# Ultra-Lightweight Cryptography

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# Outline

- Introduction
- Symmetric cryptography
  - Hardware implementations
  - Software implementations
  - Technology scaling
- Conclusion

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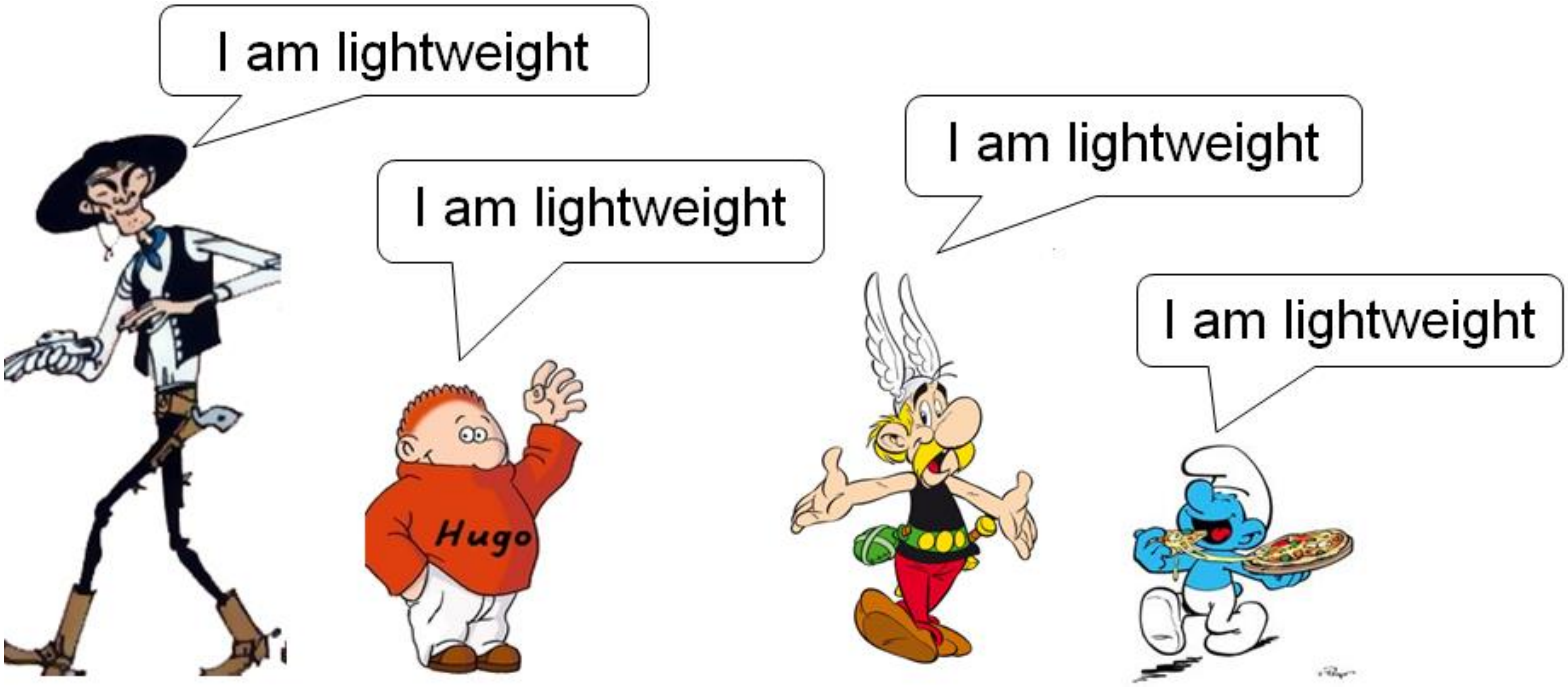
- Evaluation criteria are usually relative…



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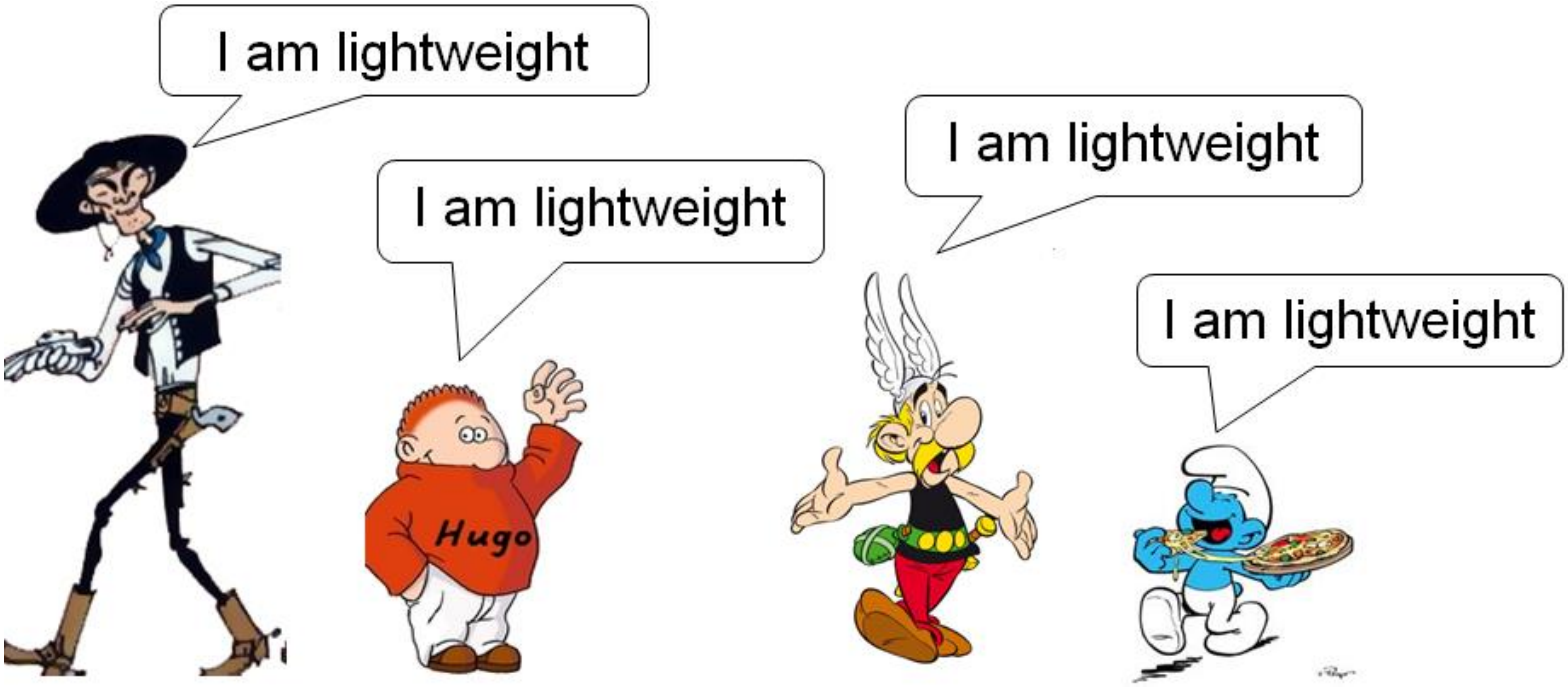


… and reflect algorithmic & implementation choices

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# Performance metrics



| application constraints | physical units | relative to | pre-layout units | HW design goals | algorithmic design goals | relevance w.r.t. algorithms |
|---|---|---|---|---|---|---|
| AREA | um² | time or energy constraints | #gates | share resources | reduce components cost & versatility | weakly discriminant *** |
| INST. POWER (dynamic) | W (J/sec) | time or energy constraints | switching activity | reduce datapath | reduce components cost & versatility | somewhat arbitrary ** |
| THROUGHPUT | bit/sec | area or power constraints | #cycles (& block size) | unroll, parallelize & pipeline | minimize the total combinatorial cost | very arbitrary * |
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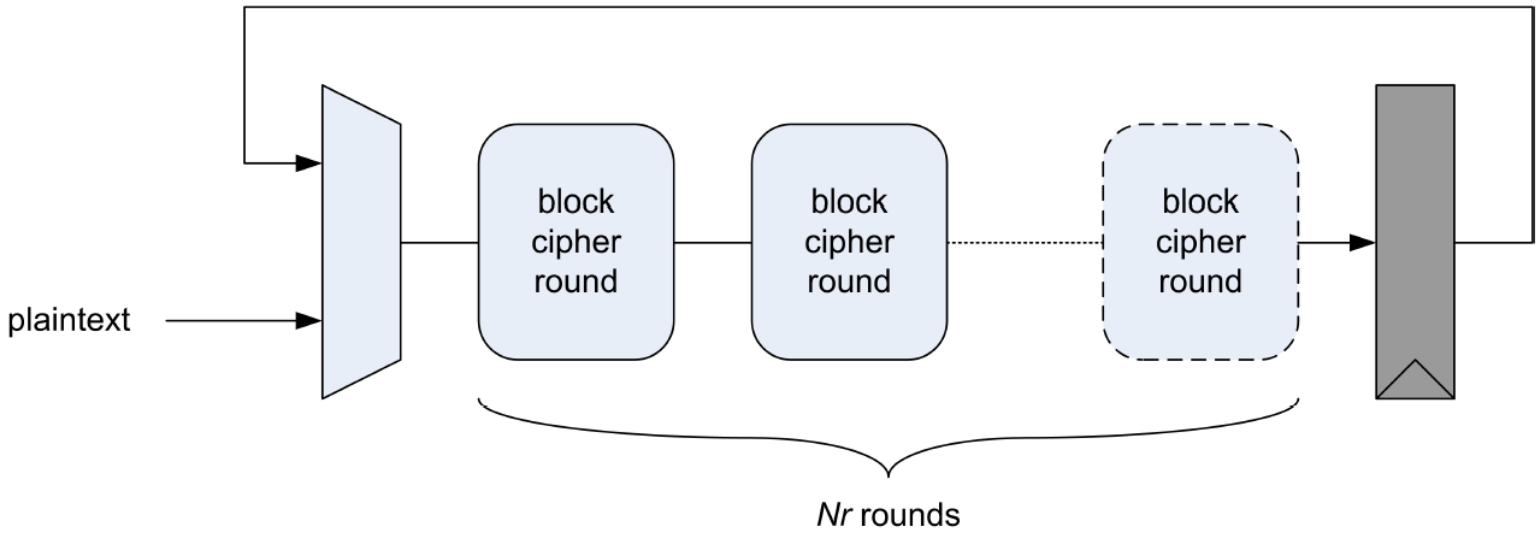
=> Can be more or less reflective of algorithms

# Case study



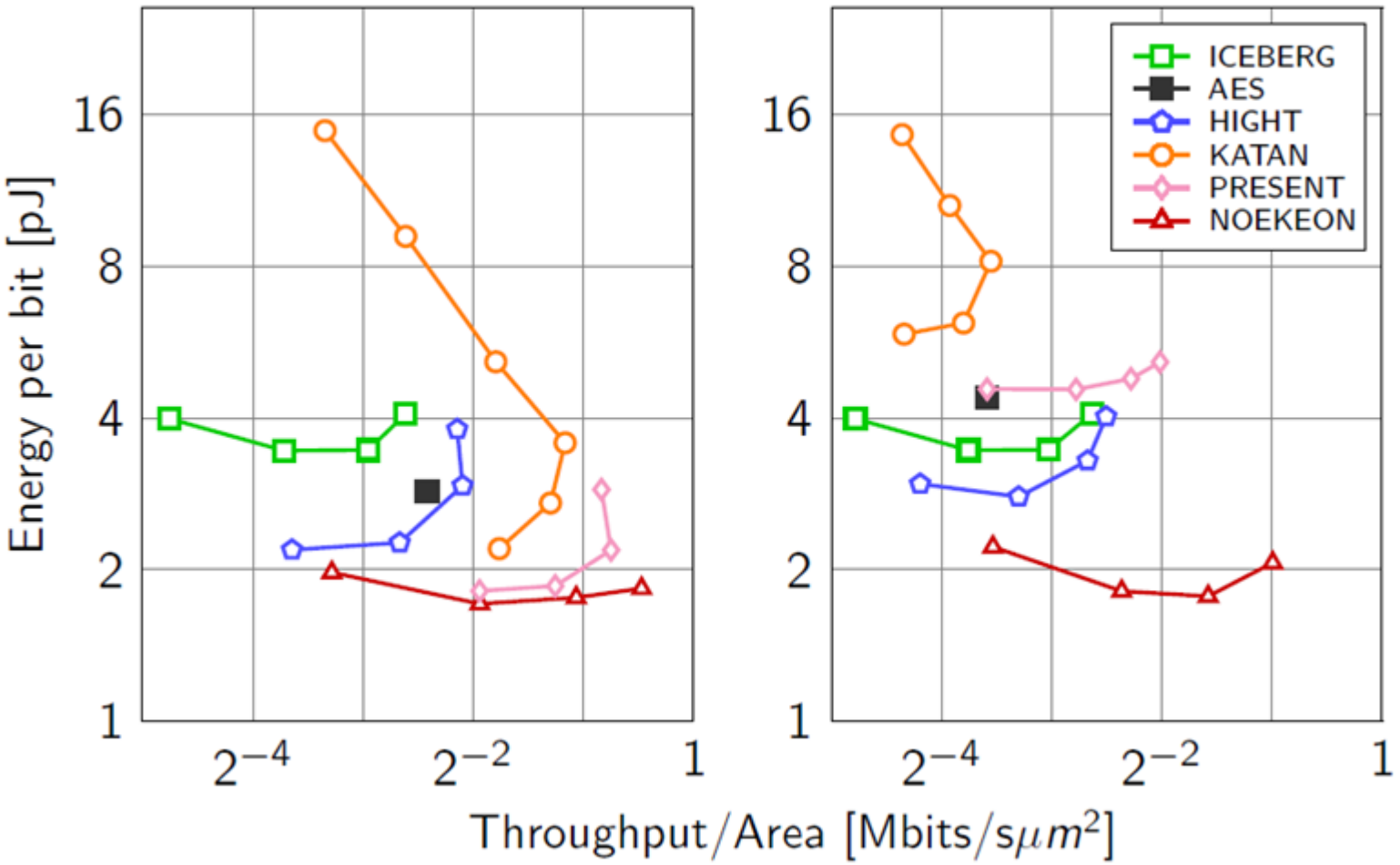
- Flexible block cipher architecture




- 3 core options: enc., dec., enc./dec.
- 65-nanometer CMOS technology

# Combined metric (Enc., Enc./Dec.)





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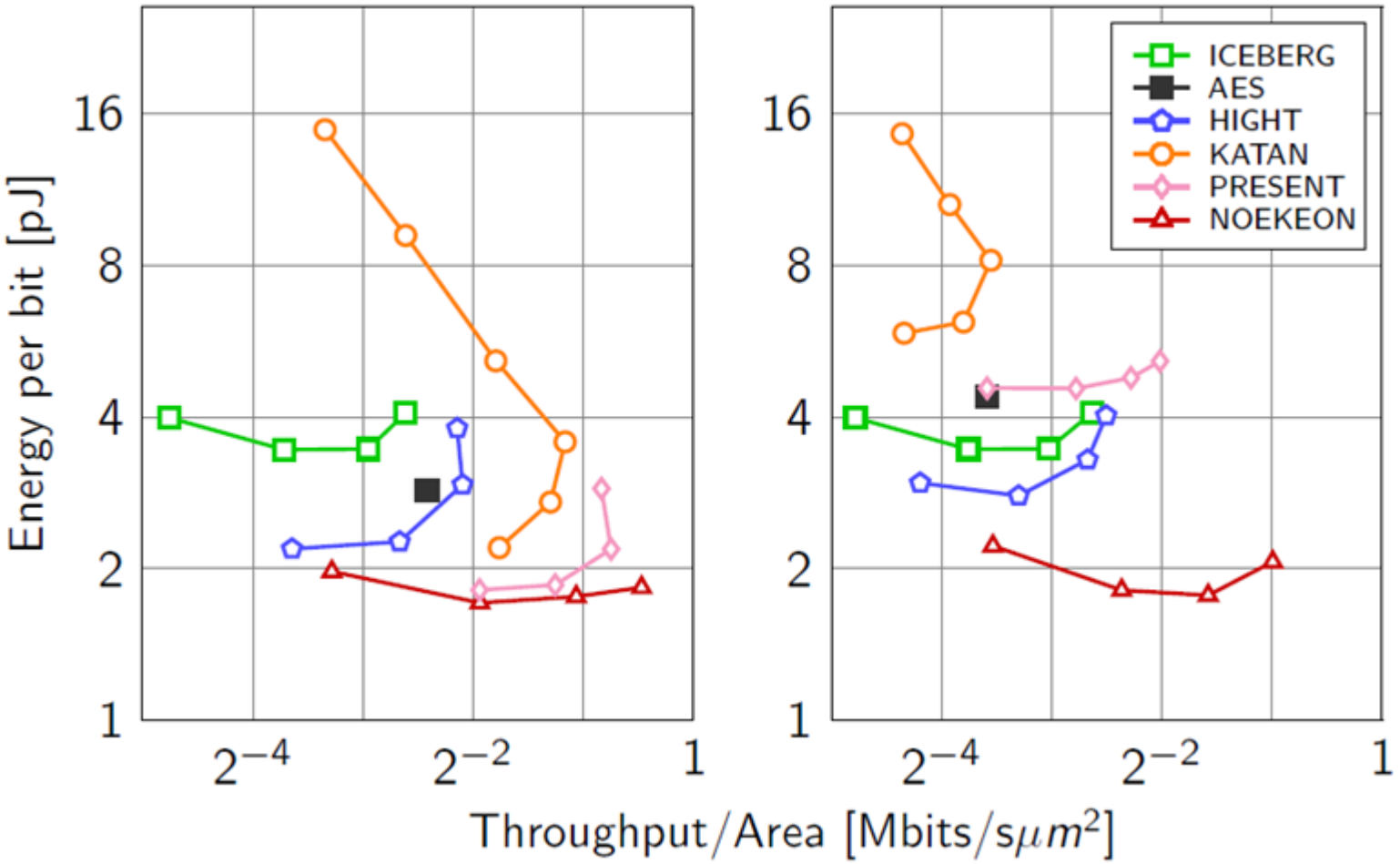
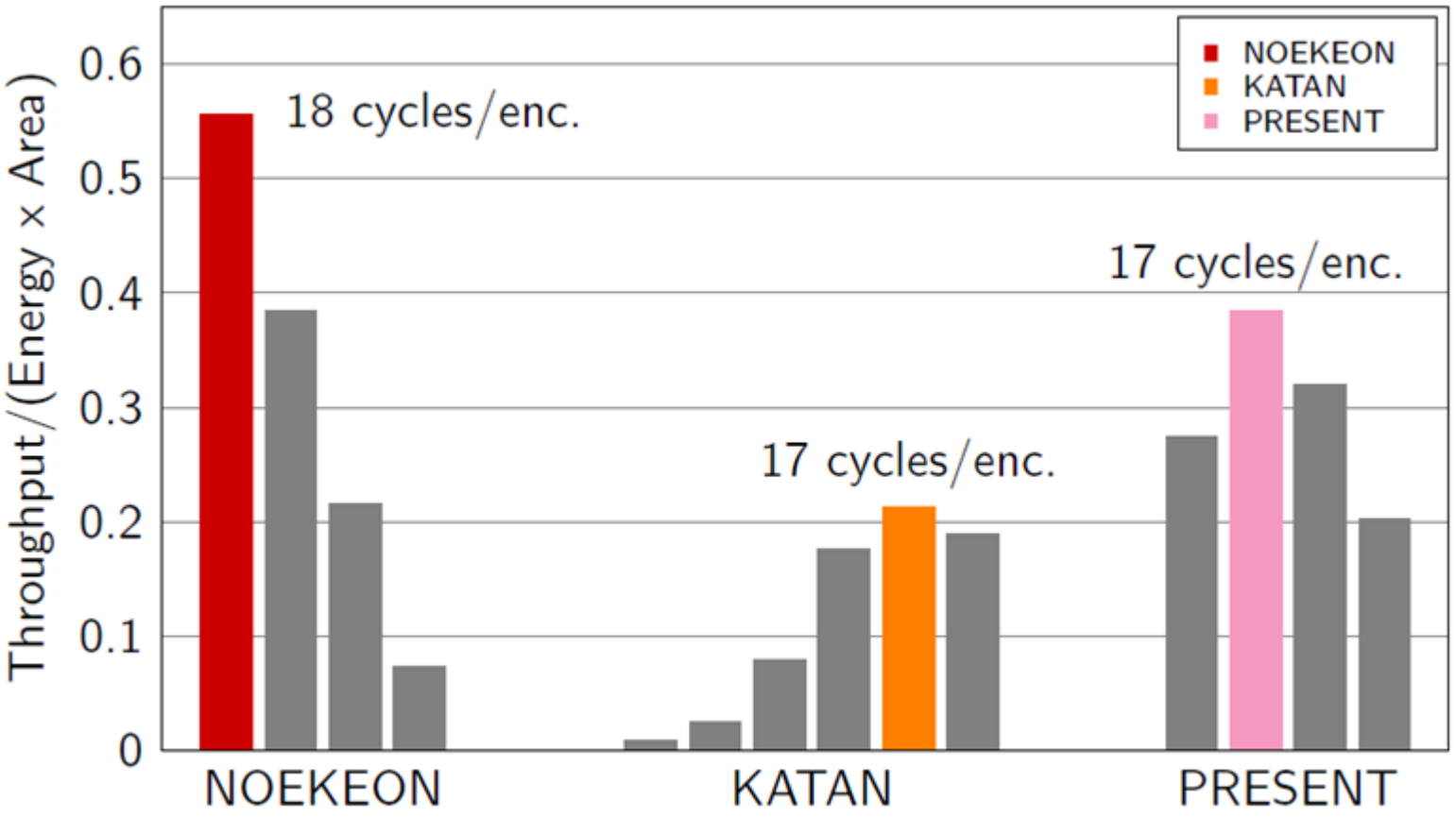



- Mostly reflects different key schedulings

# Number of rounds per cycle (Enc.)





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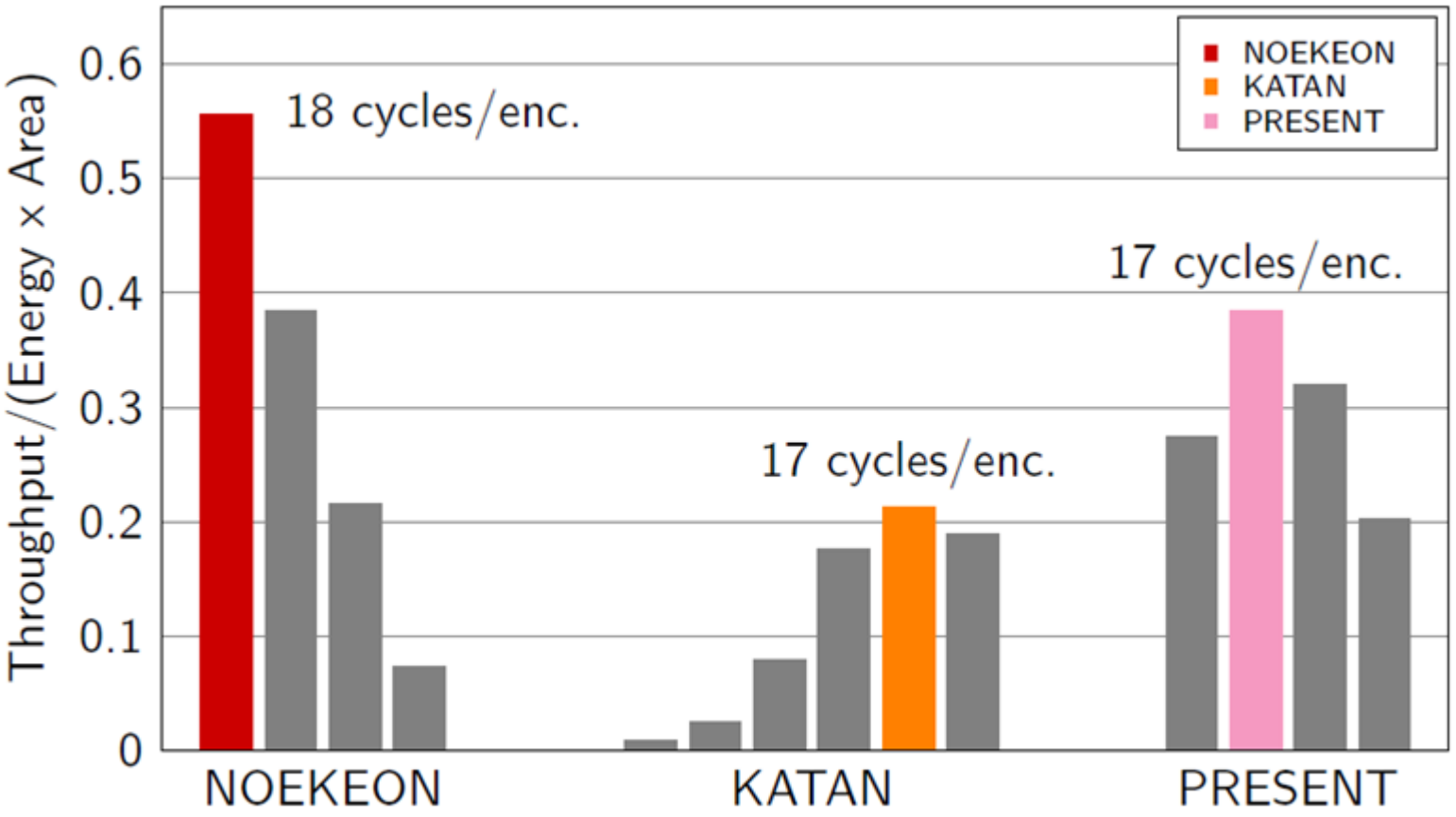


- Suggests “complexity limit” has been reached

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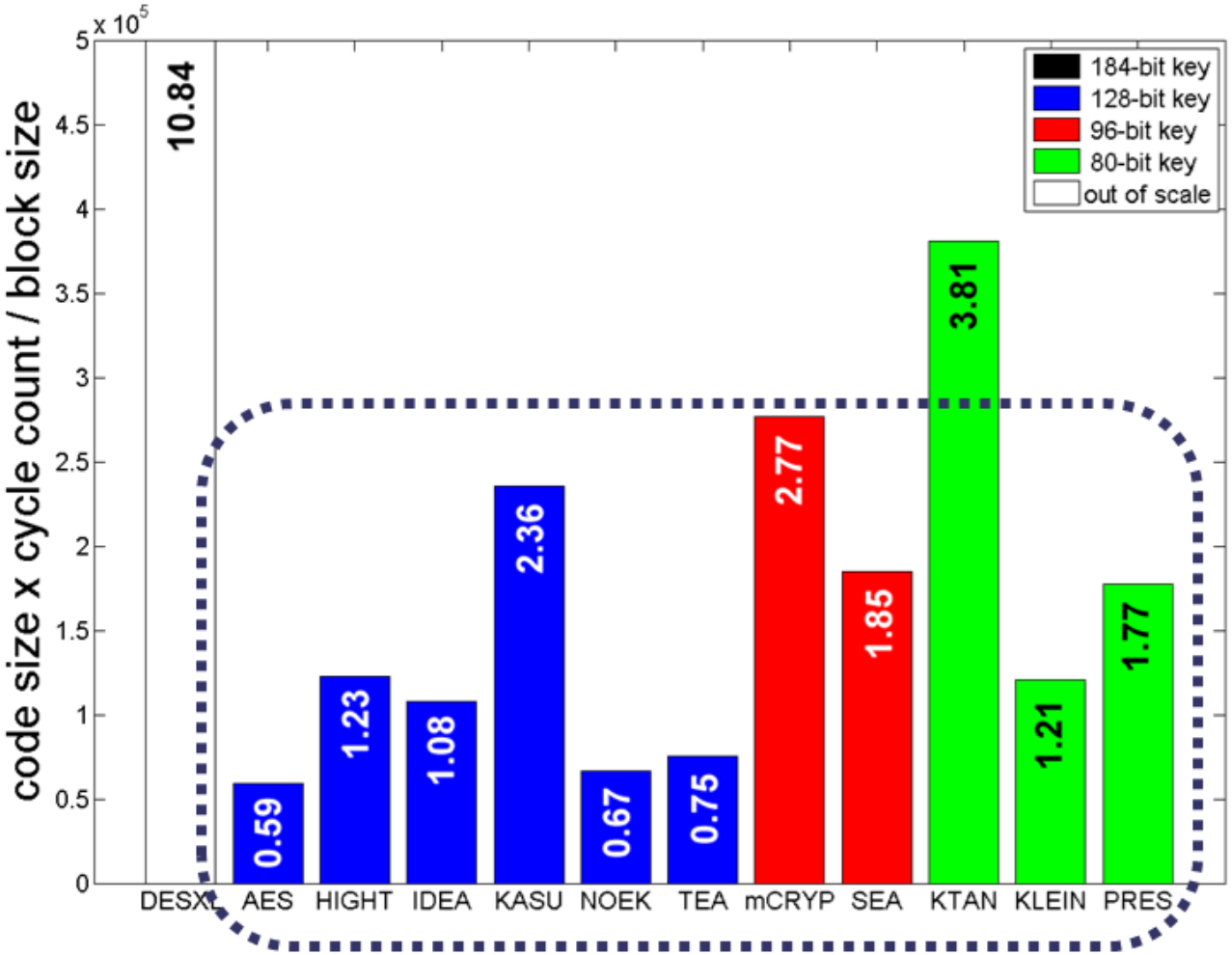
# Combined metric (Atmel AVR, Enc.)






- Time vs. code size tradeoff (because HW is fixed)

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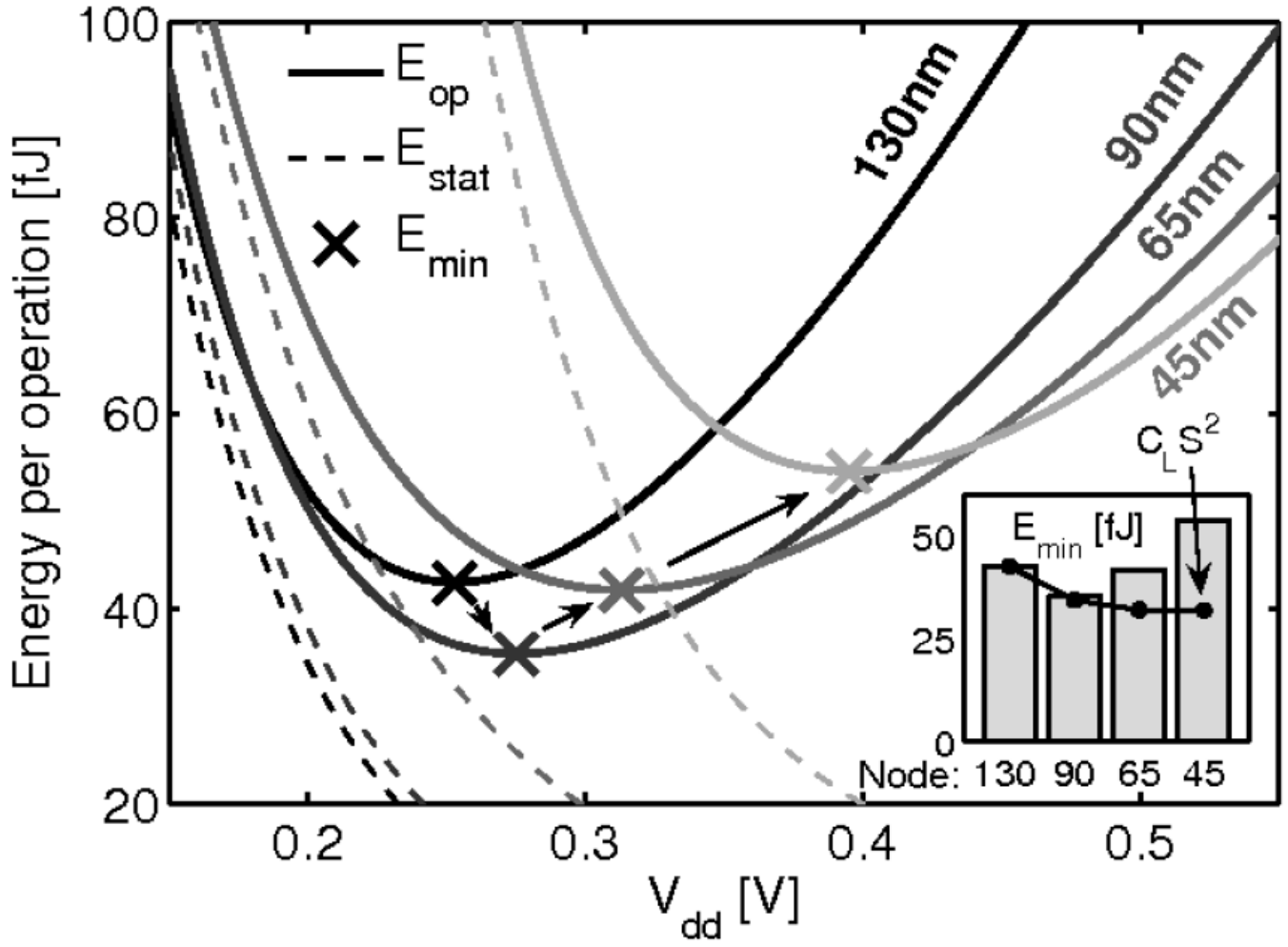
# Technology scaling



- Between and within technologies (*f* and Vdd)



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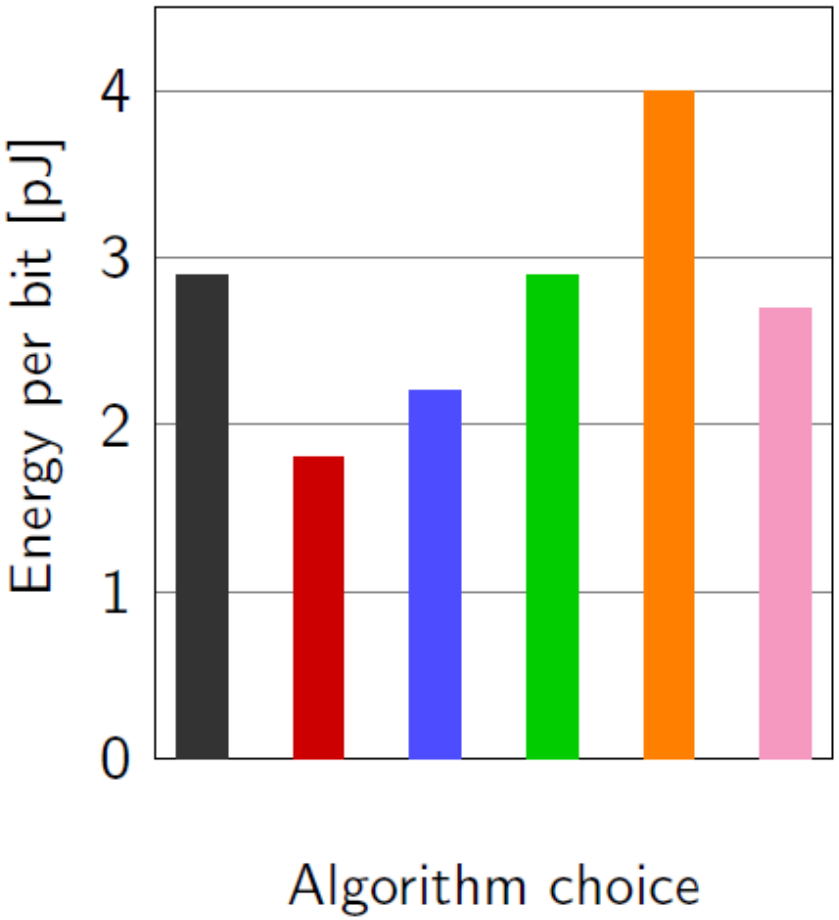


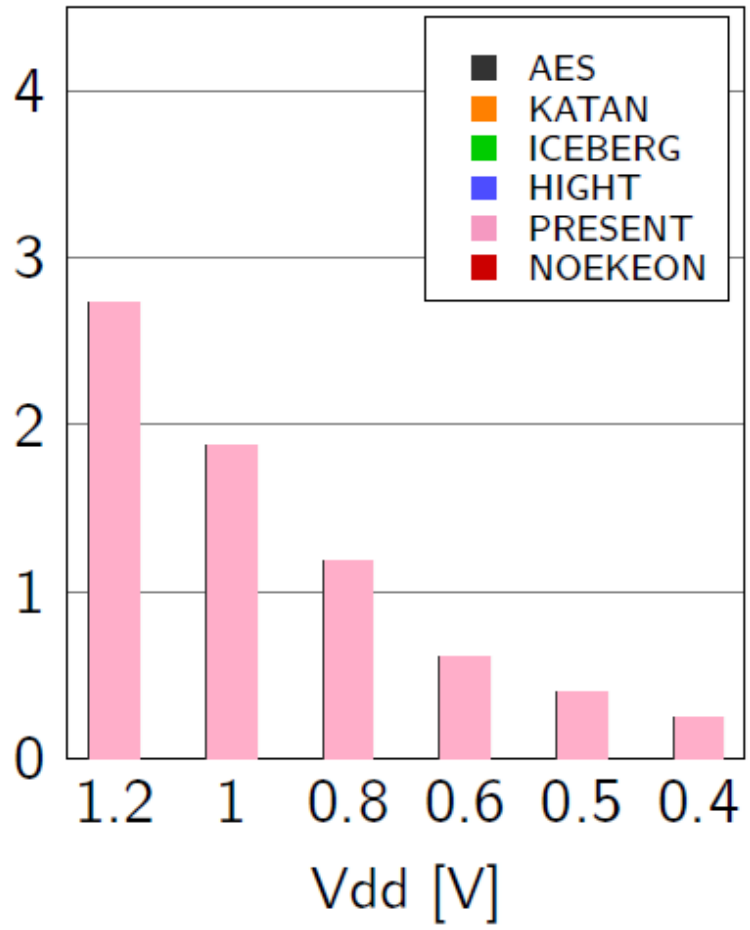

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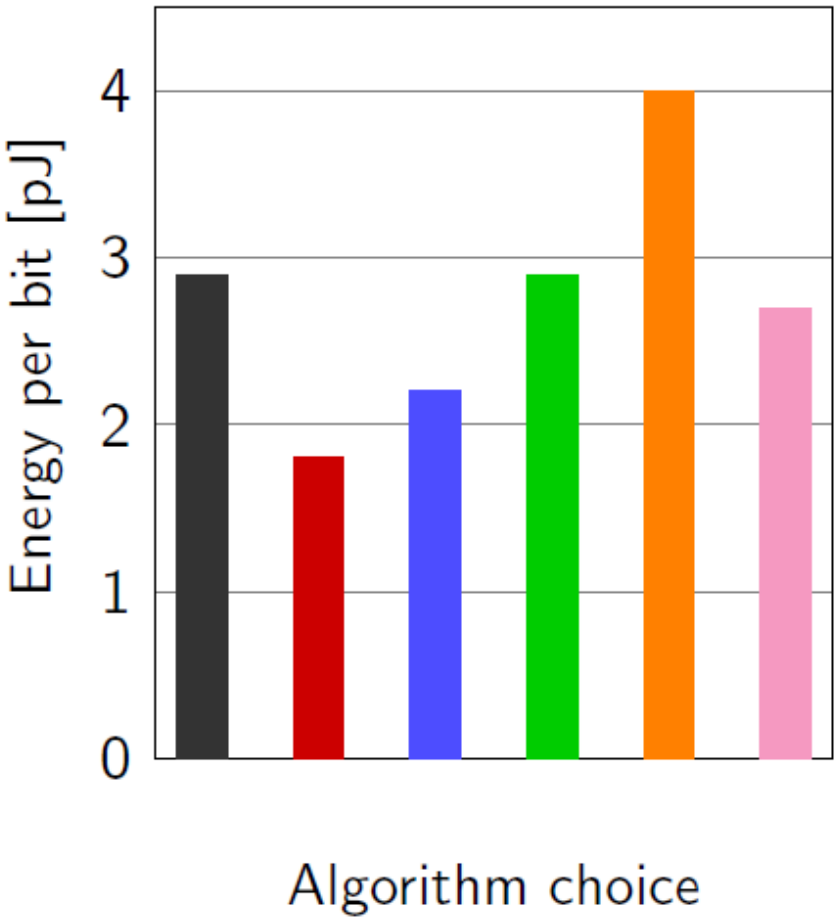


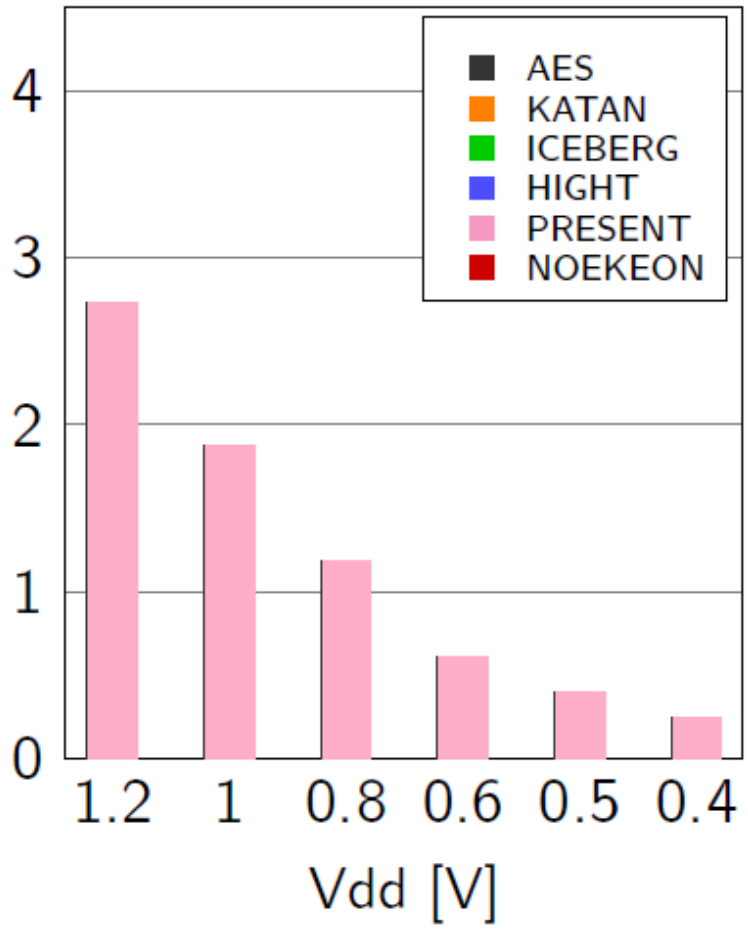


- Questions the relevance of algorithmic changes

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- Gate count limit probably reached for rounds
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  - Key scheduling
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- AES is already quite lightweight
- NOEKEON is ultra lightweight

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  - *From ciphers to modes (e.g., authenticated enc.)*

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- Implementation (at large) matters
  - Specific challenges => need of specific solutions
  - But always part of something “bigger”
  - More open source (software & hardware) needed

# THANKS

http://perso.uclouvain.be/fstandae/


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