The Idea!
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Trackmate is a GPS enabled MP3 player that allows athletes to track their speed and distance using GPS data. It provides an easy and intuitive touch screen interface and an SD card for data transfer.
Microprocessor: NXP LPC2478

- ARM7 processor
- Controls peripherals
- SDRAM support
- LCD Controller with TFT support
- SD card memory interface
- SPI interface controller for audio decoding and LCD display
- RS-232 peripheral interface for GPS and programming the processor
High Level Block Diagram

LPC2478 Microprocessor
Printed Circuit Board
TFT LCD Display With Touchscreen

• Used to display interface to user as well as GPS data and MP3 playback
• Capacitive Touch Panel Control
• 24-Bit RGB Interface for display
• Each pixel can display over 16 million different colors!

Challenges:
• Configuring the interfaces
• Parsing the touch data
Printed Circuit Board
MP3 Audio Decoder:
- Used to decode MP3 audio files stored on the SD card
- SPI interface
- Volume control built in

Audio Output:
- Used for the output of the MP3 decoder to any audio system

Challenges:
- Configuring the registers
- Verifying the data path
High Level Block Diagram

LPC2478 Microprocessor

VS1011e Audio Decoder

Audio Output

User Interface (buttons/touch screen)

TFT LCD Display With Touchscreen
Printed Circuit Board
RS-232 Connector and Level Shifter

• Used for programming the processor.
• Helpful for debugging and testing peripherals.
• Necessary to boot up the processor and run code.
Printed Circuit Board
SDRAM

- 128MB of storage
- Used to store data read from the SD card for fast access later
  - send audio data to the audio decoder
  - send video and pictures to the display

Challenges:
- Partitioning the SDRAM addressing several components.
- Configuring the pins
Printed Circuit Board
SD Card Reader

- Uses proprietary 4-bit SD/MMC interface
- Files on card organized using FAT16
- Used to store user video, pictures and audio

Difficulties:
- Understanding the 4 part SD specification
- Figuring out the DMA interface
- Parsing the FAT system
High Level Block Diagram

- LPC2478 Microprocessor
  - 128 MB SDRAM
  - RS-232 Connector and Level Shifter
  - VS1011e Audio Decoder
  - Audio Output

- User Interface (buttons/touch screen)
  - TFT LCD Display With Touchscreen
  - SD Card Reader

- RS-232 Connector and Level Shifter

- Audio Output
GPS with Internal Antenna

- Outputs a timestamp with GPS coordinates
- Distance and Speed is displayed on LCD

Difficulties:
- Communication through UART
- Parsing the GPS strings
High Level Block Diagram

- LPC2478 Microprocessor
- 128 MB SDRAM
- PMB-648 GPS Module
- RS-232 Connector and Level Shifter
- VS1011e Audio Decoder
- Audio Output
- User Interface (buttons/touch screen)
- TFT LCD Display With Touchscreen
- SD Card Reader
- RS-232 Connector and Level Shifter
Video Demonstration:
Technology and IP Re-use

- GPS Module
- SDRAM
- Processor
- Audio Decoder
- LCD Display and Touch Screen
- RS-232 Level Shifter
- SD Card
What we did right:

• Good organization and design
• Effective teamwork
• Kept the project to a reasonable level of implementation
• Dedicated ourselves to specific peripherals to be able to work in parallel after fabrication
• Read through individual data sheets before programming peripherals
• Sacrificed most of our social lives to complete the project
What we did wrong:

- Correctness of board layout and error checking
- Leaving parts of the board until the last minute to fix
- Waiting too long to start programming the board
- Voltage regulators
- Not preparing GPIO pins for testing the processor
- DIP switch issues
Advice to future students:

• Get a head start and make sure to read and understand ALL of the datasheets (especially for the processor)
• Check for errors in board layout and peripheral specifications over and over again, there's never too much you can check for
• Test Pins are cheap! Use them freely! Makes debugging easier
• Make sure there is plenty of support for a peripheral before buying it
Improvements and thoughts

- PCB is proof-of-concept
- Final product could be much smaller
- A final implementation could use a low power, low cost processor. (NXP generously donated current processor)
- Mass production will drop the cost
Thanks to all!!!

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KEIL
Tools by ARM

NXP

RAPID PROTOTYPES
TECHNOLOGY & MANUFACTURING, LLC

SUNSTONE
CIRCUITS
And one final thank you to....
Questions?