Outline

- Know the Hardware
- Writing “Embedded” code
Know the Hardware
STM32F4DISCOVERY

- STM32F407VGT6 microcontroller
  - 32-bit ARM Cortex-M4F core
    - 168 MHz
    - single cycle DSP MAC
    - floating point unit
  - 1 MB Flash,
  - 192 KB RAM
  - USART: 10.5 Mbit/s
  - SPI: 37.5 Mbit/s
  - ADC: 2.44 MSPS
STM32F4DISCOVERY
The Big Picture

- Understand the system
  - What are the major functionalities of this system?
  - What are the inputs/outputs interfaces?
  - What are the provided HW modules/peripherals?

- Read the documents!
  - Product description/brochure
  - User guide
  - Programmer guide
  - Reference manual
  - Application notes
  - Schematics
  - Errata
The Big Picture

- Observe the community
  - Opensource?
- Get a board!
  - Application fits the board?
    - Processing requirements
    - Data flow
Data Flow

System
- Power supply 1.2 V regulator
- POR/POR/PVD
- Xtal oscillators 32 kHz + 4–26 MHz
- Internal RC oscillators 32 kHz + 16 MHz
- PLL
- Clock control
- RTC/AWU
- SysTick timer
- 2x watchdogs (independent and window)
- 51/82/114/140 I/Os
- Cyclic redundancy check (CRC)

ART Accelerator™
- Floating point unit (FPU)
- Nested vector interrupt controller (NVIC)
- MPU
- JTAG/SW debug/ETM

ARM Cortex-M4
- 168 MHz
- Multi-AHB bus matrix
- 16-channel DMA

Control
- 2x 16-bit motor control
- PWM
- Synchronized AC timer
- 10x 16-bit timers
- 2x 32-bit timers

Crypto/hash processor
- 3DES, AES 256
- SHA-1, MD5, HMAC
- True random number generator (RNG)

Up to 1-Mbyte Flash memory
- Up to 192-Kbyte SRAM
- FSMC/
- SRAM/NOR/NAND/CF/
- LCD parallel interface
- 80-byte + 4-Kbyte backup SRAM
- 512 OTP bytes

Connectivity
- Camera interface
- 3x SPI, 2x PS, 3x PC
- Ethernet MAC 10/100 with IEEE 1588
- 2x CAN 2.0B
- 1x USB 2.0 OTG FS/HS
- 1x USB 2.0 OTG FS
- SDIO
- 6x USART,
- LIN, smartcard, IrDA,
- modem control

Analog
- 2-channel 2x 12-bit DAC
- 3x 12-bit ADC
- 24 channels / 2.44 MSPS
- Temperature sensor
Writing “Embedded” code
Components
Embedded Software Architecture

- Simple Control Loop
  - Single function
  - FSM
- Barebone
  - Interrupt-controlled
  - Cooperative multitasking
  - Preemptive multitasking
- Operating System
Constrains on Embedded Processing

- On Operation
  - Stand-alone
  - Error-handling

- On Resources
  - Memories
  - Processing
  - Power consumption
  - Peripherals

- On Execution
  - RT constraints
Supplementary Info

- **UART**
  - Universal Asynchronous Receiver/Transmitter

- Data are sent sequentially as individual bits.

- Sender and receiver have to agree on transmission characteristics:
  - Baud Rate: how fast data is sent over a serial line
  - Framing: number of bits
  - Synchronization: start and stop sequences
  - Error detection: parity bits
  - Flow control
Supplementary Info

- SPI
  - Serial Peripheral Interface
- Targets asynchronous problems in serial communication
  - Uses separate lines for data and clock signals
Memory Map

- Where things are!
  - On-chip memory
  - Off-chip memory
  - Registers
  - Peripherals

- Memory-mapped I/O
  - CPU uses read/write operations on different I/O and peripherals on the chip
Walkthrough

- STM32FDISCOVERY UART