A Block Cipher with Provable Security against Key Recovery

Tetsu Iwata, Yu Sasaki ,
Yosuke Todo, Kan Yasuda

Security from Industrial View

Security from Industrial View

- Distinguishing attacks are non-sense!!

Security from Industrial View

- Distinguishing attacks are non-sense!!

- There exists a better distinguishing attack than the one discussed in cryptographic community.

Reading Specification Attack (RSA)

- By reading specification, the implemented cipher can be distinguished easily.

Reading Specification Attack (RSA)

- By reading specification, the implemented cipher can be distinguished easily.
- For example, the cipher used in IPsec will be AES-GCM with non-negligible probability

Reading Specification Attack (RSA)

- By reading specification, the implemented cipher can be distinguished easily.
- For example, the cipher used in IPsec will be AES-GCM with non-negligible probability

Attack complexity

- Data:
- Time:

Reading Specification Attack (RSA)

- By reading specification, the implemented cipher can be distinguished easily.
- For example, the cipher used in IPsec will be AES-GCM with non-negligible probability

Attack complexity

- Data: 0 (no query)
- Time: 0 (no encryption, no decryption)

More on RSA

- Disadvantage

- Advantage

More on RSA

- Disadvantage

useless if specification is unpublished

- Advantage

More on RSA

- Disadvantage

useless if specification is unpublished

- Advantage

always works if internationally standardized

More on RSA

- Disadvantage

useless if specification is unpublished

- Advantage

always works if internationally standardized

~~Distinguisher~~

Key Recovery

Our Goal

- Designing a new block cipher with provable security against key recovery

Our Goal

- Designing a new block cipher with provable security against key recovery

- **I**ndependent **I**dentity **D**ata-processing for **I**mplementation **O**ptimizing **T**ransformation

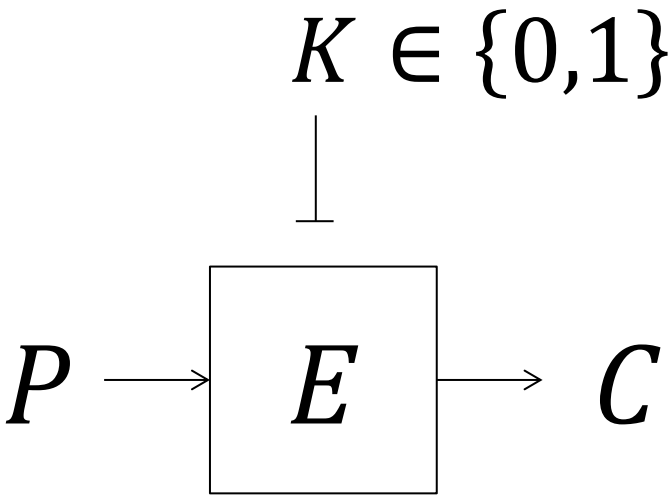
Our Goal

- Designing a new block cipher with provable security against key recovery

- **I**ndependent **I**dentity **D**ata-processing for **I**mplementation **O**ptimizing **T**ransformation

IIDIOT

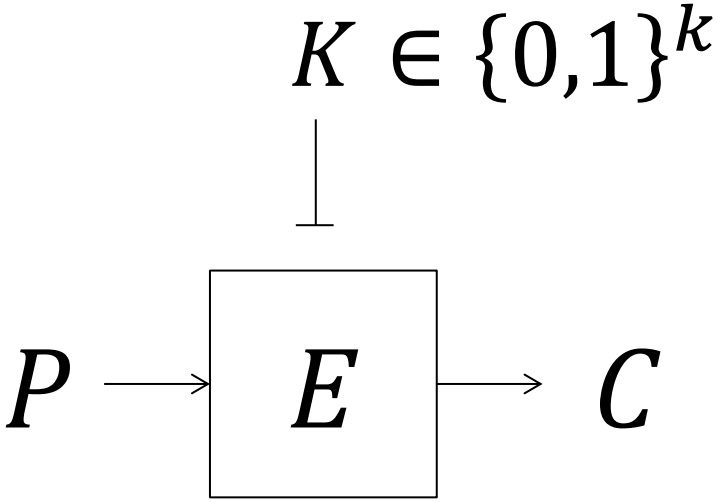
IIDIOT: Specification



$P - C$ is independent from K

E is identity mapping

IIDIOT: Specification

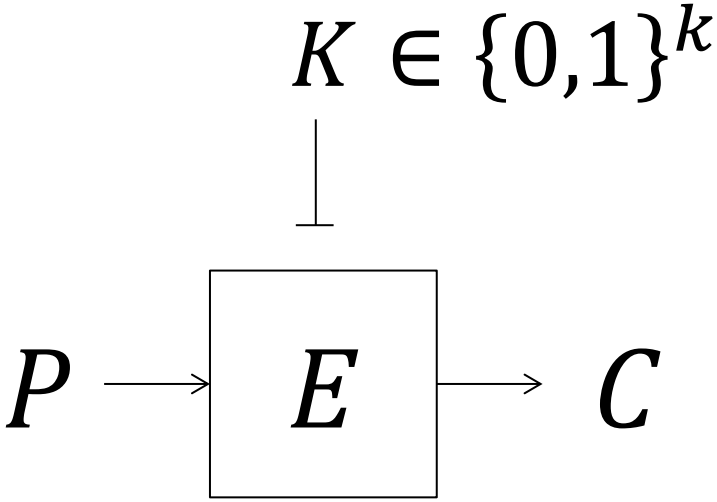


$P - C$ is independent from K

E is identity mapping

Independent-Identity Paradigm

IIDIOT: Specification



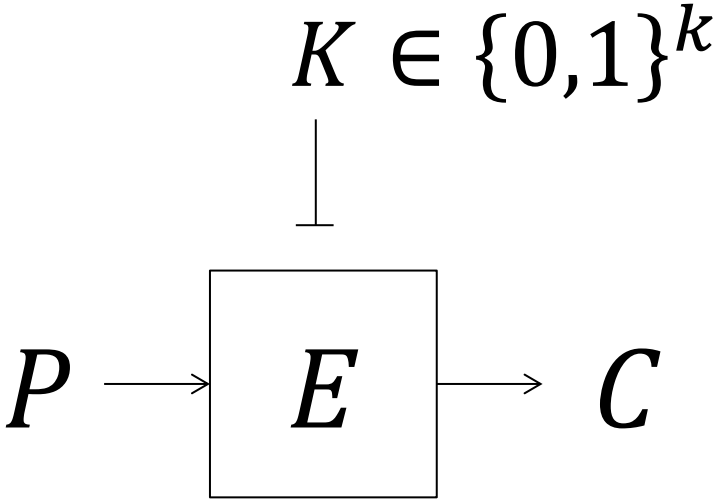
$P - C$ is independent from K

E is identity mapping

Independent-Identity Paradigm

Extremely flexible interface

IIDIOT: Specification



$P - C$ is independent from K

E is identity mapping

Independent-Identity Paradigm

Extremely flexible interface

- Block size: chosen by the users
- Key size: chosen by the users (k bits)

Implementation

IIDIOT: Implementation

- $P = C$, the implementation cost is 0.

IIDIOT: Implementation

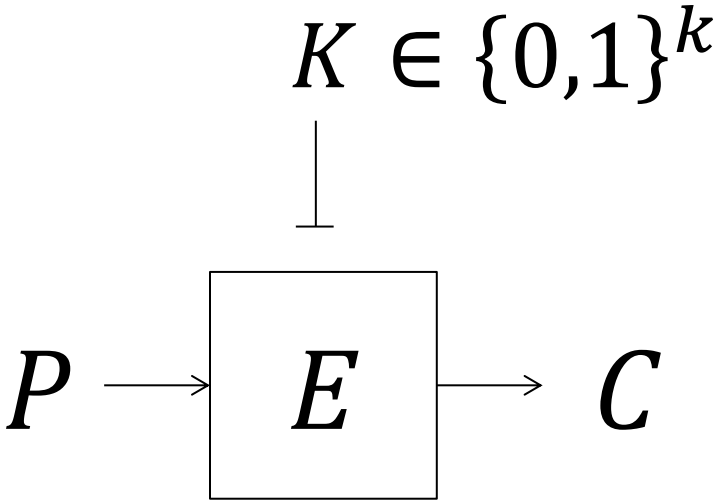
- $P = C$, the implementation cost is 0.
- Key register can be omitted if used in practice, but we need it for security proof.

Security

IIDIOT: Distinguisher

- Simple distinguisher
  1. Query P to obtain C.
  2. Check if $P = C$.

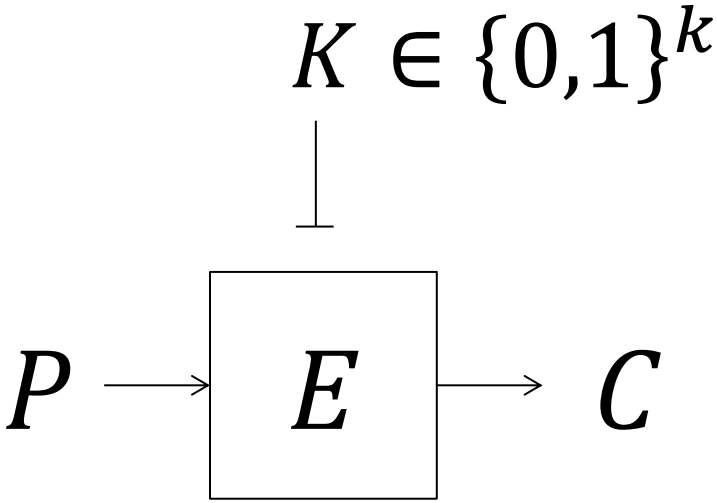
  Complexity: 1 KP



IIDIOT: Distinguisher

- Simple distinguisher
  1. Query P to obtain C.
  2. Check if $P = C$.

  Complexity: 1 KP



- This distinguisher is anyway worse than RSA (reading specification attack).

IIDIOT: Key Recover

- The game picks k uniformly at random.

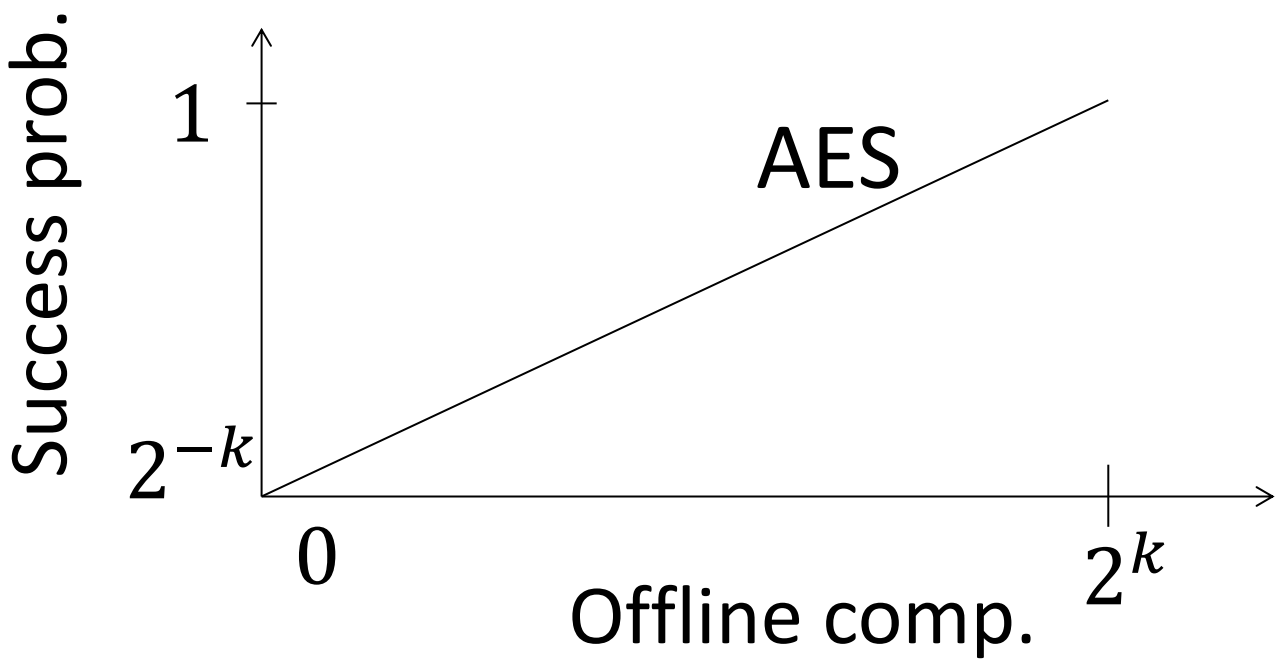
$$k \xleftarrow{\$} \mathcal{K}$$

- The game gives you the entire code book.

$$\mathrm{Adv}\, \boldsymbol{A}^{\mathcal{P},\mathcal{C}}$$

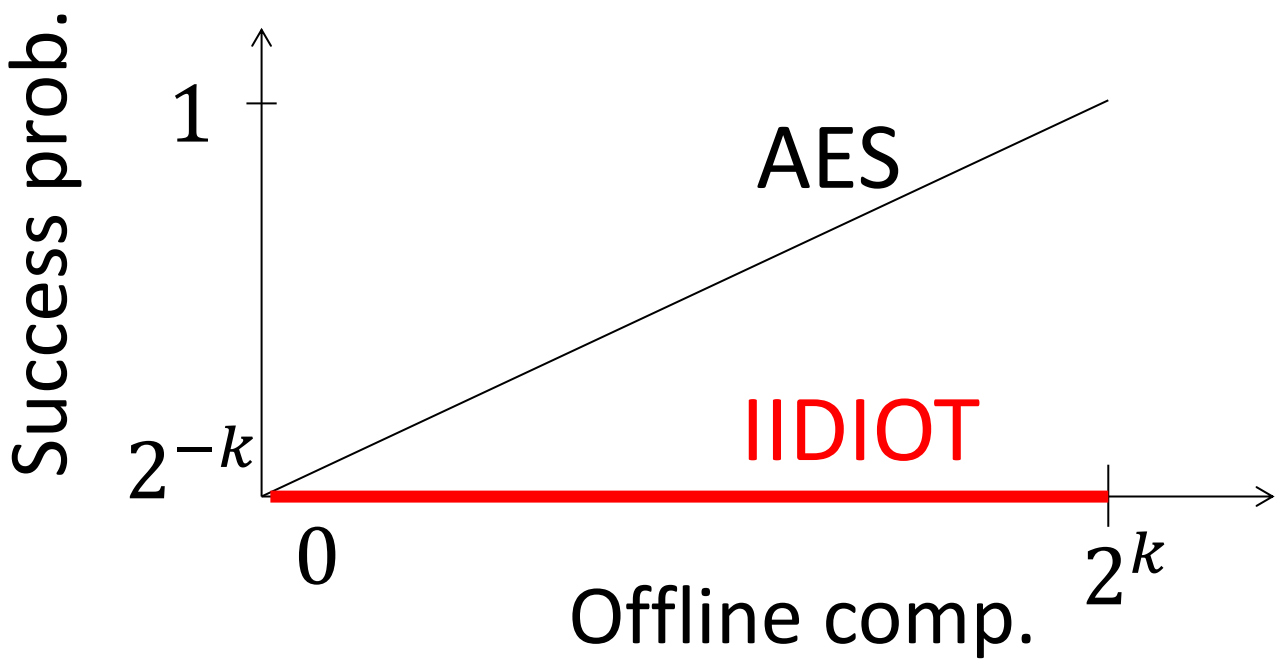
- Try to recover k.

Comparison with AES



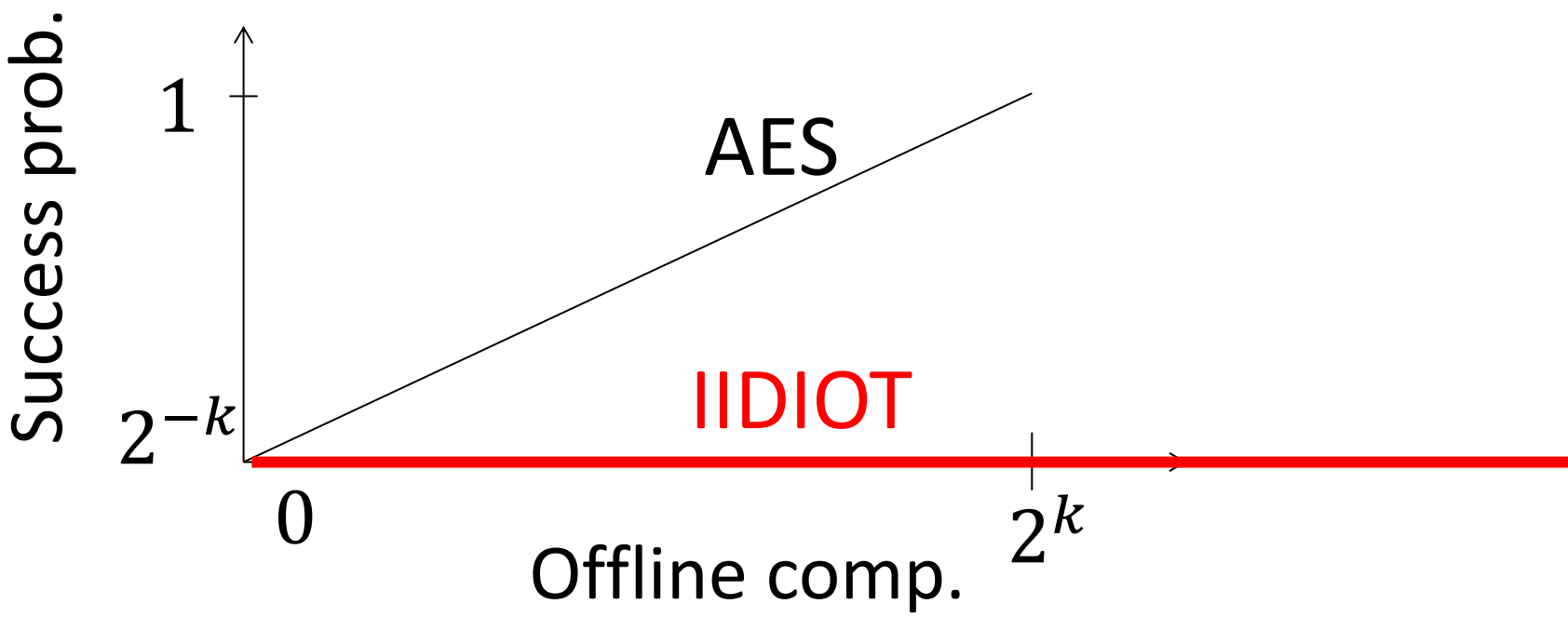
- Best attack against AES is exhaustive search.
- For each guess, check if $C = AES_{guess}(P)$

Comparison with AES



- Guess cannot be verified in IIDIOT.

Comparison with AES



- Guess cannot be verified in IIDIOT.
- provably secure against adversaries with infinite power of query and offline computation

Concluding Remarks

- What is scientifically incorrect in IIDIOT?
- Make sure not to be as idiot as IIDIOT.

"Arigato" for your attention!!