eSOCFM-1 FPGA System Board

The System-On-Chip Solution

Presented
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Summary

- SOC Development System
- FPGA Single Board Computer
- Actel ProAsic Plus FPGA Chips
- eP32 CPU Core
- SRAM, Flash, and EEPROM
- Input Output Peripherals
- eForth Operating System
- Software Development
- Demonstrations

SOC Development System

- Powerful platform for SOC design and development
- SOC system integrates:
  - CPU
  - Various types of memory
  - Various types of IO devices
  - Real time operating system
  - Application software
- Board is the ideal solution

FPGA Single Board Computer

- Powerful fourth generation FPGA chip as the core
- A complete suite of memory chips
  - 4 MB of flash
  - 256 KB of SRAM
  - 16 KB of serial boot EEPROM
- An Extensive array of IO devices
  - Serial and parallel ports
  - SPI, I2C, and LCD interfaces
- Real time operating system

FPGA Single Board Computer

- Minimal instruction set:
  - Designs scalable from 16 to 64 bits
- Dual stack architecture:
  - Return stack for nested return addresses
  - Data stack for nested parameter lists
- Compute before execution:
  - All instructions execute in 1 clock cycle
- Minimized subroutine call and returns:
  - Support modular and structured programs
  - Seamless integration of high level programming language

Actel ProAsic Plus FPGA Chips

- 0.22u Flash-based FPGA
- Secured core for IP distribution
- 150 K to 1 M system gates
- 9 KB to 22 KB two-port SRAM
- 106 IO pins
- Up to 350 MHz performance

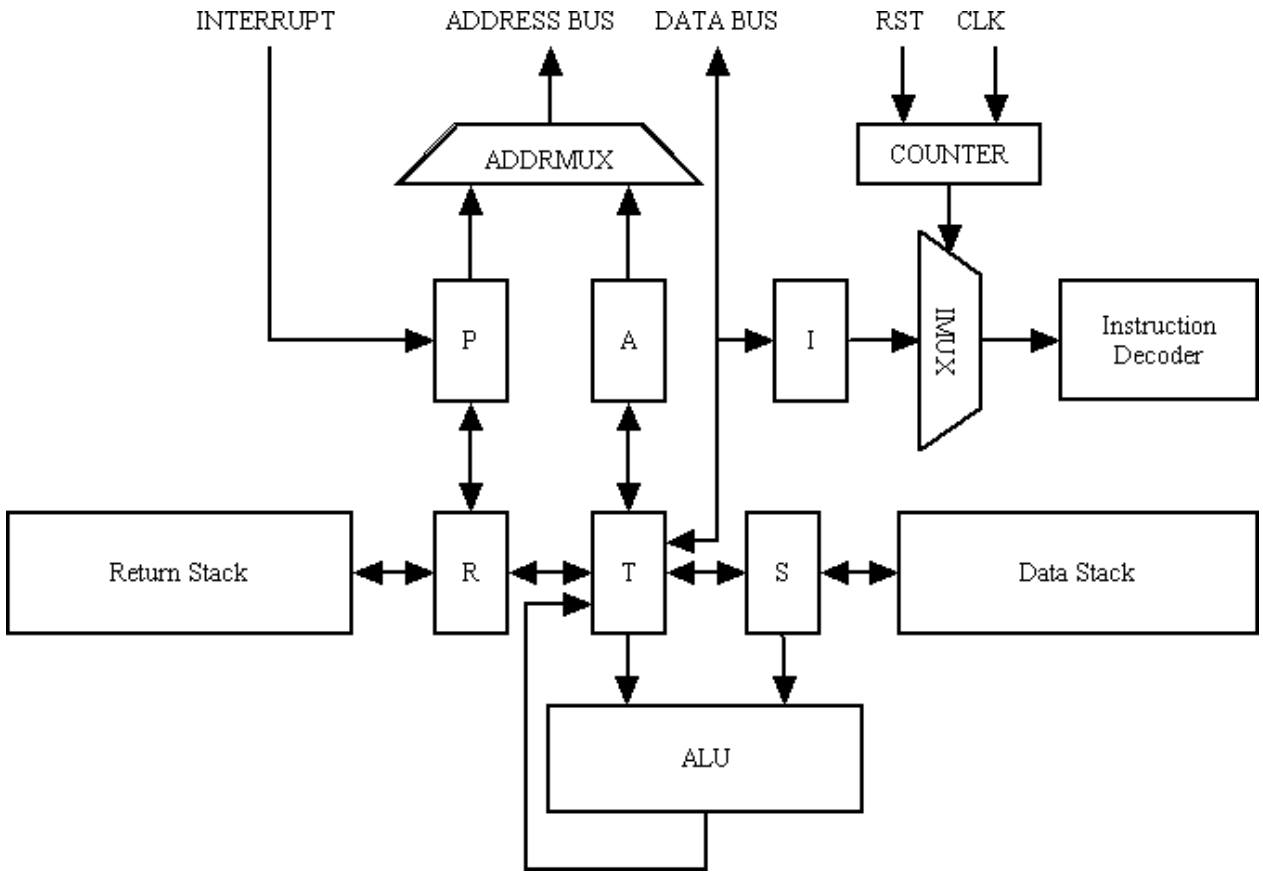
eP32 CPU Core

- 32 bit address and data busses
- 32 powerful orthogonal instructions
- 256 level return stack
- 256 level data stack
- Single cycle execution of all instructions
- Natural 5 instruction pipeline

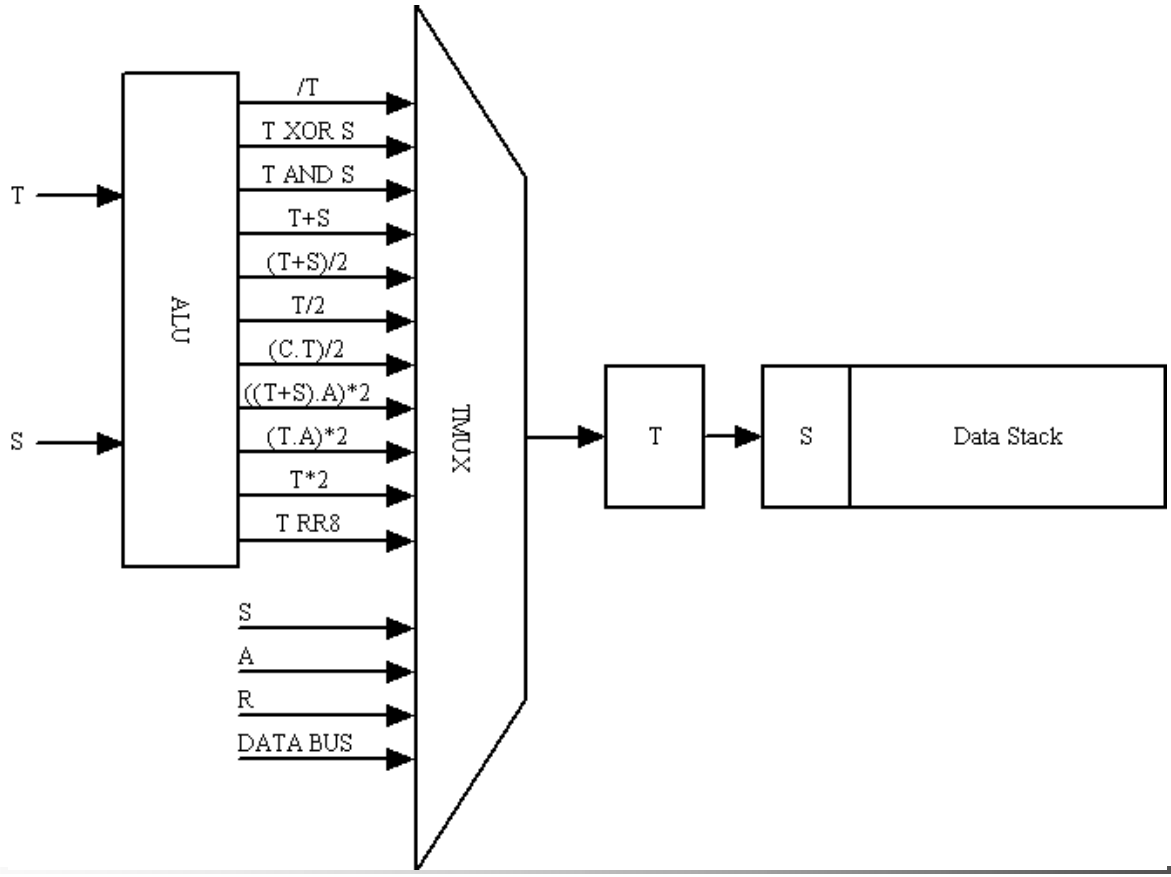
eP32 CPU Core

- CPU architectural view
- ALU and data processing chain
- Program and data memory address multiplexer
- Return address processing chain
- Instruction execution finite state machine

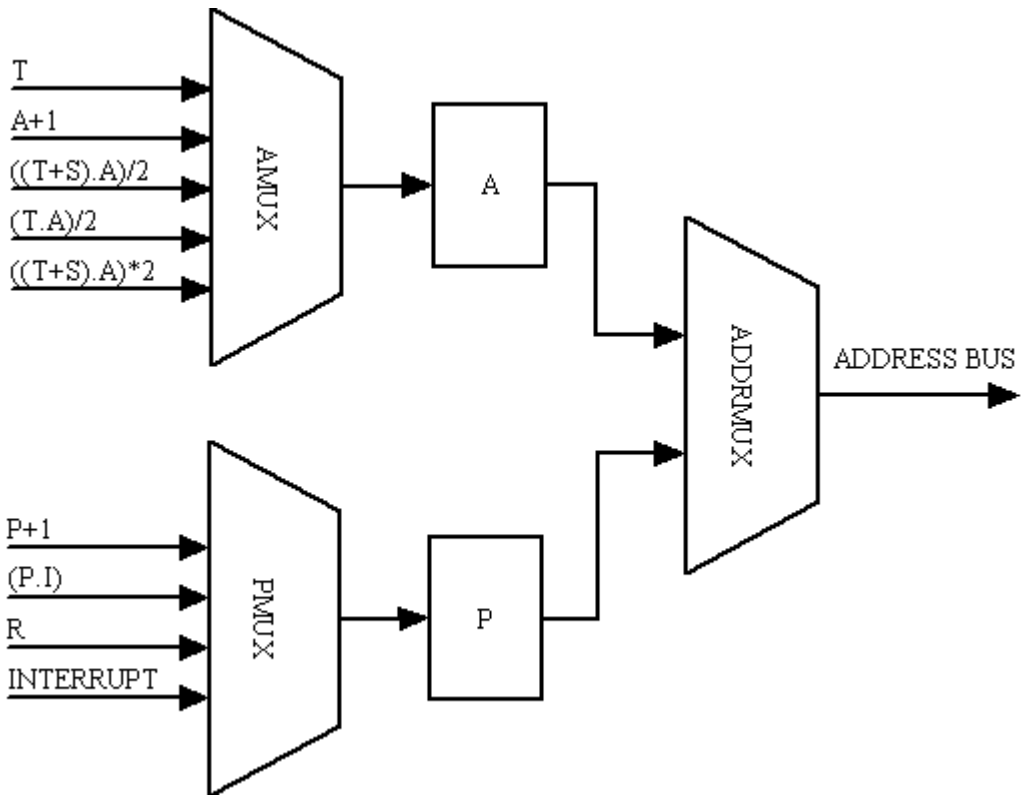
CPU Architectural View



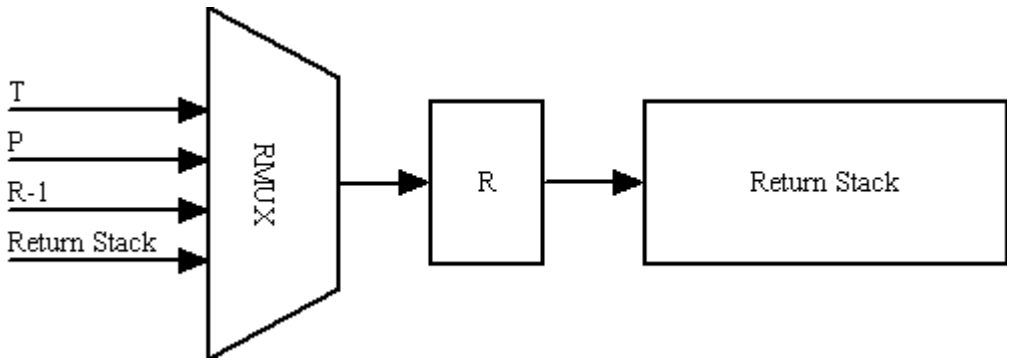
ALU and Data Processing Chain



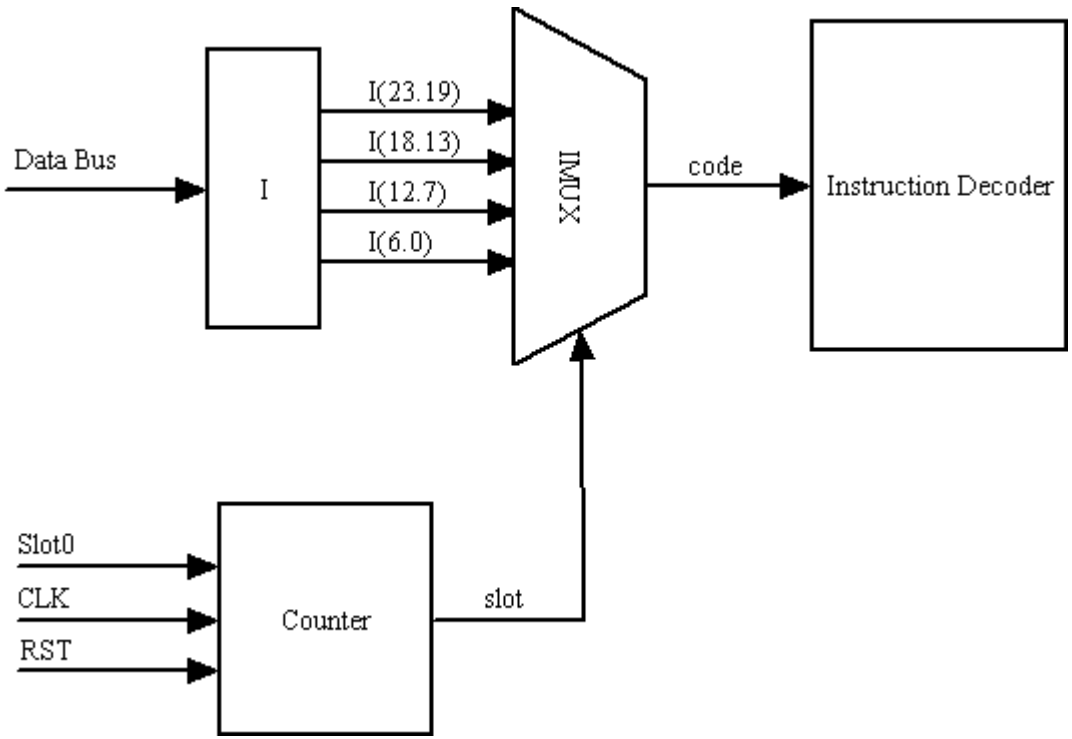
Program and Data Memory Mux



Return Address Processing Chain



Instruction Execution FSM



SRAM, Flash, and EEPROM

- A complete suite of memories
- 4 KB of internal dual port SRAM for stacks and caches
- 256 KB of external SRAM for program and data
- 4 MB of flash memory for mass storage
- 16 KB of serial EEPROM for booting

Input Output Peripherals

- 2 UART ports at 115200 baud
- SPI
- I2C
- 16 bit parallel IO port
- 8 switches
- 9 LED indicators
- LCD interface

Software Development

- eForth Real Time Operating System
- High level Forth programming language
- Interactive software development
- Convenient interface to Windows through HyperTerminal

eForth Operating System

- Ideal for SOC and embedded systems
- Serial port for human interface
- Command interpreter
- High level command compiler
- Low level assembler
- Debugging utilities

eP32 Instruction Set

- 32 orthogonal instructions
- Encoded in 6 bit fields
- 4 Types of instructions:
  - 6 Program transfer instructions
  - 5 Memory access instruction
  - 9 ALU instructions
  - 8 Register and stack instructions

Program Transfer Instructions

- BRA Branch always
- RET Return from subroutine
- BZ Branch on zero
- BC Branch on carry
- CALL Call subroutine
- NEXT Loop until R is 0

Memory Access Instructions

- **LD** Load from memory
- **LDP** Load from memory and increment A register
- **LDI** Load immediate value
- **ST** Store to memory
- **STP** Store to memory and increment A register

ALU Instructions

ADD	Add S to T
AND	AND S to T
XOR	XOR S to T
COM	Complement T
SHR	T shift to right
SHL	T shift to left
RR8	T rotate right by 8 bits
MUL	Multiplication step
DIV	Division step

Register and Stack Instructions

- PUSHS Duplicate T to S
- POPS Pop S to T
- PUSHR Push T to R
- POPR Pop R to T
- OVER Duplicate S over T
- LDA Load A to T
- STA Store T to A
- NOP

Demonstrations

- Power-up eSOCFM-1 board
- Interactive eForth system
- Control LED indicators
- Operate switches
- Download and compile source code
- Read and write flash memory

Concluding Remarks

- eSOCFM-1 Board is a complete SOC development platform
- Ideal for serious and substantial applications
- Very useful for FPGA evaluation and experimentation
- Integrated operating system allows efficient SOC system design and integration

Thank you very much!