

## Benchmarking H.264 Hardware/Software Solutions

*Insight, Analysis, and Advice on Signal Processing Technology*



### **BDTI Solution Certification™: Benchmarking H.264 Video Decoder Hardware/Software Solutions**

Steve Ammon  
Berkeley Design Technology, Inc.  
Berkeley, California USA  
+1 (510) 665-1600

info@BDTI.com  
<http://www.BDTI.com>

© 2006 Berkeley Design Technology, Inc.



### **About BDTI**

BDTI helps companies develop, market, and use signal processing technology

BDTI is a trusted industry resource for:

- Independent benchmarking and competitive analysis
- Expert product development advice
- Industry and technology seminars and reports
- Optimized DSP software development services

BDTI helps system designers:


- Make confident business and technology decisions
- Reduce risk in product development

© 2006 BDTI

INSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY

2


© 2006 Berkeley Design Technology, Inc.



## Video Processor Types

Processor Type	Chips	IP Cores
PC CPU	✓	
Embedded RISC CPU	✓	✓
Application processor	✓	
DSP (generic or specialized)	✓	✓
Media processor	✓	✓
Heterogeneous multiprocessor	✓	✓
Customizable processor	✓	✓
ASIP		✓
Reconfigurable processor	✓	✓
FPGA	✓	
Fixed-function engine	✓	✓
ASSP (incorporating one or more processor types)	✓	

© 2006 BDTI      INSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY      3



## Challenges in Evaluating Solutions

Validate the production-readiness of the solution

Measuring performance fairly

- Algorithm configurations
- Test streams
- Test conditions
- Performance metrics

Vendor data often provides little help

- Often difficult to determine the maturity of a solution
- Varying and often unrealistic configurations, test streams, test conditions, and metrics

© 2006 BDTI      INSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY      4



### The Problem with Vendor Data

Vendor performance claims are difficult to use and compare...

“Hantro’s H.264 player for series 60 handsets is based on the 6100 software decoder and PlayEngine middleware. Running on the Nokia 7610 handset, full screen video (208x176 resolution) at 15 frames per second can be achieved.”

“We’re shipping today, running a 90-MHz processor and delivering 20-frame per second QCIF video, which is a very acceptable level.”  
– Agere

“H.264 player on 600 MHz Blackfin, CIF (360 x 240) at 30 fps: 111 MHz” – ADI



### BDTI Solution Certification™

Standardization:

- Operating points (codec parameters)
- Test streams
- Metrics
- Instrumentation guidelines

Independent verification of:

- Functionality
- Performance
- Fair comparisons

**BDTi**

## BDTI H.264 Decoder Solution Certification™

Primary operating point:

- Baseline profile
- D1 resolution (720 × 480)
- 30 frames per second
- 1.5 Mbit/second test stream (*proprietary*)

Other “secondary” operating points are characterized to provide a complete performance picture

Metrics:

- CPU utilization
- External memory bandwidth utilization
- Energy consumption (mJ/frame)
- Die area or cost (mm<sup>2</sup> or \$)
- Program and data memory use (Mbytes)

© 2006 BDTI INSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY 7

**BDTi**

## Example: ARC Media Subsystem

(Preliminary Results Available, Final Results Pending)

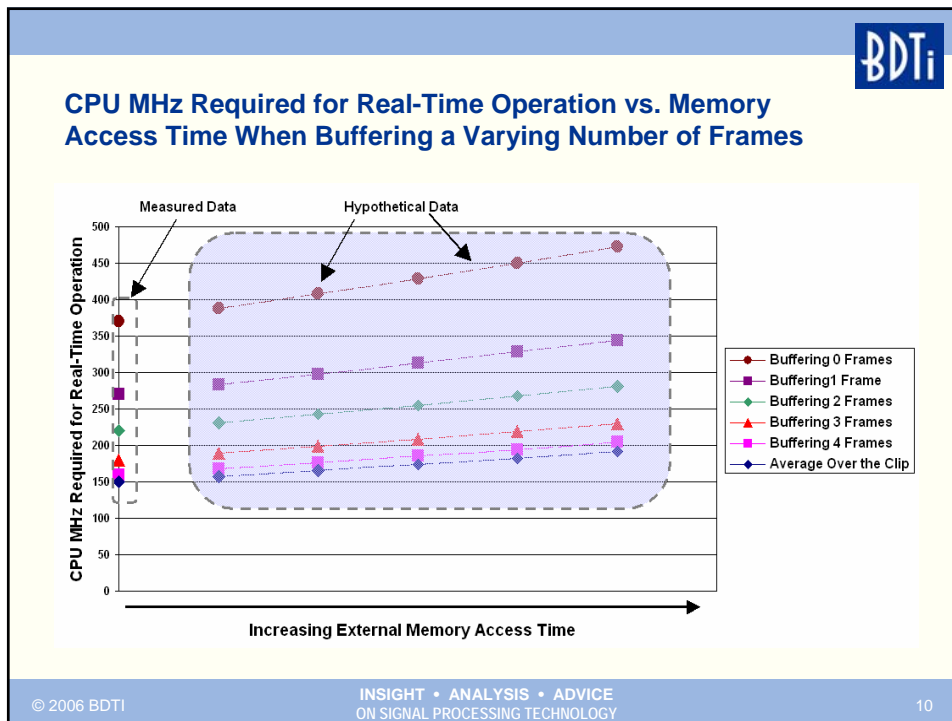
```
graph TD
    subgraph LeftBox [ ]
        EDE[Entropy Decode Extensions]
        ARC[ARC 750D (500 MHz)]
        I1[32K I$]
        D1[32K D$]
        EDE --- ARC
        ARC --- I1
        ARC --- D1
    end
    subgraph RightBox [ ]
        I2[25K I$]
        SIMD[128-bit SIMD Engine]
        D2[32K D$]
        DMA[DMA]
        I2 --- SIMD
        SIMD --- D2
        D2 --- DMA
    end
    I1 --> I2
    D1 --> D2
```

The diagram illustrates the ARC Media Subsystem architecture. It consists of two main processing blocks. The left block contains Entropy Decode Extensions, an ARC 750D processor (500 MHz), and 32K I\$ and 32K D\$ caches. The right block contains a 25K I\$ cache, a 128-bit SIMD Engine, a 32K D\$ cache, and a DMA controller. Data flow is indicated by arrows: 32K I\$ feeds into 25K I\$, 25K I\$ feeds into the 128-bit SIMD Engine, the 128-bit SIMD Engine feeds into the 32K D\$, and the 32K D\$ feeds into the DMA. Additionally, the 32K I\$ and 32K D\$ caches are connected to the ARC 750D processor, and the 32K D\$ cache is also connected to the Entropy Decode Extensions.

© 2006 BDTI INSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY 8

## Benchmarking H.264 Hardware/Software Solutions

BDTI H.264 Video Decoder Solution Certification Performance Results Baseline Profile, D1 (720x480) Resolution, 30 fps, 1.5 Mbps						
ARC 750D + SIMD/VLC Extensions (Preliminary Results)						
Metric	CPU utilization with zero wait-state external memory (MHz)	External memory bus bandwidth utilization (Mbps)	Program memory usage (bytes)	Static data memory usage (bytes)	Dynamic data memory usage (bytes)	Buffering delay (seconds)
Average over entire clip	159	152	111K	19K	N/A	N/A
Buffering 4 frames	160	152	111K	19K	5M	0.133
Buffering 3 frames	162	152	111K	19K	4.5M	0.100
Buffering 2 frames	184	152	111K	19K	4M	0.067
Buffering 1 frame	229	155	111K	19K	3.5M	0.033
No buffering - highest CPU load frame	328	168	111K	19K	3M	0.000
Estimated energy consumption	609.2 mJ for 5.23 second video clip (116.5 mW average)					
Cost (silicon area) For licensable IP	9.12 mm <sup>2</sup>					
Cost (dollars) for chips	External memory required - cost depends on type chosen					
<small>Note: Energy estimate assumes the CPU is running at 160MHz</small>						
<div style="display: flex; justify-content: space-between;"> <span>© 2006 BDTI</span> <span>INSIGHT • ANALYSIS • ADVICE ON SIGNAL PROCESSING TECHNOLOGY</span> <span>9</span> </div>						





### Future Work

Performance certification for:

- Other solutions
- Other operating points
  - Different profiles, resolutions, bit rates, etc.
- Other video and audio codecs
  - WMV (VC-1), MPEG-4, etc.
  - AAC, MP3, etc.

“Light” Solution Certification

- Verifies functionality but not performance
- Enables quick certification of a large library of codecs
- Most useful in combination with performance certification for representative codecs



### Conclusions


Choosing a video-processing solution is difficult

- Many solutions to choose from
- Suitability is difficult to assess
- Vendor performance data may be unreliable

Use BDTI Solution Certification to:

- Quickly *and* accurately assess the suitability of candidate solutions
- Determine the product-worthiness of a solution
- Save time and reduce risk

## Benchmarking H.264 Hardware/Software Solutions



### For More Information...

**[www.BDTI.com](http://www.BDTI.com)**

Benchmarks and analysis

- Video
- Communications
- General-purpose signal processing



“Sounding Board” consulting services

- Advice on processors, tools, algorithms, and software

DSP software design services

Free information

- *Inside DSP* newsletter
- *Pocket Guide to Processors for DSP*

  
  
6<sup>th</sup> Edition

© 2006 BDTIINSIGHT • ANALYSIS • ADVICE  
ON SIGNAL PROCESSING TECHNOLOGY13