Select a maximum of 4)*

- ____ Advanced Manufacturing
- ____ Aerospace
- ____ Automotive & Transportation
- ____ Bio/Medical
- ____ Climate & Meteorology
- ____ Communications
- ____ Energy – Non Nuclear
- ____ Energy – Nuclear
- ____ Engineering, Electronics & Instrumentation
- ____ Explosives & Explosives Detection
- ____ Forensics
- _X_ Information Technology
- ____ Infrastructure & Infrastructure Systems
- ____ Large Data to Decision
- ____ National Security (DoD, DHS, etc.)
- ____ Persistent Surveillance
- ____ Sensors & Sensor Technology
- ____ Space & Astronomy
- ____ Warfighter Support
- ____ Other

LANL PROGRAM OFFICE(S)

Primary LANL Program Office:
Please select the (one) most appropriate LANL Program Office for representing the technology/capability described in your penta chart.

Global Security (GS):

- ____ Emerging Threats (GS-ET)
- ____ Feynman Center for Innovation (FCI) – Industry/Non-Federal
- ____ FCI – Other Federal Government (DHHS, NIH, Commerce)
- ____ Intelligence Defense & Counterterrorism (GS-IDC)
- ____ Nuclear Nonproliferation and Security (GS-NNS)

Science, Technology & Engineering:

- ____ Advanced Computing Solutions Program Office (ACS-PO)
- ____ National Security Education Center (NSEC)
  - Science & Energy Program Office (SPO):
    - ____ Applied Energy (SPO-AE)
    - ____ Civilian Nuclear Program (SPO-CNP)
    - ____ Office of Science (SPO-SC)

Other Programs:

- _X_ Advanced Simulation & Computing Program (ASC)
- ____ Joint Munitions Program (JMP)
- ____ Other

Affiliate LANL Program Office(s):
Please select other appropriate LANL Program Offices for representing the technology/capability described in your penta chart. *(Select a maximum of 3)*

Global Security (GS):

- ____ Emerging Threats (GS-ET)
- ____ Feynman Center for Innovation (FCI) – Industry/Non-Federal
- ____ FCI – Other Federal Government (DHHS, NIH, Commerce)
- ____ Intelligence Defense & Counterterrorism (GS-IDC)
- ____ Nuclear Nonproliferation and Security (GS-NNS)

Science, Technology & Engineering:

- ____ Advanced Computing Solutions Program Office (ACS-PO)
- ____ National Security Education Center (NSEC)
  - Science & Energy Program Office (SPO):
    - ____ Applied Energy (SPO-AE)
    - ____ Civilian Nuclear Program (SPO-CNP)
    - _X_ Office of Science (SPO-SC)

Other Programs:

- ____ Advanced Simulation & Computing Program (ASC)
- ____ Joint Munitions Program (JMP)
- ____ Other

Metadata

Byfl

KEY WORDS

Please list keywords that will help people search for your penta chart.

Key Words:

performance analysis tools, high performance computing, exascale, application code optimization

RELEVANT LANL SCIENCE PILLARS

Please identify if the technology/capability described in your penta chart is relevant to any of the LANL Science Pillars.

——— Materials for the Future

_X_ Information Science & Technology for Prediction

— Nuclear and Particle Futures

——— Science of Signatures

———

NOTES

Please provide notes for any additional guidance LANL staff should know prior to distributing or presenting this penta chart. Include notes regarding previous interactions with sponsors and feedback previous sponsors have provided.

Notes/Distribution Guidance: