
EEMBC
Embedded Processors Target
Digital Entertainment Applications
Certified Performance Analysis for Embedded Systems Designers

Digital Entertainment Represents Many Market Segments

In car entertainment

Set top boxes

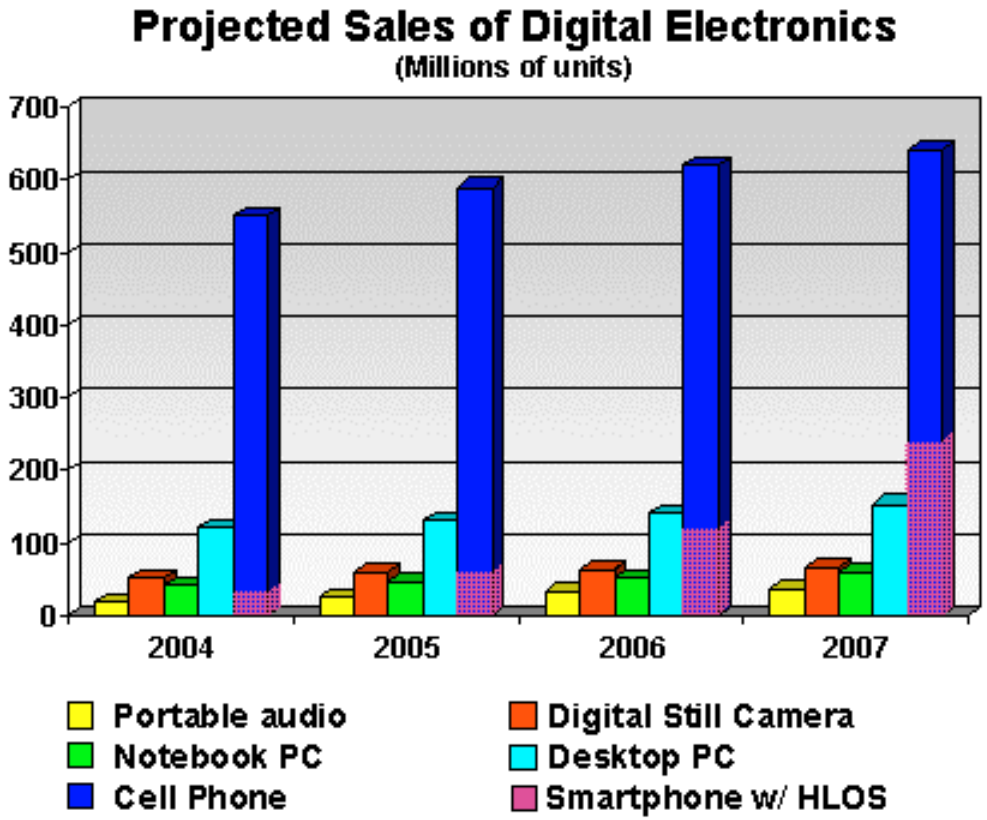
Mobile phones

PDAs

Portable audio products

Still and video digital cameras

Digital Entertainment Represents Major Growth Opportunities



- Numbers don't include IP set top box market
  - Expected to grow linearly over next 5 years
- IP set top box major consumer of MPEG 'bandwidth'

Benchmarking is Critical for Different Stakeholders

- Processor vendors and compiler vendors
  - Performance tuning and evolution
- Platform OEMs
  - Determine performance bottlenecks
  - Understand how to improve end user performance
- Service providers (e.g., Vodafone, DoCoMo)
  - Choosing the best platform to offer subscribers
- End users
  - Need help determining what to buy
  - Experience running real-world content

The EEMBC Evolution: Digital Entertainment

New digital media benchmarks

- Includes enhanced first generation Consumer version 1.1 benchmarks
- New datasets for JPEG and filter benchmarks
- Moving towards application-level focus

Growing performance requirement

- More processor performance
- More demand on caches
- More system bandwidth
- More extensive coverage compared to Consumer Version 1.1

Digital Entertainment Benchmark Details - Dynamic

- MP3 Decode
  - EEMBC has more focus on reprogrammable solutions for mobile phones, PDAs, etc.
- MPEG-4 Video encode and decode benchmarks
  - Focus on mobile market
  - Also used in set top boxes for lower bit-rate streams
- MPEG-2 Video encode and decode benchmarks
  - More high-end focused
  - Fixed and floating point versions of encode
- Cryptography
  - AES, DES, RSA, and Huffman
  - Rapidly rising demand for random numbers
  - Across the net, applications need cryptography

Digital Entertainment Benchmark Details - Static

- Digital photography manipulation
  - RGB to YIQ Conversion
  - RGB to HPG Conversion
  - RGB to CMYK
  - JPEG compression and decompression
- Multiple datasets represents a variety of workloads

Why a Portable Test Harness?

Question

How to get dozens of individual benchmarks to build and run on hundreds of embedded systems?

- Nearly all of which do not have operating systems
- Big endian, Little endian 16, 32, 64 bit
- Dozens and dozens of C compilers, libraries, header files
- Different kinds of timers, host-target interfaces

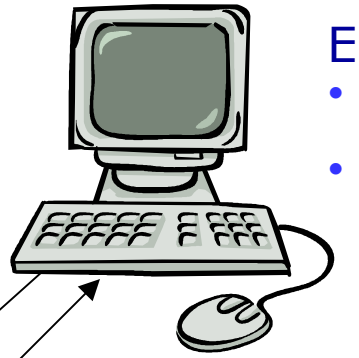
Answer

EEMBC Portable Test Harness

Download benchmark and encapsulated data from host to target

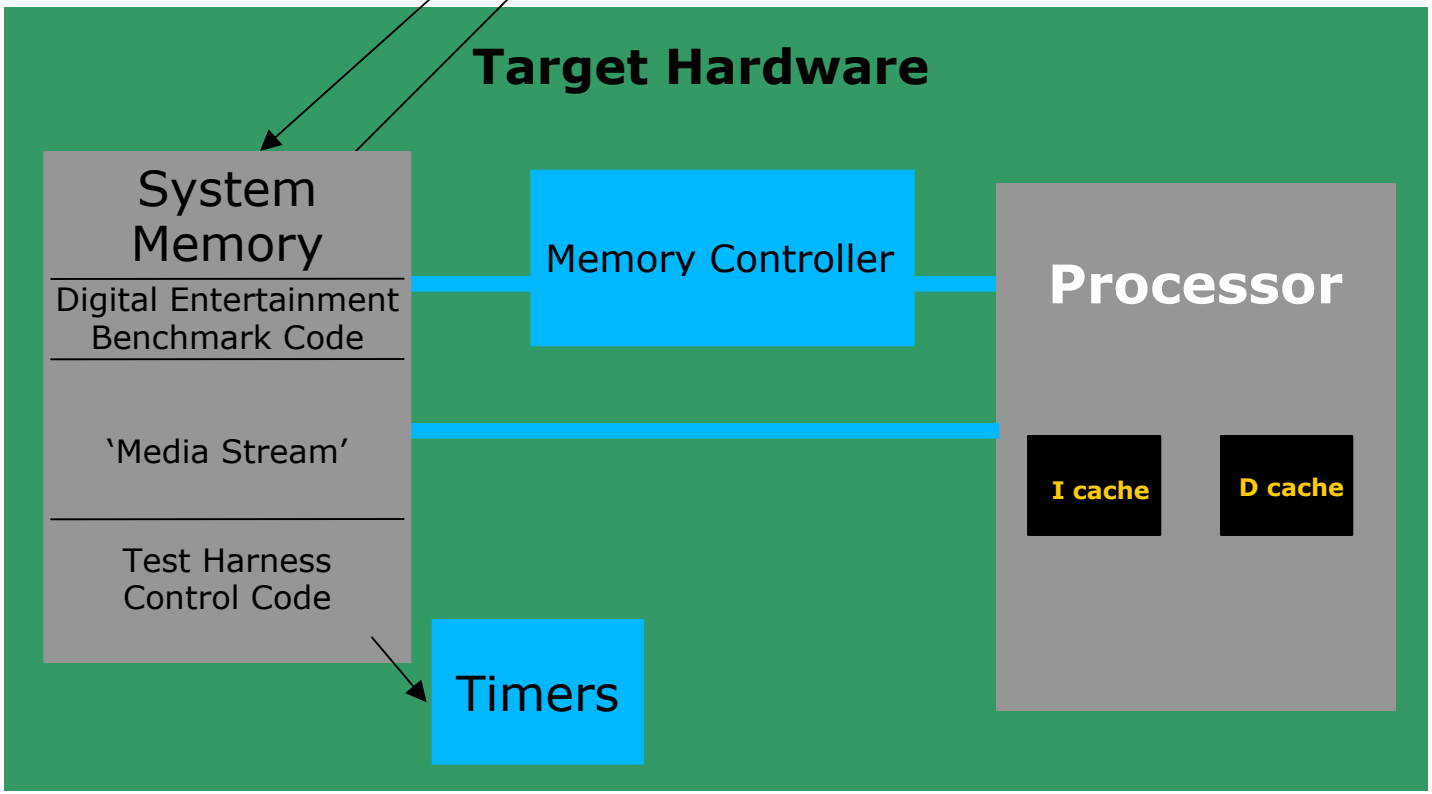
Start/stop timers, controls execution

RS-232, JTAG, Parallel, or Ethernet supported



EEMBC Test Harness

- Runs on host and on target, communicates
- Provides timing, program control, and download support.
  - Results sent back up to Host for Logging, PSNR, post-processing, etc.



Test Harness Functionality

- Abstracts individual benchmark kernels and applications from the underlying hardware and/or RTOS (if present)
- Functional Layer remains consistent
- Adaptation Layer is ported by individual companies or EEMBC Certification Lab (ECL)
  - ECL certifies ports according to strict rules to help assure consistency and accuracy
- Versions for Host-Target, Target-Only (TH Lite), Simulators
- Provides mechanisms for self-checking accuracy of resultant calculations (CRC, PSNR)
- Works for both small kernels (e.g. FFT) and for very large applications (e.g. Ghostscript)

Performance and Quality Metrics

- Big challenge to verify correctness of execution on something that is not bit exact
  - Used for MP3 decoder, MPEG-2 encoder/decoder, MPEG-4 encoder/decoder
- EEMBC uses a peak signal-to-noise-ratio (PSNR) method
  - PSNR = ratio between the SIGNAL to the NOISE
  - Higher SIGNAL, lower noise is better
- Generates separate encode and decoder PSNR scores that preserves double ended signal quality measurement.
  - This method is automated, processing several hundred intermediate files into a single score for each benchmark
- Developed by ECL

Two Ways of Calculating Benchmark Scores

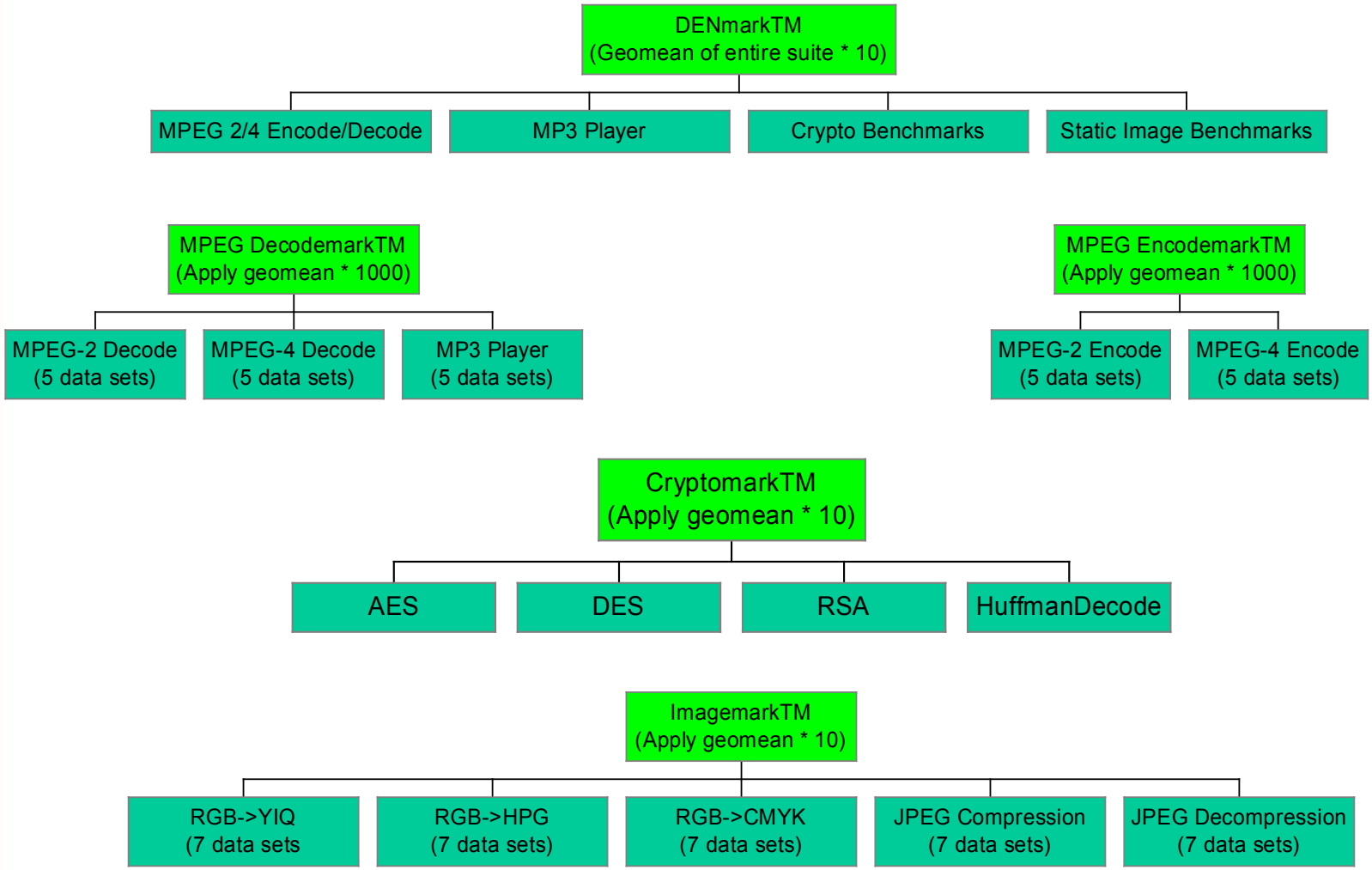
"Out-of-the-box" scores

- Must use standard benchmark source code
- Must disclose compiler, flags, environment

"Optimized" or "full-fury" scores

- Vendors can rewrite benchmark source code, even substitute assembly language
- EEMBC Certification Lab (ECL) checks code to prevent cheating

Components of Consolidated Scores for Digital Entertainment

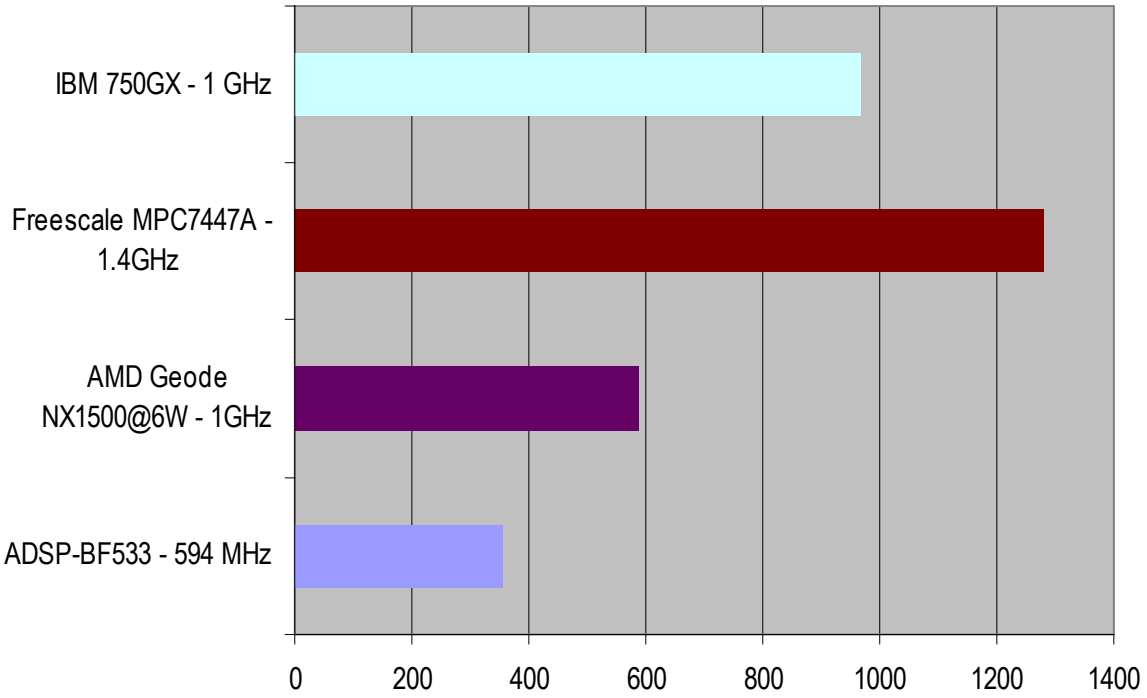


Processor Feature Comparison

Processor Name-Clock	ADSP-BF533 - 594 MHz	AMD Geode NX1500@6W - 1GHz	Freescale MPC7447A - 1.4GHz	IBM 750GX - 1 GHz
Compiler Model and Version	GHS 4.2 for Blackfin	GCC 3.3.3	GHS Version 4.1	Green Hills Software MULTI 4.0
Native Data Type	16/32-bit	32	32	32-bit
L1 Instruction Cache Size (kbyte)	16Kbytes	64Kbytes	32Kbytes	32Kbytes
L1 Data Cache Size (kbyte)	32Kbytes	64Kbytes	32Kbytes	32Kbytes
External Data Bus Width	16 bits	32 bits	64 bits	64 bits
Memory Clock	118.8 MHz	166MHz	166MHz	200MHz
L2 Cache Size (kbyte)	0	256Kbytes	512Kbytes	1024 Kbytes
L2 Cache Clock			1.4GHz	1 GHz
Chip set and/or memory interface chip	NA	VT8235	Marvell Discovery III	Marvell Discovery III

Table illustrates some of the key performance-related features that will have impact on benchmark scores

MPEG Encodemark Performance Comparison



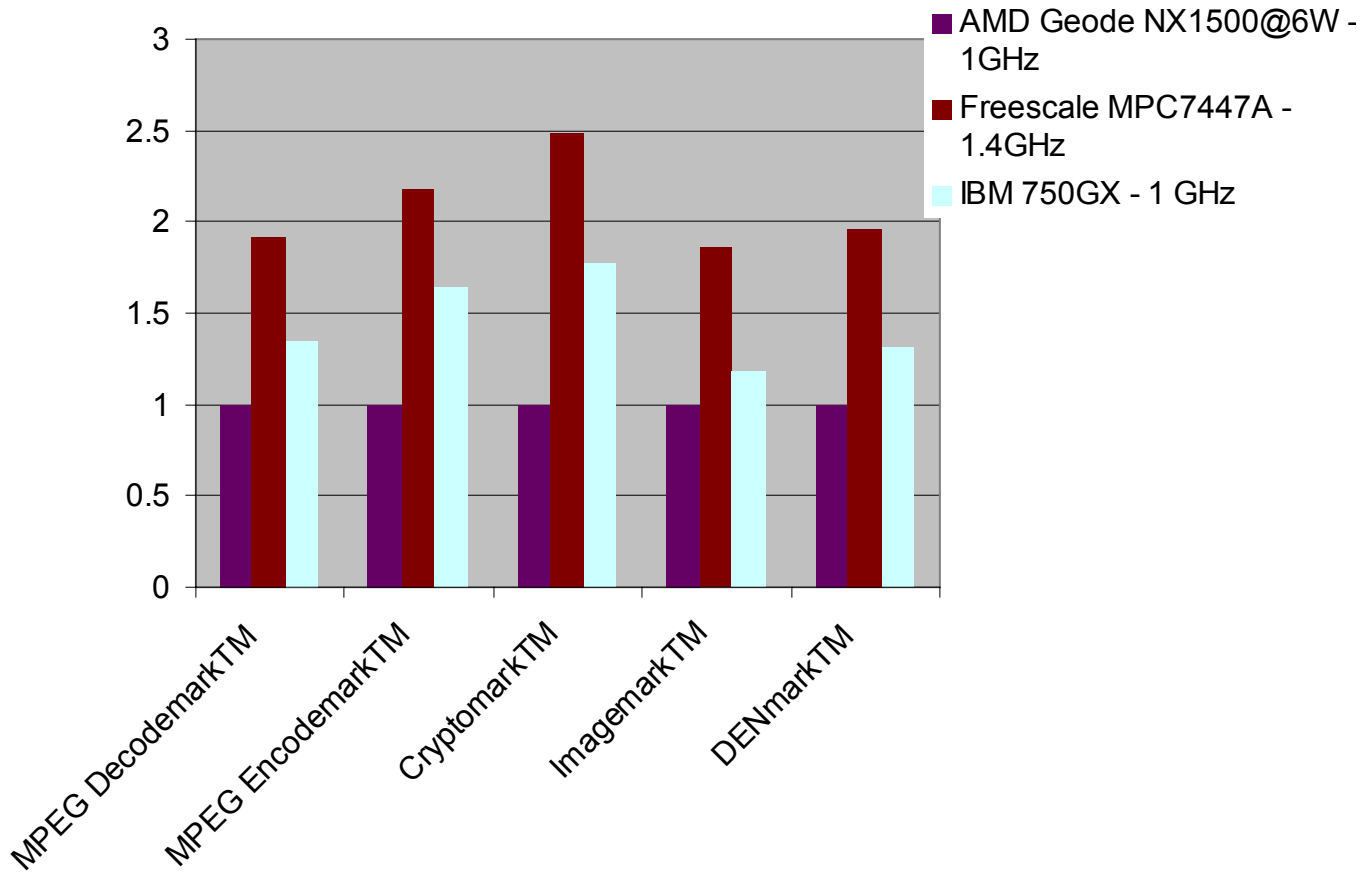
Question

What's enough performance to do the job?

Answer

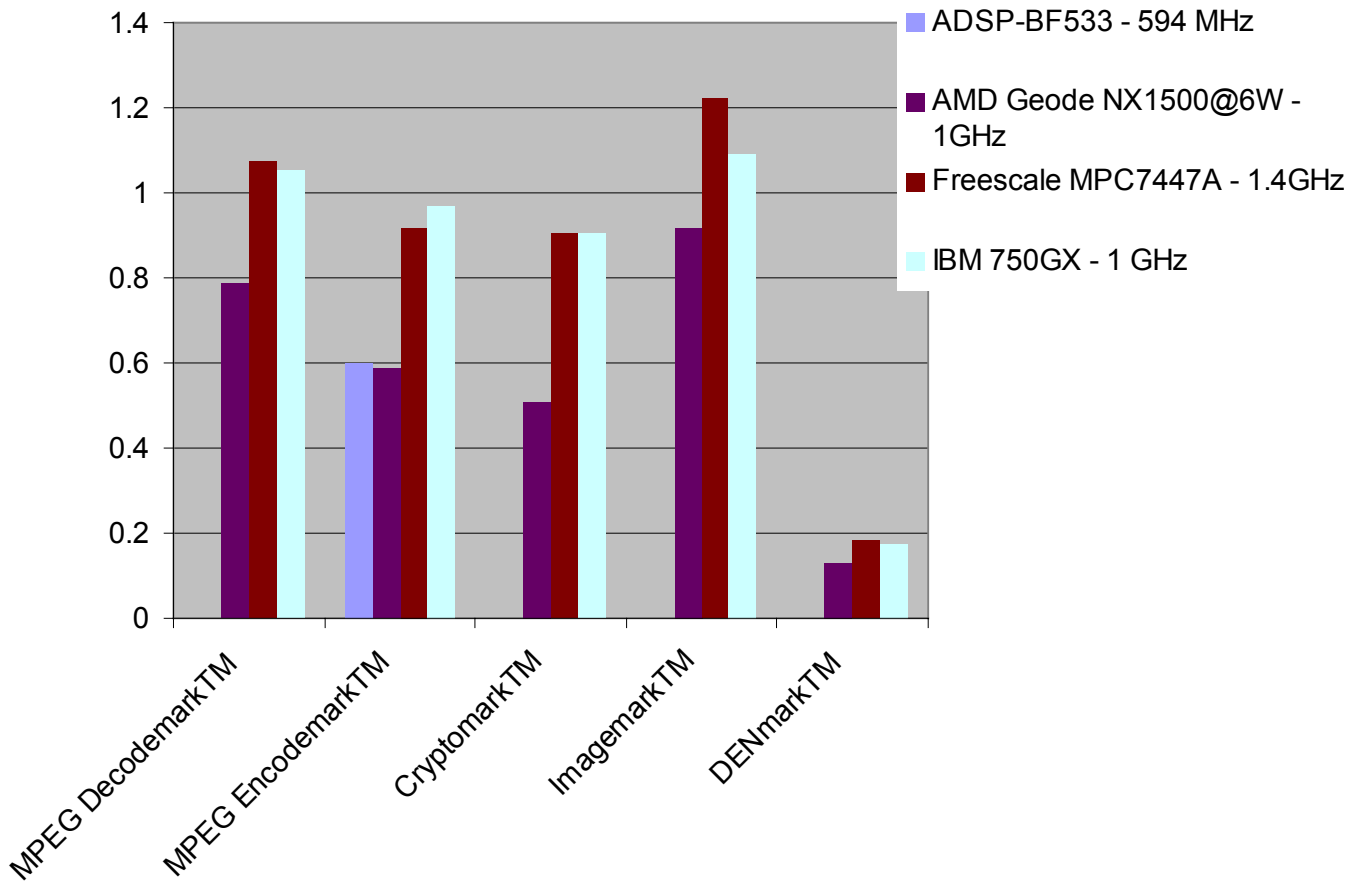
It depends on the application.

Overall Performance Comparison



Scores Normalized to AMD processor

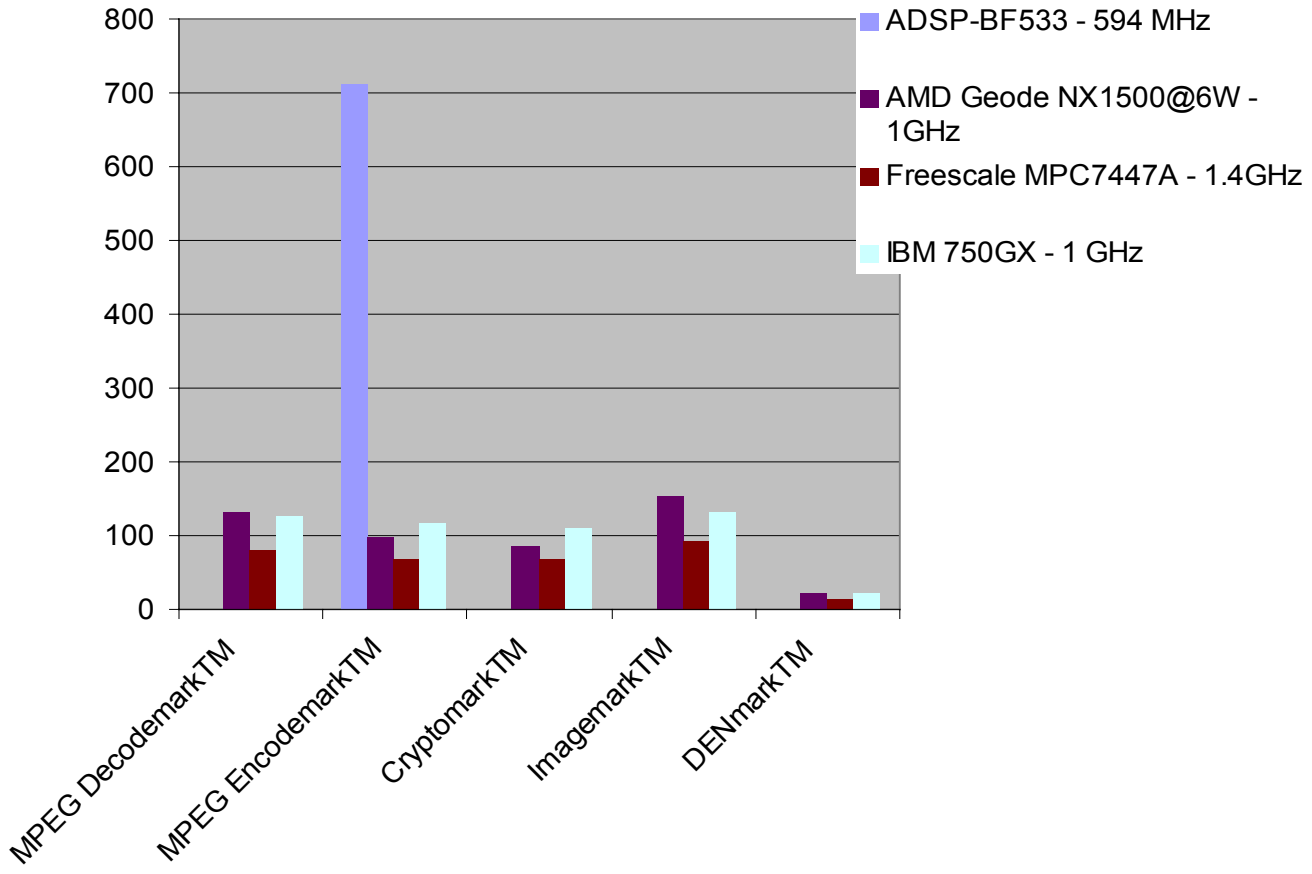
Performance/MHz Tells A Different Story



Demonstrating architectural efficiency by measuring the amount of work per clock.

There's more to the story than meets the eye.

Performance/Watt Provides A Clear Differentiator



Power (and price) categorizes processor for the application

BF533 = 0.5W; Geode = 6W; MPC7447A = 18.3W; 750GX = 8.3W

Conclusion

- EEMBC provides an industry standard method for evaluating processing subsystems
- Demonstrates value propositions in different areas: raw performance, operating efficiency, power, code size, cost
- Digital Entertainment benchmarks address a wide range of applications
  - Processor performance is a key component of a platform's success