Irreducible Complexity

eForth for Discovery

Silicon Valley FIG
July 26, 2014
Chen-Hanson Ting
Summary

- ARM7 eForth
- stm32eForth v7.20
- Irreducible complexity
- Nonconstained expansion
- Demo
  - STM32F4-Discovery Kit
  - ForthDuino Kit
ARM7 eForth

- V1.10  GameBoyAdvance, metacompiled with Win32Forth
- V2.01  GameBoyAdvance, metacompiled with F#
- V5.06  ADuC7024 with uVision3
- V6.03  AT91SAM7x256 with uVision3
- V7.20  STM32F407 with uVision5
Arm7 eForth v2.01 based on Win32Forth for GBA

- Original Direct Thread eForth Model
- Metacompiled with Win32Forth assembler
- Extensive Applications for GBA
  - Chinese Character Generator
  - eBooks
  - Bilingual Bible
  - DSO Simulator
ARM7 on GameBoyAdvance
GameBoyAdvance

- 16 MHz ARM7 core
- 32 Kbytes internal RAM
- 256 Kbytes external RAM
- 32 Mbytes Flash RAM
- 240x160 Color Display
- 10 Switches for user interface
- Serial Communication Port
- Graphic Objects
- Sound Objects
Forth Stamp
ADuC7024

- 45 MHz ARM7 core
- 64 Kbytes Flash RAM
- 8 Channels of 12-bit A/D
- 4 Channels of 12-bit D/A
- Serial Port
- Parallel Port
- Counters, Timers, Interrupt Controller
- Keil uVision3
Portable Audio Scope
Atmel AT91SAM7X256

- 64KB RAM and 256 KB flash memory
- 8 MHz ADC
- 132x132 Color LCD display
- Joystick and 2 more switches
- 3 UART ports
- JTAG, USB, Ethernet, SPI, CAN
DSO with Olimex Board
STM32F407-Discovery Board

- STM32F407VG Microcontroller
- ST-Link USB Debugging Port
- 3 Axis Accelerometer
- Audio ADC, DAC
- USB Mouse
- 80 GPIO Pins
STM32F407-Discovery Board
ForthDuino Board

- STM32F407VG Microcontroller
- USART1 Download Port
- 12 Switching Transistor Output Ports
- 13 Optical Isolated Input Ports
- Arduino I/O Ports
- LaunchPad I/O Ports
ForthDuino Board
STM32F407

- 32-bit Cortex M4 CPU
- 1 Mbytes flash
- 192 Kbytes RAM
- 168 MHz clock
- GPIO, timers, USART, ADC, DAC, SPI, I²C, CAN, USB, ..., you name it.
stm32eForth

- V7.01  Forth in flash memory
- V7.10  Forth in flash, remapped to Page 0, executing from Page 0
- V7.20  Forth in flash, copied to RAM. RAM remapped to Page 0, executing from Page 0
- V7.30  v7.20 for ForthDuino
Minimal Boot Code

AREA  RESET, CODE, READONLY

THUMB
EXPORT  __Vectors ; linker needs it
EXPORT  Reset_Handler ; linker needs it
__Vectors
  DCD  0x10000400 ; Top of hardware stack in CCM
  DCD  Reset_Handler ; Reset Handler
ENTRY
Reset_Handler
  BL  InitDevices ; RCC, GPIOs, USART1
  BL  UNLOCK ; unlock flash memory
  BL  REMAP ; remap RAM to page 0
  LDR  R0,=COLD-MAPOFFSET ; start Forth
  BX  R0
ALIGN
Minimal Peripheral Devices

- USART1
- GPIOB for TX and RX pins
- GPIOD to light LEDs
- RCC (Reset Clock Control) to provide clocks to USART1, GPIOB, and GPIOD
Minimal Command Set

- Headers of 23 system commands are commented out.
- 174 commands have headers and are searchable.
Turnkey Applications

; load appl6.txt
; load appl7.txt
0 ERASE_SECTOR
` APPL `BOOT !
TURNKEY
STM32F4-Discovery Kit

- 14 Counter-Timers.
- 80 Digital I/O Pins.
- Almost enough to build a digital electronic organ to play Bach’s organ concertos.
STM32F4-Discovery Kit

- $3 \times 12$-bit, $2.4$ MSPS A/D converters
- 24 channels and $7.2$ MSPS in triple interleaved mode
- LCD parallel interface
- Looks like a digital storage oscilloscope to me.
STM32F4-Discovery Kit

- ST-Link can be used to debug another STM32F4 chip
- It is used to debug ForthDuino Kit
- Stm32eforth730 is tested and verified on ForthDuino Kit.
STM32F4-Discovery Kit
stm32eForth Manual

1 eForth for ARM chips
2 Assemble stm32eforth
3 stm32 eforth source code
   3.1 Virtual Forth Machine
   3.2 eForth kernel
   3.3 Text interpreter
   3.4 Forth compiler
   3.5 Debugging tools
Demo

Stm32eforth720 on Discovery
Stm32eforth730 on ForthDuino
Use ST-Link on Discovery to debug ForthDuino
Demo
Demo
Demo
Conclusions

- Discovery is the cheapest ARM microcontroller board ever.
- It is the first microcontroller I don’t feel constrained by RAM memory.
- Its peripherals are overwhelming.
- It is a very good platform for firmware engineering.
Questions?
Thank You.