



DSP Processors, Embodiments, and Alternatives

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DSP Processors

- ❑ DSP systems and, in particular, real-time DSP systems contain mainly **repetitious** application of **data-driven** behaviours defined by **mathematical algorithms** under **strict timing constraints**
- DSP processors are designed for repetitive, numerically intensive tasks
- ❑ DSP applications define two main requirements
 - timing
 - sequence of operations must be performed in given time
 - error
 - accuracy of results must be less than specified
- DSP processors contain features to improve the accuracy and performance of computations

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DSP Processors: The Most Important Features

- ❑ Fast multiply-accumulate
 - single-instruction cycle MAC
 - multiplier and accumulator integrated into main arithmetic unit (data path)
- ❑ Multiple-access memory architecture
 - parallel instruction fetch and operand accesses
- ❑ Specialized addressing modes
 - dedicated address generation units
- ❑ Specialized execution control
 - efficient looping capabilities
- ❑ Specialized features to improve numerical accuracy
- ❑ Peripherals and input/output interfaces

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Embodiments (#1)

- ❑ DSP found in new application areas with new requirements
 - No single processor can fulfill all the requirements
 - increase of integration levels
 - new packaging techniques
- ❑ Single-chip processor
- ❑ Multi-chip modules (MCM)
 - multiple dies combined into a single package
 - higher packaging density
 - higher operation speed
 - reduced power dissipation
- ❑ Multiple processors on a chip
 - microprocessor or -controller and DSP processor are integrated into a single chip
 - increased performance
 - reduced power consumption
- ➔ TI: two TMS320C40 processors with 128k*32 SRAM
- ➔ Motorola: M86356 contains M68000 and DSP 56000

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Embodiments (#2)

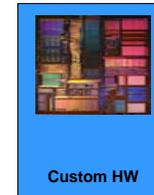
- ❑ Chip sets
 - processor is divided into several packages
 - processor is complex or requires large number of I/O pins
 - separate packages allow use of smaller and cheaper package
 - increased flexibility
 - ➔ Butterfly DSP: LH9124 processor and LH9320 address generator are separate components. Several address generators can be used with a single processor.
- ❑ Multiprocessors
 - high-performance systems requiring programmability
 - some DSP's have been designed especially for multiprocessor systems
 - ➔ TMS320C4X and ADSP-2106X have dedicated communication ports for inter-processor communications.
 - ➔ TMS320C8X contains four DSP processors and a RISC processor in a single chip.

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DSP Cores

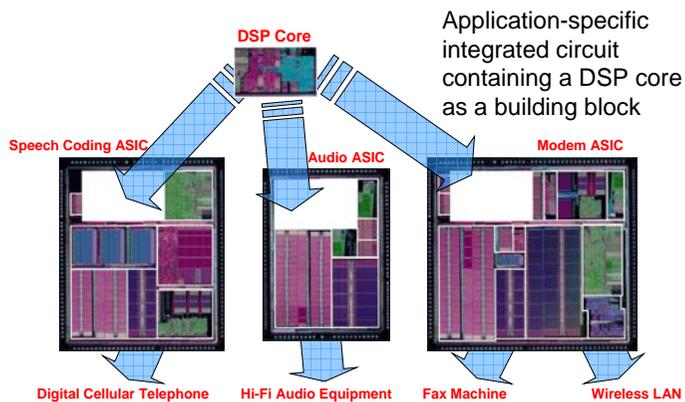
- ❑ Final chip is combination of
 - DSP processor
 - programmability
 - existing development tools
 - existing SW libraries
 - user defined custom logic
 - low production cost
 - small size
 - low power consumption
- ❑ Used in high-volume designs



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DSP Core Based ASICs



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DSP Core Based ASICs

- ❑ Foundry-Captive Cores
 - core vendor provides also the foundry services for ASIC fabrication
 - ➔ TI: standard DSP processors are macrocells which are surrounded by full-custom layouts, standard cells, or gate arrays or mixture of these.
 - ➔ SGS-Thompson: D950-CORE is offered as macrocell in standard ASIC library.
- ❑ Licensable Cores
 - core vendor licenses the core design to the customer, who selects an appropriate foundry
 - typically optimized full-custom layout compatible with fabrication process of a particular foundry
 - also synthesizable HDL designs
 - modifications possible
 - foundry selected freely

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Customizable DSP Processors

- ❑ Modification of the core itself rather than including additional surrounding circuitry
 - DSP processor, which may be extended or modified
 - additional functional units in data path
 - error coding unit
 - bit manipulation unit
- ❑ Modifications in core must be reflected also to the development tools
 - AT&T Microelectronics: DSP1600 was designed for easy attachment of extra execution units into the data path and the development tools support new units.
 - Philips: EPICS core has been demonstrated with different word widths.



Alternatives to Commercial DSP Processors (#1)

- ❑ General-Purpose Microprocessors in Embedded Systems
 - for less-demanding DSP applications
 - compared to DSP processors
 - more cost effective
 - development tools more sophisticated and powerful
 - RISCs have features to support multimedia applications
 - single instruction cycle MAC (under certain circumstances)
- ❑ PCs and Workstations
 - software-only DSP with loose requirements
 - scientific and engineering DSP simulations (no real-time requirements)
 - cost effective (no extra hardware required)
 - DSP capabilities can be extended with add-on boards
 - on-board DSP processors
 - A/D and D/A converters
 - telephone line interfaces



Alternatives to Commercial DSP Processors (#2)

- ❑ Custom Hardware
 - the best performance
 - the lowest production cost
 - board level realization the most common
 - standard logic devices
 - FPGA's
 - fixed-function or configurable arithmetic units
 - application-specific processors
 - development may be time-consuming
 - difficult to modify (fixed nature)
- ☞ Implementation options are not mutually exclusive
 - In reality, DSP systems are designed with different technologies for different parts of the system