The Untold Story About Smart Devices

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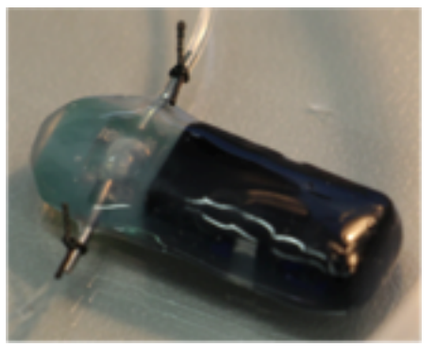
Table of Content

- The Embedded Communicating Systems Laboratory
- Energy
- Transmit / Receive
- Software
- Vertical Integration
- Other Stuff
- Q&A

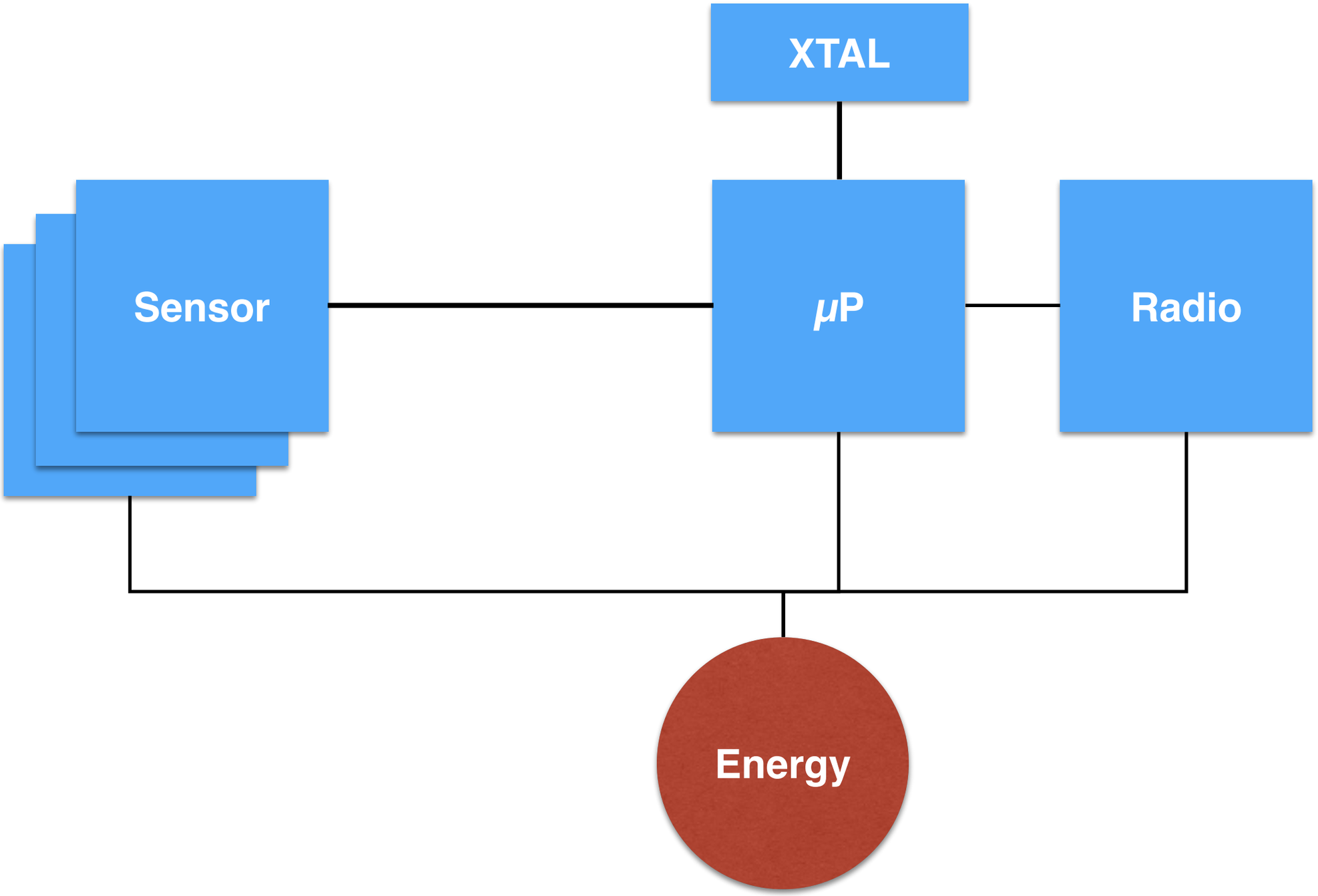
Embedded Communicating Systems

- Team
  - 2 junior engineers (assistants with limited employment)
  - 5 senior engineers (scientific collaborators with fix employment)
  - 4 professors
- Activity
  - Embedded systems @ ultra low power and size
  - Ultra low power radio frequency communication
  - Wireless power transfer
  - Antennas
- Projects
  - Mainly development projects with local / swiss industry
  - Some few academic research projects
  - Up to two special research projects per year financed by institute
- Partners
  - Nordic Semi Conductors, Keil, STM

ECS Background



Energy



NEVER forget!

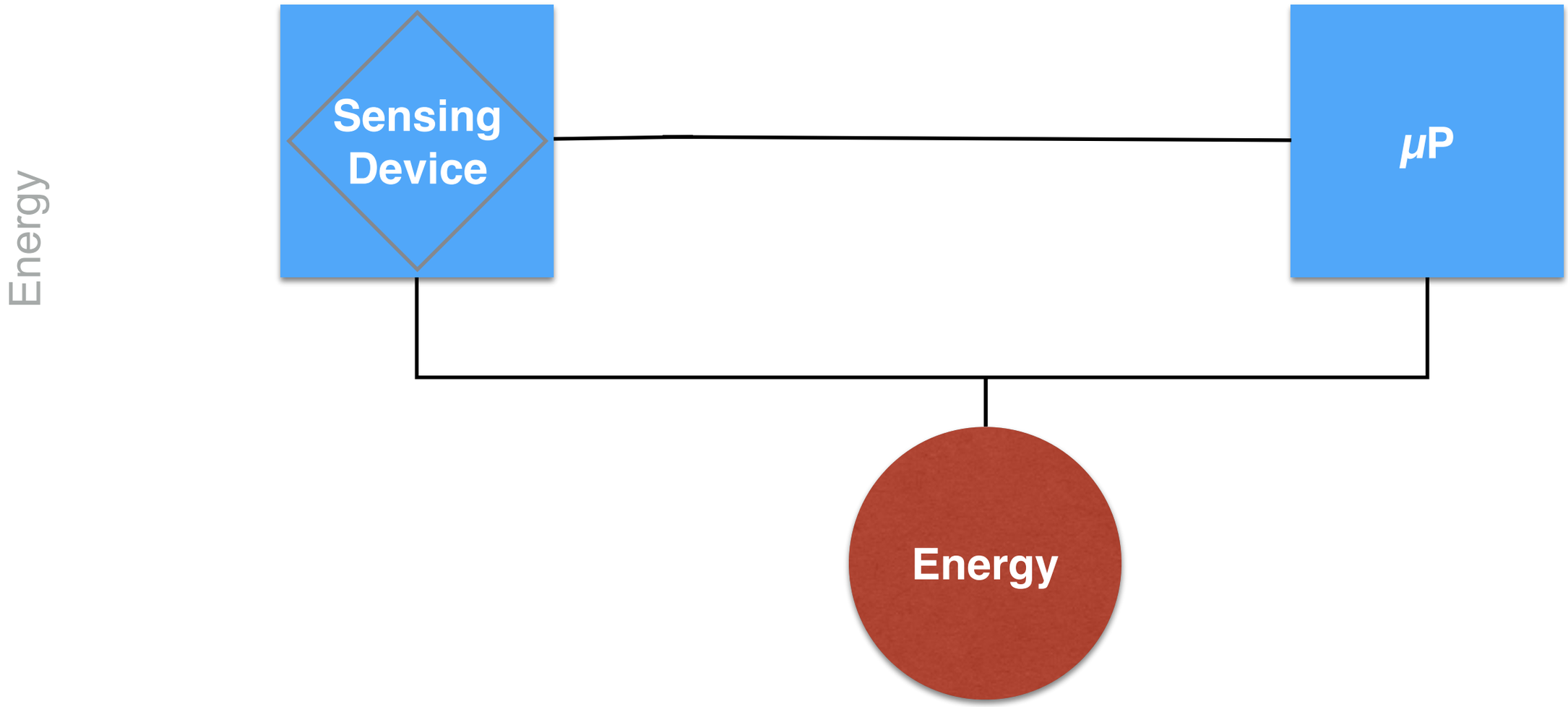
$$E = P * t$$

Energy

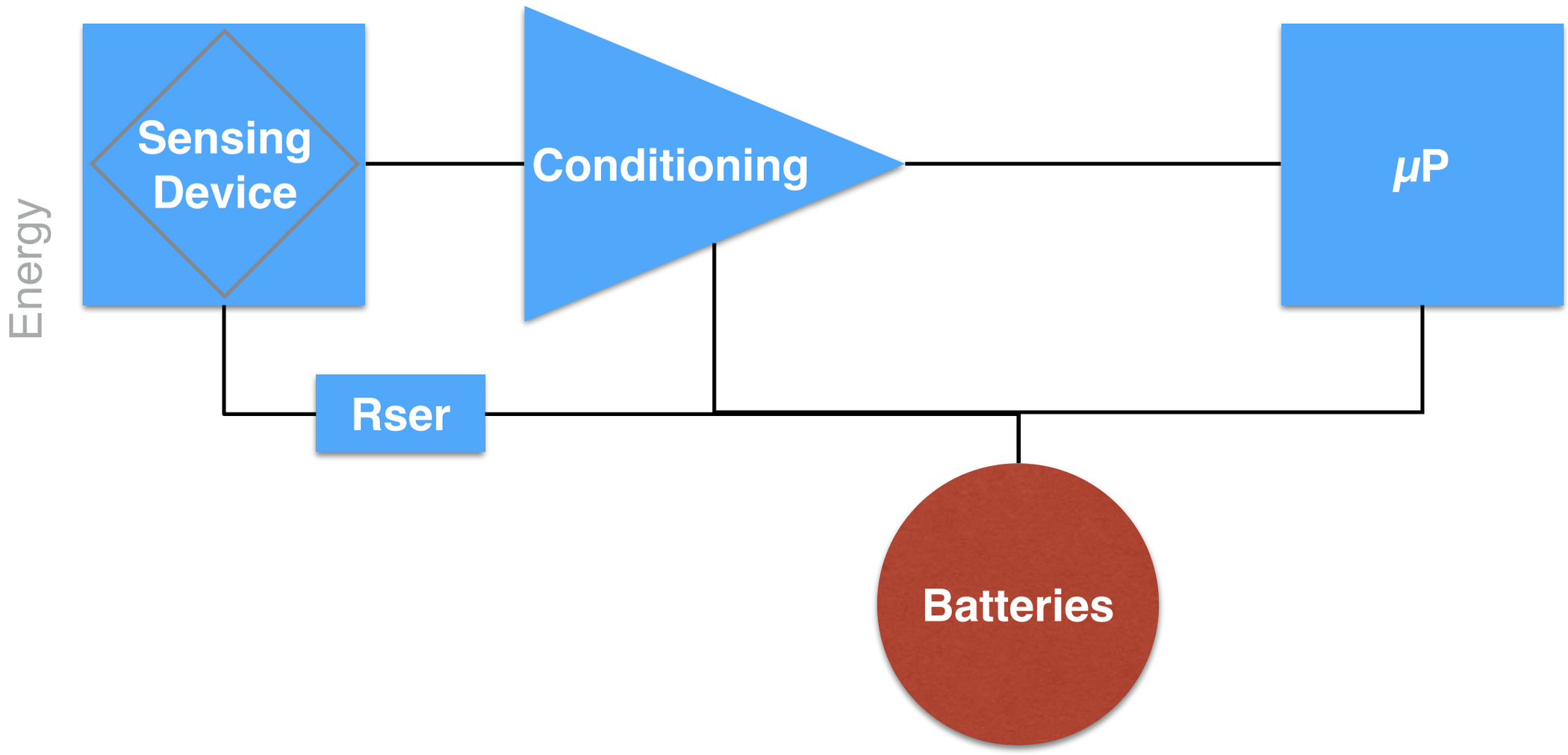
$$P = U * I$$

$$U = R * I$$

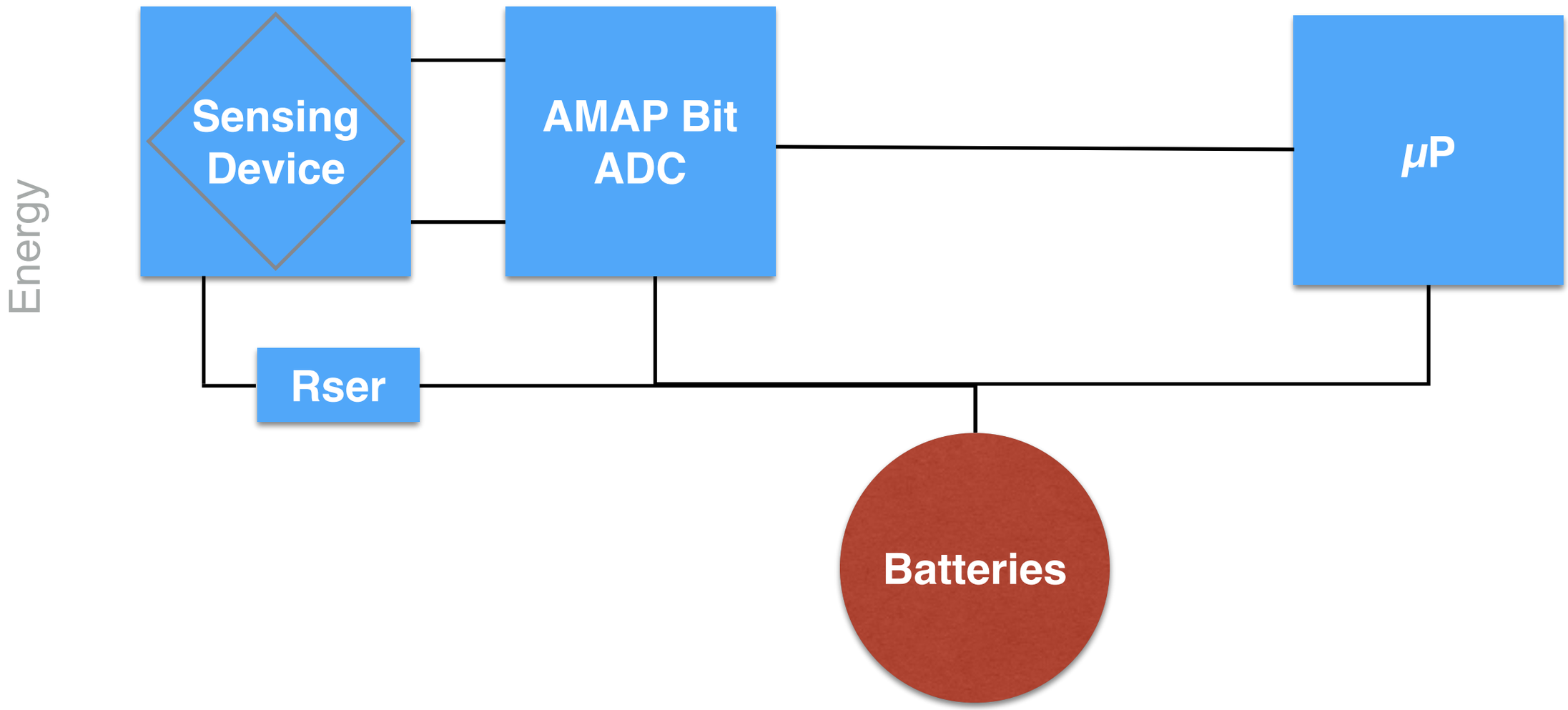
Sensing v1



Sensing v2



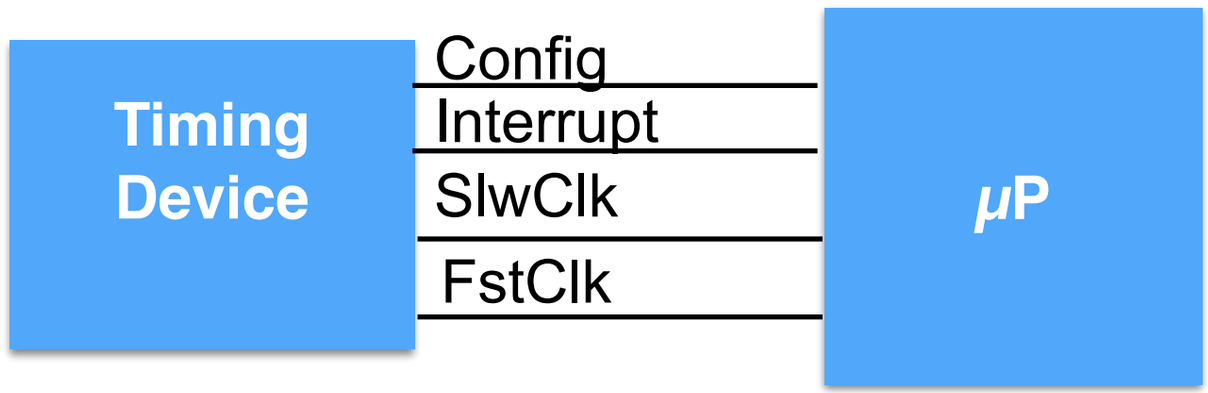
Sensing v3



X-TALS

- Active
  - Oscillators
  - PLLS
  - Multiplexers
- Passive
  - RC (low Q)
  - X-TAL (very high Q)

Energy



- Micro Crystal
  - RV-8063-C7 : 3 x 1.5 mm, 190 nA

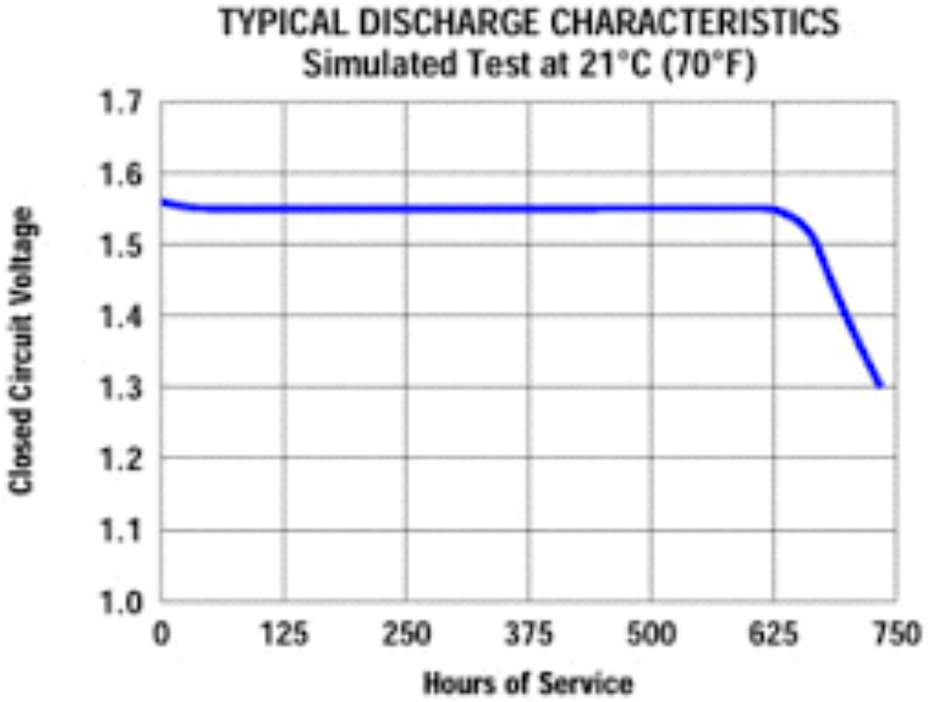
Other Consumers

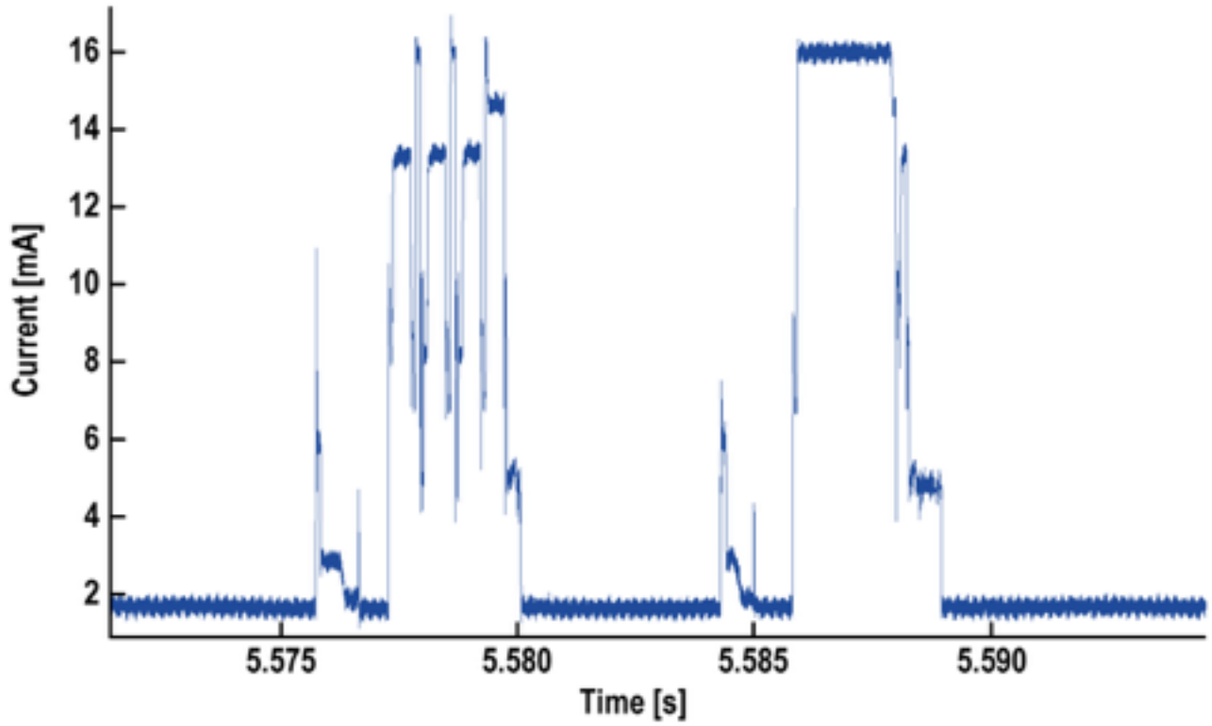
- µController
- External periphery
- Programming languages
- RTOS

Energy

The Battery Stall Effect

Energy





Transmit And Receive

- Technology:
  - Wired
  - Wireless narrow band
  - Wireless wide band

- „Wireless Standards“
  - RFID
  - Bluetooth
  - ZigBee
  - WIFI
  - LoRa
  - LTE-M
  - Custom

- „Wired Standards“
  - UART
  - I2C
  - SPI
  - JTAG

The Only Rule to Never Forget

TRX

The most efficient way to save energy is:
DO NOT COMMUNICATE

Strategies For Low Power Protocols

- Try not to be in receive mode (RX mode is 5-10 mA)
- Try to send only when necessary
- Try to send at the least power level possible
- Pack your data
- Try to optimize protocol overhead
- Set long connection intervals (this will make you device less reactive)
- Let decide the embedded device whether it will communicate or not
- Omit MESH topologies

TRX

Wireless Rules

- The best and cheapest transmitter is a good antenna
- The best and cheapest receiver is a good antenna
- Good TX antenna is not equal good RX antenna

TRX

- Bad range:
  1st cause: Bad antenna (at transmitter)
  2nd cause: Bad antenna (at receiver)
- Doubling TX power increases current flow by factor 4 but maybe does not increase range

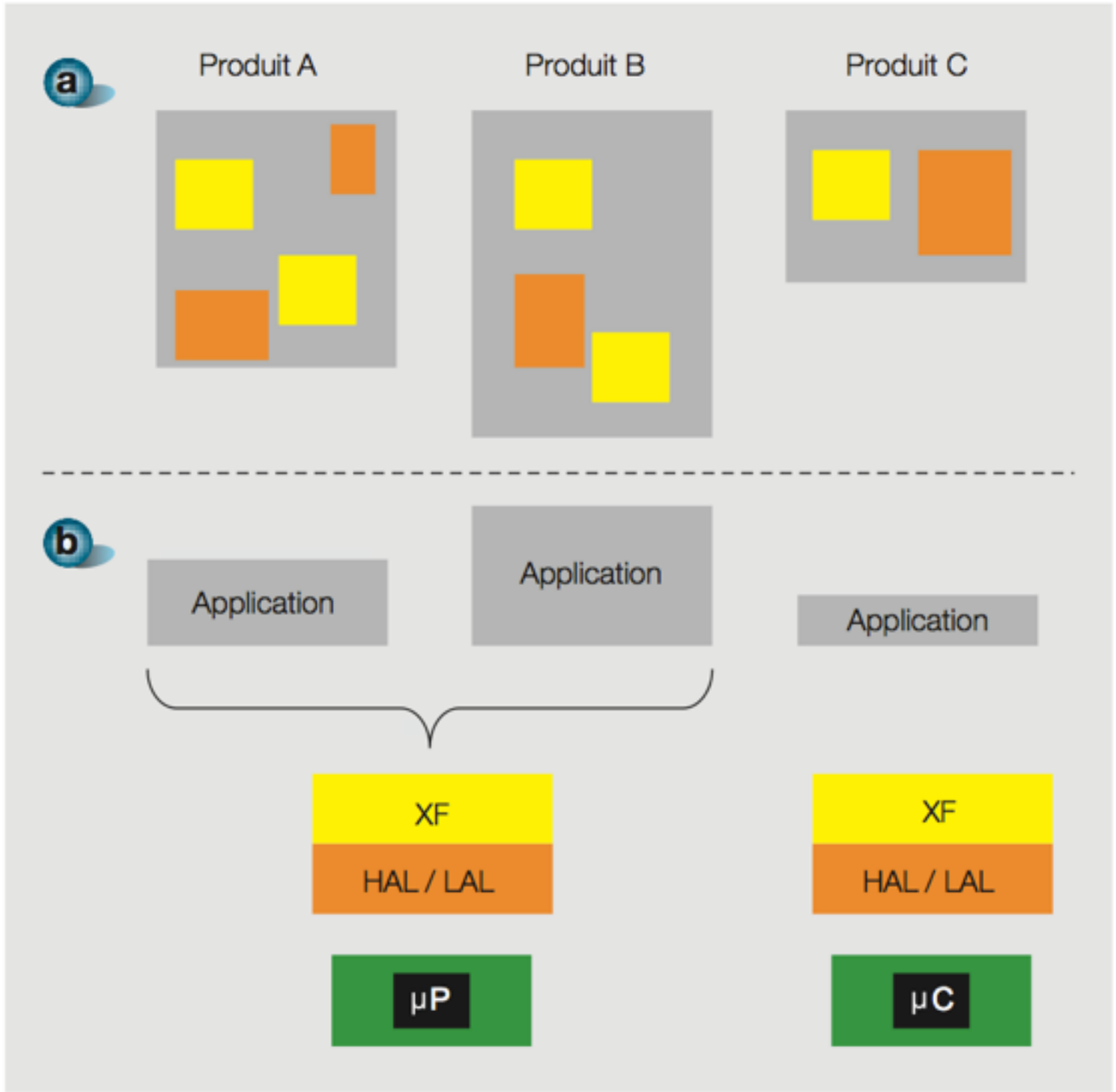
Do Never Forget

Communication always happens between two devices.

TRX

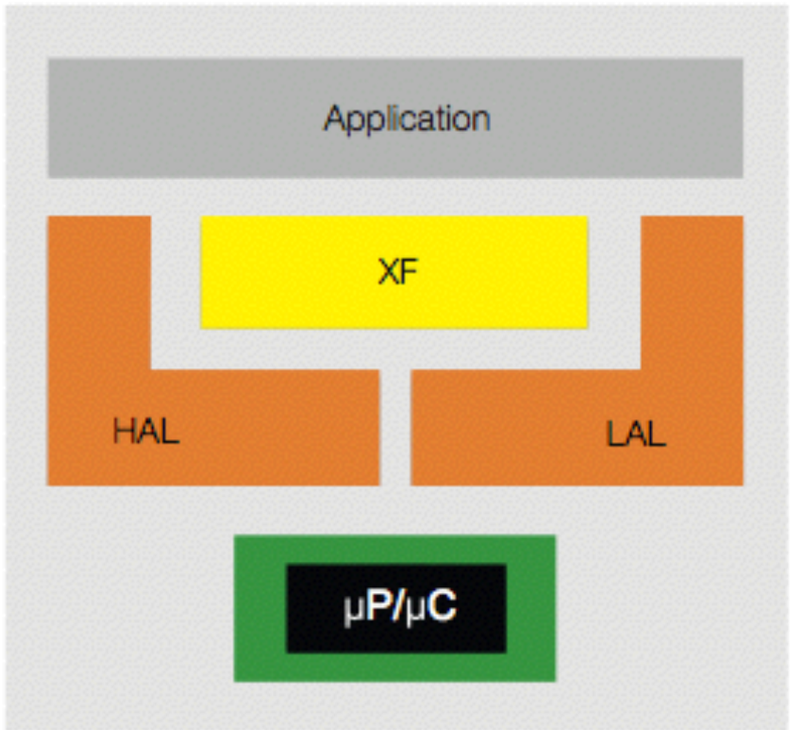
If one device behaves poorly then the other device will behave poorly too!

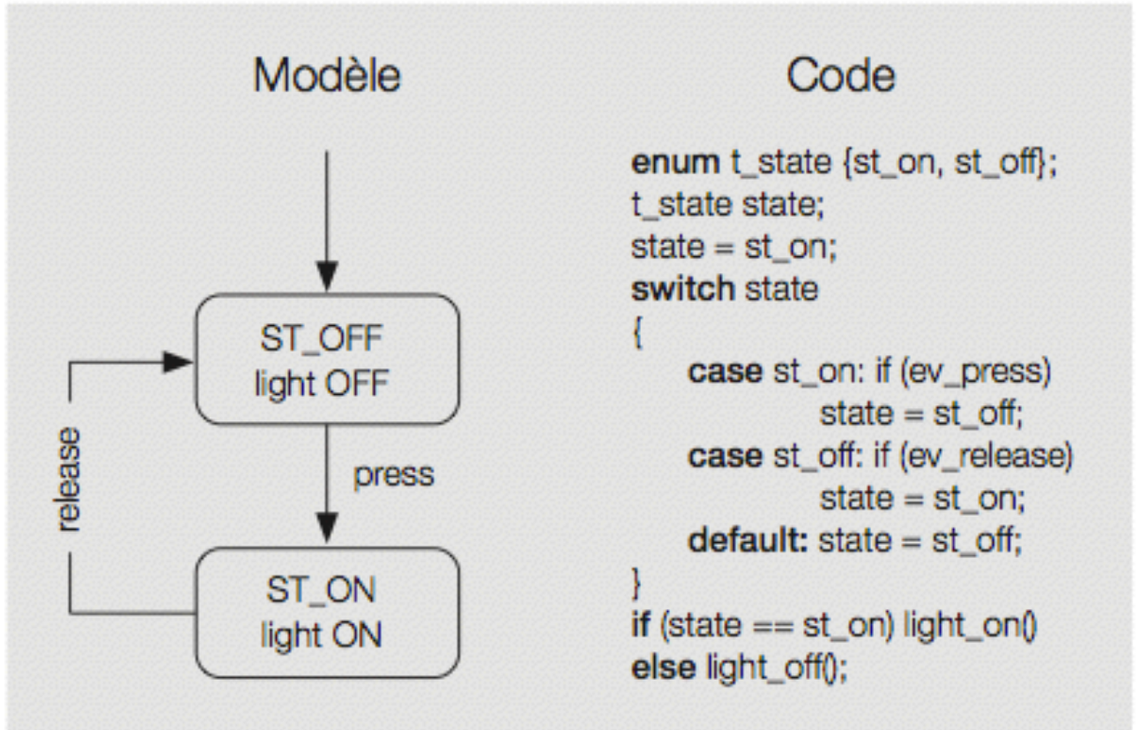
Software


a
Produit A
Produit B
Produit C
b
Application
Application
Application
XF
HAL / LAL
µP
XF
HAL / LAL
µC

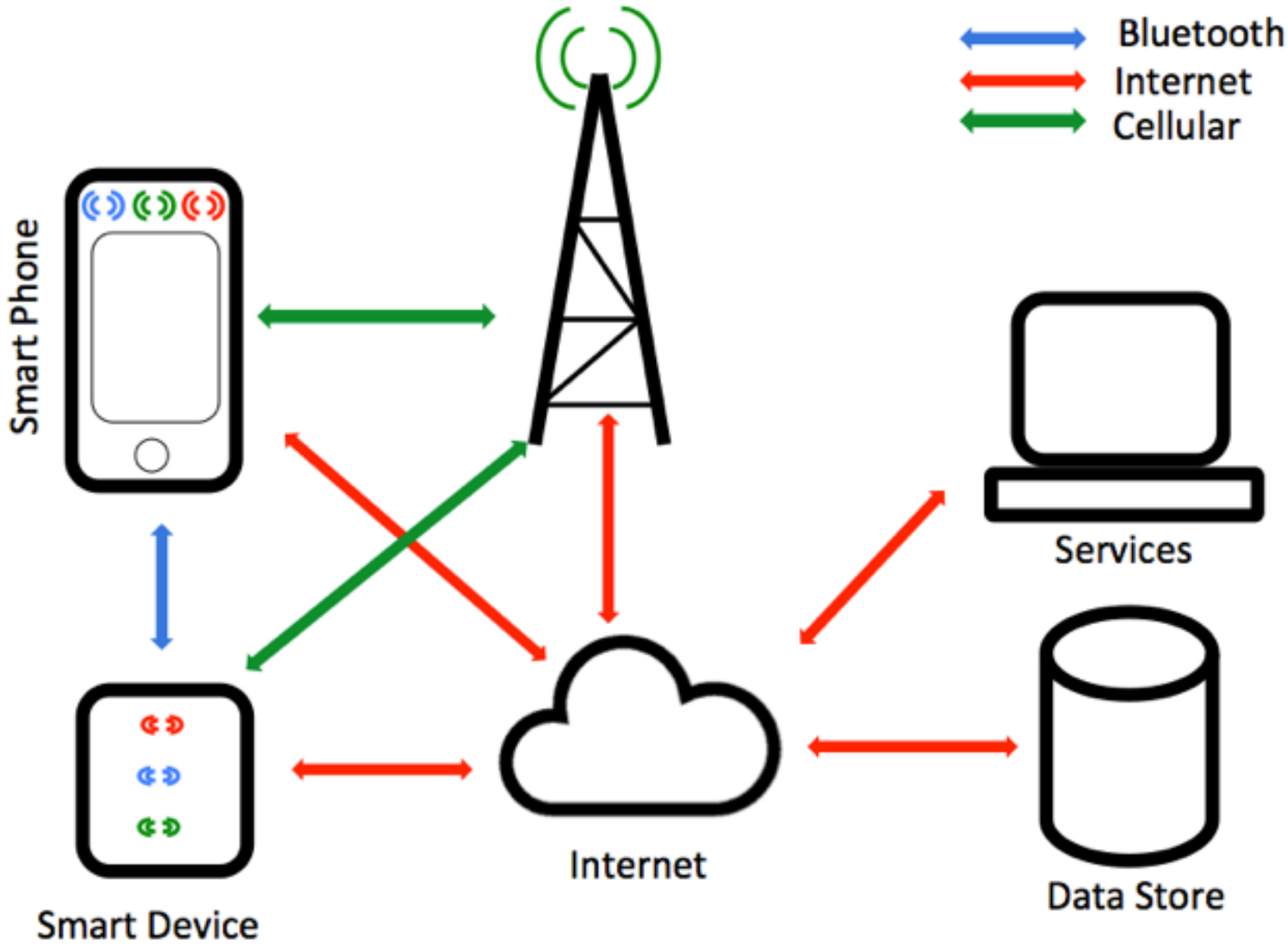
Software Engineering!

Architecture + Stateful Method





Vertical Integration



Emerging Verticalizing Technologies

- IPV6 will replace IPV4
  - Security issues

- Cellular technologies will take over
  - no more smart phone / smart device romance
  - LoRa / LTE-M

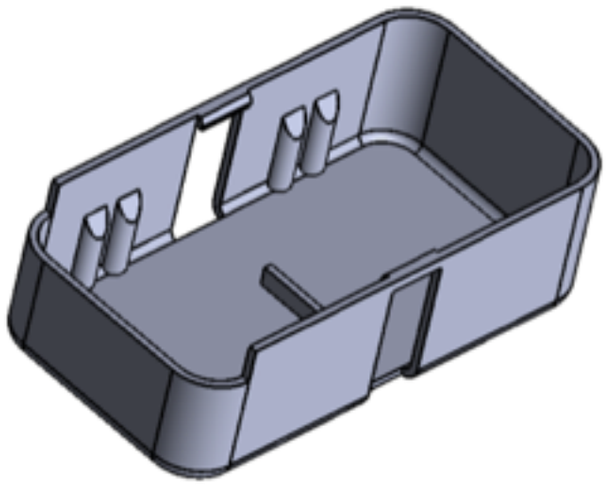
Do NOT Forget

- For technical reasons
  - You need a cloud specialist
  - You need Smartphone specialist
  - You need a desktop software specialist
  - You need a security specialist
  - You need a lawyer
- For commercial reasons
  - You need a sales specialist
  - You need a hotline

Other Stuff

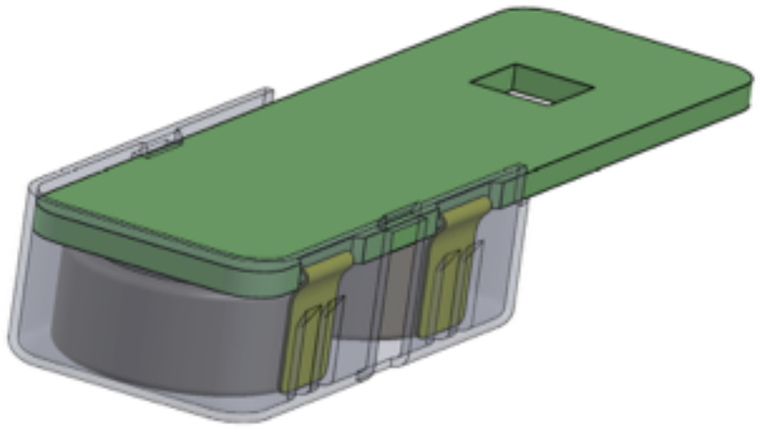
You will need to certify for FCC

- You will for sure need a casing!
- Design it, the customers eye buys your product
- Mechanical problems can stress a project to death



RULE:

Co-design electronics and mechanics!



Q&A

Many thanks for your attention!