

# Why do I work with electronics, and why is it so complex?

- Carsten Wulff
- Wireless Group Manager at Nordic Semiconductor
- Postdoctoral research fellow at NTNU
- Married with three kids
- Master of Science (2002) from NTNU, Ph.D. (2008) from NTNU

## Controlled study proves activity monitor and motivational website increase children's physical activity and improve health by making exercise fun



Zamzee uses Nordic Semiconductor technology to encourage children to exercise

The 'Zamzee' activity monitor, which includes a new Bluetooth Smart wireless version that employs Nordic Semiconductor wireless technology, encourages sedentary children to start enjoying the health and wellness benefits of physical activity by measuring performance and rewarding effort with virtual badges, "pointz", and virtual currency called "Zamz" which can be redeemed for prizes like toys and gift cards

Oslo, Norway | 2014/08/26

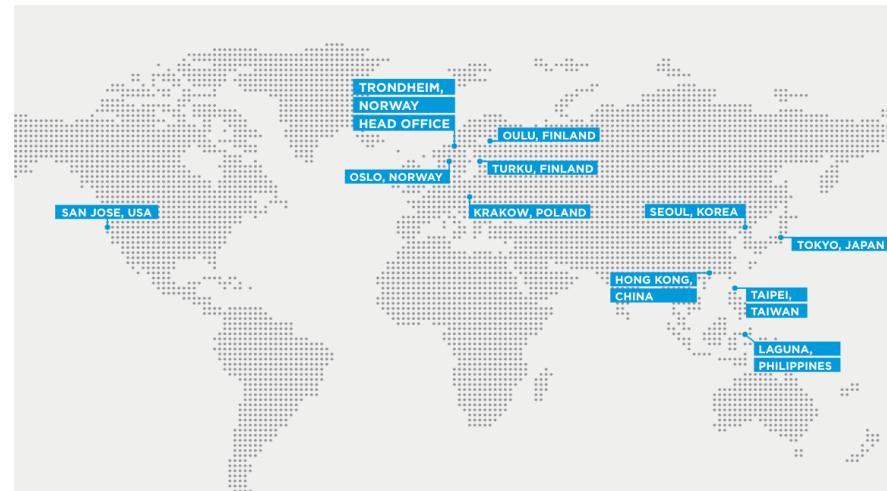
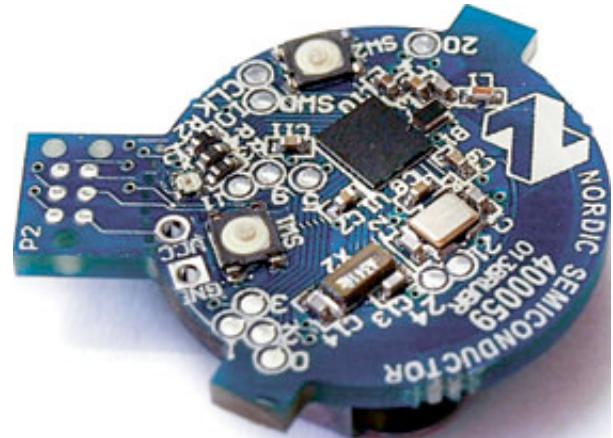
Ultra low power (ULP) RF specialist Nordic Semiconductor ASA (OSE: NOD) today announces that U.S.-based non-profit research organization, HopeLab, has specified Nordic nRF8001 Connectivity ICs to provide the Bluetooth Smart® (previously known as Bluetooth low energy) wireless link in the latest wireless version of its 'Zamzee' activity monitor for children.

In a six-month randomized controlled trial of 448 subjects aged 11 to 14, Zamzee was proven to increase the weekly moderate-to-vigorous physical activity (MPVA) in children by 59 percent (equating to 45 additional minutes of MPVA per week) compared to a control group. (See "A summary of the behavioral and biological

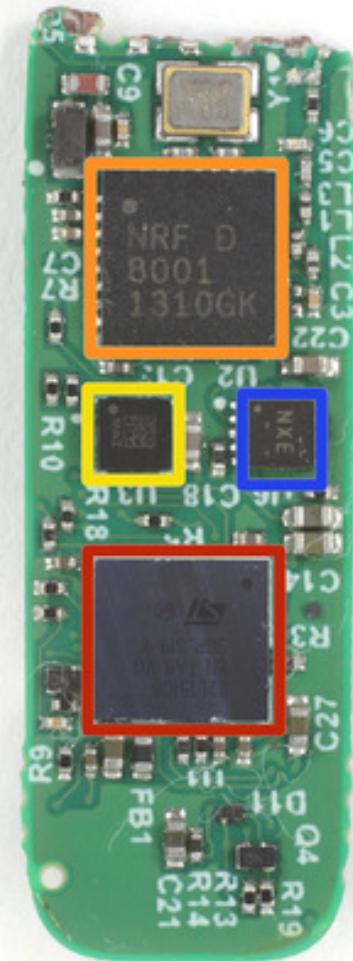
[Press release](#)

# Who is Nordic Semiconductor?

- Norwegian company (1983 - )
- Main product
  - 32 –bit ARM MCU with multi-protocol 2.4GHz transceiver (nRF51 & nRF52)



# End product example



# How can a small Norwegian company rule the low-energy wireless world?



**NORDIC**  
SEMICONDUCTOR

Some of our customers:

Found googling "nrf8001 teardown"



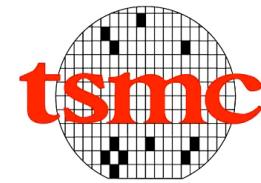
A common subcontractor

**FOXCONN**<sup>®</sup>

Wait for it

**NORDIC**  
SEMICONDUCTOR

Some of our suppliers



43591 (2014)

A common subcontractor

**ASML**

11533 (2015)

<https://www.youtube.com/watch?v=ShYWUIJ2Fzs>

**CYMER**  
An ASML company

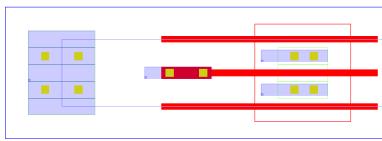
1300 (2015)

<https://www.youtube.com/watch?v=8xJEs3a-1QU>

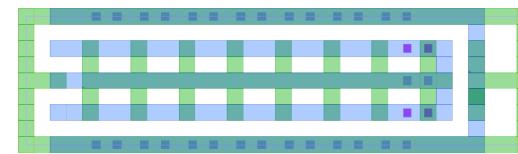
# Who makes electronic things?

| Companies with the most employees in the world |   |                |           |
|--|---|----------------|-----------|
| Rank   | Employer                                  | Country        | Employees |
| 1  | Walmart                                   | United States  | 2,200,000 |
| 2  | Hon Hai Precision Industry (T.A. Foxconn) | Taiwan         | 1,090,000 |
| 3  | Sinopec                                   | China          | 1,021,979 |
| 4  | G4S                                       | United Kingdom | 620,000   |
| 5  | Tata Group                                | India          | 602,000   |
| 6  | United States Postal Service              | United States  | 601,601   |
| 7  | Tesco                                     | United Kingdom | 597,784   |

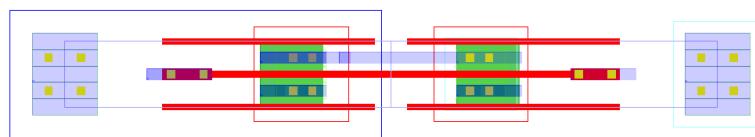
# Basic building blocks



Transistor (NMOS)

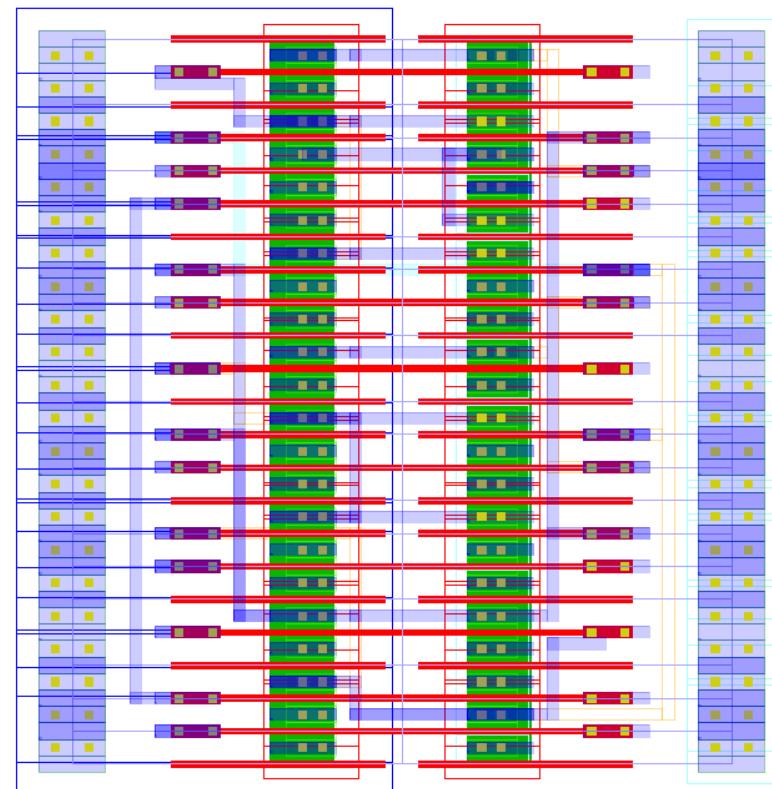


Capacitor (MOM)



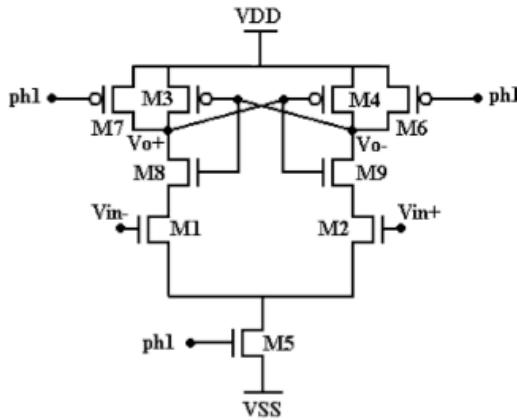
Inverter

D-flip-flop with reset

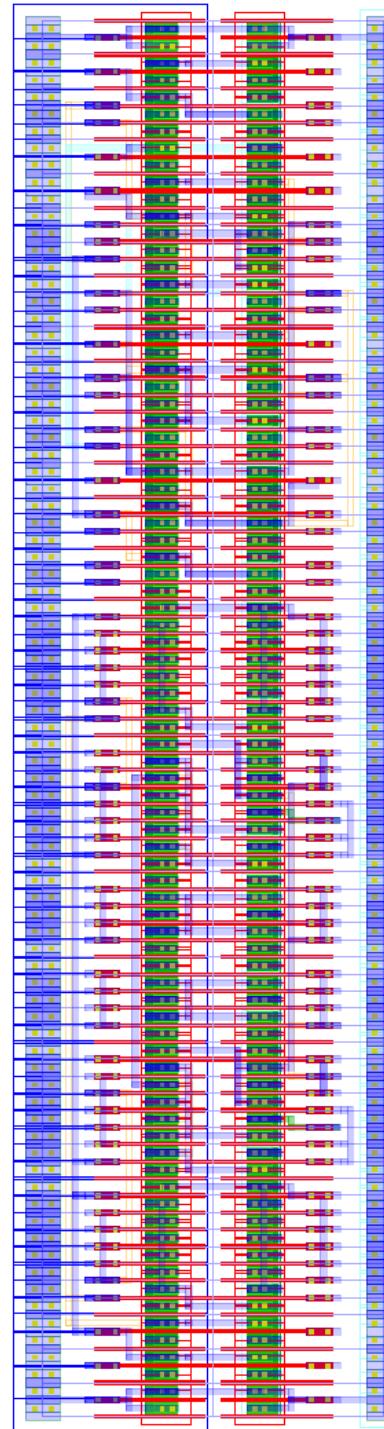


# Strong-arm comparator

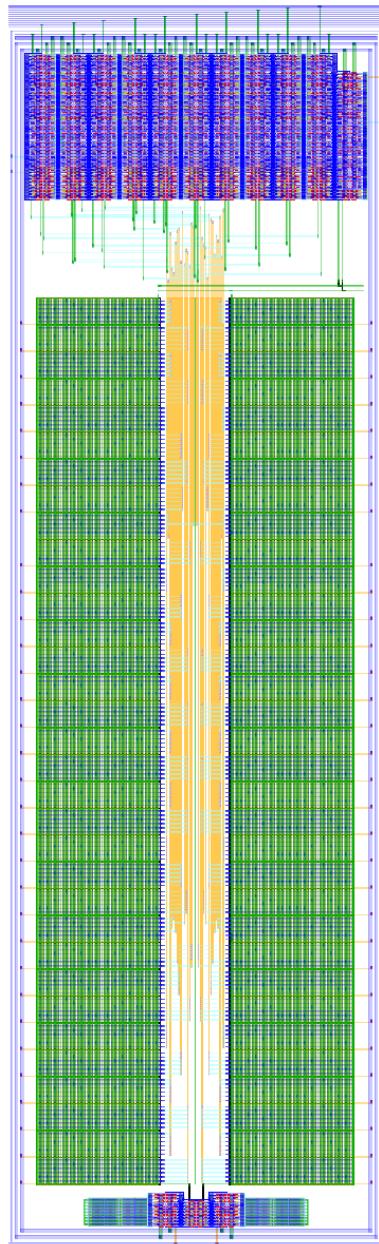
```
.SUBCKT SARCMPX1_CV CPI CNI CPO CNO CK_CMP CK_SAMPLE PWRUP EN DONE NC1 NC2 AVDD AVSS  
XA0 AVSS TAPCELL_CV  
XA9 CK_CMP CK_B AVDD AVSS IVX1_CV  
XA10 CK_B CK_N AVDD AVSS IVX1_CV  
XA1 CPI CK_B CK_N AVDD AVSS SARKICKHX1_CV  
XA2 CPI CK_B CNO_I CPO_I N1 NC1 AVDD AVSS SARCMPHX1_CV  
  
XA2a CPO_I CPO AVDD AVSS IVX4_CV  
XA3a CNO_I CNO AVDD AVSS IVX4_CV  
  
XA3 CNI CK_B CPO_I CNO_I N1 NC2 AVDD AVSS SARCMPHX1_CV  
XA4 CNI CK_B CK_N AVDD AVSS SARKICKHX1_CV  
  
XA11 PWRUP CK_SAMPLE RST AVDD AVSS NDX1_CV  
XA13 TIEH DONE RST NC3 NN1 AVDD AVSS DFRNQN1_CV  
XA12 TIEH AVDD AVSS TIEH_CV  
XA14 NN1 RST EN AVDD AVSS ANX1_CV  
XA15 AVSS TAPCELL_CV  
.ENDS
```



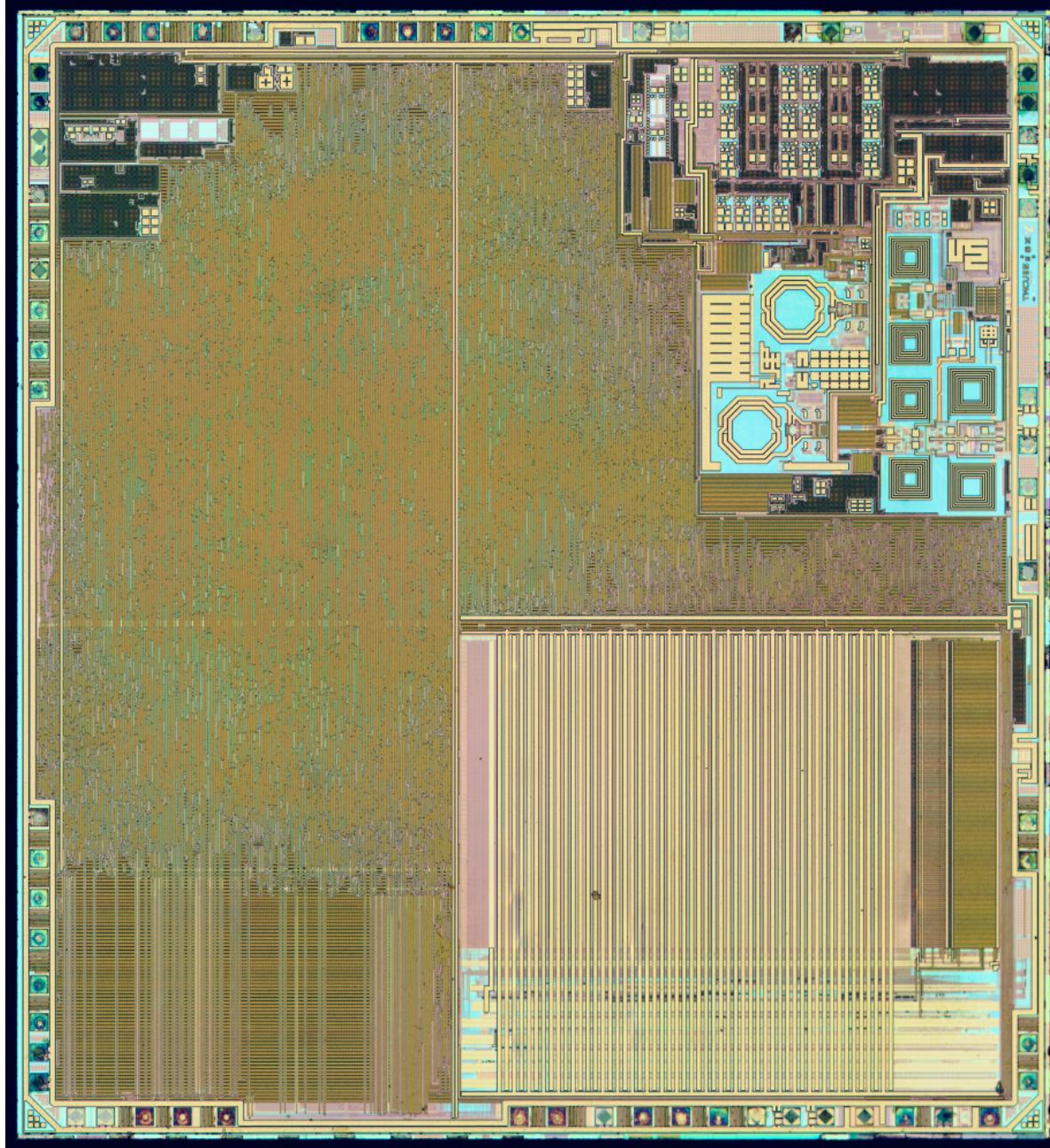
<http://www.designers-guide.org/Forum/Attachments/cmp.png>



# A complete ADC

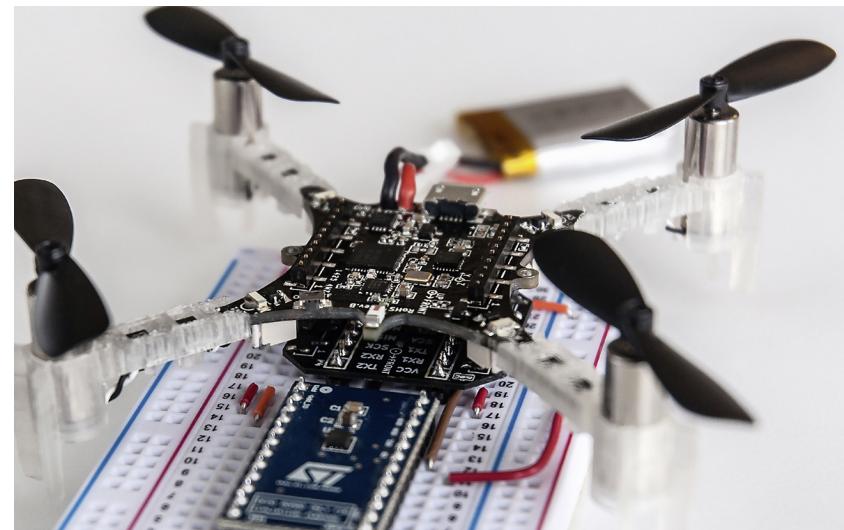


# nRF51



# Enabling devices

- High sales of smartphones enable rapid development of products
  - 500 million iPhones (2014)
  - 100 million Samsung Galaxy (2013)
- Fun projects
  - Open source [quadcopter](#)



# Nordic market segments - Q2 2011

## PC / Media controllers

Wireless PC mouse / keyboard,  
Media center remote control,  
Game controller

Q2 Revenue: MUSD 28.6 (MUSD 31.2)

- *PC Peripherals:* Strong growth potential, particularly in low cost category (emerging markets and replacement of wired devices)
- *Media remotes:* New market for remote controls for connected TV's based on mouse/keyboard designs
- *Game controller:* Designs for new interactive controllers currently under development



## Sports / Health monitors

Heart monitors, foot pods, watches

Q2 Revenue: MUSD 1.8 (MUSD 1.8)

- Production issue impacts Q2 sales.  
Very strong order backlog for Q3.



## Audio devices

Wireless audio streaming,  
microphones, gaming headsets

Q2 Revenue: MUSD 0.1 (MUSD 0.3)

- Slow market ahead of launch of new Nordic audio product



## Other applications

RFID, Toys, etc.

Q2 Revenue: MUSD 4.0 (MUSD 3.0)

- New toy design, RFID product and other new devices drive growth



## ASIC components / consulting

Wide sector span

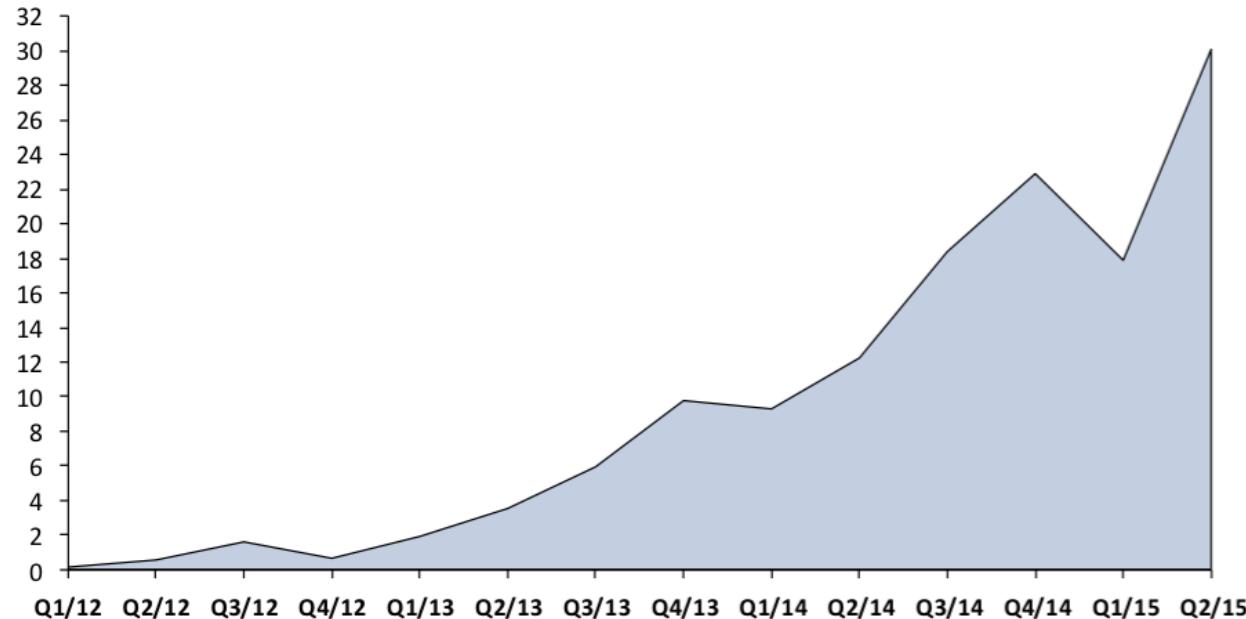
Q2 Revenue: MUSD 4.0 (MUSD 5.7)

- Recent release of an end product with a Nordic ASIC design driving revenues

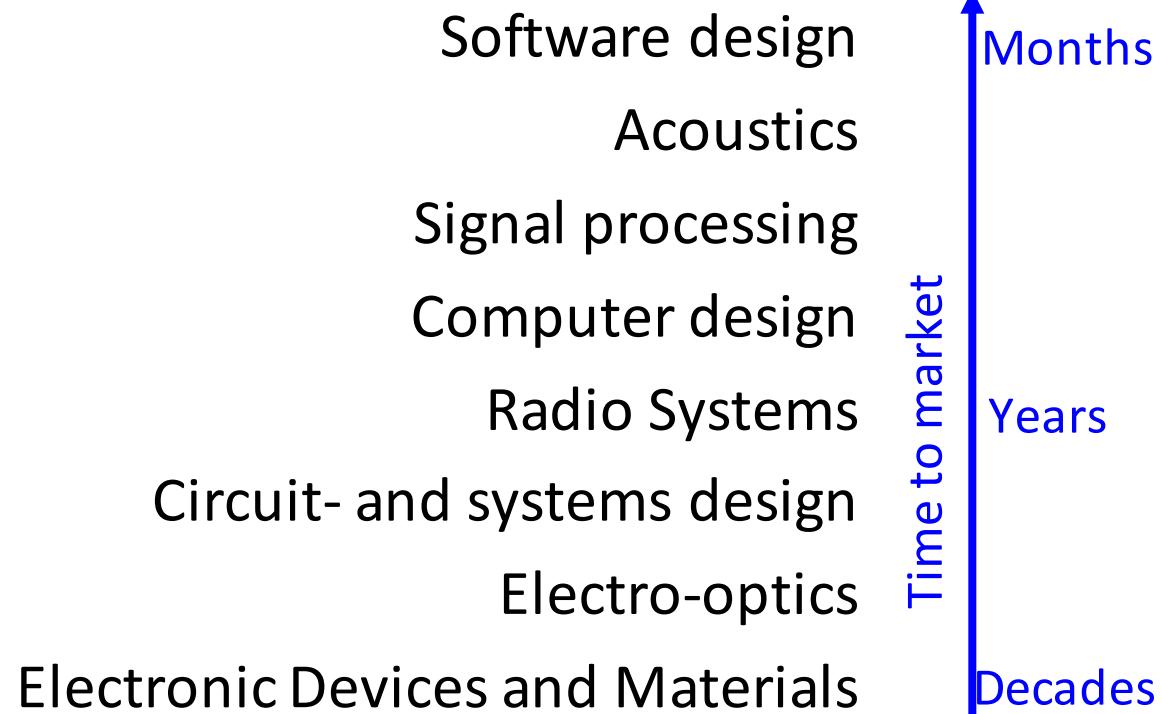
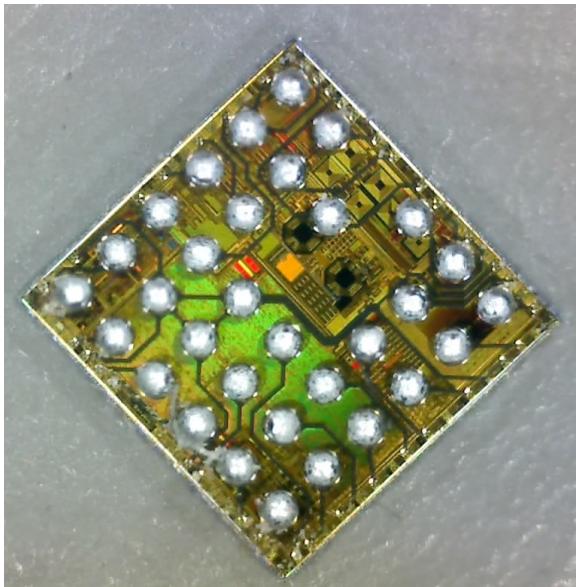


# Nordic market segments - Q2 2015

Total Nordic revenue from Bluetooth Smart, 2012 – Q2 2015 (MUSD)



# Research & development takes time



# Divide and conquer

- Break complex stuff down into smaller pieces
- Ignore the difficult stuff, and try to get an approximate understanding, then add in the difficult stuff
- Don't be afraid if something is difficult
- Don't think you're stupid and won't be able to understand
- Don't think that everybody else is smarter than you

# When you don't understand

- Ask someone
- Don't be afraid to show that you don't know something, not knowing is OK (except on the exam, and in a job interview)
- Use wikipedia

# What you need to teach yourself

- Ability to work hard (constant speed)
- Programming
- Report writing
- Explaining things to other people
- Convincing people that your right through persuasive arguments

# Questions?



# Things you should know about

Software:

Scripting (Bash, Perl, Python, Ruby, TCL, LISP)

Programming (C, C++)

Editors (Emacs)

Math software (Matlab, Maple, Octave)

Information sources:

<http://ieeexplore.ieee.org>

Where to buy electronic supplies:

[www.digikey.no](http://www.digikey.no)

[www.mouser.com](http://www.mouser.com)