The CoolFlux BSP: the Novel Low Cost Ultra Low Power Processor Core for Software Defined Digital Basebands

NXP Semiconductors, c/o Skip Canevit (WiseWins Consulting)
December 2007
Overview

- NXP Semiconductors: Vibrant Media Technologies
- CoolFlux DSP: The Ongoing Success Story
- CoolFlux BSP: The Innovations
- CoolFlux BSP: The User Benefits
- CoolFlux BSP: Available now!
- Conclusions
NXP Semiconductors:
Vibrant Media Technologies
NXP Semiconductors

- Established in 2006 (formerly a division of Philips)
- Builds on a heritage of 50+ years of experience in semiconductors
- Provides engineers and designers with semiconductors and software that deliver better sensory experiences
- Top-10 supplier with Sales of € 4,960 Bln (2006)
- Sales: 35% Greater China, 31% Rest of Asia, 25% Europe, 9% North America
- Headquarters: Eindhoven, The Netherlands
- Key focus areas:
  - Mobile & Personal, Home, Automotive & Identification, Multimarket Semiconductors
- Owner of NXP Software: a fully independent software solutions company
NXP is the Leader in Vibrant Media Technologies

- NXP Semiconductors is the leader in vibrant media technologies that help engineers and designers develop products that deliver better sensory experiences. We invest to extend our Philips heritage as innovators in semiconductor solutions, from systems on a chip to single-function ICs and software.

- Our vibrant media technologies make it easy to bring your product ideas to life. Creating better sensory experiences for consumers: brilliant images, crisp clear sound, and easy sharing of information in homes, cars, and mobile devices. All with exceptional effectiveness and efficiency. With NXP, you gain a competitive advantage that can be seen, heard, and felt.

- With NXP as a partner, you can be more successful by bringing products to life that deliver better sensory experiences.
CoolFlux DSP:
The Ongoing Success Story
CoolFlux DSP Design Goals

- Ultra low power consumption – well balanced with good performance and low gate count
  - ULP techniques used throughout design hierarchy

- Programmable in Ansi-C with highly optimizing and efficient compiler
  - More maintainable and shorter SW development schedules, without loss of quality

- Small core, small memory footprints

- Core to be usable:
  - In stand-alone mode (as host DSP)
  - As coprocessor for microcontroller
  - Powerful multi-core configuration also possibilities (efficiently scalable to high performance e.g. for high end multi channel Audio)
CoolFlux DSP Success Stories

- Announced: DSPFactory, (now part of AMI Semiconductors) licenses CoolFlux for their Ultra Low Power Hearing Aid Applications endorsing the ultra low power (ULP) capabilities

- Additional licensees using CoolFlux in chips for MP3 players and digital audio subsystems on mobile multimedia, DVD, wireless audio, car audio ...

- CoolFlux e.g. being used in
  - ULP NXP chips for the Hearing market
  - European Hearing Instruments
  - Japanese Mobile Phones
  - Chinese MP3 players
CoolFlux DSP Core
Track Record

- Best in Class for any Audio subsystem for years to come
  - Well balanced architecture with ultra low power & gate count in combination with good performance
  - 24/56-bits organization optimal for digital audio
  - Supporting stand-alone, co-processor & multi processor setups
  - Low gate count offers excellent multi-core scalability towards (very) high end if needed

- High quality IP
  - Extensively tested by NXP and Synopsys before release as Star IP under DesignWare
  - Proven on silicon numerous times all first time right including NXP demo chip
  - Part of intense ongoing developments after launch 3+ years without any hardware bug had to be repaired ever since
  - Adopted by growing list of Tier 1 Semiconductor Companies
CoolFlux BSP: The Innovations
CoolFlux DSP architecture

- 24/56 bit data paths (CF6-24)
- 2x 24x24 bit multipliers
- 2x 24/56 bit ALUs + 1x24 bit ALU
- 2x 56 bit accumulators
- JTAG debug interface
- 8 Operations in parallel per clock cycle
CoolFlux **BSP** Architecture Enhanced for Baseband Signal Processing (driven by WiMAX)

- All 24/56 bit data paths of CoolFlux DSP usable backwards compatible at C-level
  - 24 bit addressing
- **PLUS:**
  - Modes for Complex Arithmetic and SIMD
    - 2x 12x12 bit quadruple multipliers
    - 2x 12/28 bit dual ALUs + 1x12 bit dual ALU
    - 2x 28 bit dual accumulators
    - Instruction enhancements for FFT and Viterbi
- **RESULTING IN e.g.:**
  - 18 Operations in parallel per clock cycle
  - 2 cycle complex butterfly FFT performance
**Enhanced Powerful Software development environment** *(Target Compiler Techn. Tool Suite distributed by NXP)*

- CoolFlux DSP ISA designed for best compiler performance
  - Highly efficient ANSI-C compiler: compact, cycle efficient code, exploiting instruction level parallelism
  - No extra assembly programming needed, yet Assembler is available next to Compiler, Linker, Simulator and Graphic Debugger
- TRANSPARANT SIMD and COMPLEX ARITHMETIC HANDLING by the C-COMPILER!
- Cycle-true, bit-accurate instruction set simulator
  + Source level graphic debugging
  + Extensive profiling information
  + Native mode for your own preferred PC C-compiler
Extended Application Software

Available : CODECS
- MP3 CODEC
- WMA9 Decoder
- AAC LC Decoder with Dynamic Range Compression
- AAC-LC Encoder with Long Windows, MS Stereo, TNS enabled
- EH-AAC Vs. 1 & 2 CODEC
- IMA ADPCM CODEC
- AMR NB CODEC
- AMR WB CODEC
- Wideband Speech CODEC G.722
- High quality low bit rate voice decode and encode (<10k-bps)
- SBC CODEC for Bluetooth Audio
- OGG Vorbis decoder
- BSAC decoder

Available : SOUND PROCESSING
- Graphic equalizer
- Spectrum analyzer
- Dynamic Bass Boost
- Surround Sound
- Noise reduction for voice rec.
- Time Scaling var. speed/keep tone for voice
- MIDI playback
- Sample Rate Converter

Available: RADIO
- FM demodulation
- Stereo Decoding
- AM demodulation
- RDS demodulation

Available : OTHER
- Bluetooth Audio Upper Stack
- Mathematical library
- JPEG decoder

EXTENDED To Baseband functionalities
- OFDM
- (Q) PSK
- FSK
- (Q)AM
- High performance Radix2 and Radix4
- Viterbi

1 More available on customer request, future roadmap subject to customer driven changes
CoolFlux BSP: The User Benefits
Application Domains for CoolFlux BSP

- Used for low power WiMAX handset chips
- Very well suited for Software Defined Radio baseband such as for (ultra) low power combinations of
  - WiMAX with other mobile basebands
  - WIFI
  - Bluetooth
  - Zigbee
  - NFC
  - RF-ID
  - DVBT
  - DVBH
  - Satellite and Terrestrial Radio Standards
  - Settop Box Modems
CoolFlux DSP – Well Balanced Results*

- **Very Small Baseband Signal Processing Core:**
  - 48kgates + 4.5kgates JTAG (90 nm CMOS)

- **Good Performance (svt lib) – peak MOPS = 8x MIPS (=MHz)**
  - >160 MHz WCCOM @ 1.8 V 180 nm CMOS or > 2800 MOPS peak
  - >200 MHz WCCOM @ 1.2 V 130 nm CMOS or > 3600 MOPS peak
  - >240 MHz WCCOM @ 1.2 V 90 nm CMOS or > 4300 MOPS peak
  - >280 MHz WCCOM @ 1.2 V 65 nm CMOS or > 5000 MOPS peak (5 GOPS !!!!)

- **Very Low Power microwatts Consumption (core only)**
  - 240 μw/MHz @ 1.8 V in 180 nm CMOS
  - 95 μw/MHz @ 1.2 V in 130 nm CMOS
  - 91 μw/MHz @ 1.2 V in 90 nm CMOS
  - 40 μw/MHz @ 0.8 V in 90 nm CMOS
  - 70 μw/MHz @ 1.2 V in 65 nm CMOS
  - 31 μw/MHz @ 0.8 V in 65 nm CMOS

*Numbers based on NXP standard digital CMOS libraries and worst case commercial conditions (WCCOM), comparable with TSMC. Synthesis optimized for power consumption. Results subject to change and depend on used technology, library selection and synthesis approach.
CoolFlux BSP Availability
Availability of CoolFlux BSP

- NOW !!! (next to DSP)
- For Taiwan and Mainland China & Hong Kong please contact:
  
  Mr. Skip Canevit  
  Managing Director  
  WiseWins Consulting  
  Shanghai  
  +86-1381-8687774
Conclusions
Summary

- The CoolFlux BSP is an ultra low power programmable core optimized for Baseband Signal Processing applications
  - Well-balancing power, area and performance
  - C-compiler friendly
  - Robust market proven IP

- Available now for licensing

- We offer partnership providing world leading expertise in:
  - Ultra low power systems design
  - Digital baseband algorithms
  - DSP SW maintenance and low TCO
  - IP design in support

- THANKS for your attention!