THE EMBEDDED JAVA BENCHMARK SUITE

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OUTLINE

- Benchmark targets and related work
- Benchmark categories
- Some numbers
- Open questions
- Summary

BENCHMARK TARGETS

- Real applications
- WCET analyzable
- Embedded Java (J2ME)
  - CLDC 1.1 library - tested with Sun Squawk
  - SCJ JDK subset
- Multi-processor scaling measurements

Related work

- CaffeinMark
  - Kernel benchmarks
- CDx
  - RTSJ, single periodic thread
- PapaBench
  - Will be presented tomorrow

General properties

- Big variation of embedded systems performance
- Runtime should be reasonable
- Self adapting
  - Increase iterations till one second elapsed
  - Result is iterations per second

CATEGORIES

- Micro benchmarks
- Kernels
- Applications
- Multithreaded

MICRO BENCHMAKRS

- Measure single / two bytecodes
- Useful for Java processors and interpreting JVMs
- Two measurement loops
  - Subtract overhead loop

Micro Measurement

```
/*
   14:  iload_2
   15:  iload_3
   16:  iadd
   17:  iload_3
   18:  iadd
   19:  istore_2
*/
public int perform(int cnt) {

   int a = 0;
   int b = 123;
   int i;

   for (i=0; i<cnt; ++i) {
      a = a+b+b;
   }
   return a;
}
```

```
/*
   14:  iload_2
   15:  iload_3
   16:  iadd


   17:  istore_2
*/
public int overhead(int cnt) {

   int a = 0;
   int b = 123;
   int i;

   for (i=0; i<cnt; ++i) {
      a = a+b;
   }
   return a;
}
```

Applications

- Embedded Java applications in industrial use
- Kfl, Lift, UdpIp
- WCET analyzable
- Developed for JOP
- Looking for more *external* applications

WCET ANALYSIS

- Provide loop bounds
- Use only analyzable libraries
  - No hash tables,....
- Application benchmarks are analyzable
  - Used to test WCET tools

APPLICATION RESULTS

Benchmark	Squawk/MacBook 2.5 GHz	picoJava II 40 MHz	JOP 100 MHz
Kfl	121814	23322	24058
Lift	149114	25244	24308
UdpIp	61478	11736	10144

Multithreaded

- Embedded Java goes CMP
  - Hope for more performance
- Scaling tests
  - Simple scaling examples (automatic scaling)
  - Pipeline application
- General multithreaded application missing

MT BENCHMARKS

- Guide CMP development
  - Memory subsystem (caching)
    - Memory controller
    - Locks
- Alternatives to locks - transactional memory

SPEEDUP EXAMPLE

- 8 vs. 1 JOP cores

Benchmark	Speedup
Matrix multiplication	6.5
NQueens	6.5
Raytrace (6 threads)	4.2
(Lift)	6.6

FUTURE WORK

- More applications
- SCJ wrappers
- Real-time measurements

Open Questions

- What are real-time benchmarks?
- Low-level interrupt latency, scheduling overhead?
- Reduce periods till deadline miss?
- Measure slack time and/or jitter?

SUMMARY

- Benchmarks for embedded Java
- Some real world applications
- Open-source at SF
- Wiki for collection of results