The Landscape of Committing Authenticated Encryption

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NIST Workshop 2023— October 3, 2023

What Kind of Security Should Encryption Offer?

Classical encryption

Example: CBC, CTR

Provide privacy only

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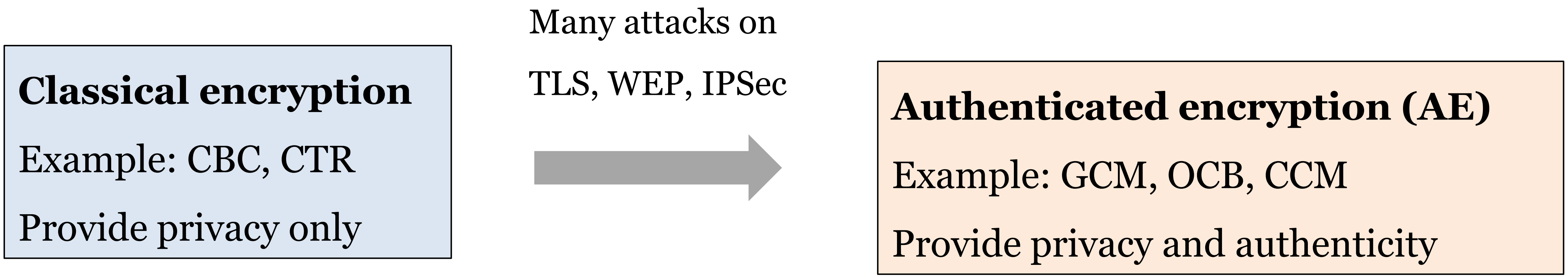

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Authenticated encryption (AE)

Example: GCM, OCB, CCM

Provide privacy and authenticity

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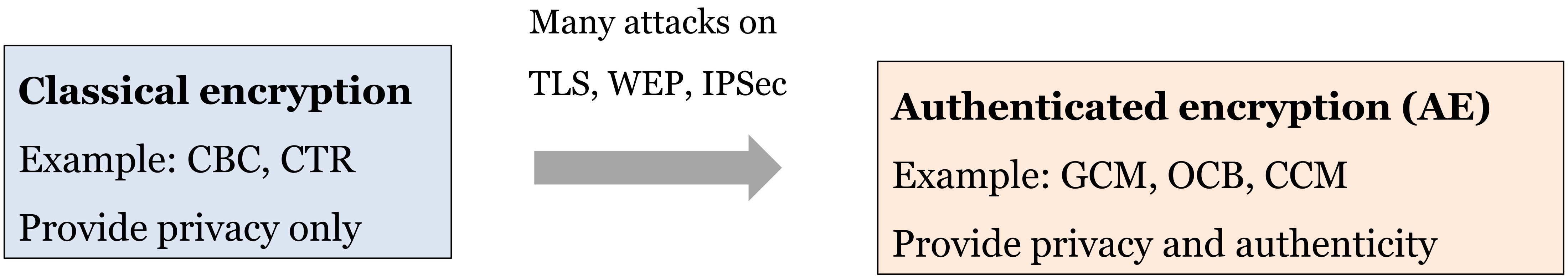

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Message franking

aws

Amazon Clo

OPAQUE

pw-based key exchange

Googl

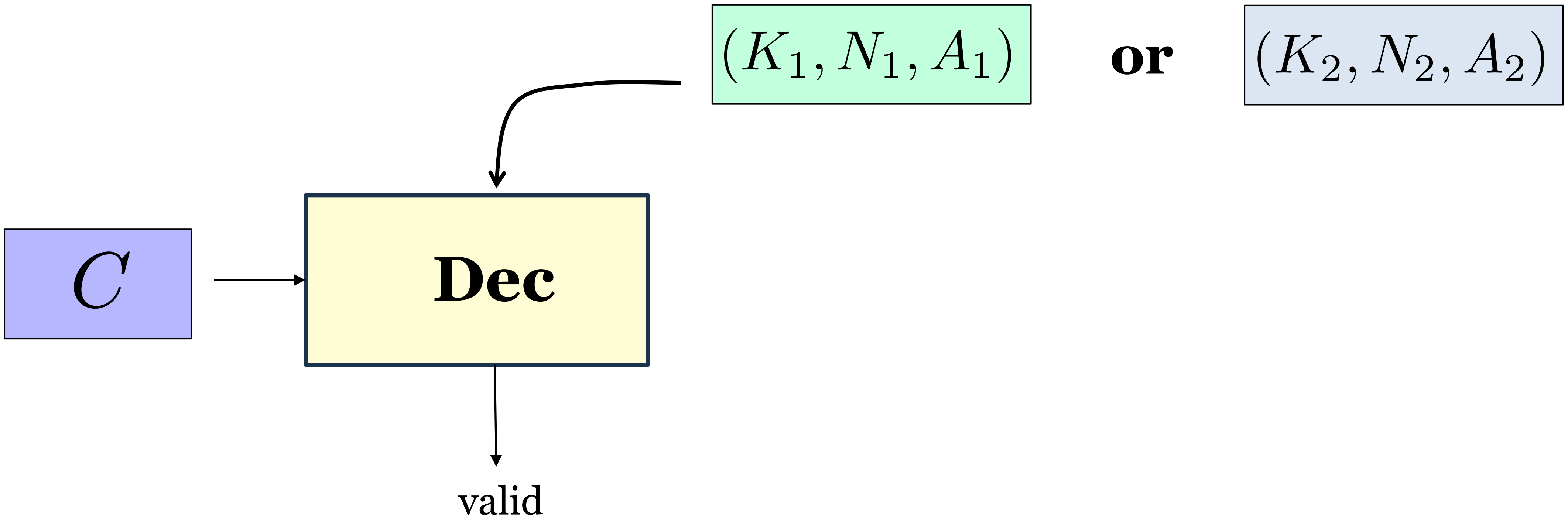
bscribe with Go

Shadowsocks

VPN

What We Need: Committing Security

[FOR17]



Intuition: A ciphertext cannot be opened properly under two different contexts (possibly to different messages)

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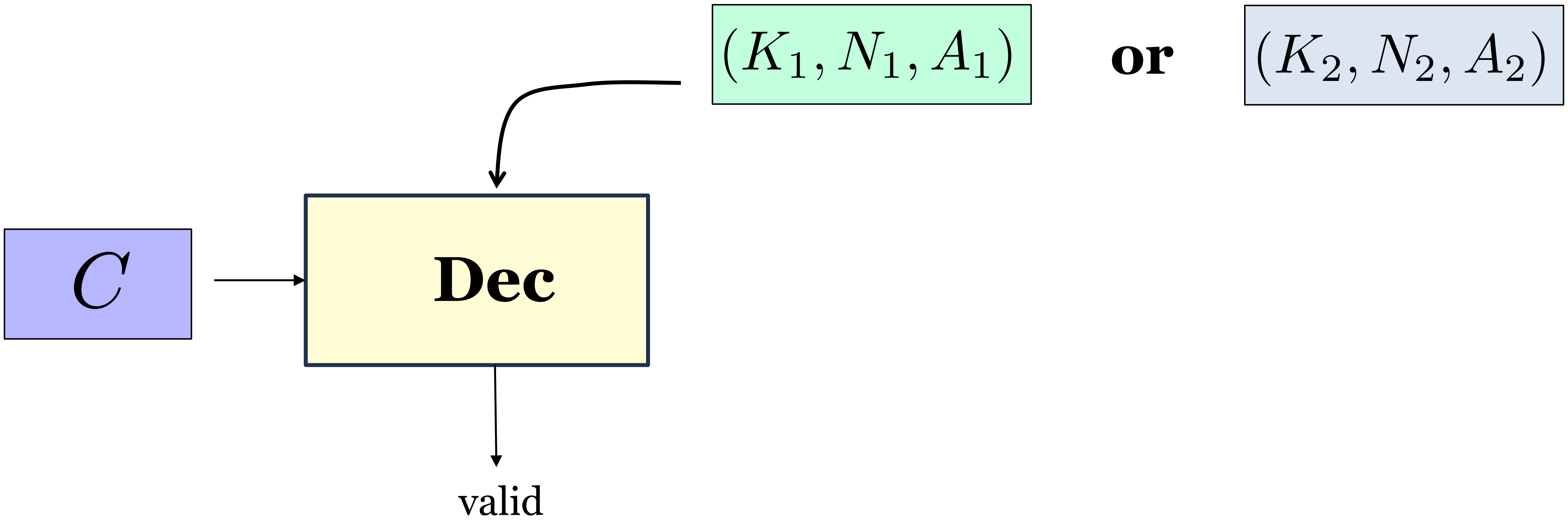

(K_1, N_1, A_1) **or** (K_2, N_2, A_2)

C

Dec

valid

Intuition: A ciphertext cannot be opened properly under two different contexts (possibly to different messages)

Not supported by standard encryption schemes

A Hierarchy of Committing Definitions

[BH22]

App: Facebook's message franking

CMT-4: Commit (K, N, A, M)

App: Amazon Cloud encryption

CMT-1: Commit just K

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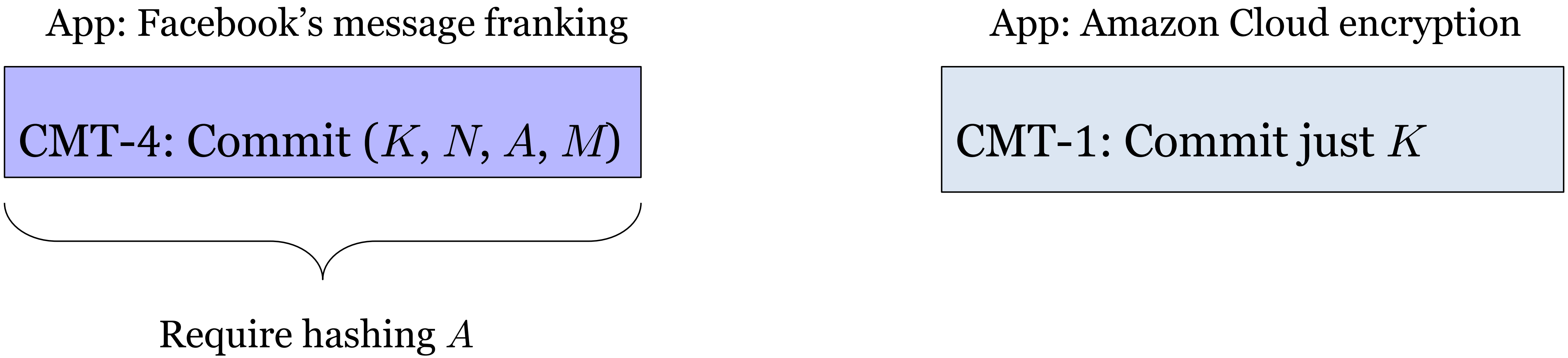

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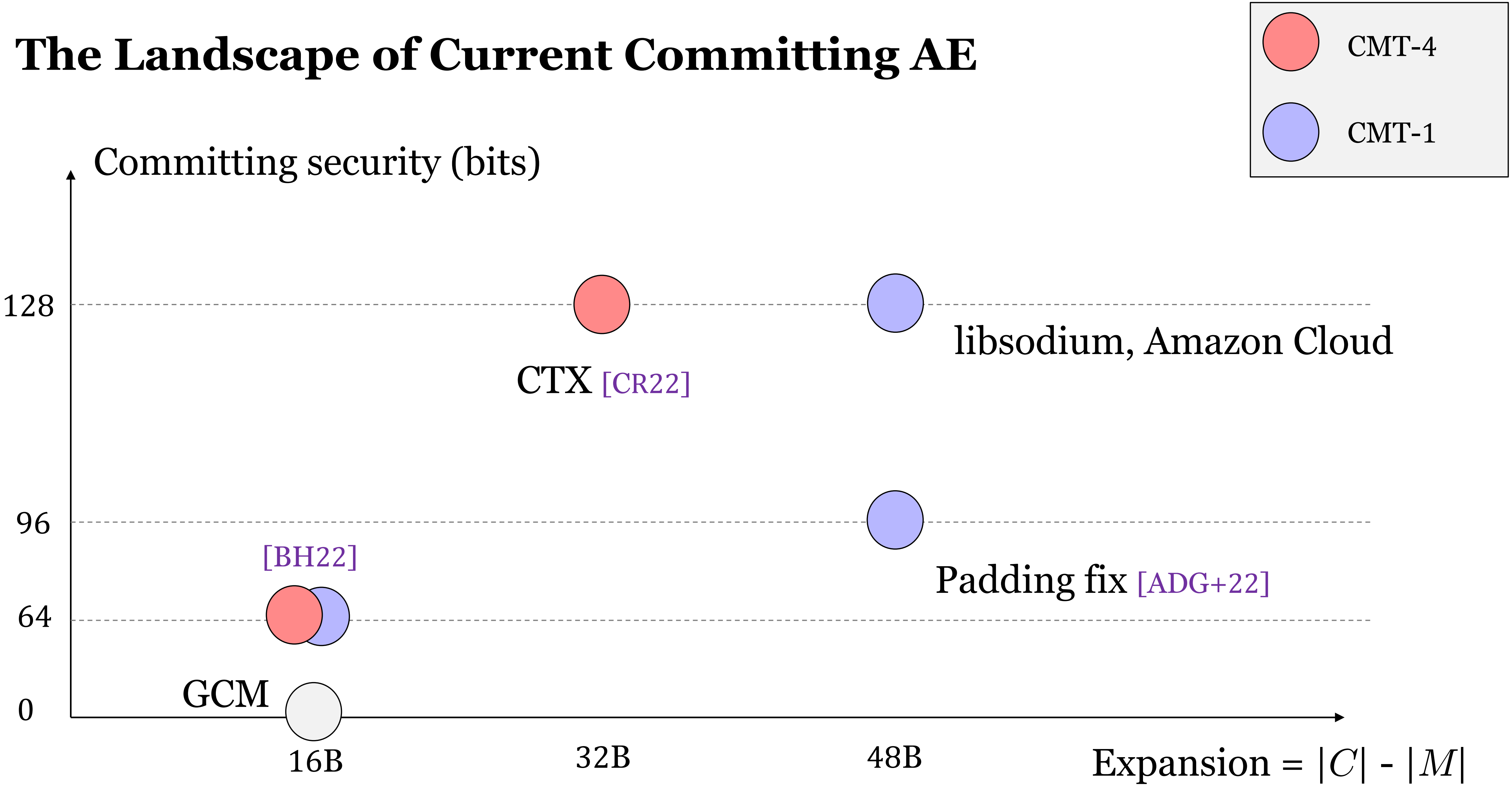
Question #2: Is birthday-bound security (64 bits) enough?

No, here attacks are offline. Should go close to 128-bit security.

The Landscape of Current Committing AE



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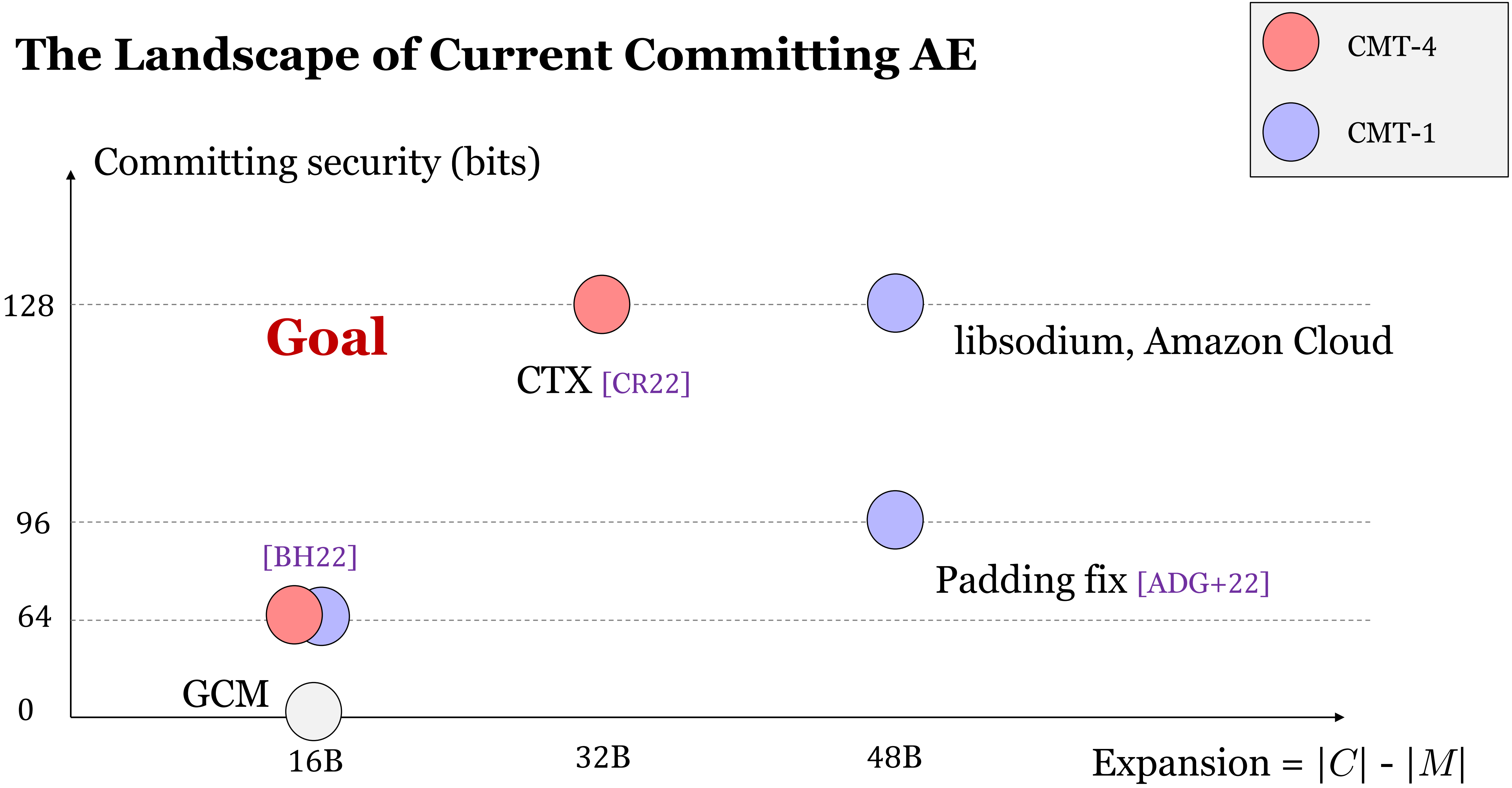

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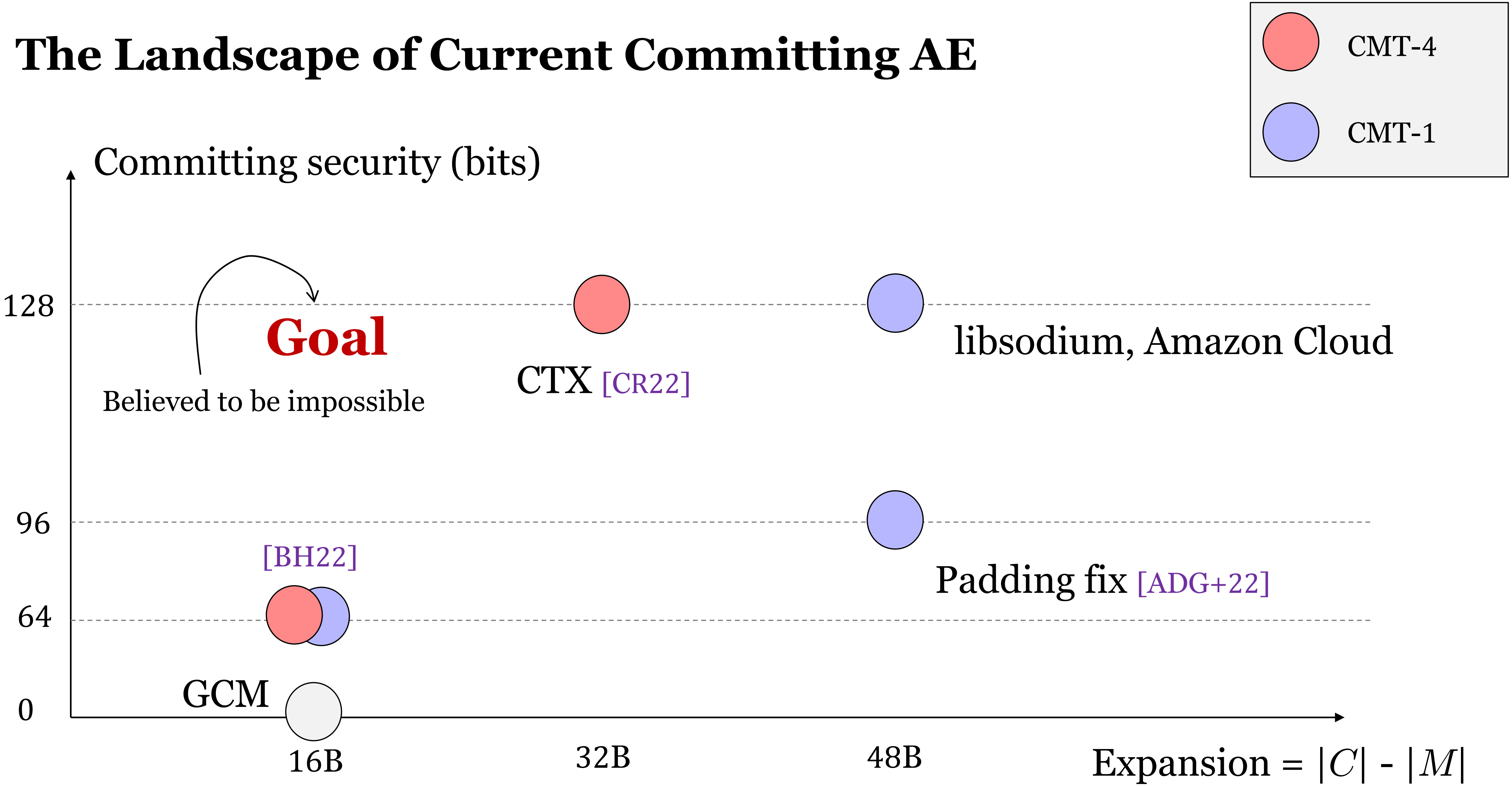
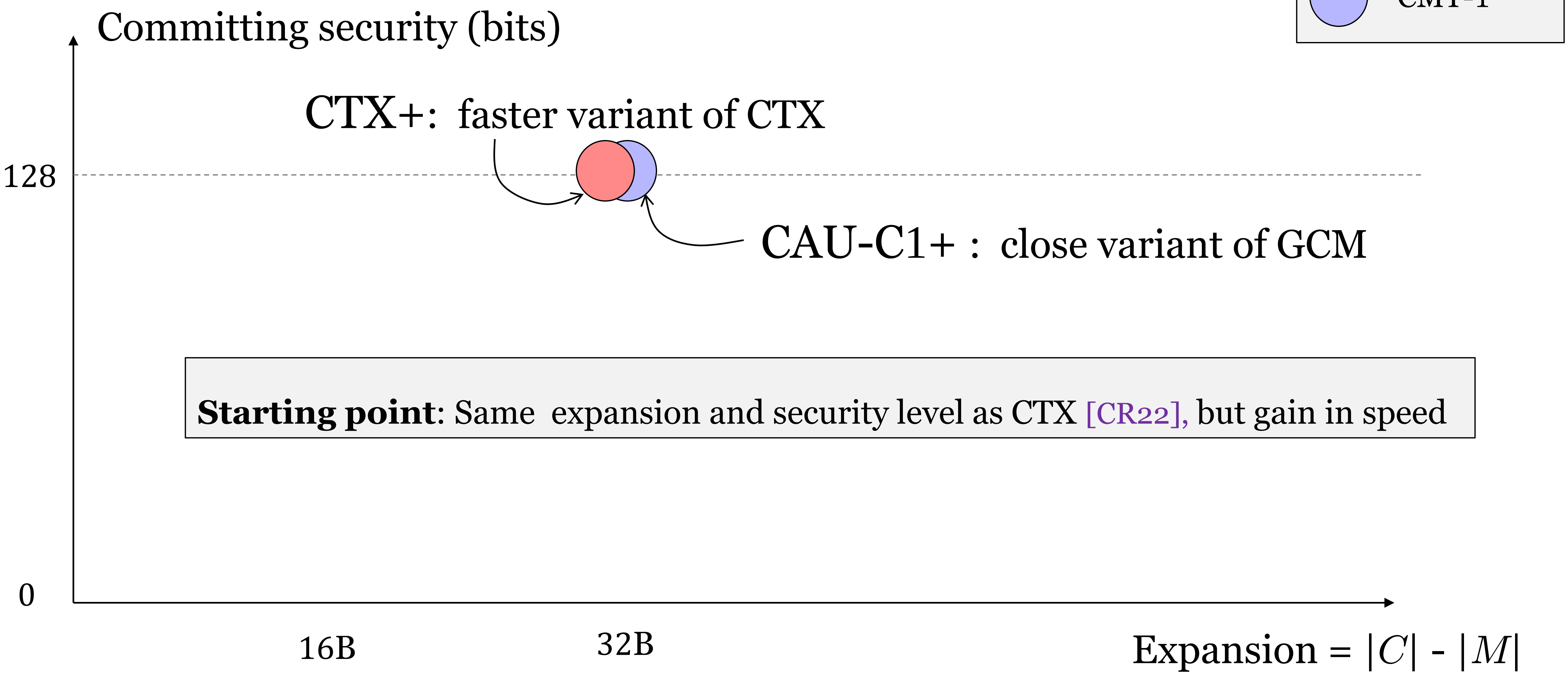


Our Work: Achieve The Goal Efficiently

[BHW23]

🔴 CMT-4

🔵 CMT-1



CTX+: faster variant of CTX

CAU-C1+ : close variant of GCM

Starting point: Same expansion and security level as CTX [CR22], but gain in speed

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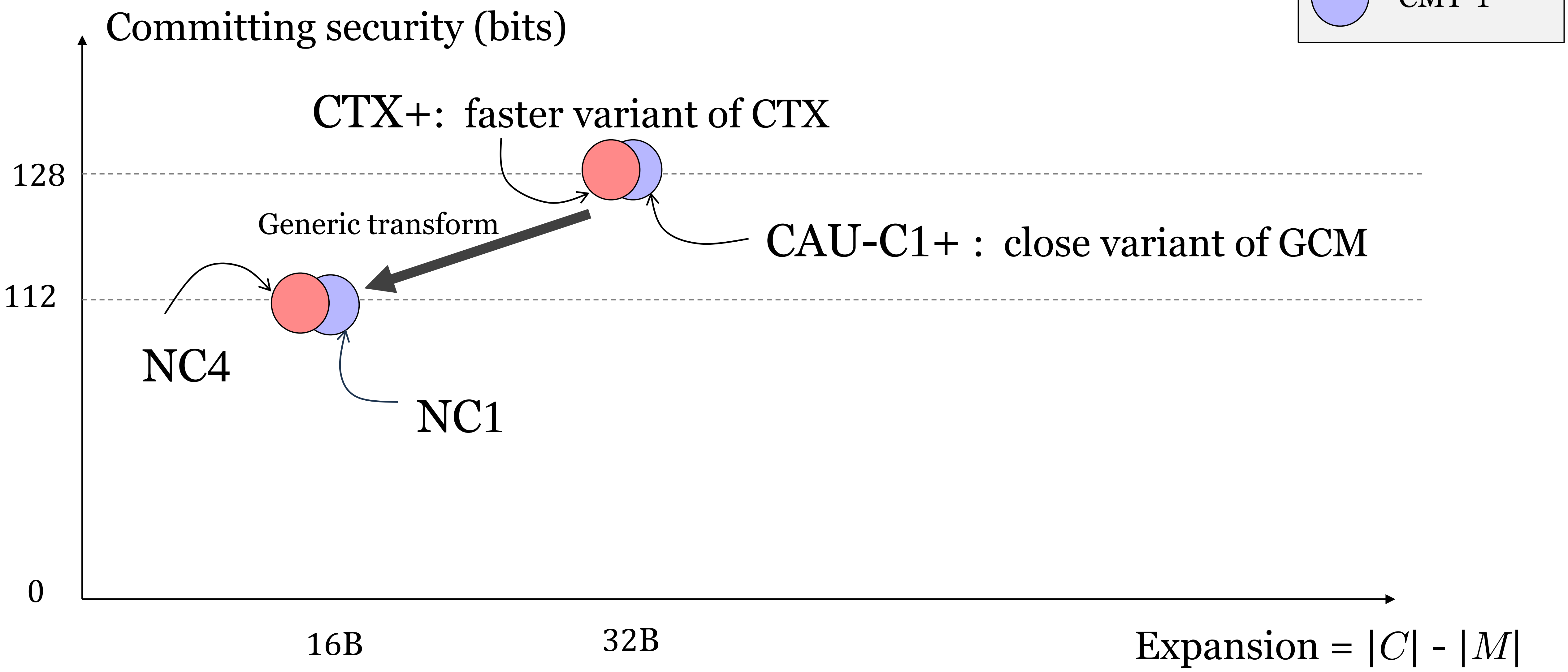

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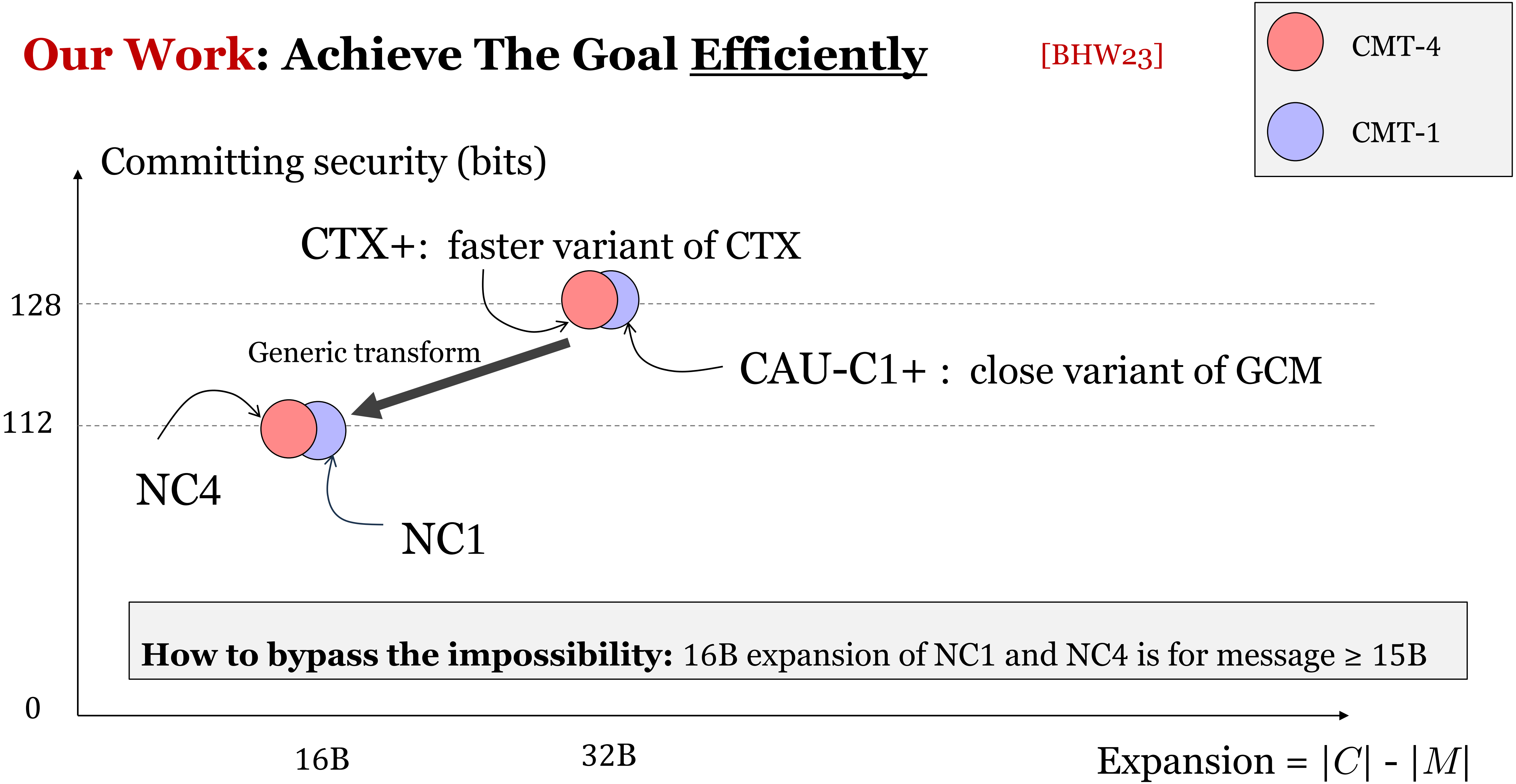
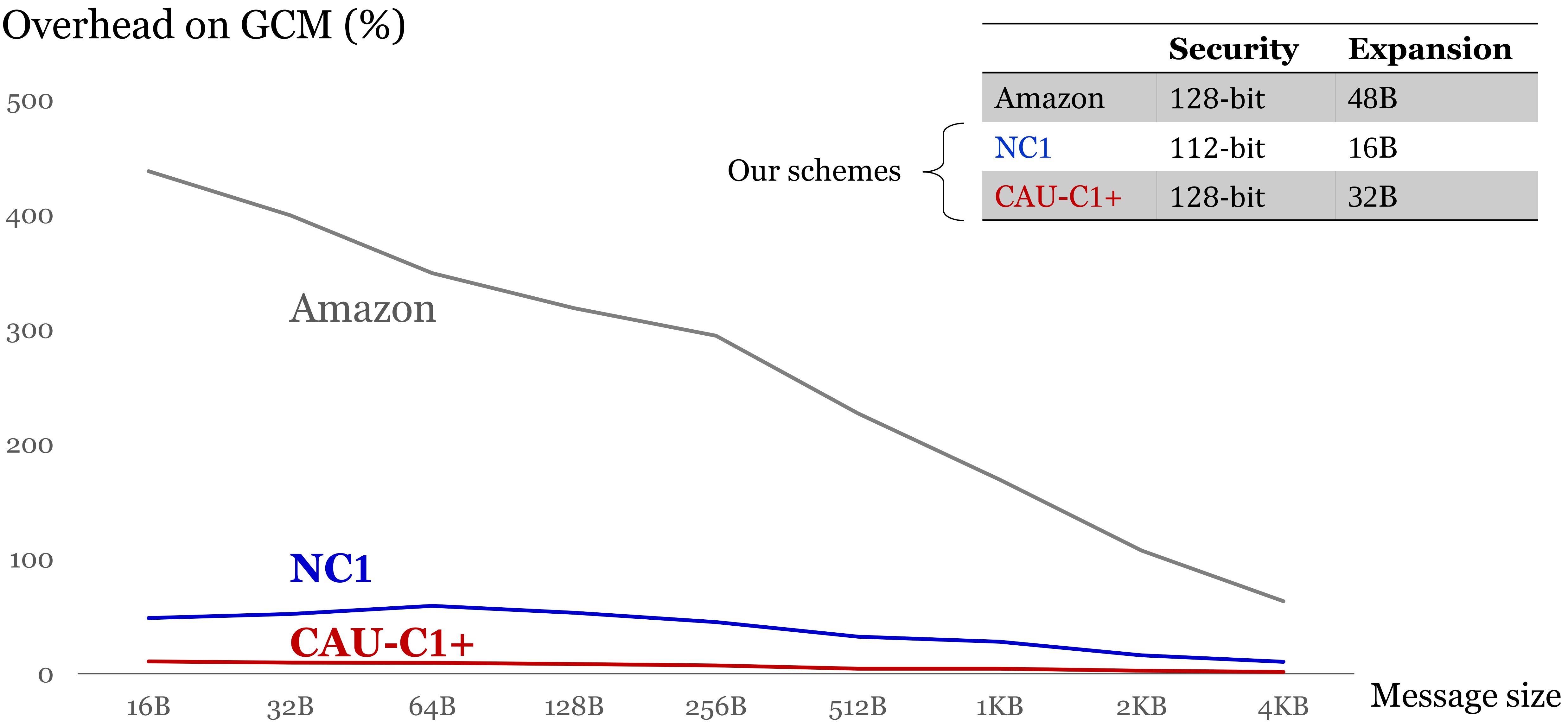


How to bypass the impossibility: 16B expansion of NC1 and NC4 is for message ≥ 15B

Speed Comparison: CMT-1 Schemes

Intel Xeon Gold 6240
5B AD



Our schemes

	Security	Expansion
Amazon	128-bit	48B
NC1	112-bit	16B
CAU-C1+	128-bit	32B

Speed Comparison: CMT-4 Schemes

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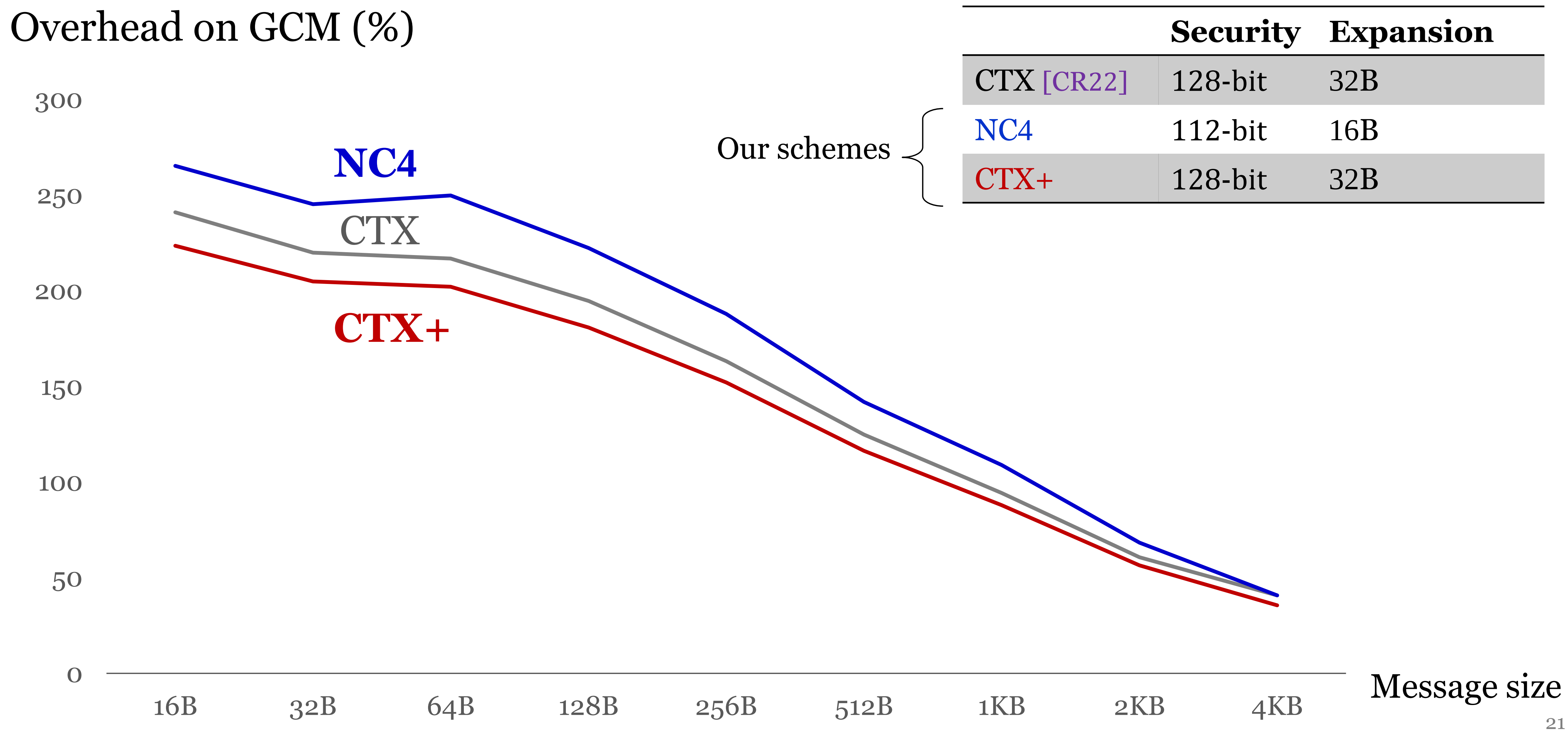

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Our schemes: NC4, CTX+

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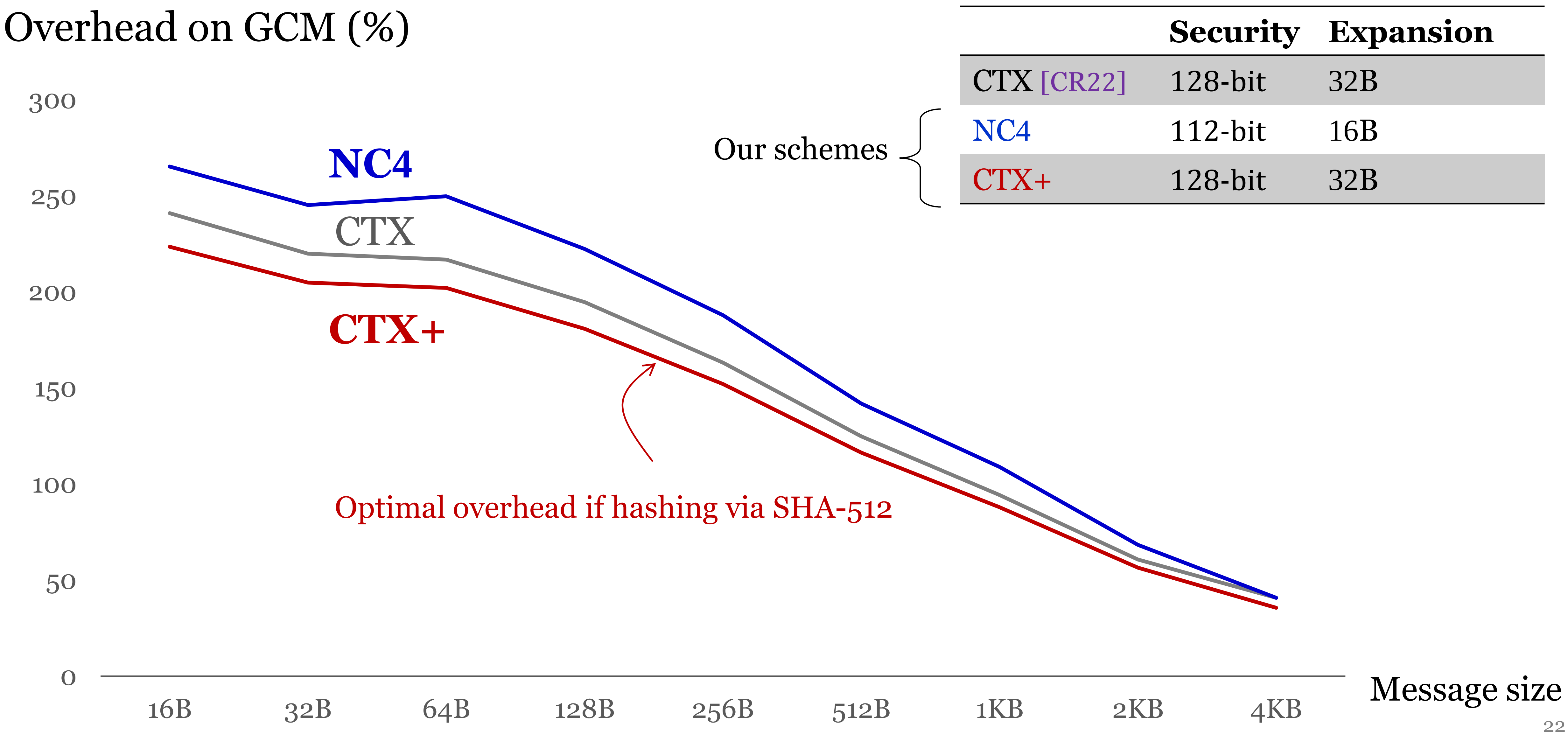
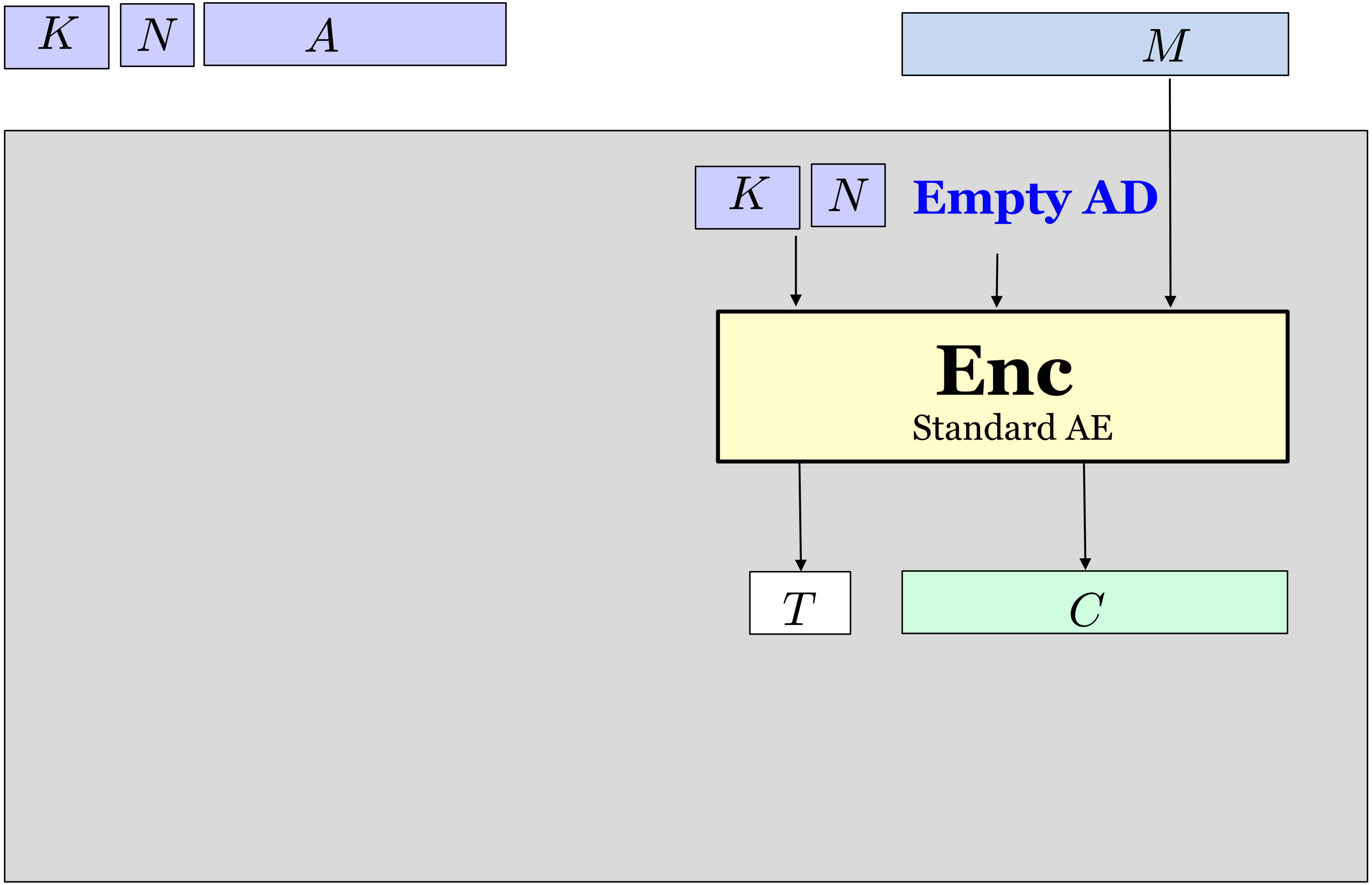


Optimal overhead if hashing via SHA-512

Achieving CMT-4 Security: The CTX+ Transform

[BHW23]

Faster variant of CTX [CR22]



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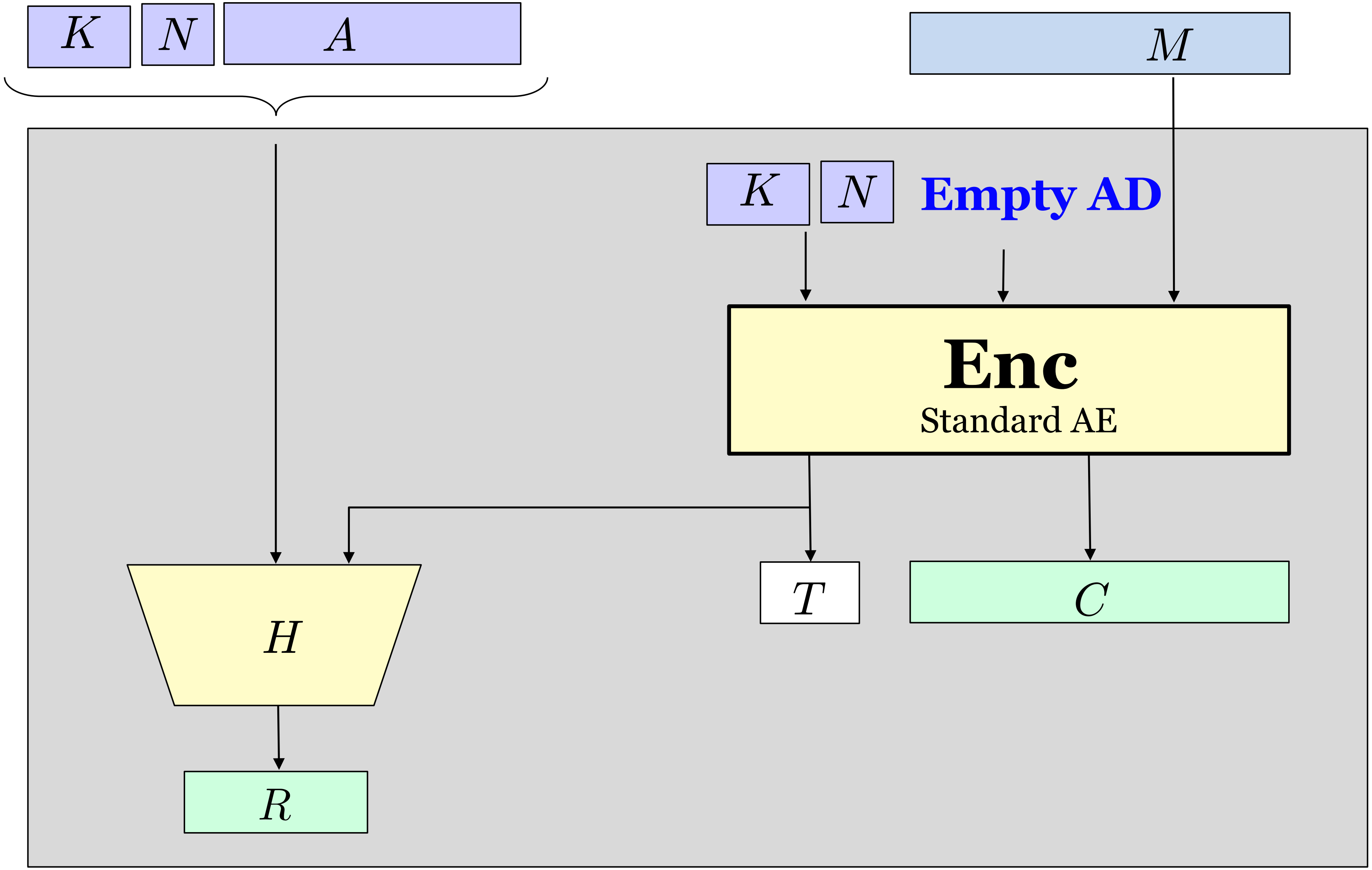

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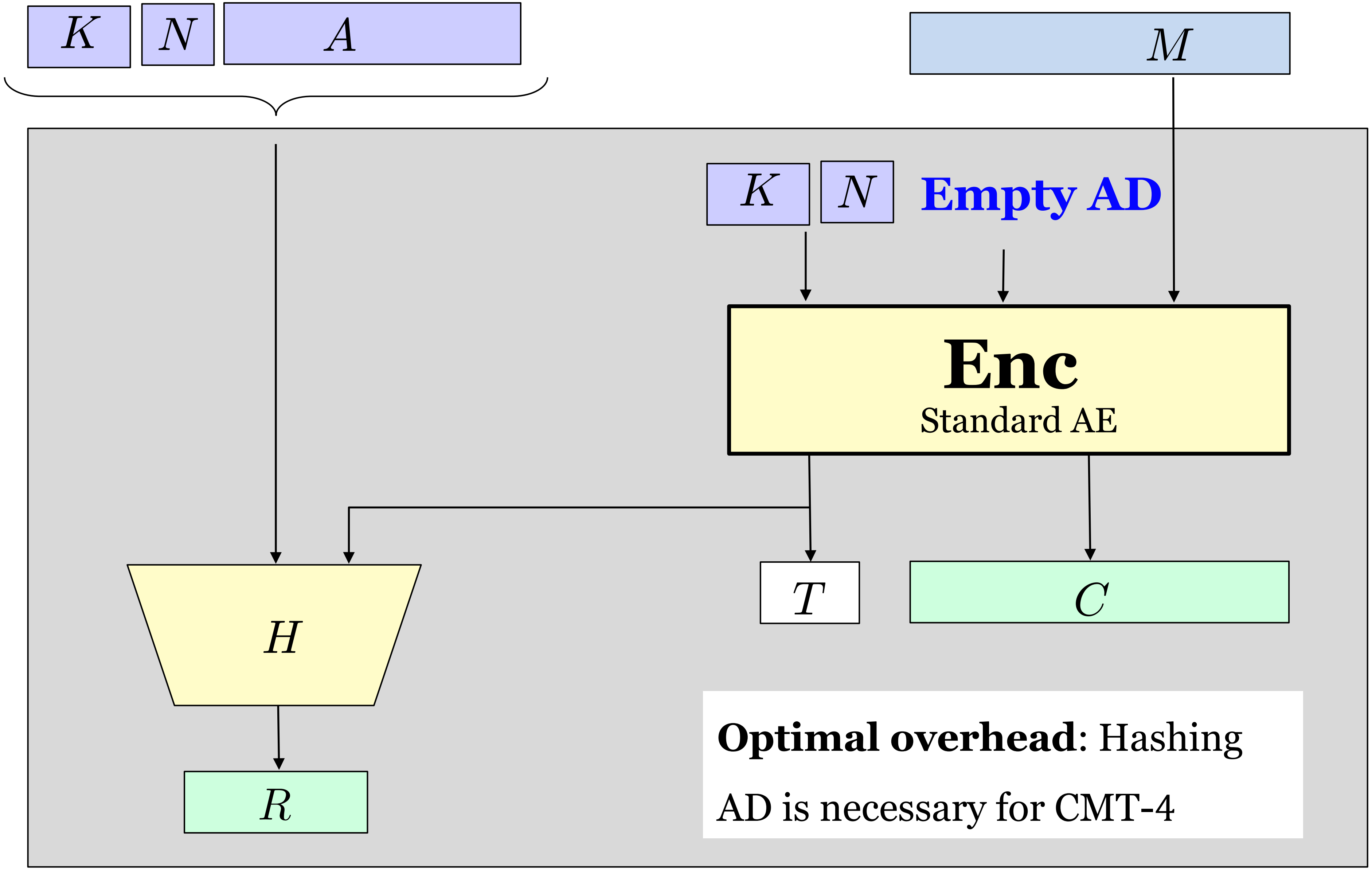


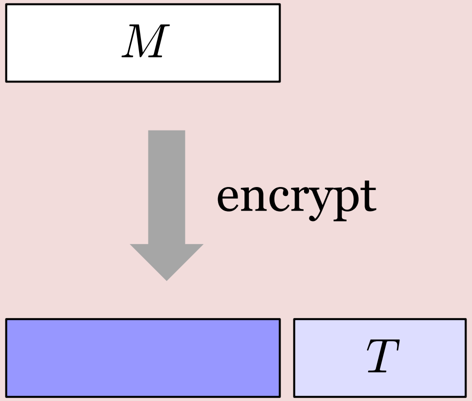
Optimal overhead: Hashing

AD is necessary for CMT-4

How To Reduce Ciphertext Expansion?

Common View

Commitment = Tag



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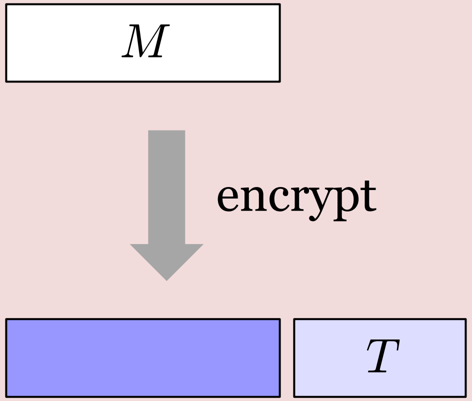

Birthday attack: $|T| \geq 256$

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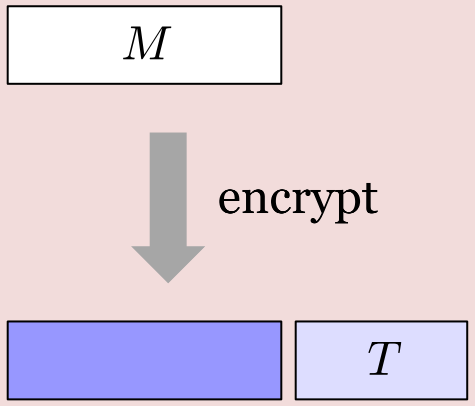

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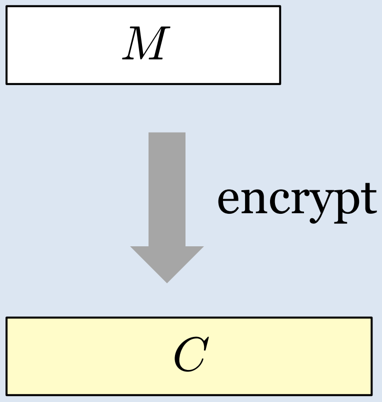

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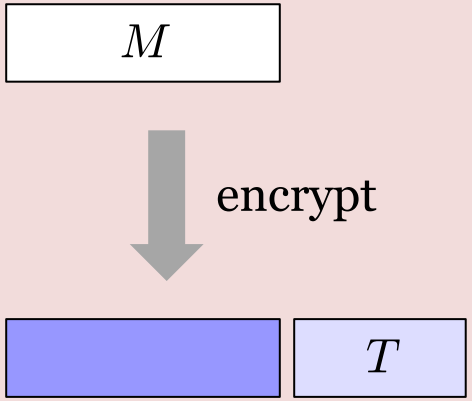

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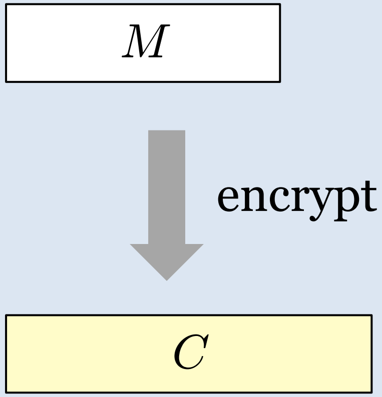

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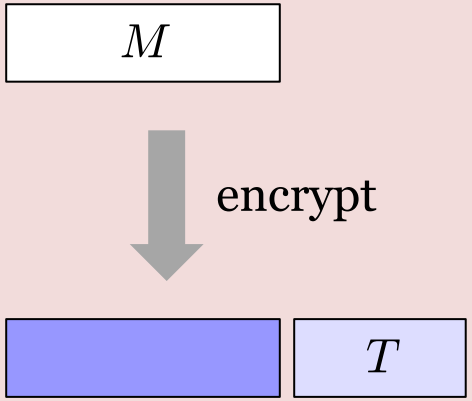

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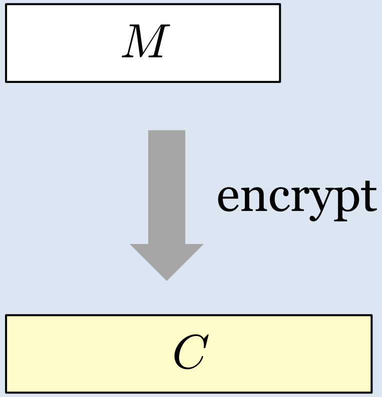

Birthday attack: $|C| \geq 256$

Expansion is $\max\{256 - |M|, 128\}$

A Stepping Stone: Committing Concealer

[BHW23]

A special-purpose committing AE

Conventional AE

Committing Concealer

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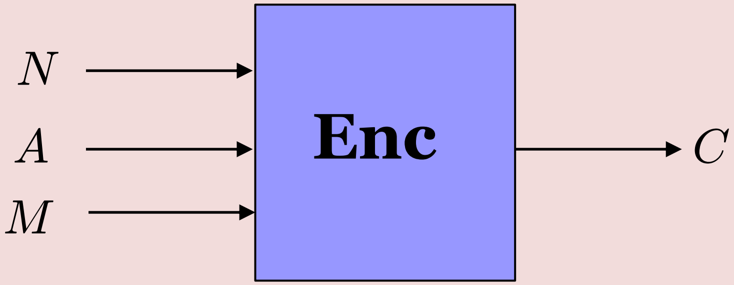
Conventional AE



Committing Concealer

A Stepping Stone: Committing Concealer

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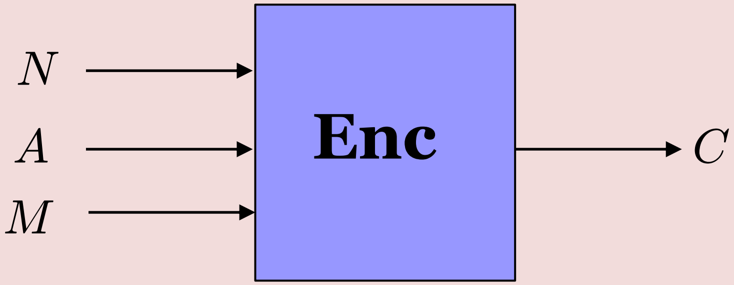
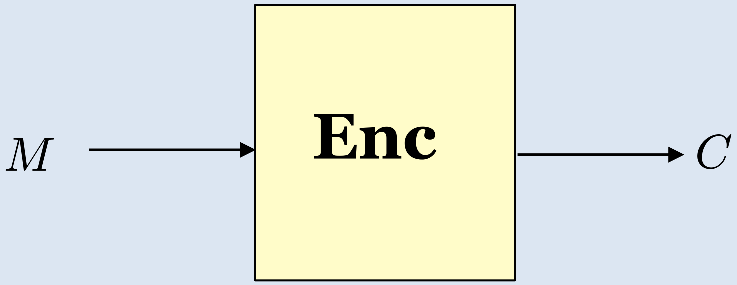


Committing Concealer

No nonce and AD



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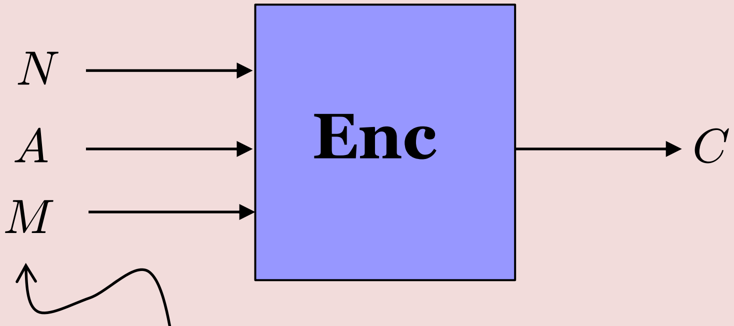
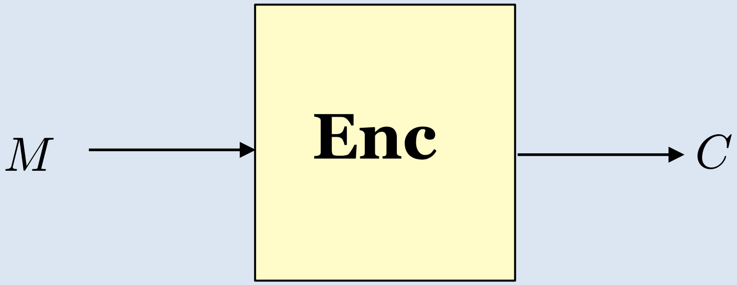


arbitrary

Committing Concealer

No nonce and AD



A Stepping Stone: $\underbrace{\text{Committing Concealer}}_{\text{A special-purpose committing AE}}$

[BHW23]

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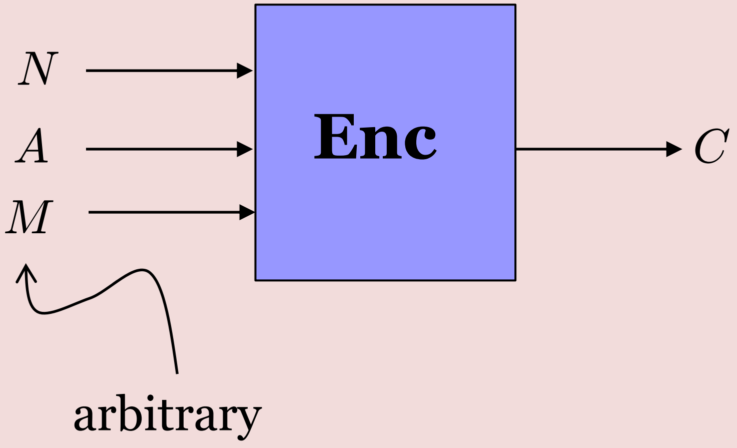

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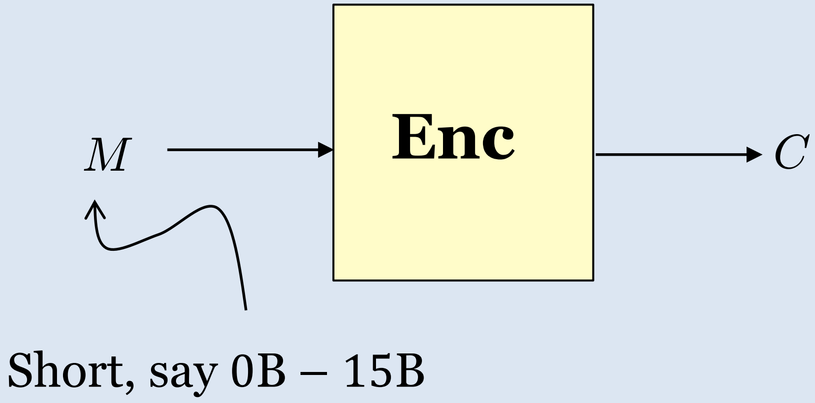

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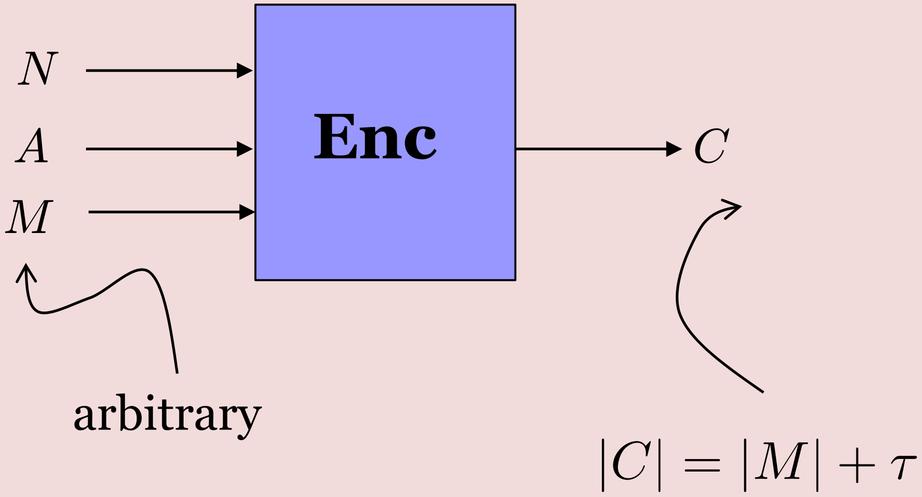

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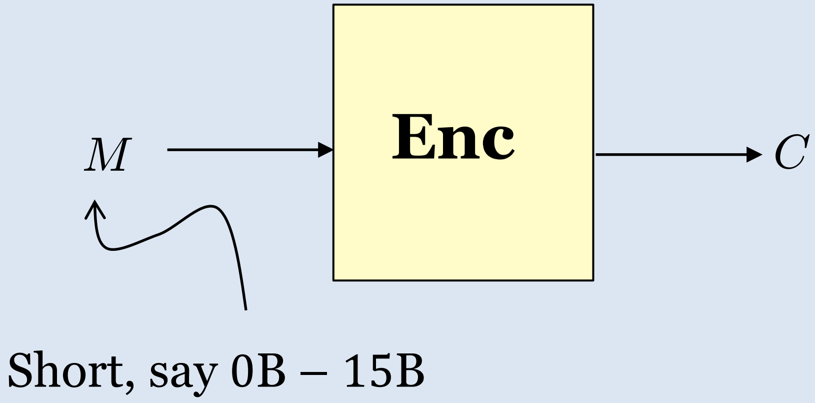

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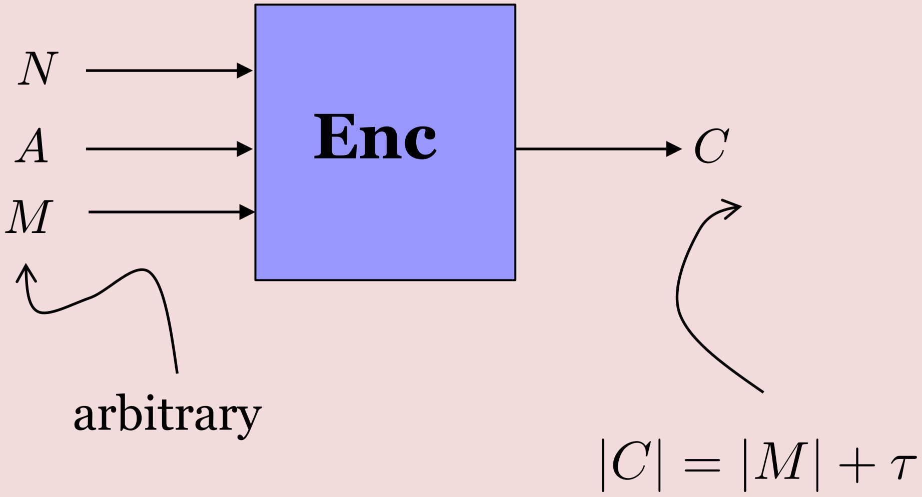

arbitrary

$|C| = |M| + \tau$

Committing Concealer

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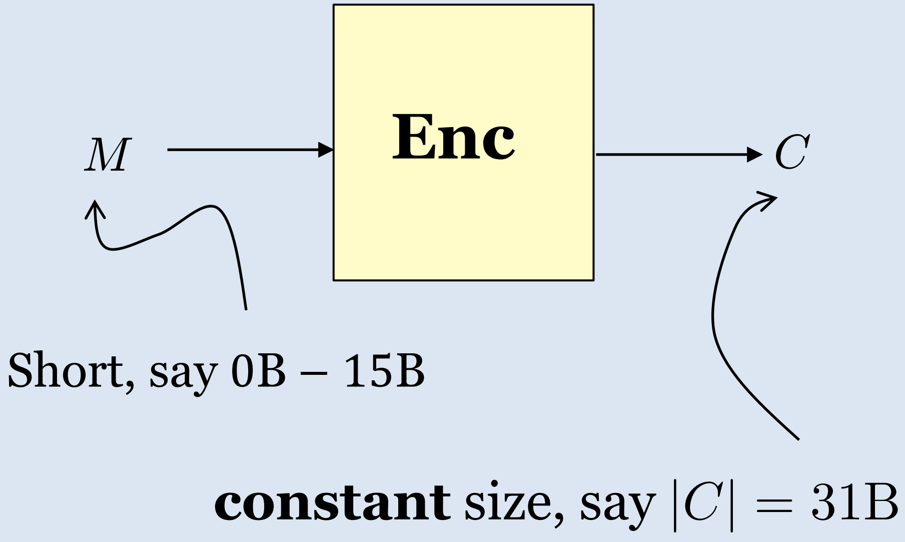


Short, say 0B – 15B

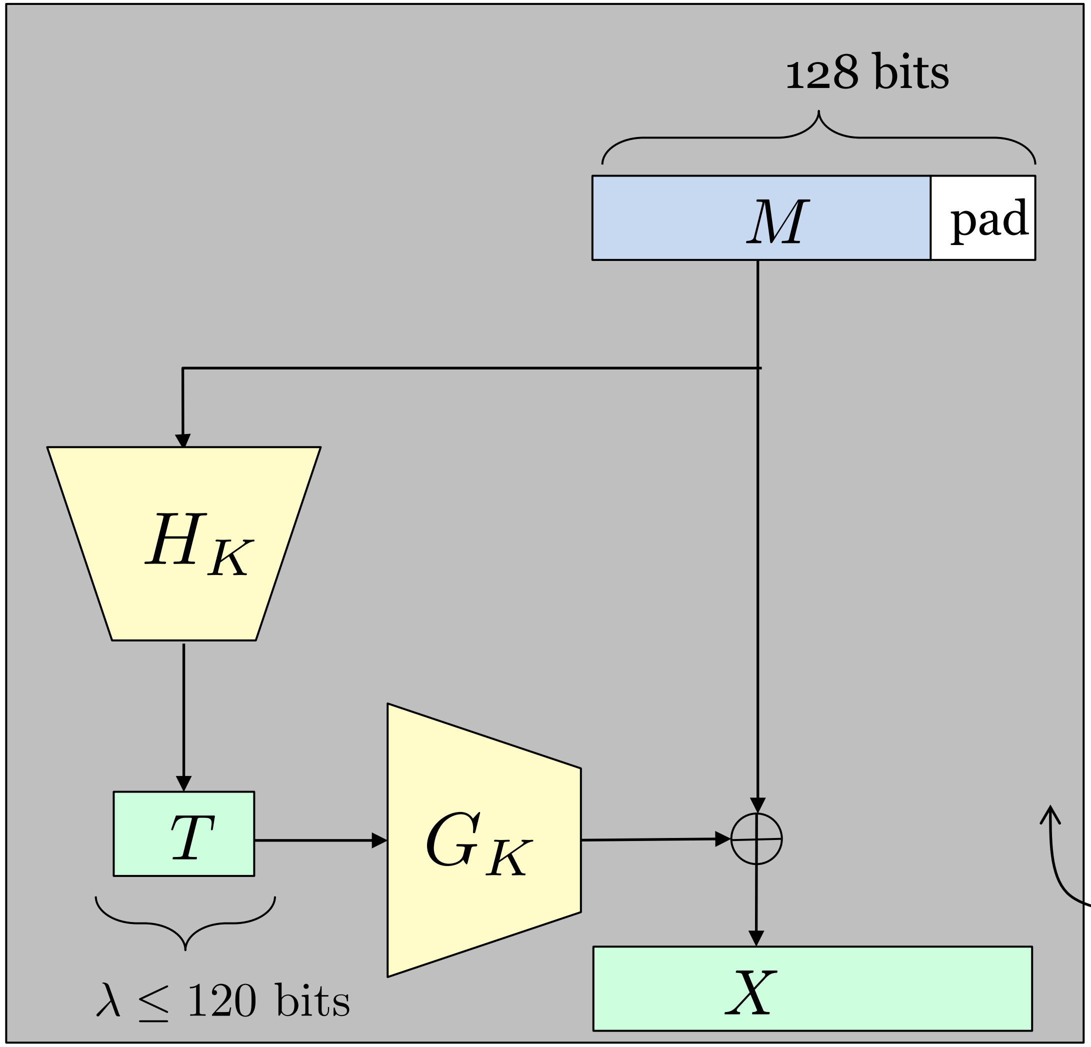
constant size, say $|C| = 31\text{B}$

Building Committing Concealer

The Hash-then-Mask (HtM) Construction

[BHW23]

The HtM construction, conceptual view



SIV paradigm [SR06]

Building Committing Concealer

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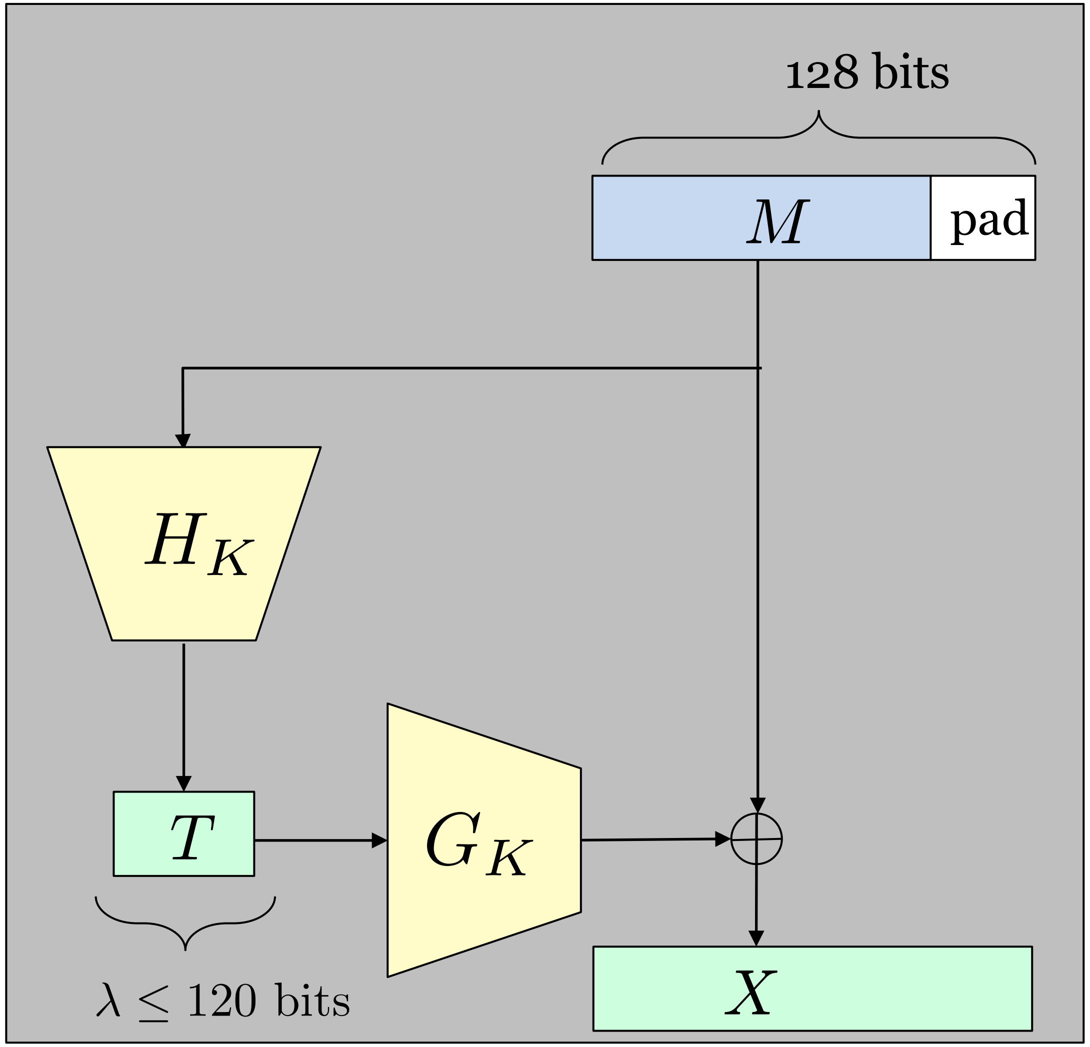
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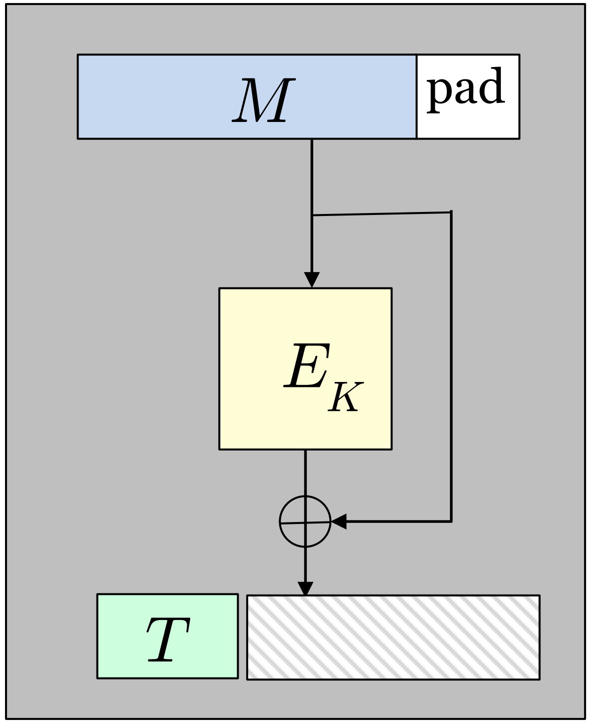
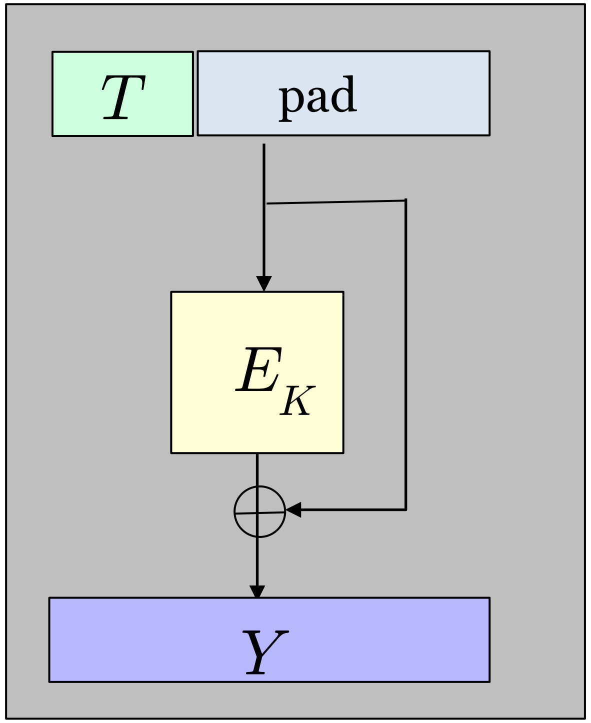

Instantiate H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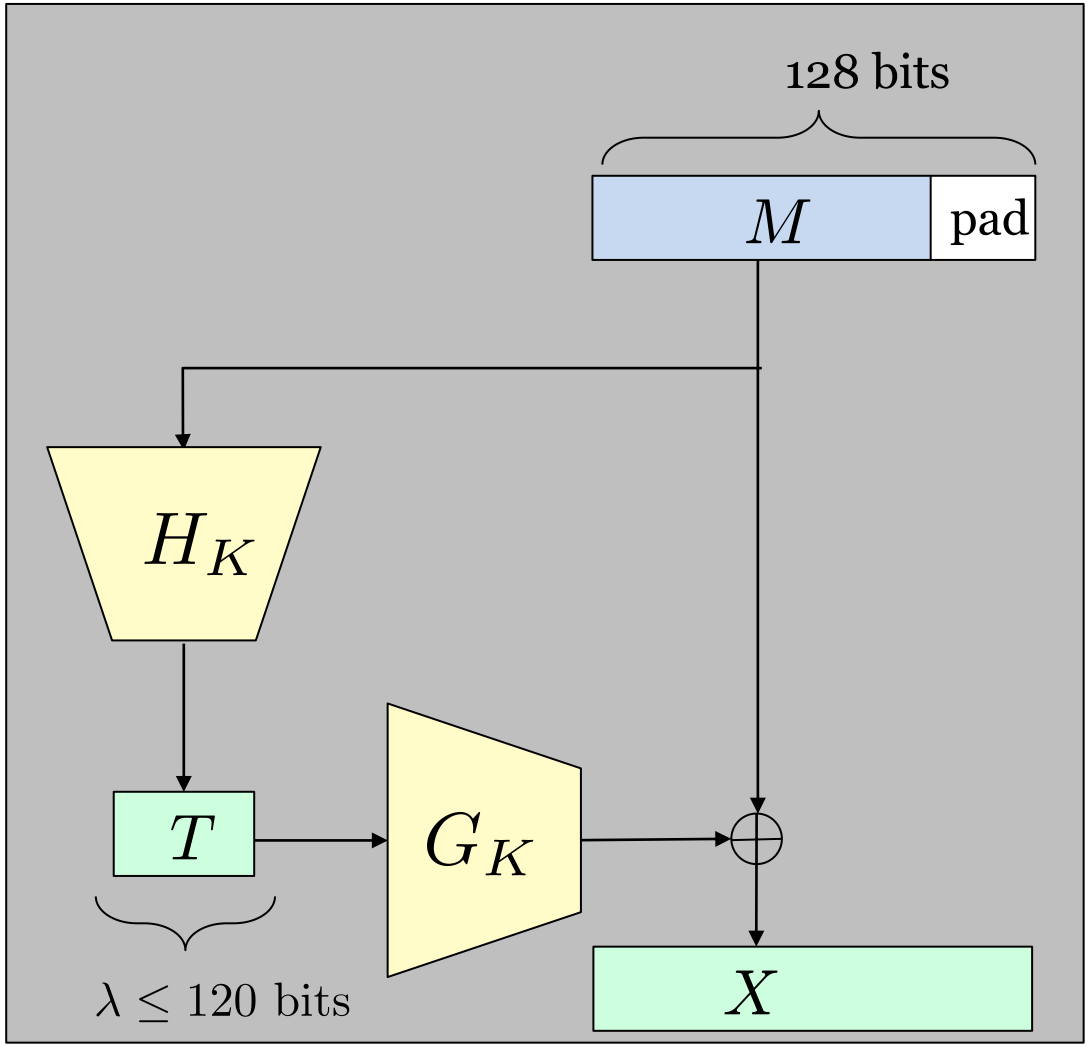

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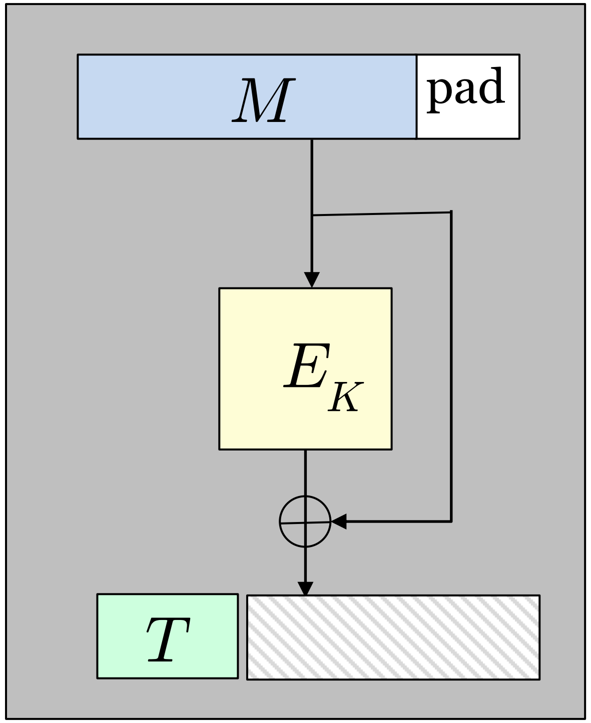

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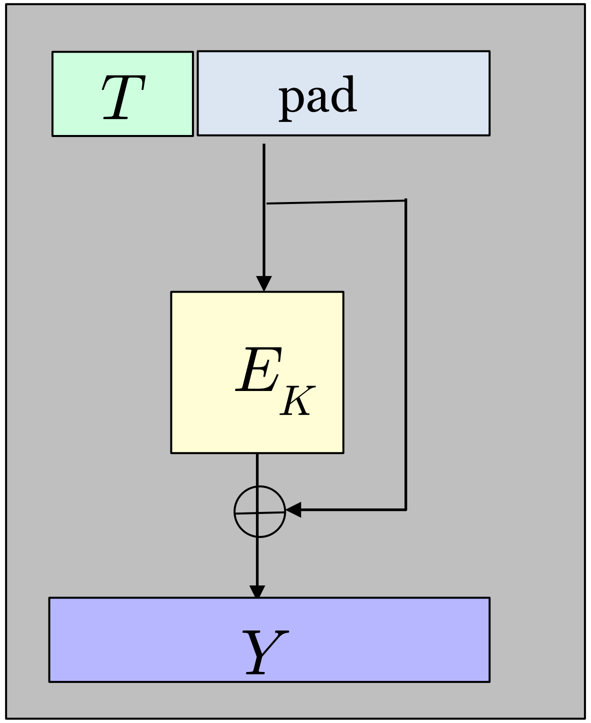
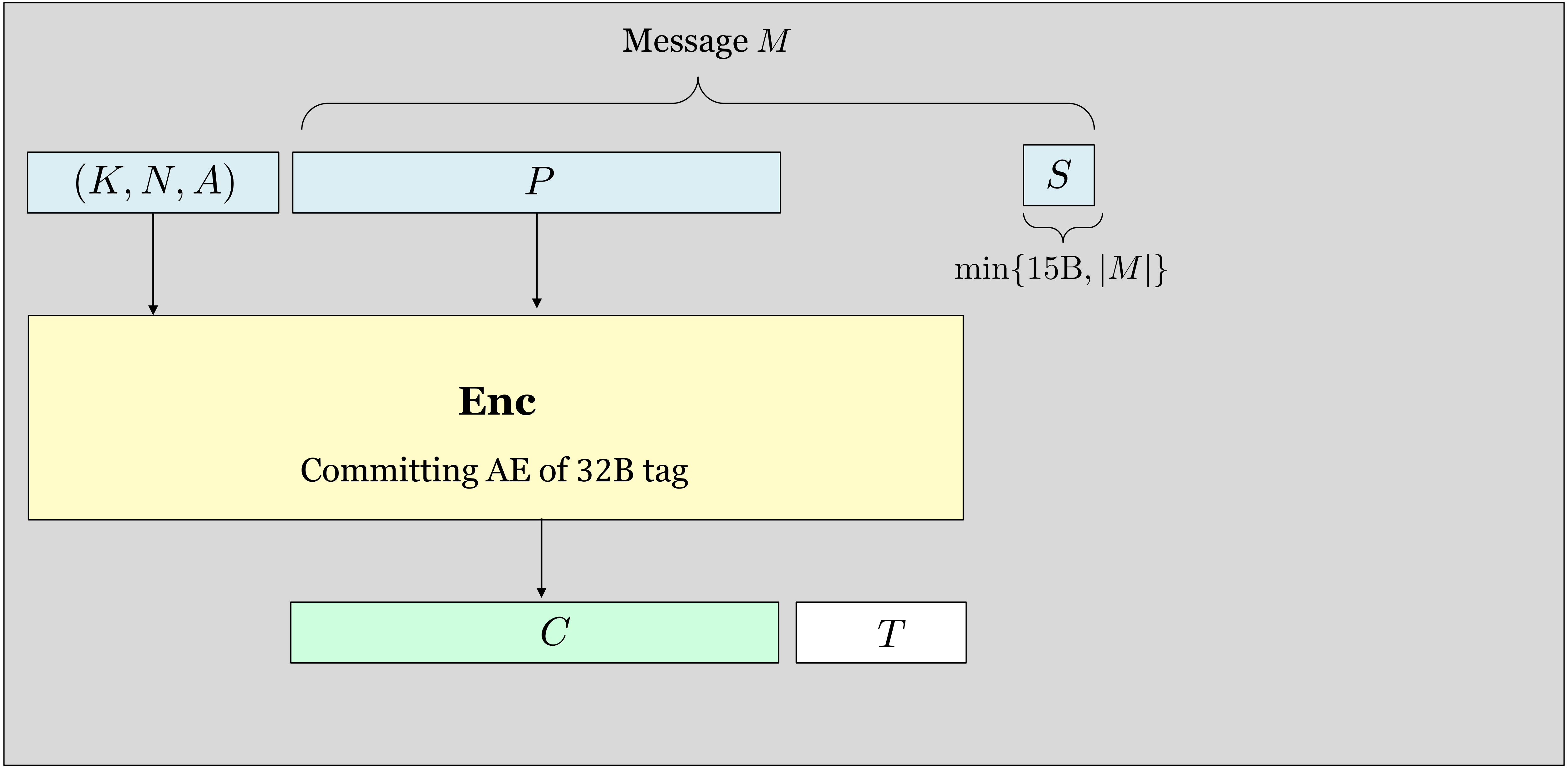


Ideal-cipher model

$\lambda - 8$ bits of committing security

Using Committing Concealer To Reduce Size

[BHW23]



Using Committing Concealer To Reduce Size

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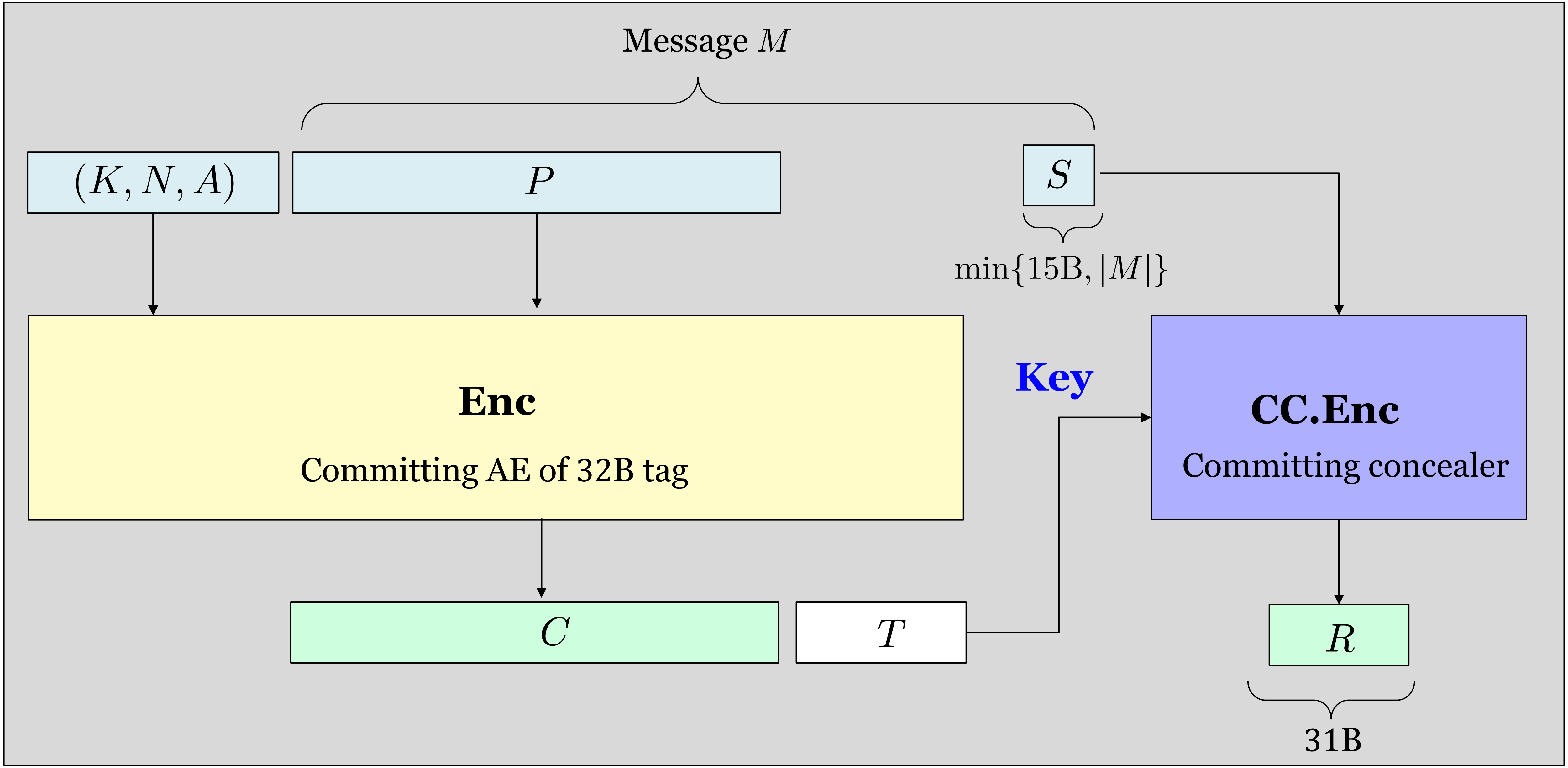

It’s Time To Have Committing AE Standard?

Many applications need committing security but each has its own (suboptimal) scheme

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This won’t happen if we have committing AE standards. Our schemes offer a good starting choice

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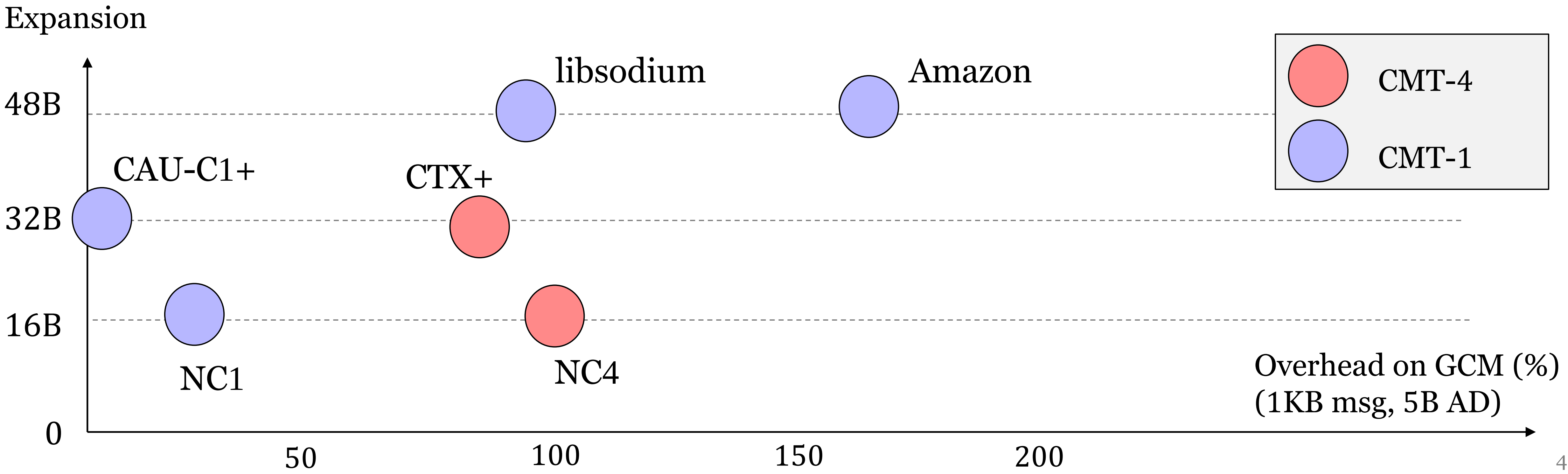
Expansion
48B
32B
16B
Overhead on GCM (%)
(1KB msg, 5B AD)
libsodium
Amazon
CAU-C1+
CTX+
NC1
NC4
CMT-4
CMT-1