A Genetic Algorithm to Improve Linux Kernel Performance on Resource-Constrained Devices

James T. Kukunas, Robert D. Cupper, and Gregory M. Kapfhammer

Department of Computer Science
Allegheny College, Pennsylvania, USA

Late Breaking Abstracts
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What is a Resource-Constrained Device?

A Resource-Constrained Device Is . . .

- Any Device In Which Resources Are *Intentionally* Constrained

James Kukunas <jkukunas@acm.org>

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Why Do We Intentionally Constrain Resources?

The Goal of This Research is to...

- Achieve BMW Performance With A Honda Motor While Keeping Honda Benefits

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Intel Atom Specifics: In-Order Execution

Out-of-Order Instruction Execution

- Hardware Dynamically Reorders Instructions to Reduce Dependency Stalls in the Pipeline
Intel Atom Specifics: In-Order Execution

In-Order Instruction Execution

Pipeline Sensitive to Dependency Stalls

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Pipeline Modeling . . .
- At Compile-Time Reduces Dependency Stalls

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Intel Atom Specifics: Power-Aware Cache

At Higher Processor Power States . . .

- All Caches Blocks are Enabled

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Intel Atom Specifics: Power-Aware Cache

At Lower Processor Power States . . .

- Cache Blocks are Disabled to Conserve Power
What is the Linux Kernel?

Hardware

CPU  Mem  Disk  Peripherals

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What is the Linux Kernel?

System Layout

User Space

Applications

System Calls

Kernel Space

I/O  Mem. Mgmt  Proc. Mgmt

Interrupts

Hardware

CPU  Mem  Disk  Peripherals

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Allegheny College
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Precise Fitness Metric

System Calls with Counts > 26

- open
- stat64
- mmap2
- close
- fstat64
- getxattr
- read

Fitness Metric

- System Calls Model User/Kernel Space Interaction

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Precise Fitness Metric

Only 10% of System Calls had Non-Zero Counts

System Calls with Counts > 26

System Calls
- open
- stat64
- mmap2
- close
- fstat64
- getxattr
- read

System Call Counts (#)
50 100 150 200

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Initialization: Individual Represents Enabled Compiler Options
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Genetic Algorithm

- **Initialization**
- **Fitness Operator**
- **Selection and Crossover Operators**

- **Bottom 25% Discarded**
- **Top 75% Reproduce Enough to Replace Bottom 25%**

- **Selection Operator**: Enforces Strong Elitism

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Genetic Algorithm

- Initialization
- Fitness Operator
- Selection and Crossover Operators
- Mutation Operator

1% Chance of a Bit Flip

- Mutation Operator: Too Much Mutation Masks Evolution

James Kukunas <jkkukunas@acm.org>
Allegheny College

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Termination Condition: Predefined Generation Count

James Kukunas <jkukunas@acm.org>
Allegheny College
Results Analysis

Results Analysis Technique

- Phoronix Test Suite
- Suite to emulate netbook workload
  - SQLLite
  - GnuPG
  - Ogg
  - CRay
  - SciMark
  - 7Zip
  - GTKPerf
GTK Results

The Fastest Evolved Kernel . . .

- is About 20 Seconds Faster
SQLLLite

The Fasted Evolved Kernel ... is About 140 Seconds Faster

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Conclusions and Future Work

Conclusions

- Evolved Kernels Outperformed Stock Fedora Kernel
- Genetic Algorithm Excels at Finding Correlations Between Optimizations

Future Work

- More Platforms
- More Compilers
- More GA Options
Conclusions and Future Work

More Information at ...

- Jim Kukunas <jkukunas@acm.org>
- http://member.acm.org/~treak007