



# ScroogeMote

Sensor motes for cheapskates

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# About me & our project



- Visiting professor for Media Informatics, University of Regensburg
- Course with Raphael Wimmer: „Sketching with Hardware“  
<https://www.youtube.com/watch?v=0f8ghiZXtIA>
- Introduction to electronics, Arduino & hardware hacking in general
- Looking for projects for an advanced follow-up course...
- idea: design a „starter kit“ for wireless sensor networks

# Design Goals



- communicates with „regular“ devices (smartphone, laptop, ...)
  - use WiFi or Bluetooth (no extra dongle required)
- can be programmed with Arduino IDE over USB
  - use AVR microcontroller + compatible bootloader
- long lifetime (~ months) with coin-cell battery
  - require power-saving  $\mu$ C (e.g. PicoPower) + Bluetooth 4.0 (Low Energy)
- can be assembled by beginners, compatible with regular breadboards
  - use only through-hole components
- very, very low cost (~ 5 € per mote)
  - ... ?

# (not quite) Impossible?



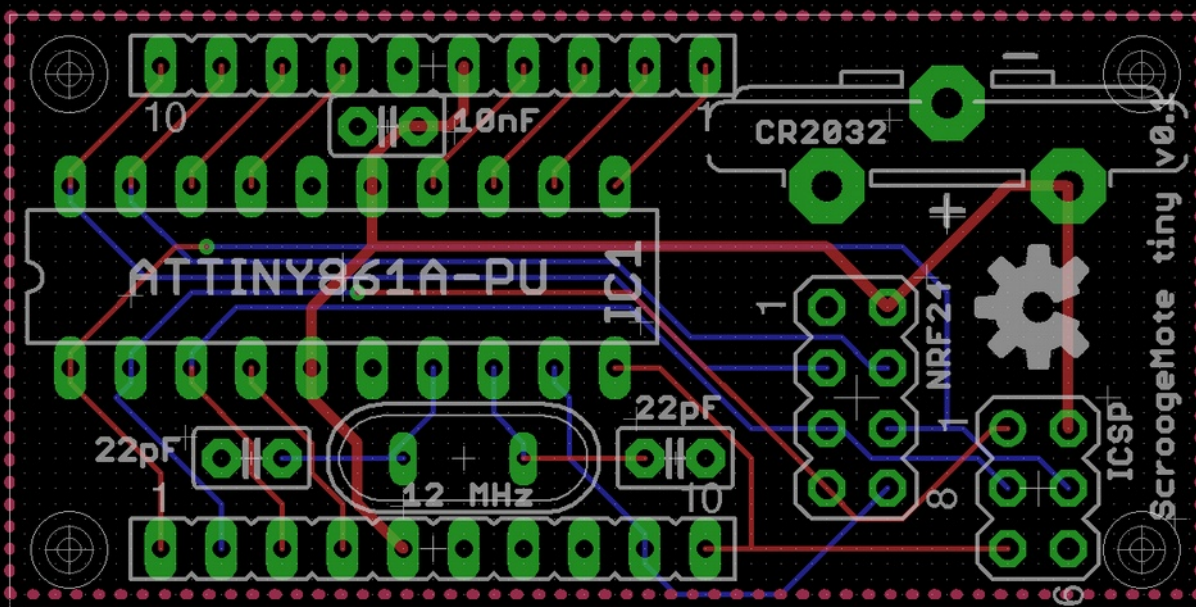
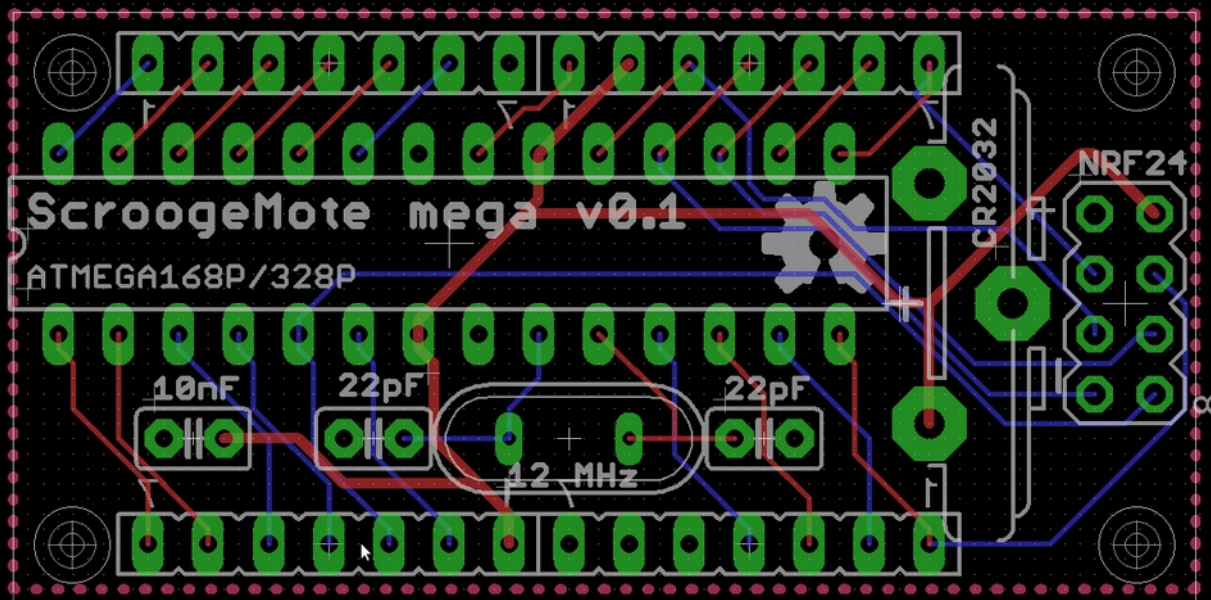
- Bluetooth 4.0/LE module: ~ 15 €
- „regular“ Bluetooth module: ~ 5 €
- nRF24L01+ module (generic 2.4 GHz transceiver): ~ 2 € (!)
- Thanks to Dmitry Grinberg: nRF24 can communicate with BTLE devices!  
<http://dmitry.gr/index.php?r=05.Projects&proj=11.%20Bluetooth%20LE%20fakery>
- small subset of BTLE: broadcasts on announcement channels, but still...
- available as Arduino library on Github: <https://github.com/floe/BTLE>
- use B-BLE (Android) or LightBlue (iOS) to detect/read data

# The Scroogemote

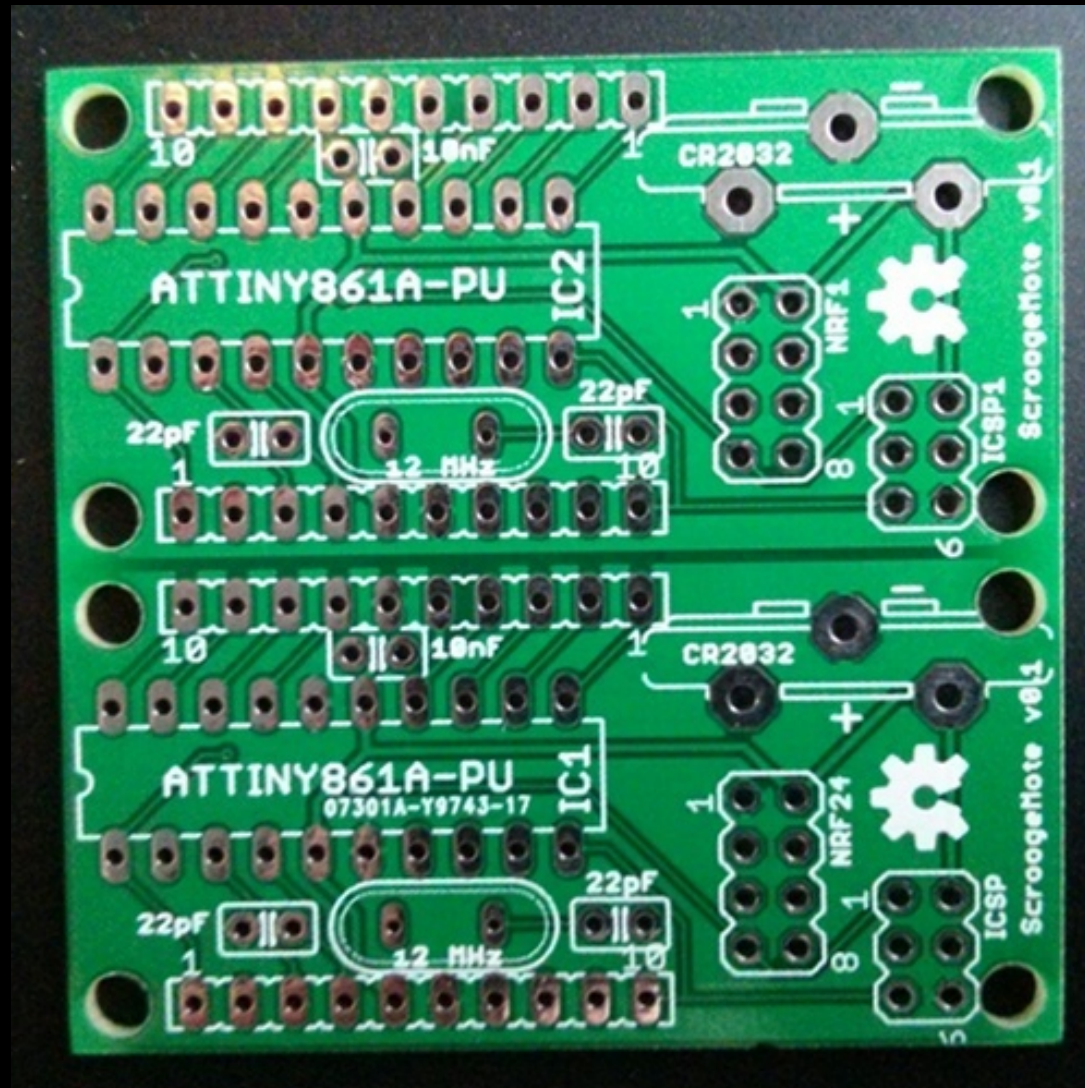


- 4 major components:
  - PCB
  - nRF24L01+ module + pin header
  - ATtiny861A / ATmega328P + IC socket
  - coin cell + holder
- Optional components
  - 12 MHz quartz + capacitors
  - pin headers for breadboard connection
  - 1 resistor + 2 diodes + cable for USB connection

# The Scroogemote



# The Scroogemote



# BOM (ScroogeMote tiny)



<i>Amount</i>		<i>Type</i>	<i>Reichelt</i>	<i>iTeed</i>
10		Cap. 10 nF	0,60 €	
20		Cap. 22 pF	1,20 €	
10		Crystal 12 MHz	1,70 €	
10		2x4 pin female header	2,60 €	
10		CR2032 coin cell	4,40 €	
10		20 pin DIP socket	0,80 €	
20		1x10 pin male header		1,20 €
10		coin cell holder (vertical)		2,40 €
10		PCB		7,92 €
10		nRF24L01+ module		17,60 €
10		ATtiny861A-PU	19,00 €	
		<b>Shipping</b>	5,60 €	5,84 €
		<b>Sum</b>	35,90 €	34,96 €
		<b>Grand Total:</b>	59,42 €	70,86 €



# BOM (ScroogeMote mega)



<i>Amount</i>		<i>Type</i>	<i>Reichelt</i>	<i>iTead</i>
10		Cap. 10 nF	0,60 €	
20		Cap. 22 pF	1,20 €	
10		Crystal 12 MHz	1,70 €	
10		2x4 pin female header	2,60 €	
10		CR2032 coin cell	4,40 €	
10		20 pin DIP socket	0,80 €	
20		1x10 pin male header		1,20 €
10		coin cell holder (vertical)		2,40 €
10		PCB		7,92 €
10		nRF24L01+ module		17,60 €
10		ATMega328P-PU	39,00 €	
		<b>Shipping</b>	5,60 €	5,84 €
		<b>Sum</b>	55,90 €	34,96 €
		<b>Grand Total:</b>	79,42 €	90,86 €

# Open Questions...



- Power management vs. Arduino core
  - tradeoff between ease-of-use and power consumption
- Suggestions for small(er) Arduino core for ATtiny  $\mu$ C?
  - current code size with regular Arduino core ~ 6k
- PCB manufactured at iTead
  - best pricing?
- Current layout: 2 motes on 5x5cm board
  - alternative: perhaps 7+1 on 10x10 board?
- *Any experience with milling of panelized PCBs?*
  - *iTead disallows v-grooves etc., but how about snap-off milling?*