

# NETMF

{ Embedded development with .NET



- ⌘ Background
- ⌘ What is .NET Micro Framework (NETMF)?
- ⌘ What do I need to get started?
- ⌘ What can I do with it?
- ⌘ DEMO

# Agenda



- ⌘ Bachelor thesis
- ⌘ No experience with embedded programming
- ⌘ No C knowledge
- ⌘ Short time frame

# Background



- ⌘ Started with SPOT in 2004
  - ⌘ Smart hardware and software for household electronics

# What is NETMF?





{ SPOT Watch

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{ SPOT Watch

# What is NETMF?

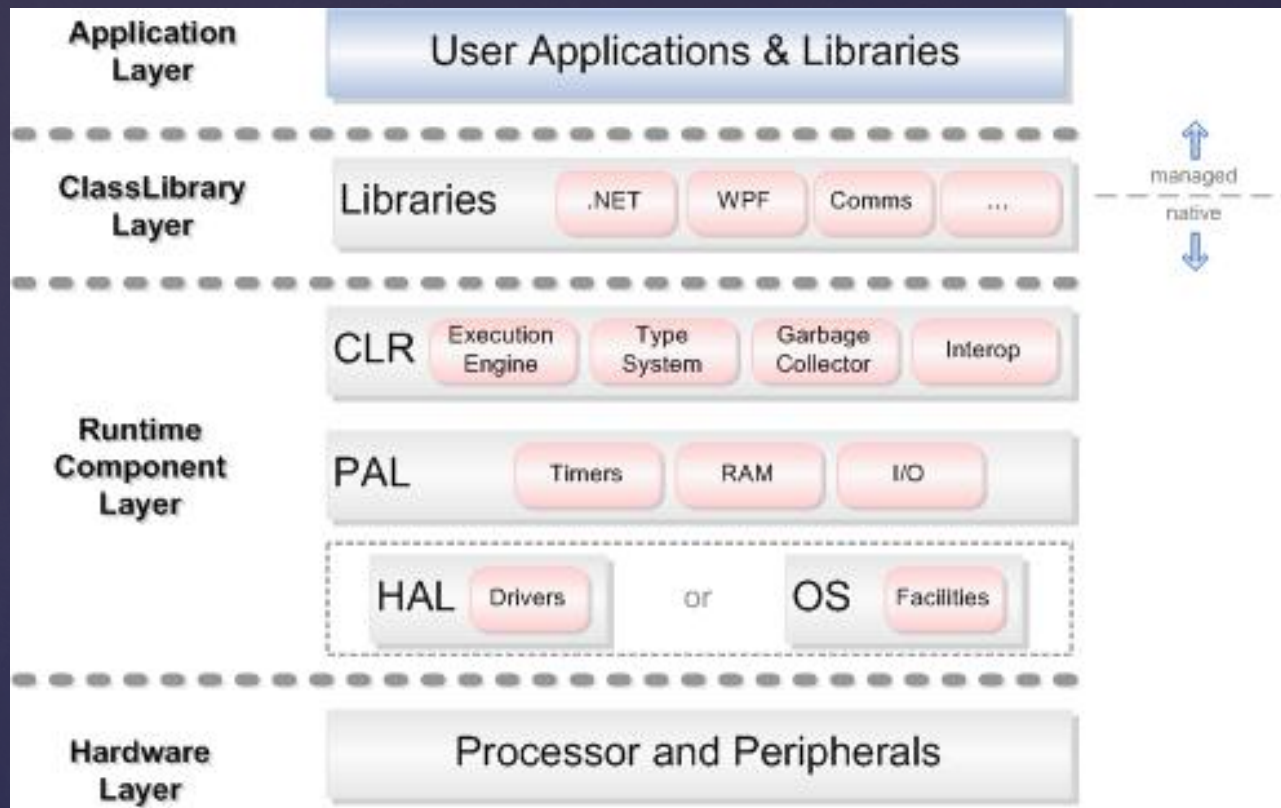




- ⌘ A re-implementation of the desktop CLR for embedded devices that are unable to run high-end embedded OS such as WinCE
- ⌘ No OS
- ⌘ Very small memory footprint
  - ⌘ 512KB ROM and 256KB RAM
- ⌘ Runs on ARM7 and up
- ⌘ Programming is entirely C# managed code
- ⌘ Can be debugged live with Visual Studio
- ⌘ Open Source ([netmf.codeplex.com](http://netmf.codeplex.com))

# What is NETMF?





# Architecture



Windows 7

Notebook

Desktop

Windows  
Embedded

Industrial robots

ATMs, Fuel  
pumps

Windows  
CE

Windows  
Mobile

Zune

.NET Micro  
Framework

Sensor networks

Remote controls,  
wireless devices

# Platforms

## System.Web

Services

UI

Cache

Security

Configuration

Session state

## System.Windows.Forms

Design

Component model

## System.Drawing

Drawing 2D

Printing

Imaging

Text

## System.Data

ADO.NET

SQL Client

Design

SQL Server CE

## System.XML

XML Document

Serialization

Xslt/XPath

Reader/writers

# System

Collections

IO

Configuration

Security

Net

Service process

Text

Reflection

Diagnostics

Globalization

Resources

Threading

Runtime

# .NET Framework



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# .NET CF



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# .NET MF



- ⌘ C# knowledge
- ⌘ Visual Studio 2010
- ⌘ .NET Micro Framework SDK
- ⌘ An embedded device

# What do I need to get started?



- & C# knowledge
- & Visual Studio 2010
- & .NET Micro Framework SDK
- & ~~An embedded device~~

# What do I need to get started?

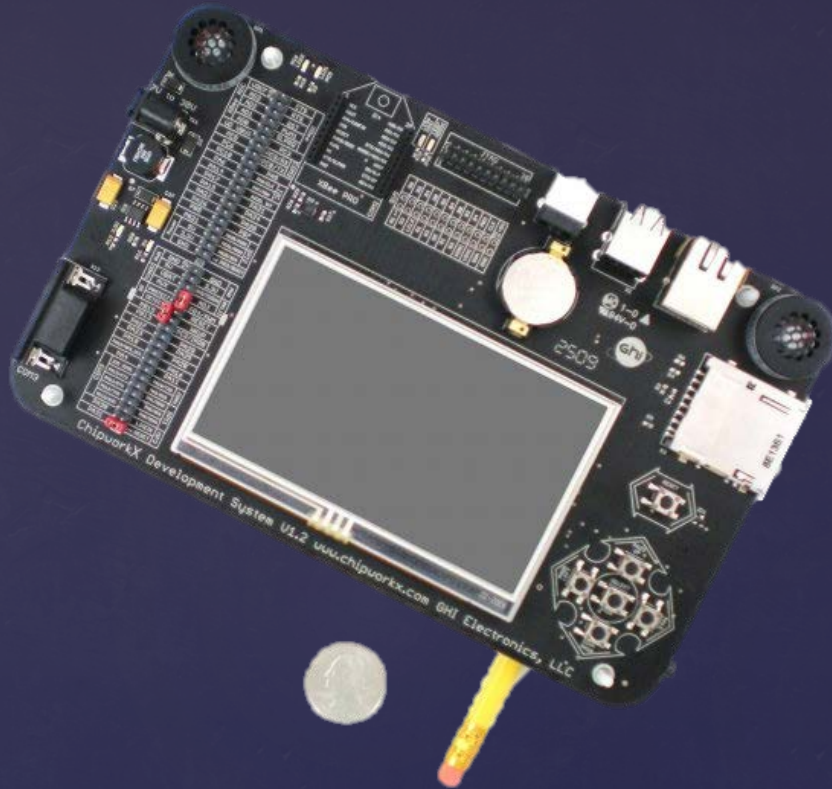






- ⌘ Extensible
- ⌘ Default emulator
  - ⌘ Five buttons
  - ⌘ LCD screen

# Emulator



- ⌘ 200MHz ARM9
- ⌘ 256MB FLASH
- ⌘ 64MB RAM
- ⌘ 4.3" TFT Touch Screen
- ⌘ Dual USB Host
- ⌘ Ethernet
- ⌘ Accelerometer
- ⌘ SD Card
- ⌘ \$400 (Sale for \$300)

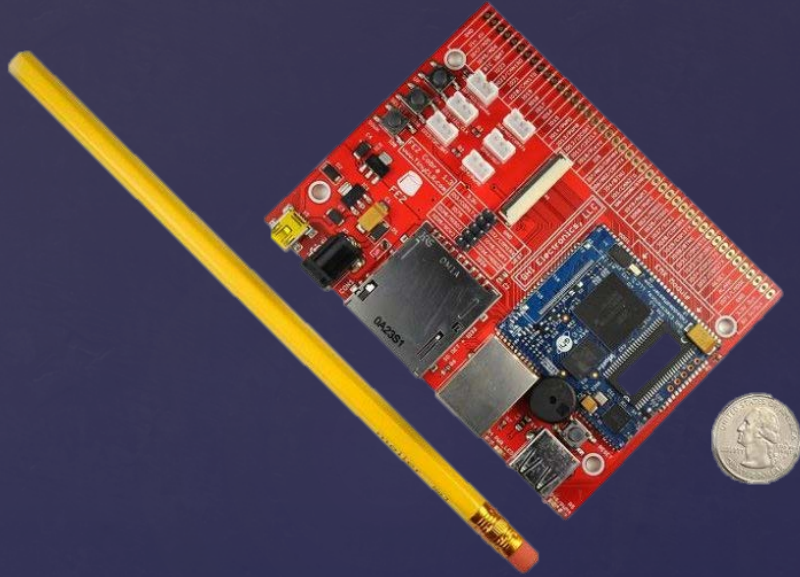
# ChipworkX



- ⌘ 100MHz ARM9
- ⌘ 4MB FLASH
- ⌘ 8MB RAM
- ⌘ 3.5" TFT Touch Screen
- ⌘ USB
- ⌘ Ethernet
- ⌘ Accelerometer
- ⌘ SD Card
- ⌘ Temperature sensor
- ⌘ \$350

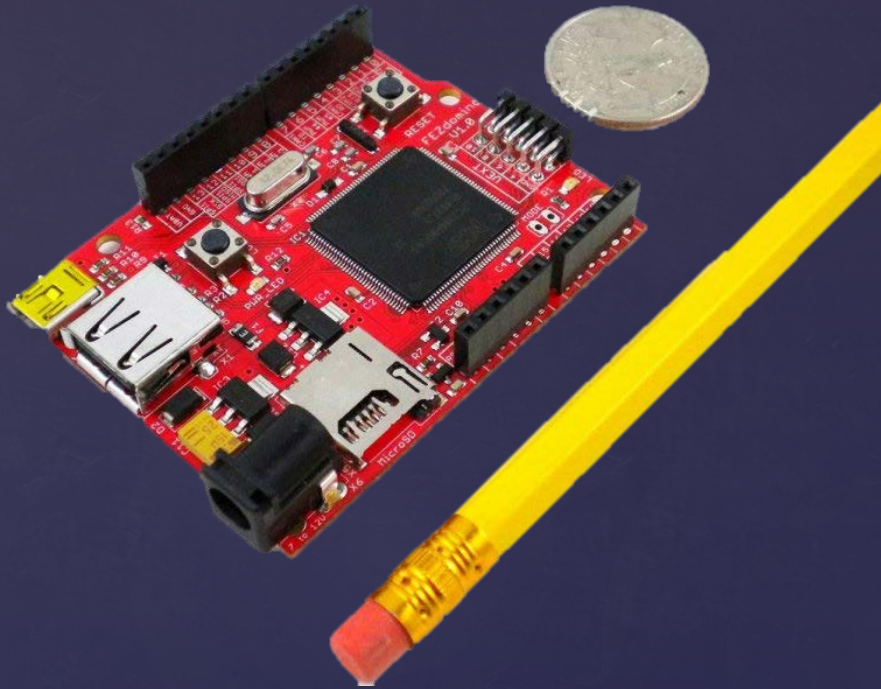
# Tahoe-II





- ⌘ 72MHz ARM7
- ⌘ 3MB FLASH
- ⌘ 12MB RAM
- ⌘ TFT Touch Screen support
- ⌘ USB Host
- ⌘ Ethernet
- ⌘ SD Card
- ⌘ Open Source Hardware
- ⌘ \$150

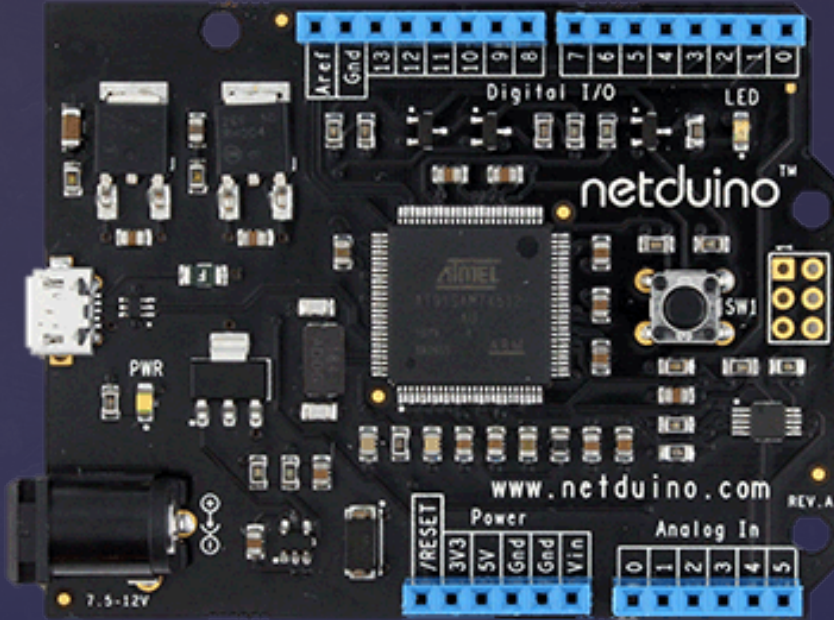
# FEZ Cobra



- & 72MHz ARM7
- & 148KB FLASH
- & 62KB RAM
- & USB Host
- & MicroSD Card
- & Open Source Hardware
- & Arduino form factor
- & \$40

# FEZ Domino





- & 48MHz ARM7
- & 128KB FLASH
- & 60KB RAM
- & Open Source Hardware
- & Arduino form factor
- & \$35

# Netduino





- & 72MHz ARM7
- & 148KB FLASH
- & 62KB RAM
- & Open Source Hardware
- & \$25

# FEZ Mini

Anything!

What can I do with it?

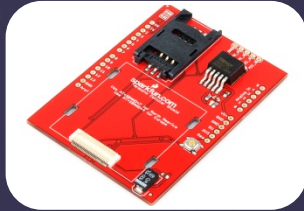


## Examples:

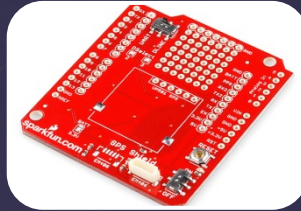
- ⌘ Gyros
- ⌘ Accelerometers
- ⌘ Temperature, humidity sensors
- ⌘ Wi-Fi or Ethernet
- ⌘ Xbee
- ⌘ Cellular modules (GSM)
- ⌘ GPS
- ⌘ LCD Screens
- ⌘ Radio
- ⌘ RFID

# Connect to anything...

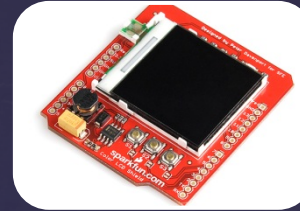




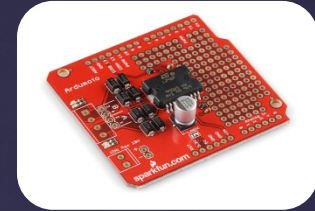
Cellular



GPS



LCD



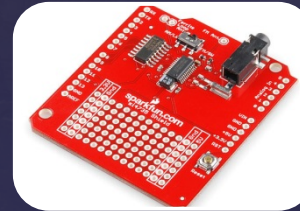
Motors



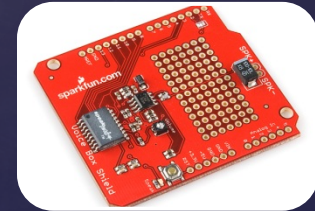
Mp3



Wi-Fi

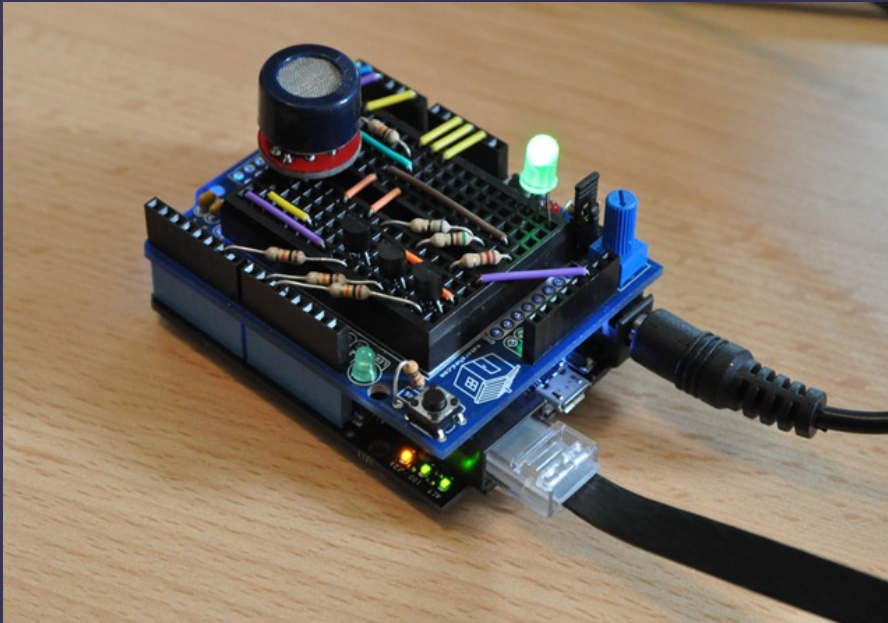


FM/AM



VoiceBox

# Arduino Shields



**Drunkduino** Drunkduino  
x\_x at 10:08:54 PM



**Drunkduino** Drunkduino  
Whoa! **#WINNING** at 10:08:45 PM



**Drunkduino** Drunkduino  
Drunk at 10:08:36 PM



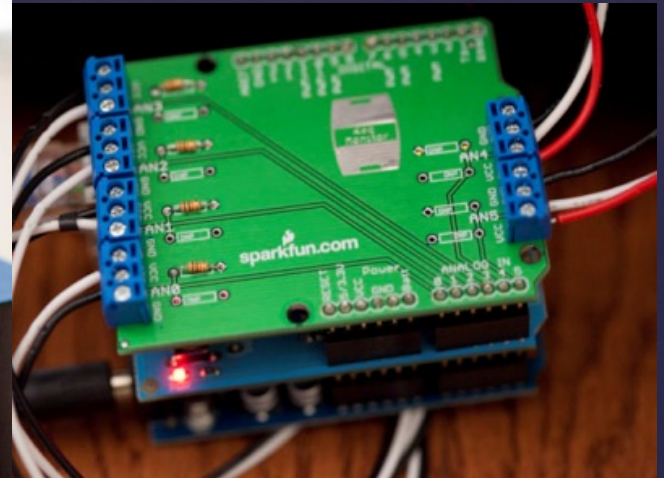
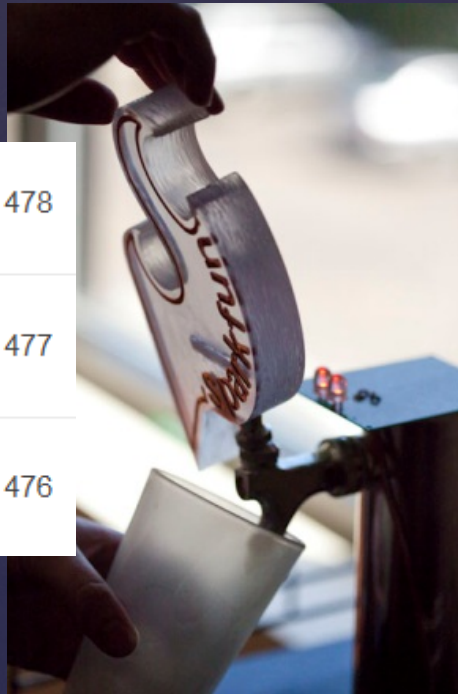
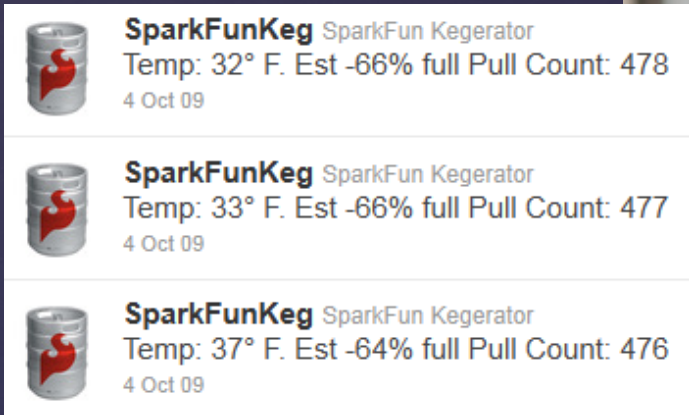
**Drunkduino** Drunkduino  
Tipsy at 10:08:27 PM



**Drunkduino** Drunkduino  
No alcohol detected at 9:06:53 PM

# A tweeting breath analyzer





# Tweeting kegerator



# DEMO

{ Time to get our hands dirty ☺



Sites worth checking out:

↳ [SparkFun.com](http://SparkFun.com)

↳ [TinyCLR.com](http://TinyCLR.com) and GHI Electronics

↳ [channel9.msdn.com](http://channel9.msdn.com)

↳ [NETMF.com](http://NETMF.com)

Kristian Hellang

[@khellang](https://twitter.com/khellang)

# Questions?

