The State-Test Technique on Differential Attacks:

a 26-Round Attack on CRAFT and Other Applications

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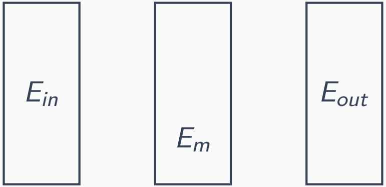
Asiacrypt, December 10, 2025

Inria Paris, France

Key Recovery in Differential Attacks



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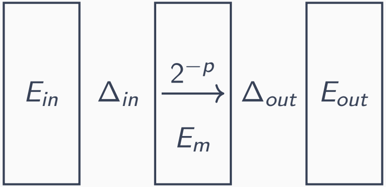

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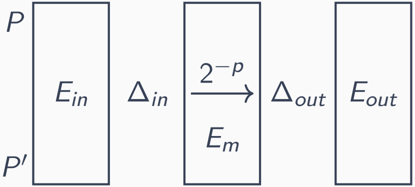

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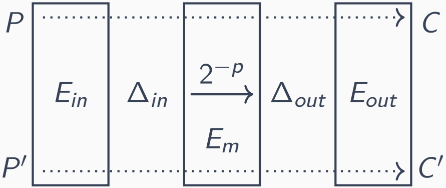

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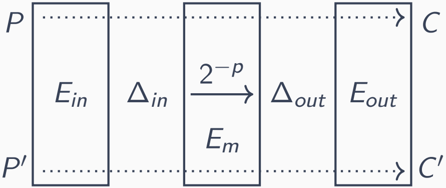

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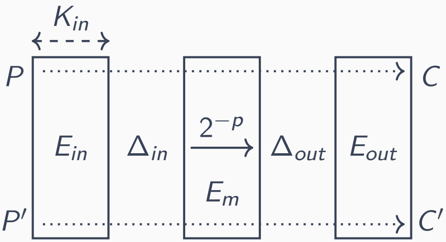

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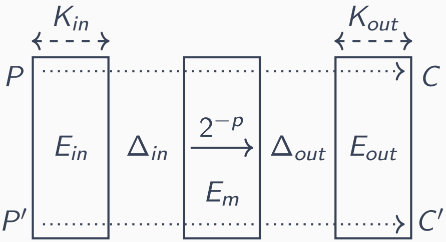

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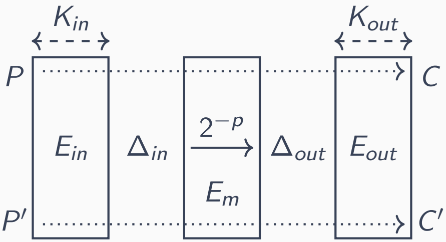

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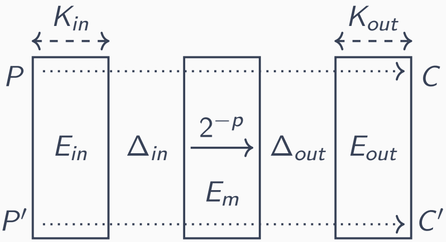

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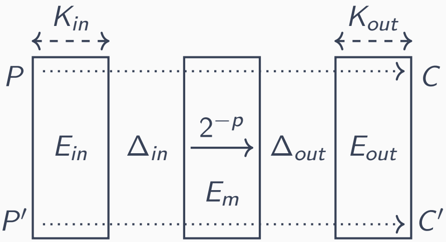

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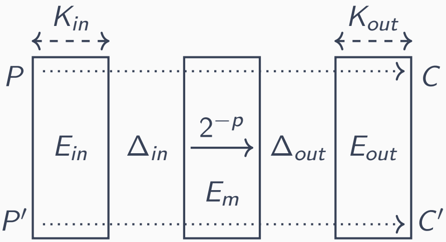

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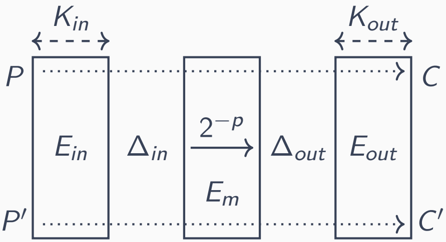

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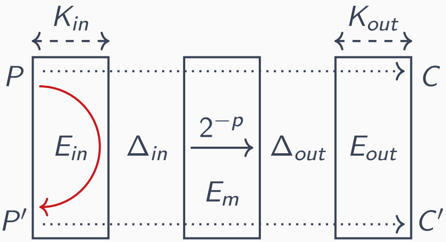

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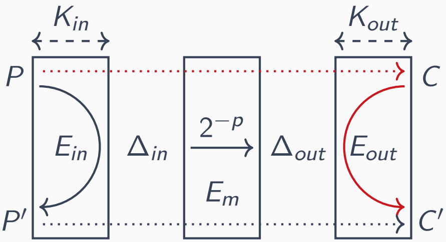

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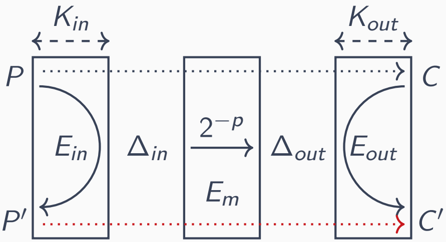

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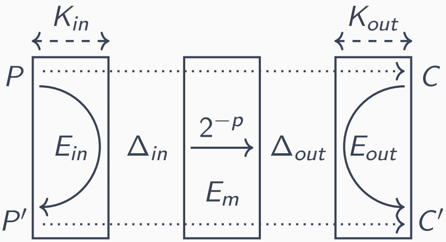

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  - Solving them allows to recover more key material

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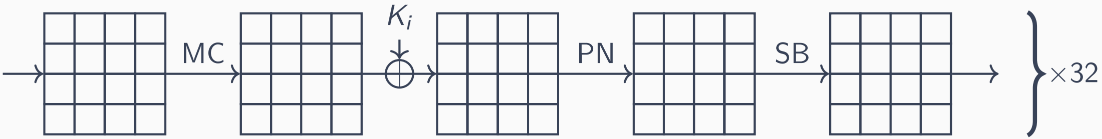

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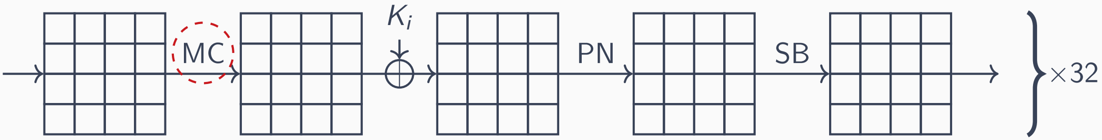

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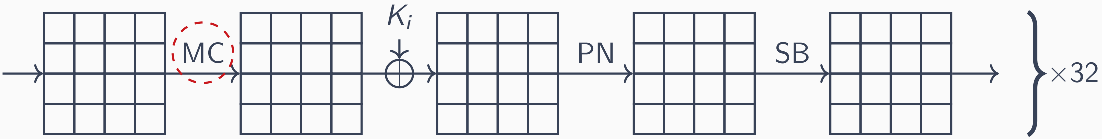

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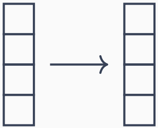

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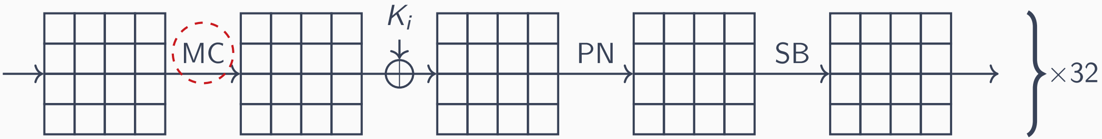

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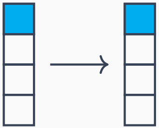

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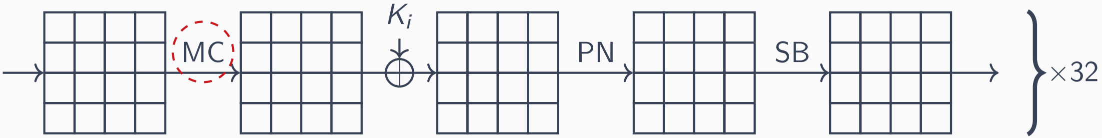

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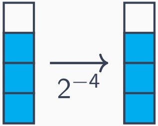

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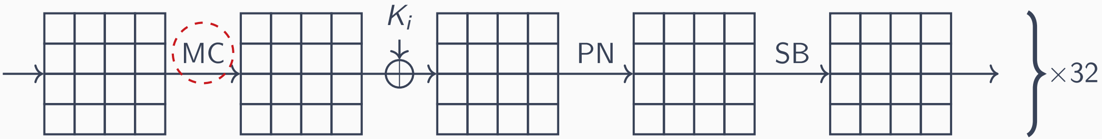

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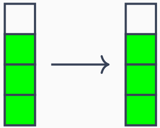

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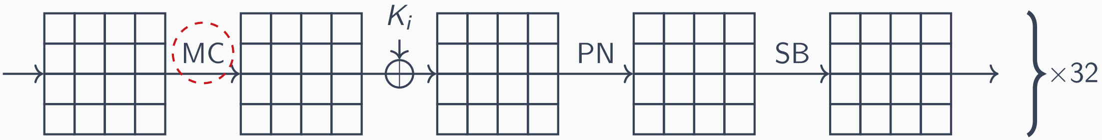

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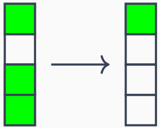

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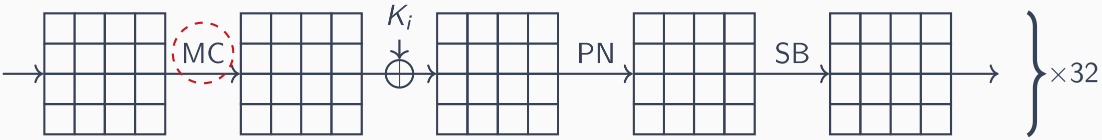

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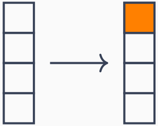

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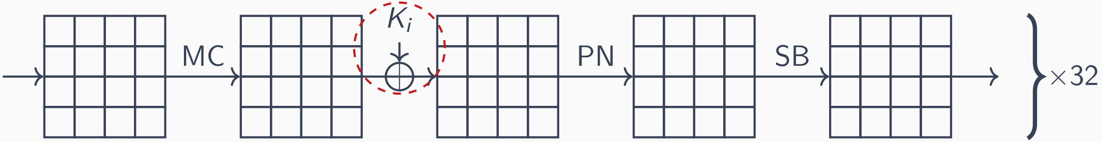

Key Addition

Add $K_{i \bmod 2}$ in round i

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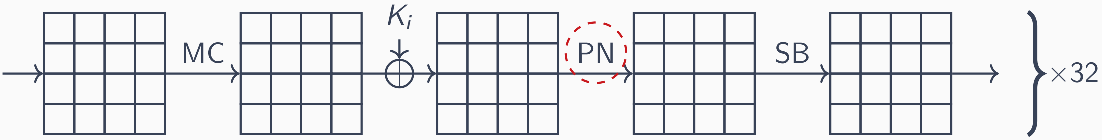

Permute Nibbles

0	1	2	3
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8	9	10	11
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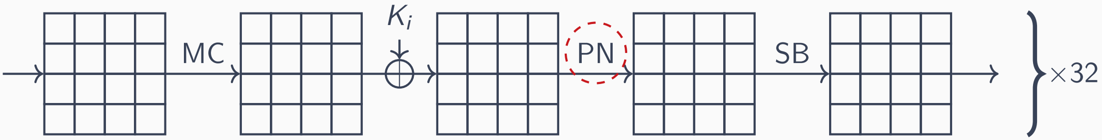

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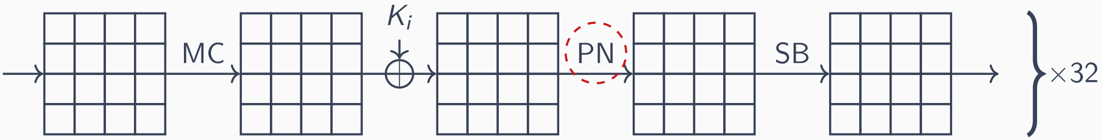


Permute Nibbles

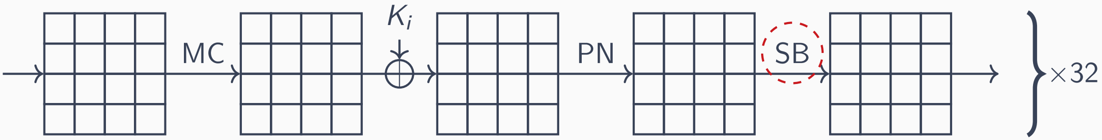
0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

$\longrightarrow$

15	12	13	14
10	9	8	11
6	5	4	7
1	2	3	0

The Tweakable Block Cipher Craft [BLMR19]

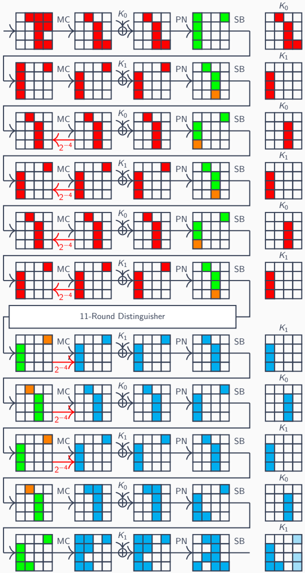
- 64 bit state, represented as a 4×4 matrix, and 128 bit key (K_0, K_1)



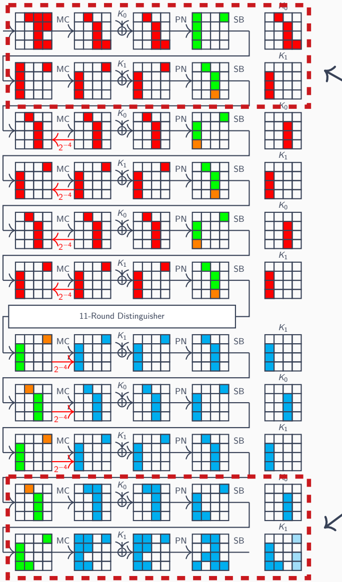
S-Box Layer

Apply s-box to all cells

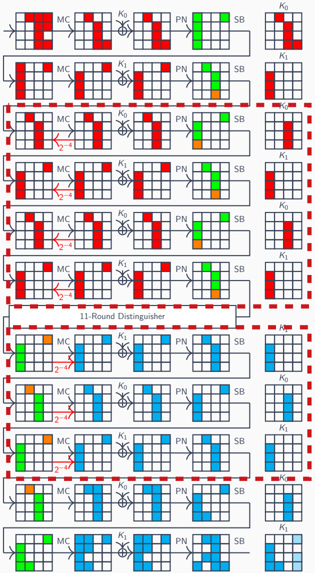
Differential Meet-in-the-Middle Attack on 23-Rounds [AKMMNP24]



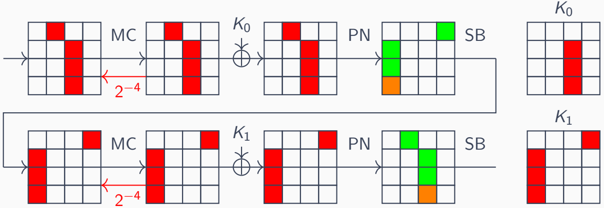
Differential Meet-in-the-Middle Attack on 23-Rounds [AKMMNP24]



Deterministic Extension



Probabilistic Key Recovery



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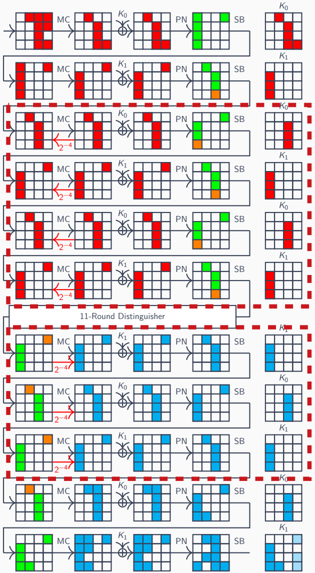

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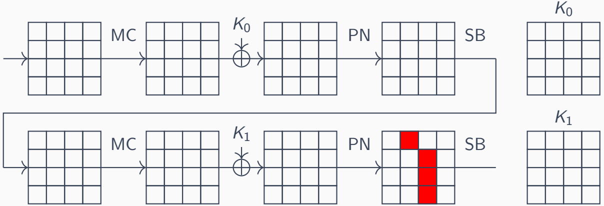

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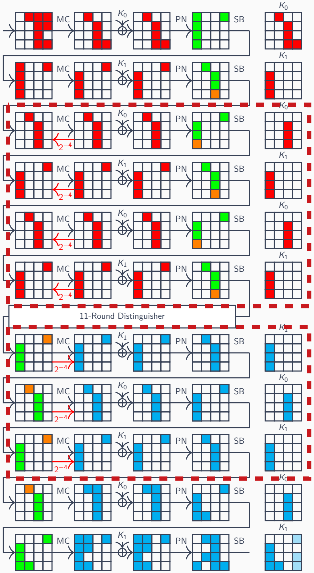

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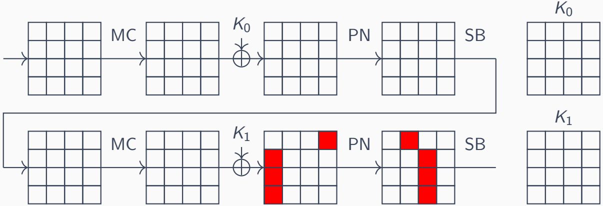

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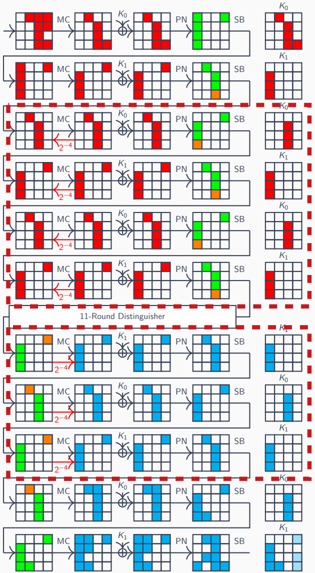

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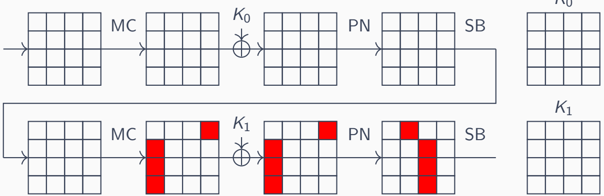

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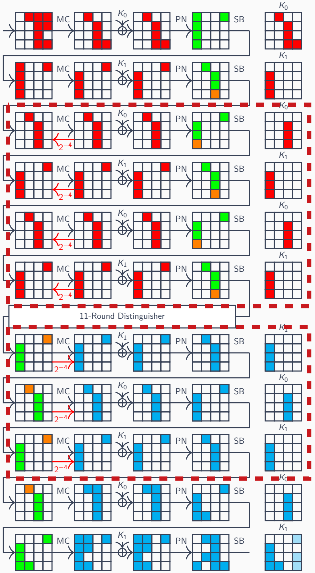

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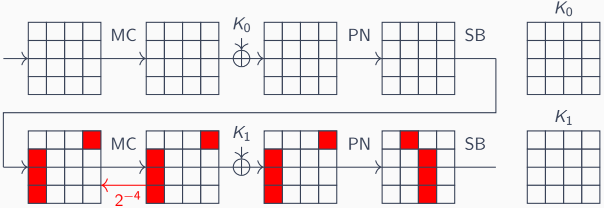

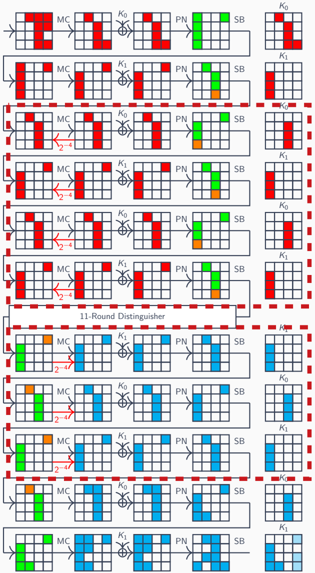

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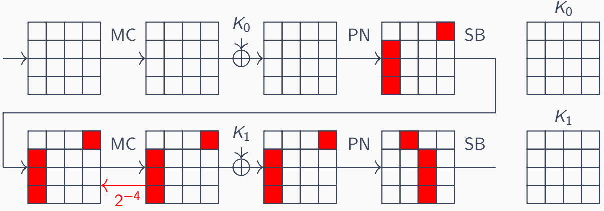

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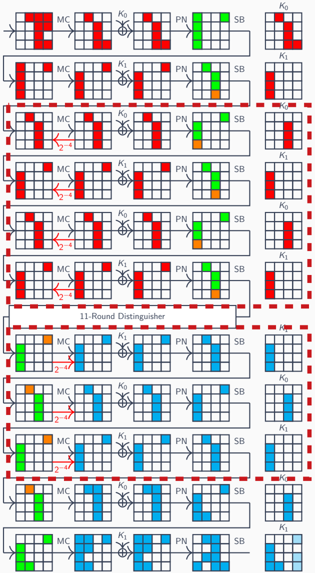

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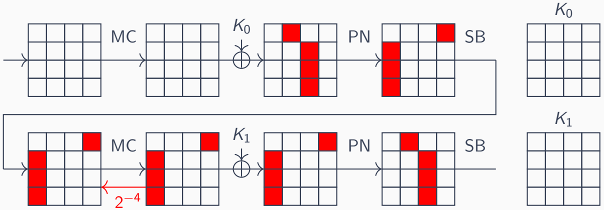

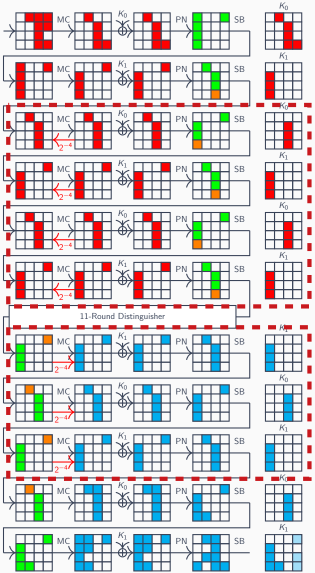

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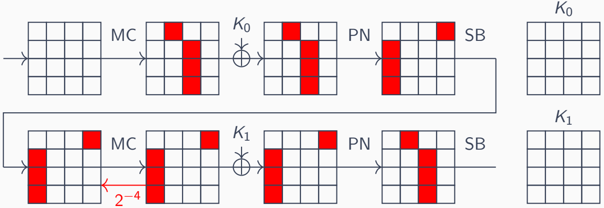
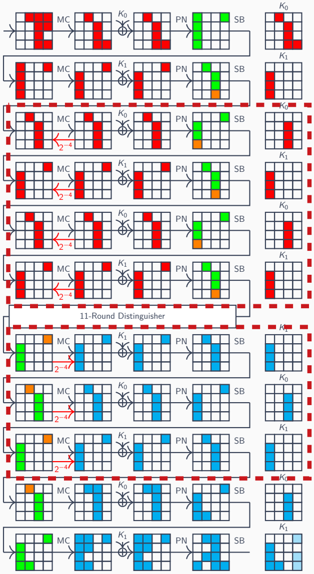


Differential Meet-in-the-Middle Attack on 23-Rounds [AKMMNP24]



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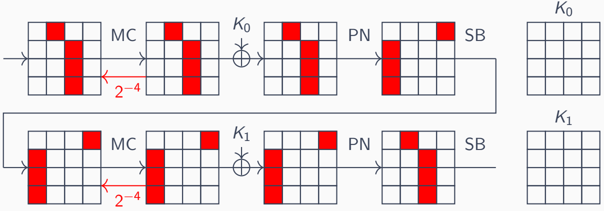

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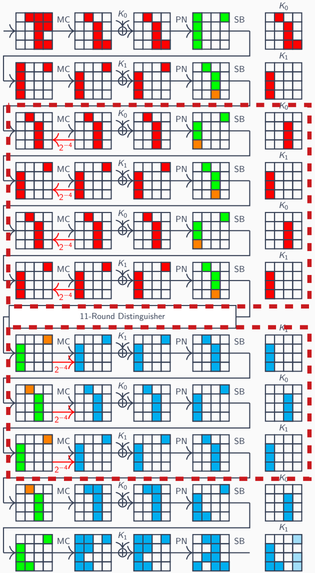

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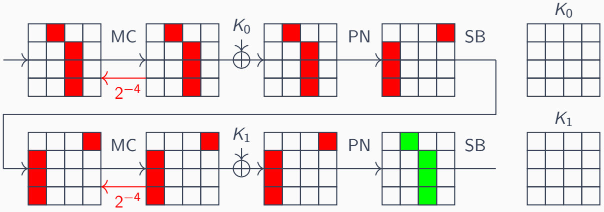

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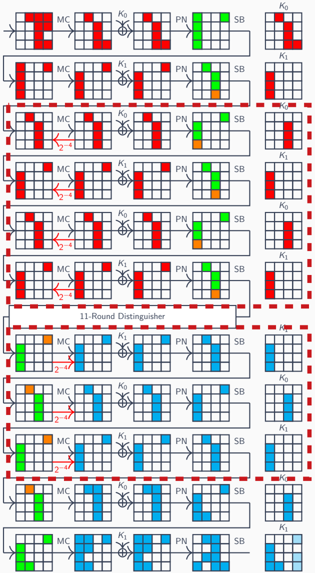

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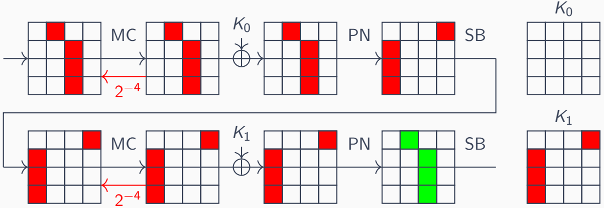
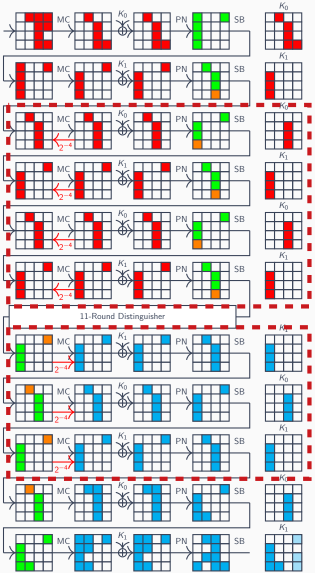


Differential Meet-in-the-Middle Attack on 23-Rounds [AKMMNP24]



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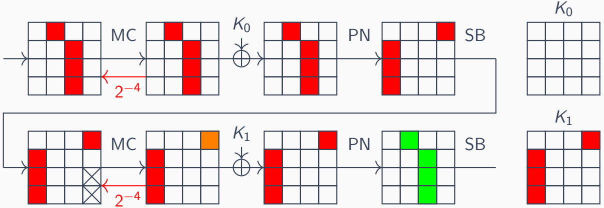
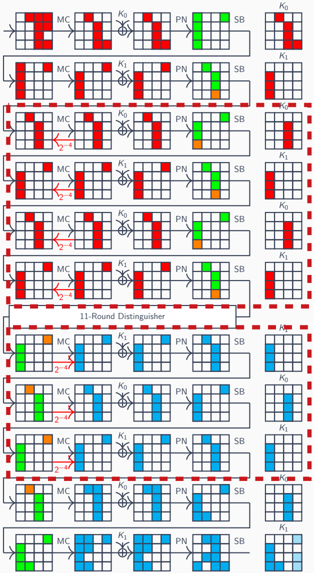


Differential Meet-in-the-Middle Attack on 23-Rounds [AKMMNP24]



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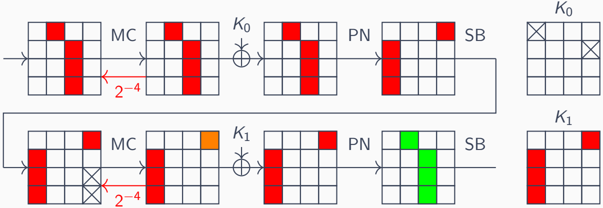

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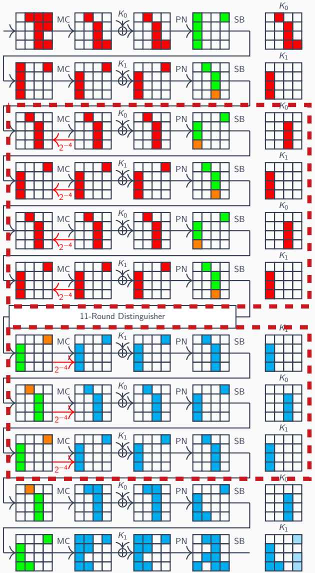

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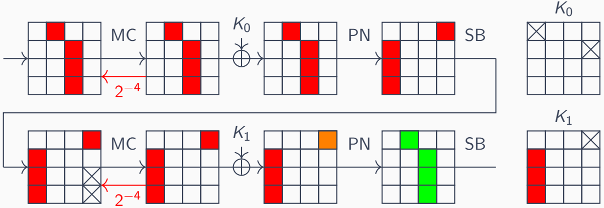

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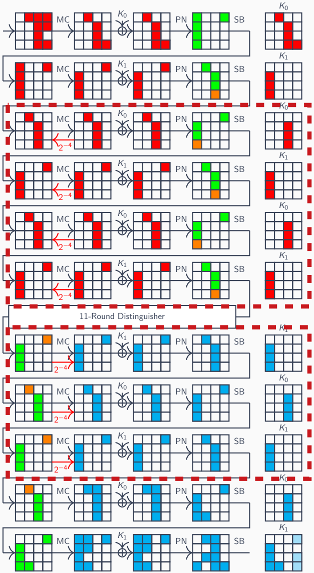

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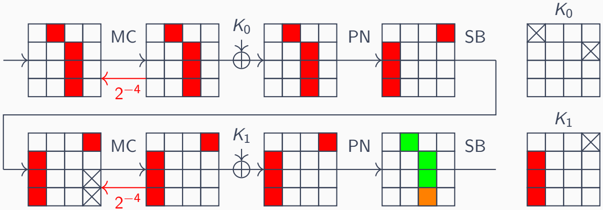

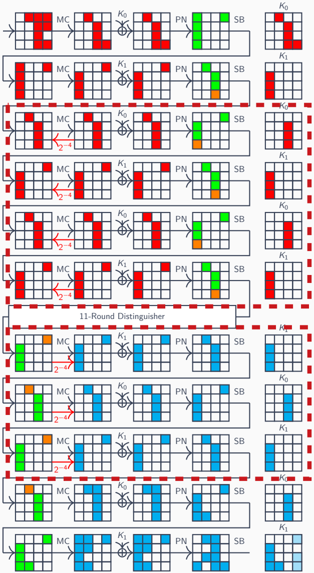

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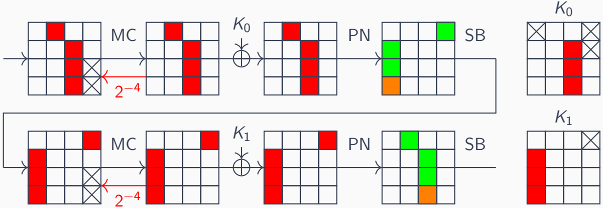

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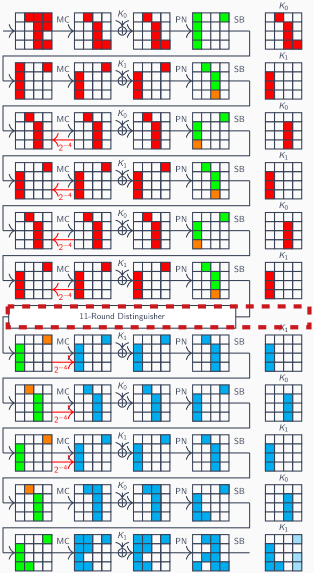

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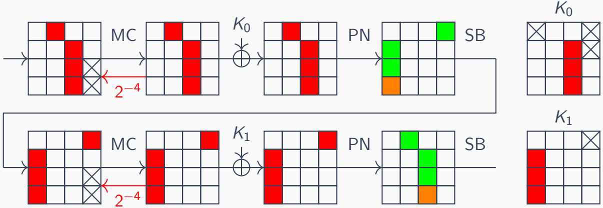
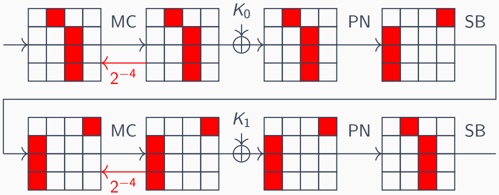
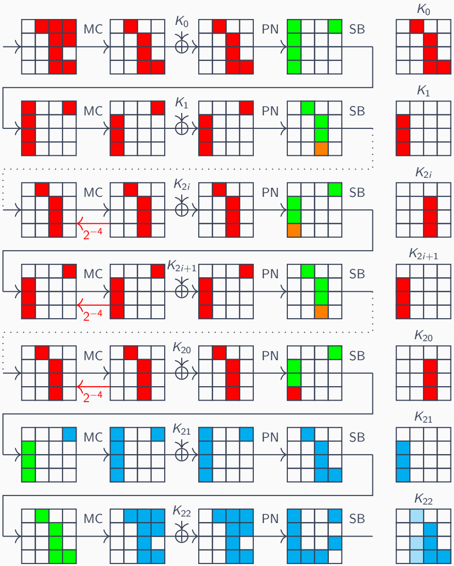


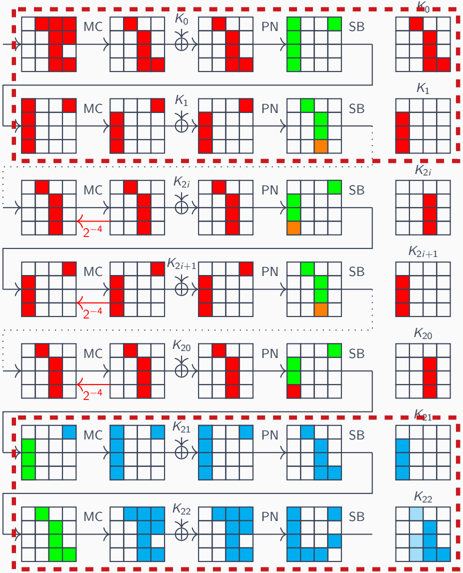
Truncated-Differential Characteristic



Our Attack

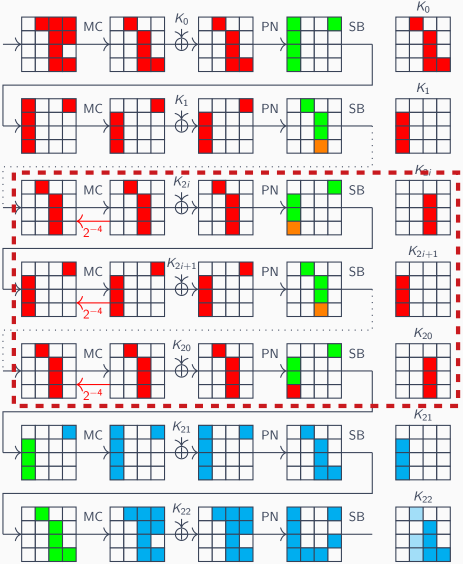


Our Attack



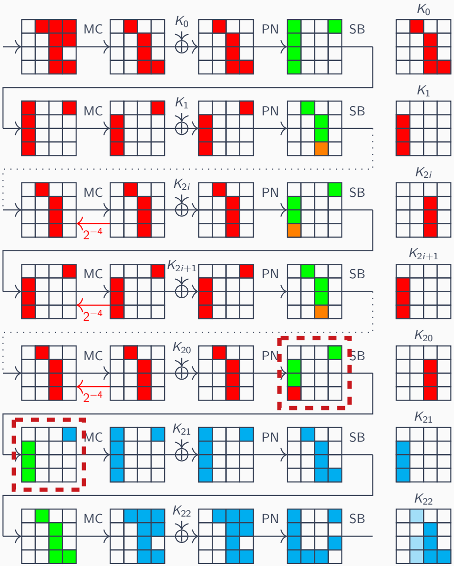
Deterministic Extension

Our Attack



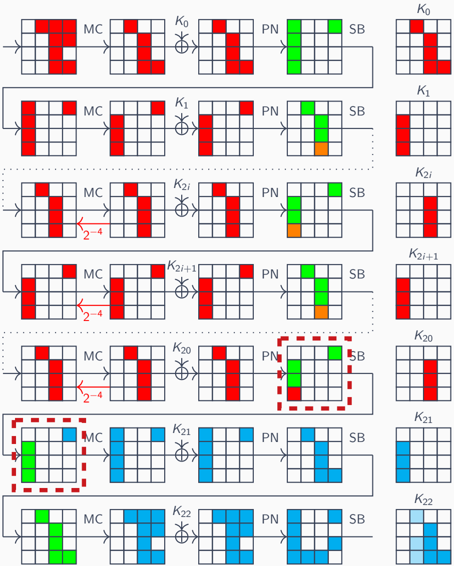
Probabilistic Key Recovery

Our Attack



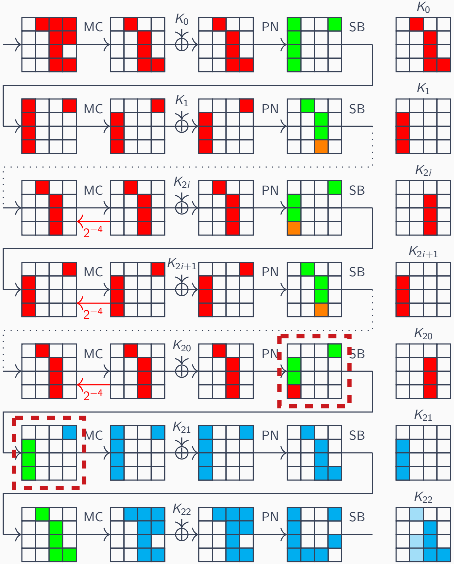
Zero-Round Distinguisher

Our Attack



Zero-Round Distinguisher

Compute same cells from both sides

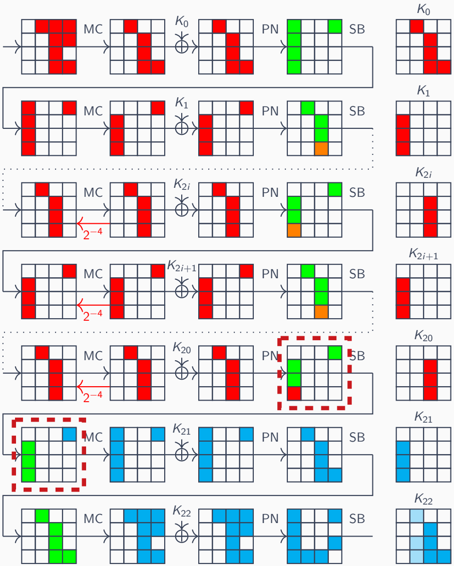


Zero-Round Distinguisher

Compute same cells from both sides

→ Use as additional filter

Our Attack



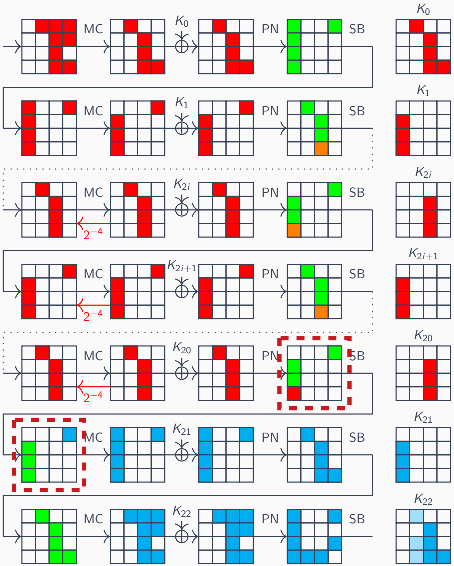
Zero-Round Distinguisher

Compute same cells from both sides

→ Use as additional filter

Two-Round Structure

Our Attack



Zero-Round Distinguisher

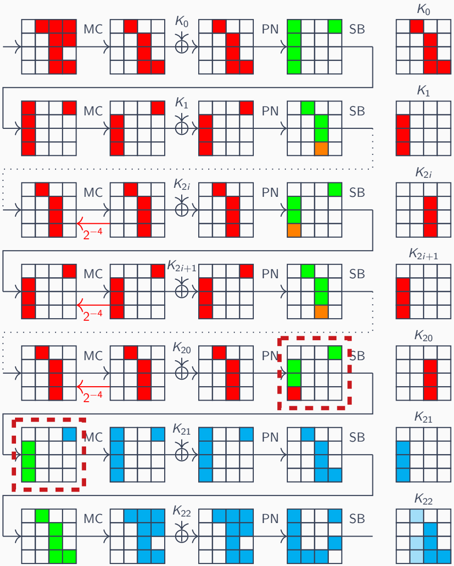
Compute same cells from both sides

→ Use as additional filter

Two-Round Structure

One-round structure in [AKMMNP24]

Our Attack



Zero-Round Distinguisher

Compute same cells from both sides

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Two-Round Structure

One-round structure in [AKMMNP24]

Details in the paper

Comparison with Prior Work

Cipher	Rounds	Time	Memory	Data	Attack	Ref.
CRAFT	23	2^{125}	2^{101}	2^{60}	TD-MitM	[AKMMNP24]
		$2^{111.46}$	2^{120}	$2^{60.99}$	D	[SYCHW24]
		2^{109}	2^{36}	2^{58}	TD-MitM	This Work
	24	2^{110}	2^{34}	2^{60}	TD-MitM	This Work
	25	$2^{117.58}$	2^{48}	2^{60}	TD-MitM	This Work
	26	2^{118}	2^{34}	2^{64}	TD-MitM	This Work

D: Differential TD-MitM: Truncated Differential MitM

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D: Differential TD-MitM: Truncated Differential MitM

Thank you for your attention!