# AES Data Encryption in a ZigBee network: Software or Hardware?

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research groups: DraMCo / COSIC

## Outline

- About the research groups
- Background information
  - ZigBee
  - Types of WSN
- Motivation
- Test setup
- Results
- Conclusions/future work

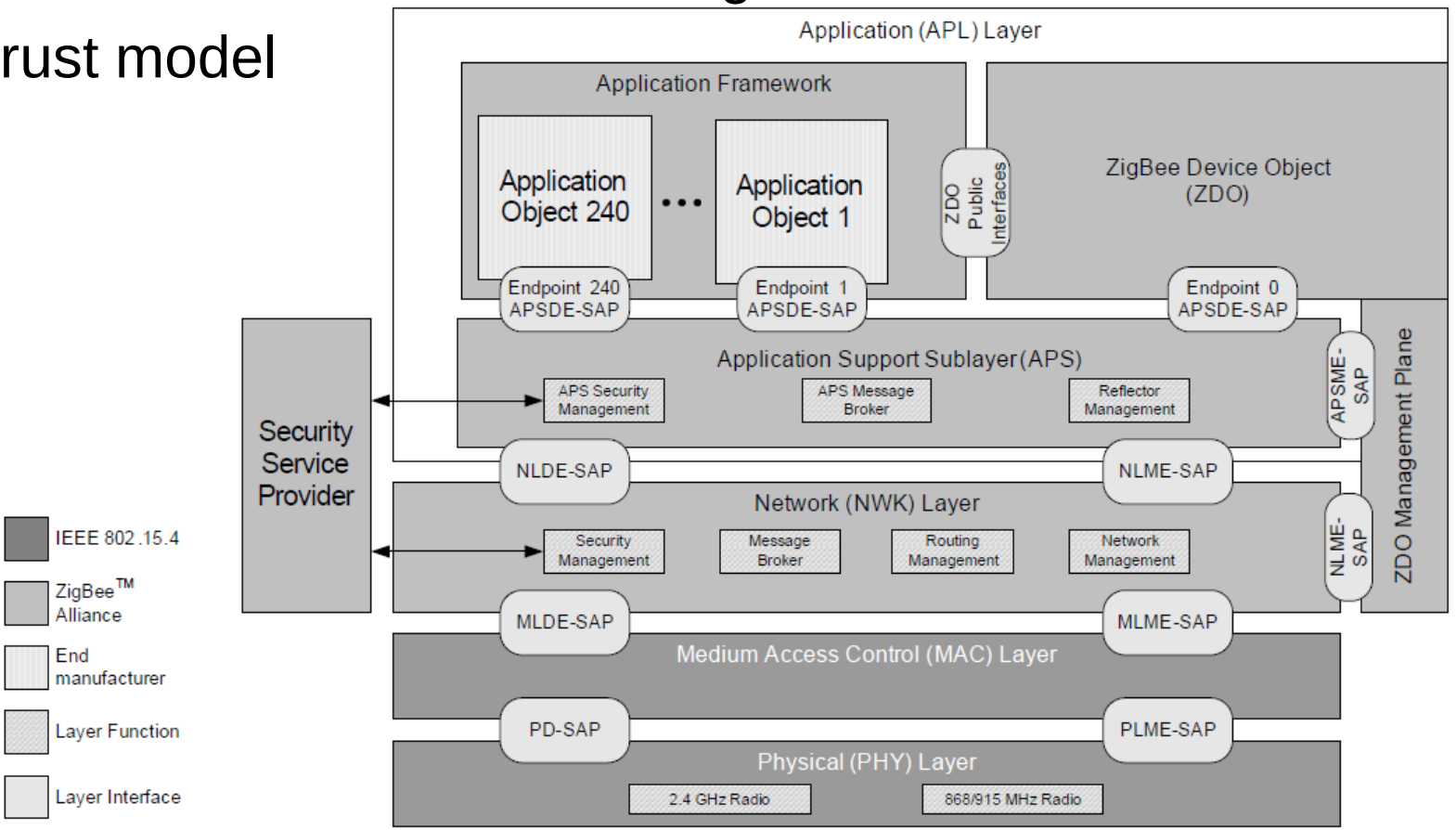
## About the research groups

- DraMCo research group
  KaHo Sint-Lieven (+ 5000 students)
  Wireless and Mobile Communication
  www.dramco.be
  www.kahosl.be


- COSIC research group
  K.U. Leuven (35.000 students)
  Computer Security and
  Industrial Cryptography
  www.esat.kuleuven.be/cosic
  www.kuleuven.be

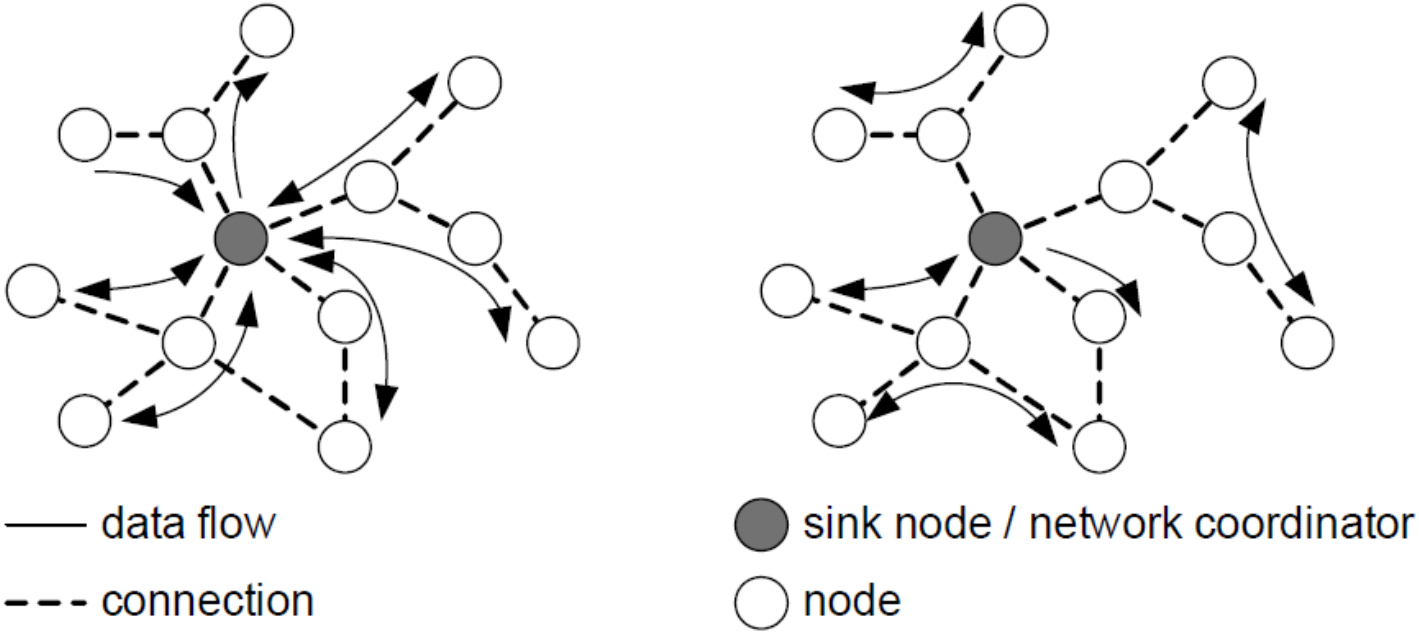
# ZigBee

- ZigBee security = key establishment, key transport, frame protection and device management
- Open trust model



## Types of WSN (applications)

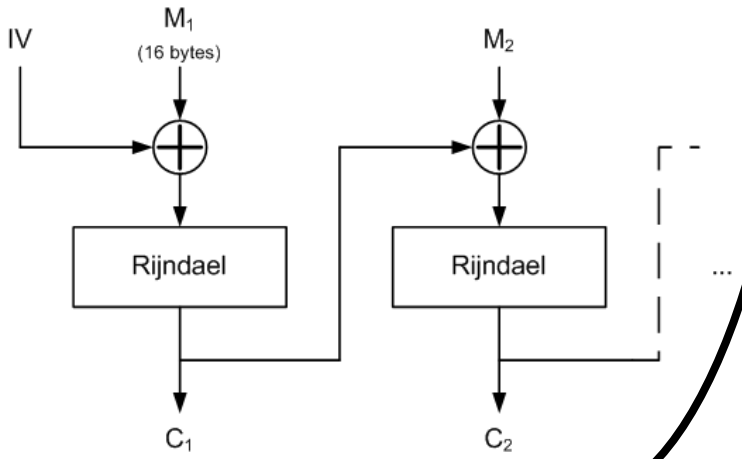
- Centralized (e.g. fire detection) versus distributed (e.g. lighting)




- Combination is possible

## What did we investigate and why?

- Properties of WSN (like ZigBee): low-data rate, robust, low-power, unattended operation, low processing power, etc.
- ZigBee: AES 128 (CBC) for data encryption (confidentiality)




- Algorithm in hardware or software?

Keeping this in mind

## What did we investigate and why?

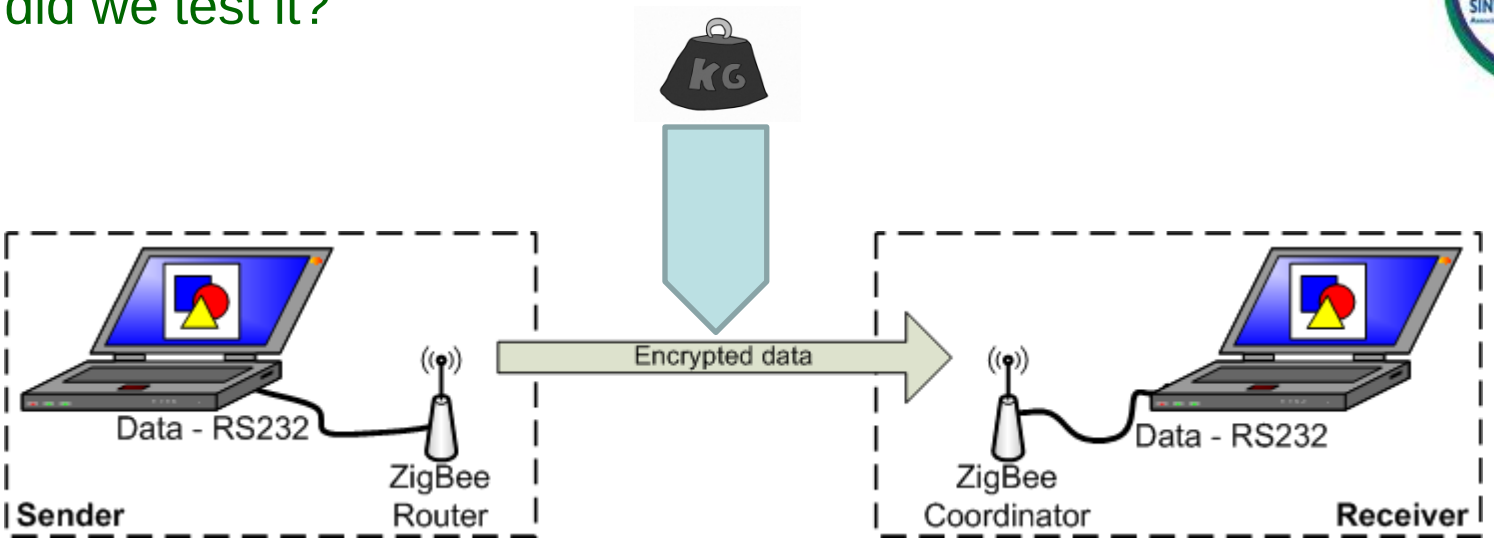
- Statement: *"Hardware is faster and (thus) more energy-efficient than software."*



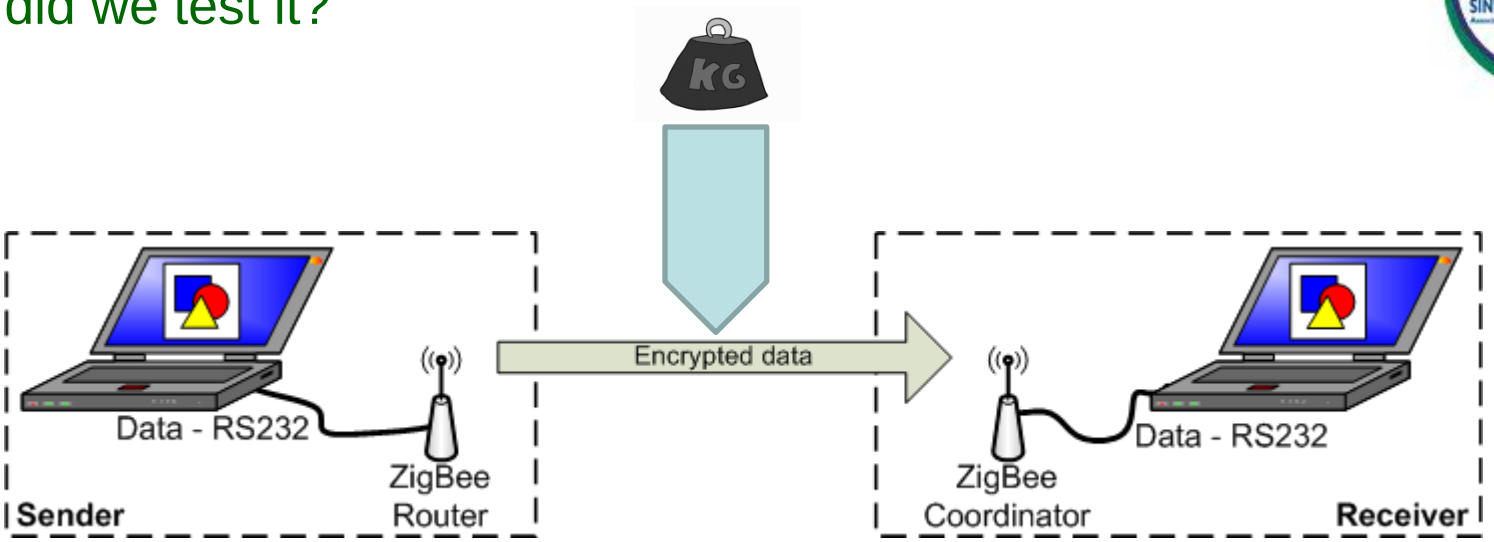
- But will the use of hardware pay off in sensor networks?

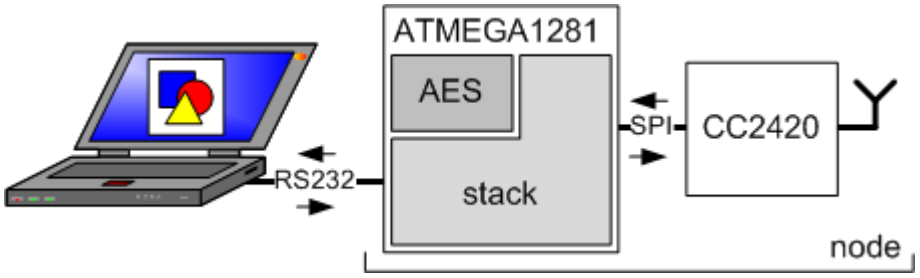
  ⇒ Test both approaches in a worst-case scenario.

# How did we test it?



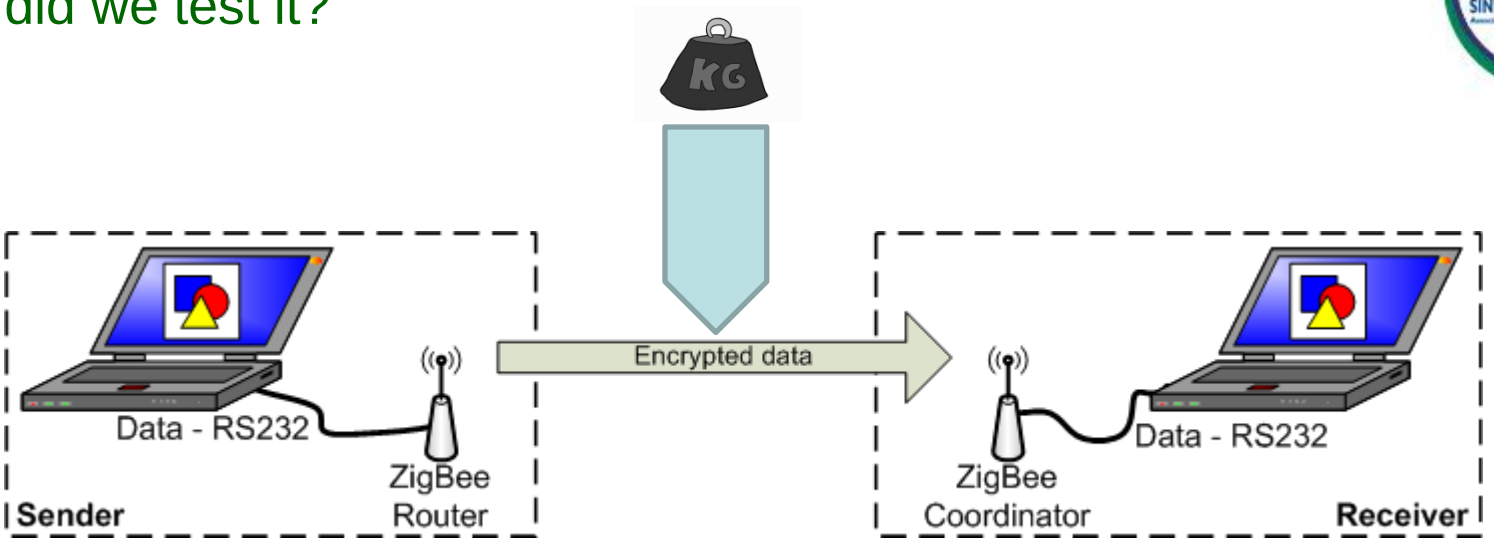
# How did we test it?

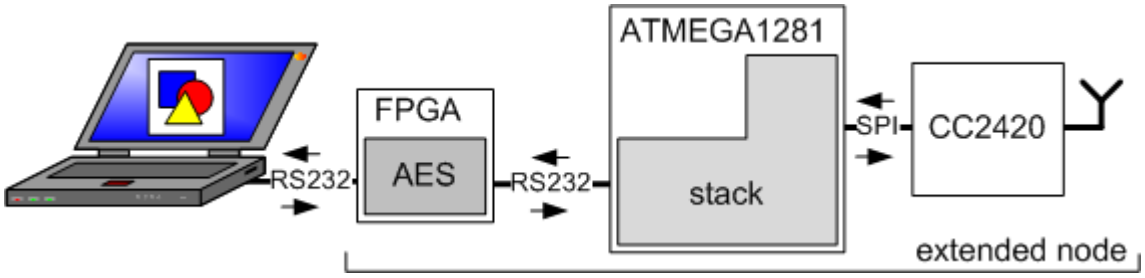



- written in C
- optimized for 8-bit Atmel MCU
- 8 MHz $f_{MCU}$

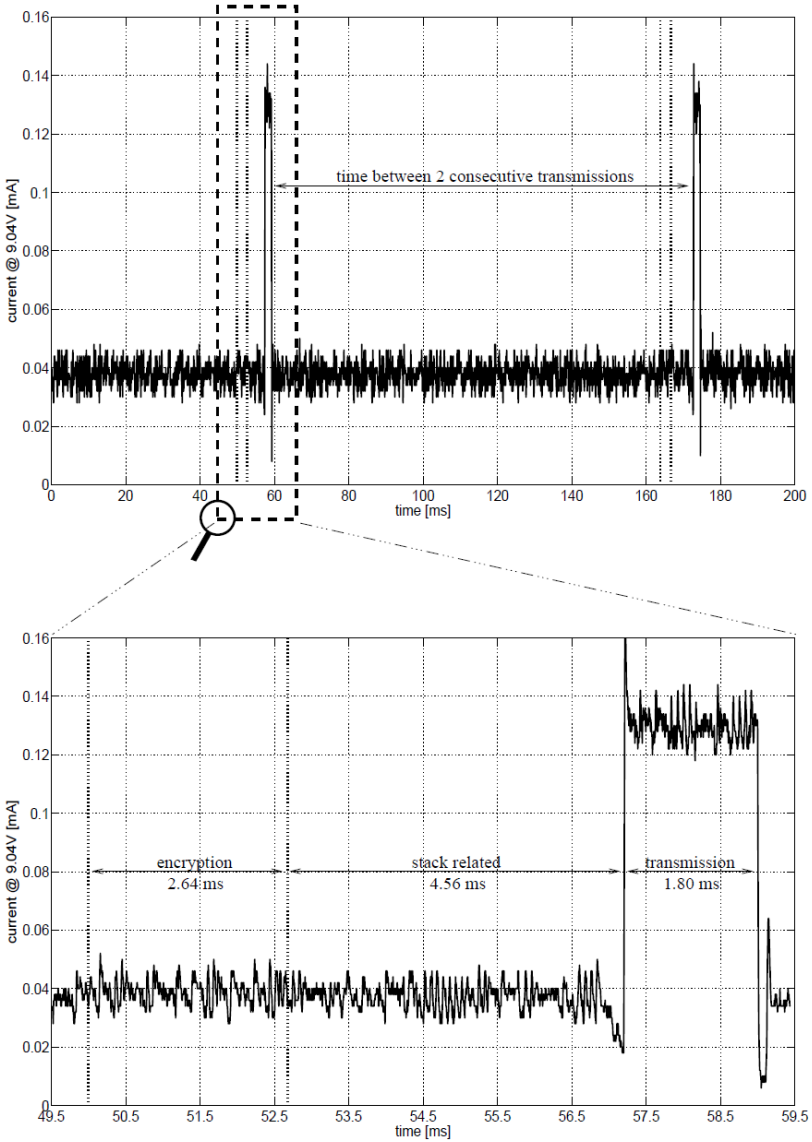
# How did we test it?




- VHDL
- Optimized for speed
- 1 round/clock cycle

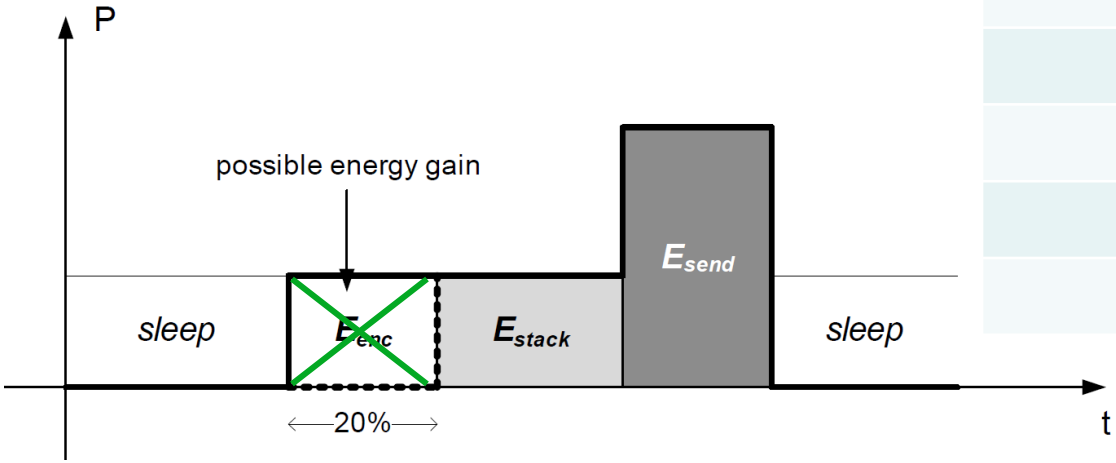
# What have we found?




| Measurement | Software | Hardware |
|---|---|---|
| $E_{send}$ | 2.01 mJ | 2.01 mJ |
| $E_{recieve}$ | 343 µJ | 343 µJ |
| $E_{enc}$ | 782 µJ | 0.1 µJ |
| $E_{dec}$ | 949 µJ | < 0.2 µJ |
| data rate | 2.0 kbps | 2.1 kbps |
| $E_{tot}$ | 4.0 mJ | 3.2 mJ |

## What can we conclude?

- Energy to send represents a large share of the total energy (TX power !)
- Hardware encryption = 20 % energy gain

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## Hardware or software?

- Depends on the application and network
- Transmission power ↑ relative share of encryption energy ↓
- No influence on the data rate
- Implementing AES in software is feasible, but …

## What about the future?

- Dedicated co-processor (ZC, storage and management)
- Large network with different types of nodes

# Questions?

Thank you for your attention

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