Insight, Analysis, and Advice on Signal Processing Technology

Benchmarking Processors for DSP Applications

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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

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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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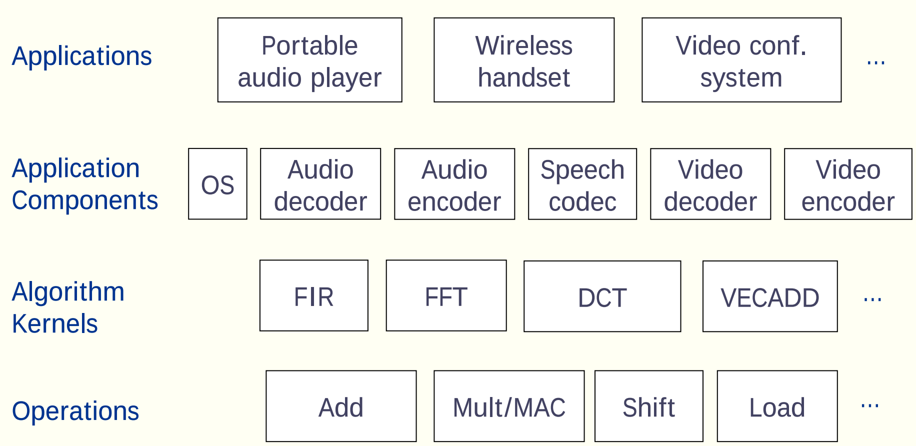
Typical Application Decomposition



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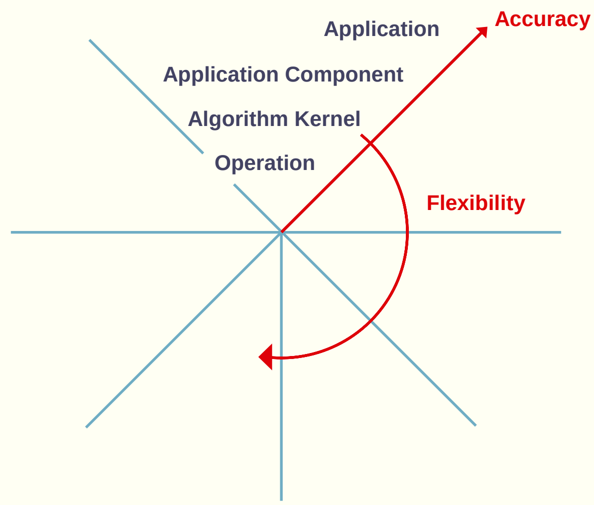
Flexibility vs. Accuracy



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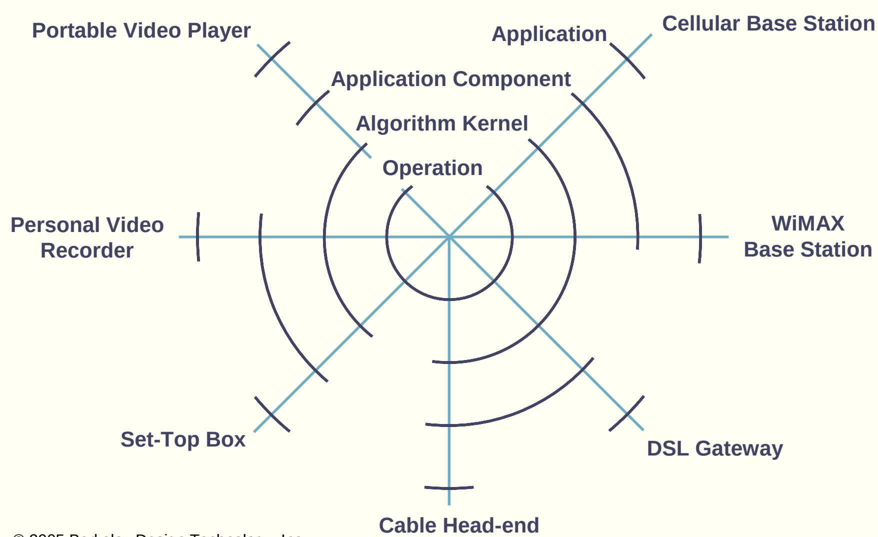
Flexibility vs. Accuracy



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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!

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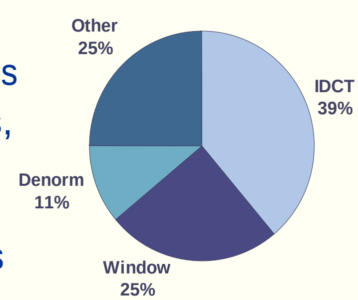
Algorithm Kernels

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

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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

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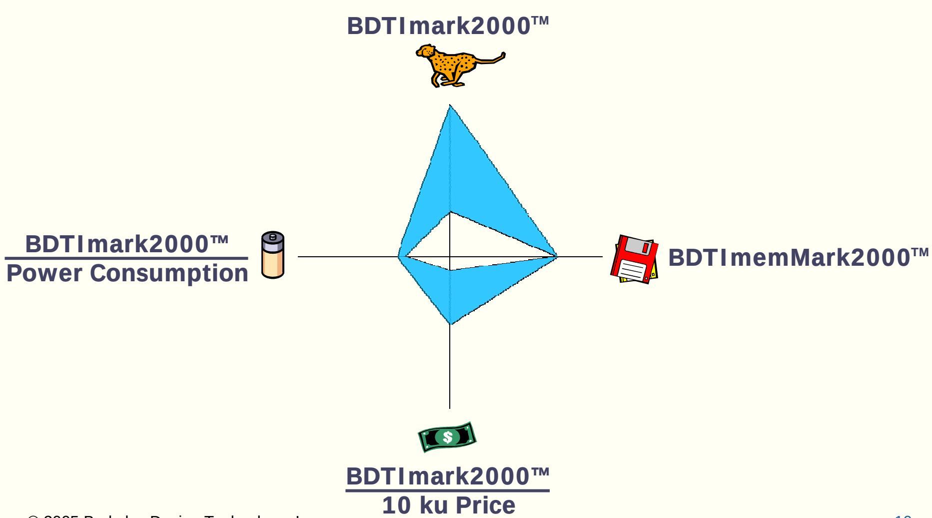
Benchmark Results

Example: C64x Family



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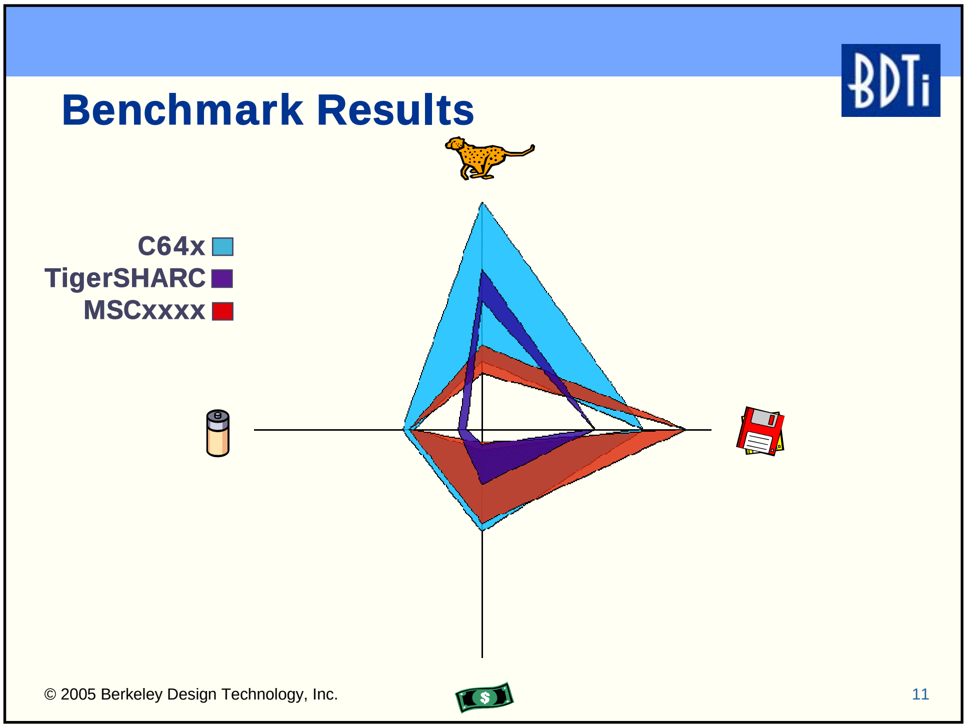
Benchmark Results
C64x
TigerSHARC
MSCxxxx
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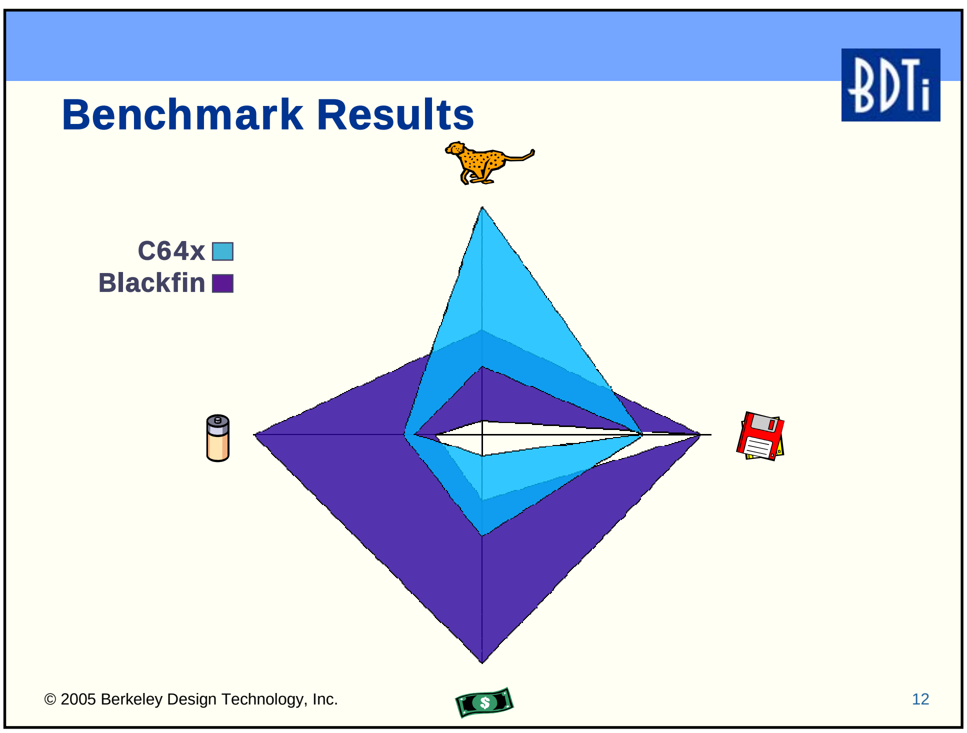
Benchmark Results
C64x
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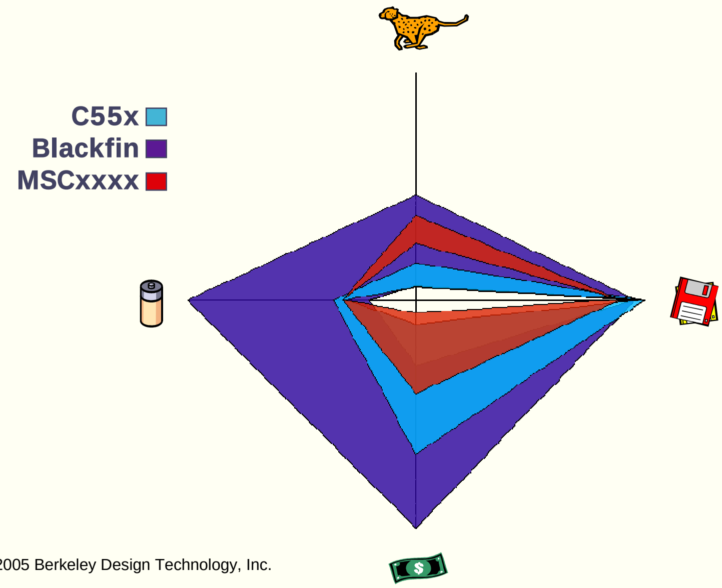
Benchmark Results



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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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Typical Application Decomposition

Level						
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	...	

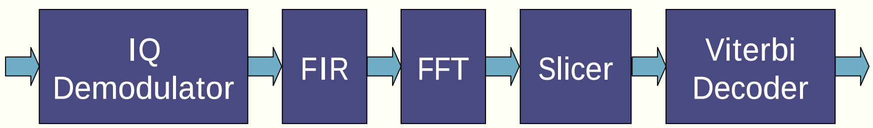
Application Components

- 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



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BDTI Communications Benchmark™

	DSP A	DSP B	Altera Stratix 1S20-6	Altera Stratix 1S80-6
Channels	<0.2	~0.7	~20	~60
Cost (1 ku)	~$15	~$210	~$210	~$3,200
Cost per channel	~$90	~$300	~$10	~$50

From BDTI's report *FPGAs for DSP* and unpublished benchmarks.

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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

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Inside [DSP] newsletter and quarterly reports

Benchmark scores for dozens of processors

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- Signal processing applications
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