Presentation Goals

By the end of this workshop, you should know:
• Why benchmarks are important
• Benchmarking approaches
• Strengths and weaknesses of each approach
• Challenges of benchmarking
• Benchmark results for TI processors and selected competitors
**Why Do Benchmarks Matter?**

Assess key processor metrics accurately...
- Speed (*not* cycle counts!)
- Cost efficiency
- Energy efficiency (*not* power consumption!)
- Memory efficiency

...to determine the best processor

Use limited engineering resources effectively

Compare performance across a wide range of architectures, applications

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**Typical Application Decomposition**

**Applications**
- Portable audio player
- Wireless handset
- Video conf. system

**Application Components**
- OS
- Audio decoder
- Audio encoder
- Speech codec
- Video decoder
- Video encoder

**Algorithm Kernels**
- FIR
- FFT
- DCT
- VECADD

**Operations**
- Add
- Mult/MAC
- Shift
- Load
Flexibility vs. Accuracy

Application vs. Accuracy

Algorithm Kernel vs. Operation

Application Component vs. Flexibility

Flexibility vs. Accuracy

DSL Gateway

WiMAX

Base Station

Cable Head-end

Cable Head-end

Set-Top Box

Personal Video Recorder

Portable Video Player

Cellular Base Station

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What’s Wrong with MMACS?

MMACS approximates performance on some signal processing algorithms like FIR filters, but:

- It ignores other operations required to sustain repeated MACs
- It ignores memory bandwidth bottlenecks
- Many important signal processing algorithms don’t use MACs!

Example: ‘C5510 and PXA255

- 200 MHz ‘C5510: 400 MMACS and 1,200 million bytes/sec
- 400 MHz PXA255: 800 MMACS and 1,600 million bytes/sec
- These two processors have comparable signal processing speed!

Algorithm Kernels

A Good Compromise

- The most computationally intensive portions of signal processing applications
  - Examples: FFTs, IIR filters, Viterbi decoders
- Application-relevant kernels are strong predictors of overall performance
- Results for common kernels widely available
- Programming effort is modest
The BDTI Benchmarks™

• Hand optimized
  † Reflects common coding practice
  † Accurate representation of architecture capability
  • Moderate level of effort
• Detailed programming rules
  † Ensures fair comparison between architectures
  † Complicates programming
  † Large base of results available for comparison
  † About 70 architectures already benchmarked
  † Provides easy means for quick and accurate analysis

Benchmark Results
Example: C64x Family

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Algorithm Kernel Weaknesses

Algorithm kernel benchmarks are good for measuring general signal processing performance, but they...

- Require careful application for multi-core processors
- Do not measure system-level performance
- Do not measure OS overhead
- Cannot be easily applied to hardware accelerators, FPGAs, etc.
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Application Components

Model a key signal processing task
- Often representative of overall workload
- Easier to implement than a full application
- Less general than a set of kernel benchmarks

Larger workload vs. kernel benchmarks
- Allows comparison of different types of architectures
- Simplifies programming rules

Can benchmark the entire system
- Capture effects of memory size, bandwidth, etc.
- Does not capture effects of combining multiple tasks
Example Application Component

BDTI Communications Benchmark™ (OFDM) is based on a simplified 10 Mbps OFDM receiver:
- Closely resembles a real-world task
- Simplified to enable optimized implementations
- Constrained to ensure consistent, reasonable implementation practices

BDTI Communications Benchmark™

<table>
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<tr>
<th></th>
<th>DSP A</th>
<th>DSP B</th>
<th>Altera Stratix 1S20-6</th>
<th>Altera Stratix 1S80-6</th>
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<td>Channels</td>
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<td>~0.7</td>
<td>~20</td>
<td>~60</td>
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<td>Cost (1 ku)</td>
<td>~$15</td>
<td>~$210</td>
<td>~$210</td>
<td>~$3,200</td>
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<td>~$300</td>
<td>~$10</td>
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</tbody>
</table>

From BDTI’s report *FPGAs for DSP* and unpublished benchmarks.
Full Application Benchmarks

- Potential for highly accurate results
  - Results useful only for specific application (or highly similar applications)
  - Applications tend to be ill-defined
- May be able to use existing application code as a benchmark ...
  - Example: BDTI Solution Certification service
- ... but costly and time-consuming to implement a new application
- For processors, similar results via simpler approaches
  - But this is not true for all implementation technologies

Conclusions

Relevant, meaningful benchmark results are essential
- Consider all relevant metrics
- Fastest doesn’t mean best
Different benchmarking approaches make different trade-offs
- Choose the right approach for the task at hand
- Consider what’s available
Beware the many benchmarking pitfalls
Factors other than performance are always important
For More Information...
www.BDTI.com

Inside [DSP] newsletter and quarterly reports
Benchmark scores for dozens of processors
Pocket Guide to Processors for DSP
• Basic stats on over 40 processors
Articles, white papers, and presentation slides
• Processor architectures and performance
• Signal processing applications
• Signal processing software optimization
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