Tweaking Even-Mansour Ciphers

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Outline

Background: Tweakable Block Ciphers

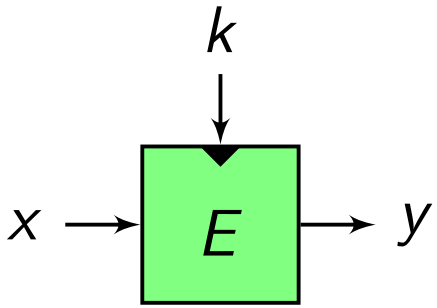
Our Contribution

Overview of the Proof for Two Rounds

Longer Cascades

Conclusion and Perspectives

Tweakable Block Ciphers (TBCs)



- tweak t: brings variability to the block cipher
- t assumed public or even adversarially controlled
- each tweak should give an "independent" permutation
- few "natively tweakable" BCs:
  - Hasty Pudding Cipher [Sch98]
  - Mercy [Cro00]
  - Threefish [FLS+10]
  - CAESAR proposals KIASU, Deoxys, Joltik, (i)SCREAM, Minalpher

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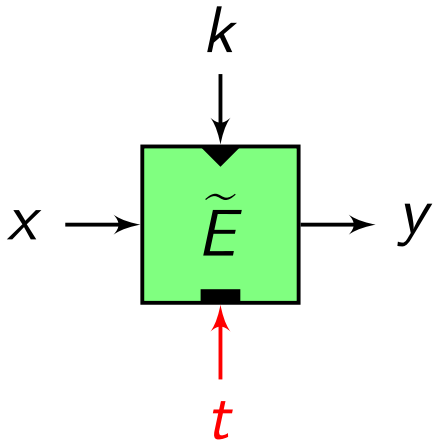

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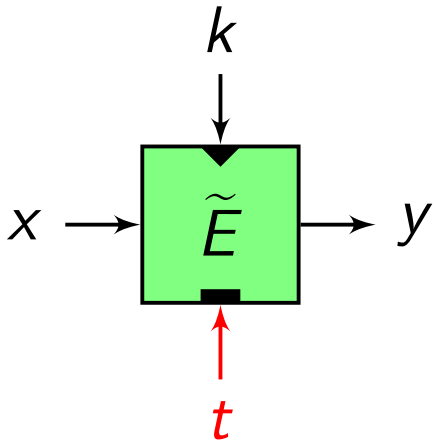

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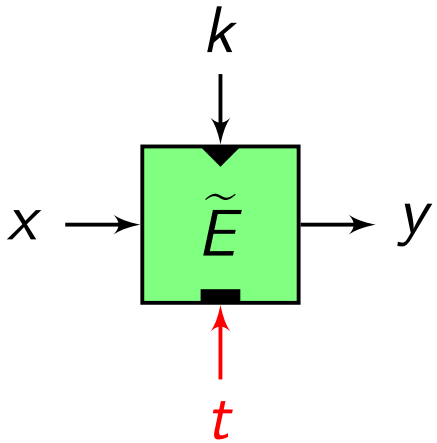

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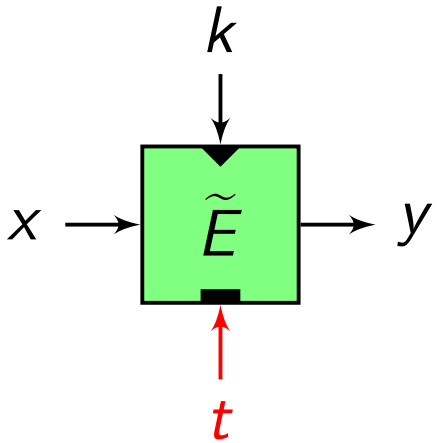

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Generic Constructions of TBCs

- A generic TBC construction turns a conventional block cipher E into a TBC $\widetilde{E}$
- example: LRW construction by Liskov *et al.* [LRW02]

- h is XOR-universal, e.g. $h_{k'}(t) = k' \otimes t$ (field mult.)
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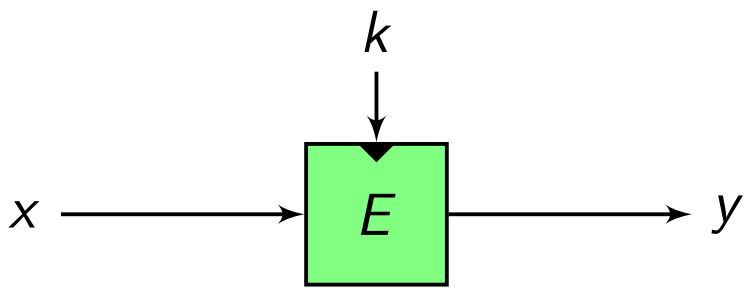

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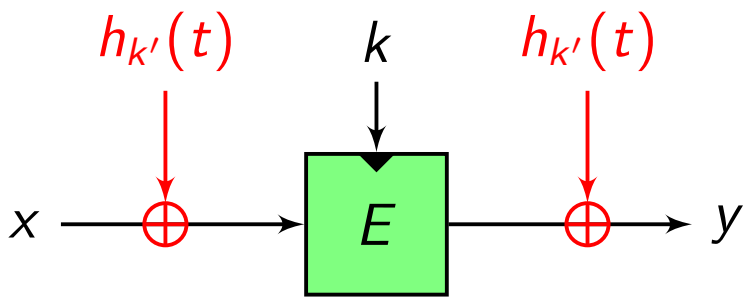

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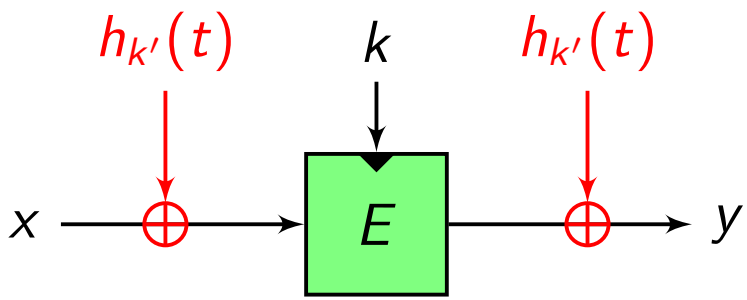

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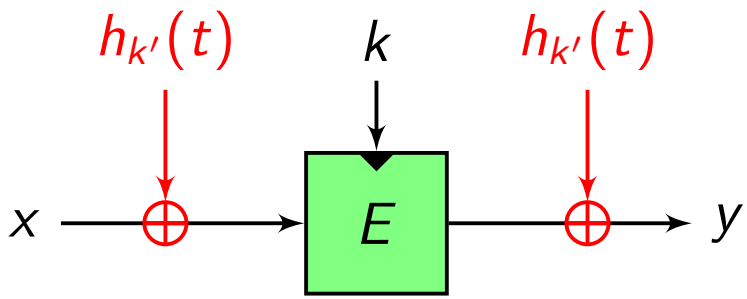

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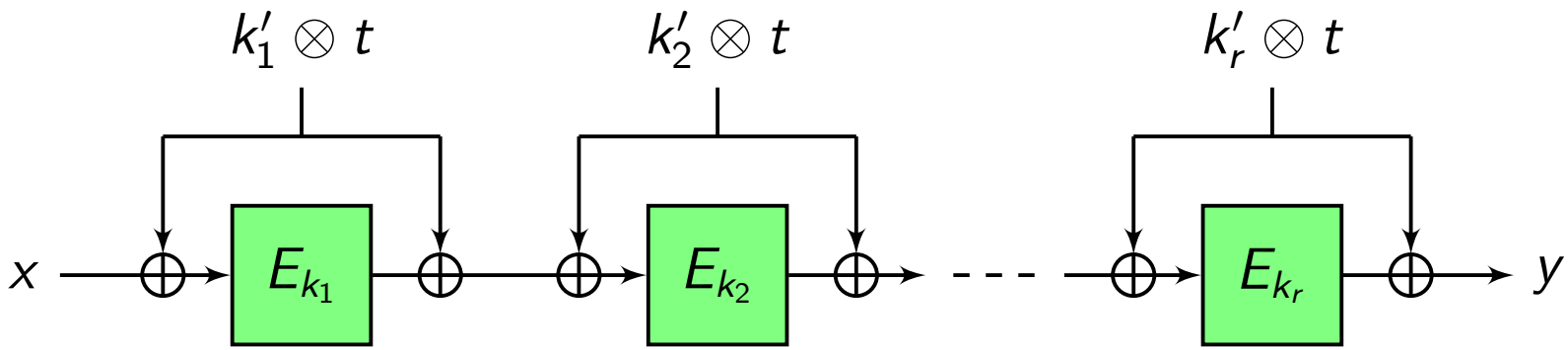

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  $\Rightarrow$ total key-length $= r(\kappa + n)$
- 2 rounds: provably secure up to $\sim 2^{2n/3}$ queries [LST12]
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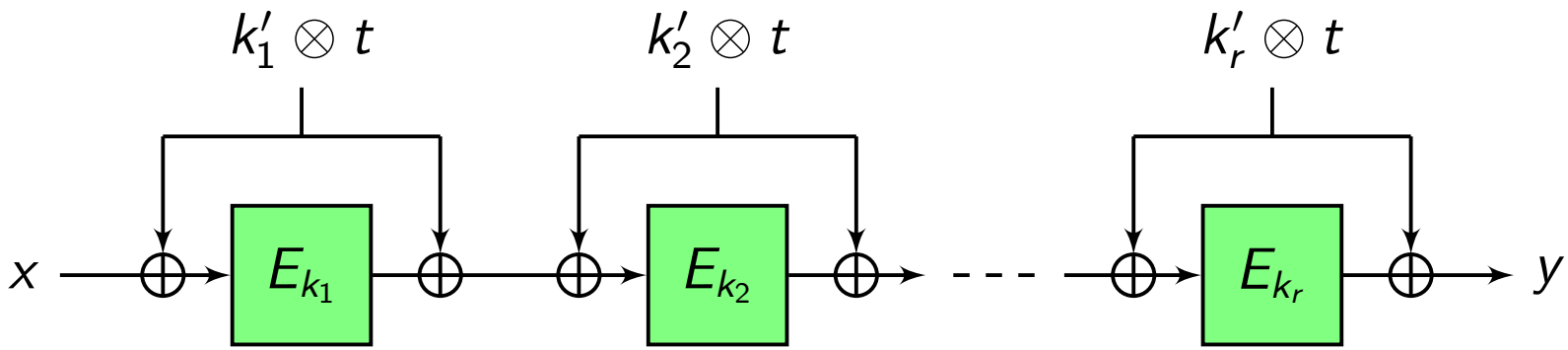

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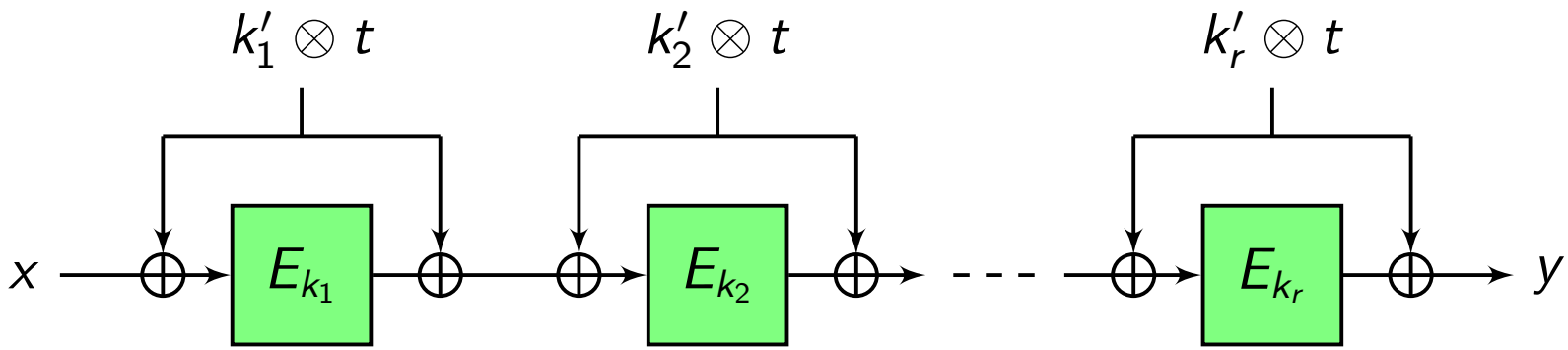

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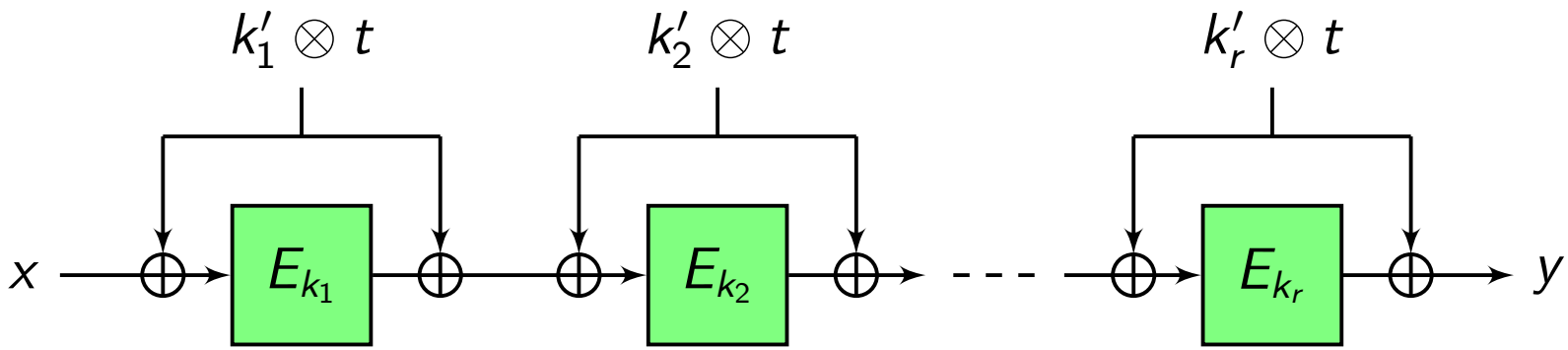

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- "from scratch" $\rightarrow$ from some lower level primitive
- from a PRF: Feistel schemes [GHL+07, MI08]
- this work: SPN ciphers (more gen. key-alternating ciphers)

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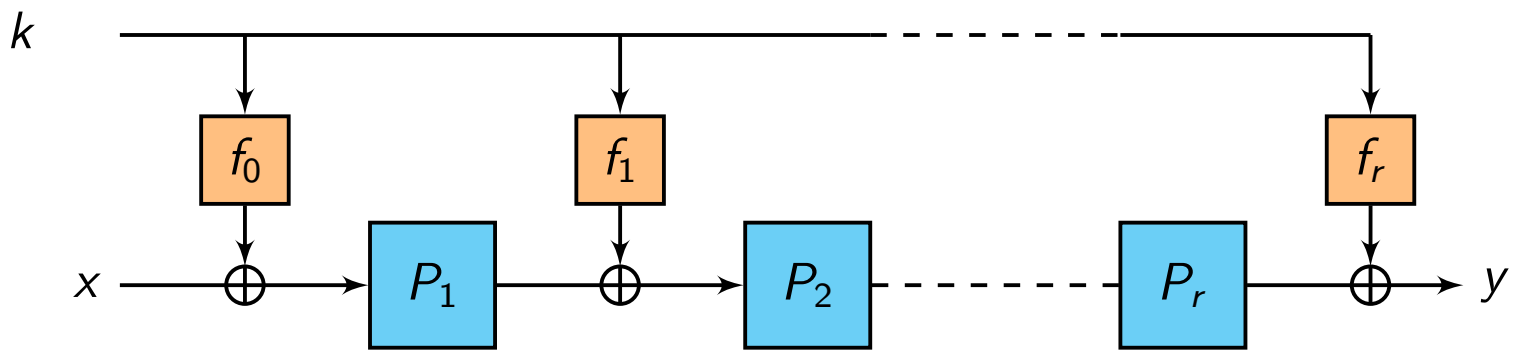

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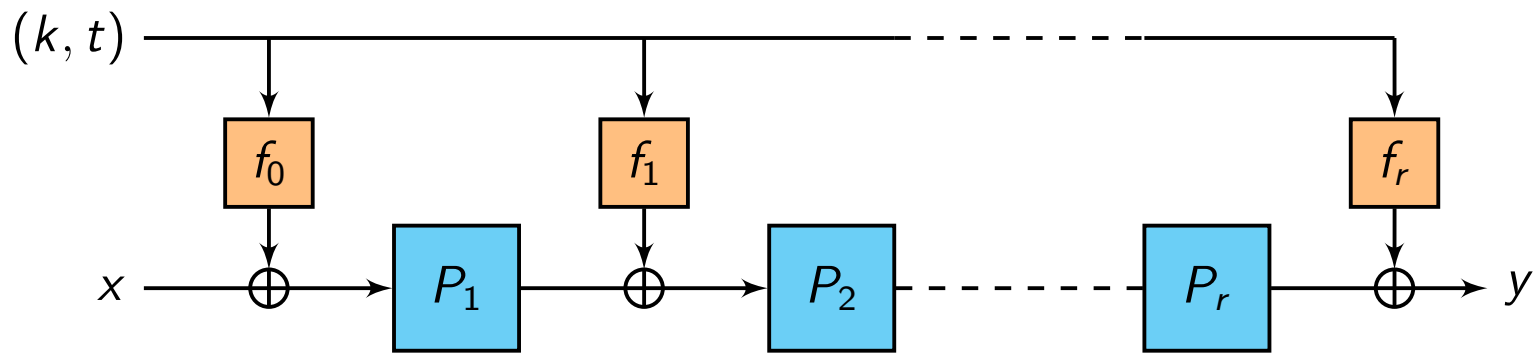

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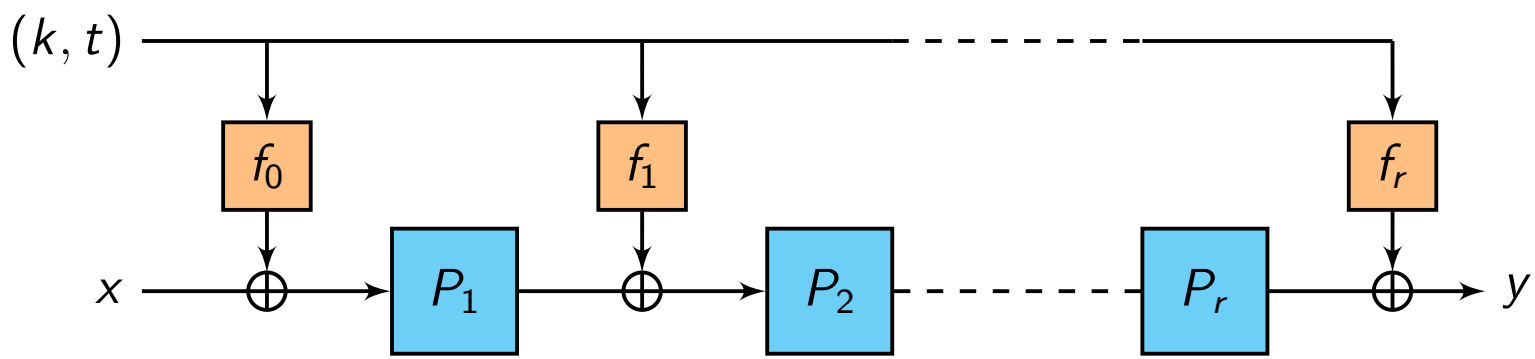

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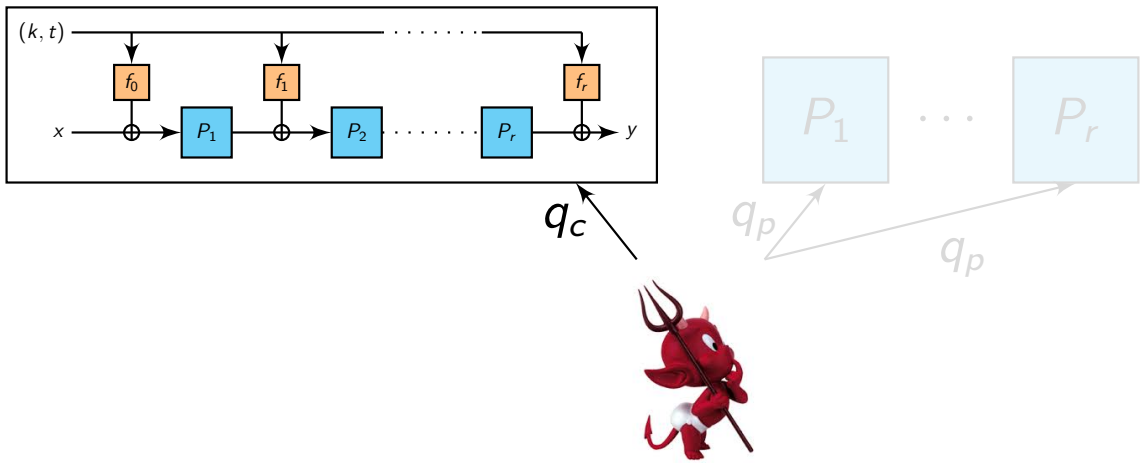

- the P_i's are modeled as public random permutation oracles (adversary can only make black-box queries)
- adversary cannot exploit any weakness of the P_i's
  $\Rightarrow$ generic attacks
- complexity measure of the adversary:
  - q_c = # construction queries = pt/ct pairs (data D)
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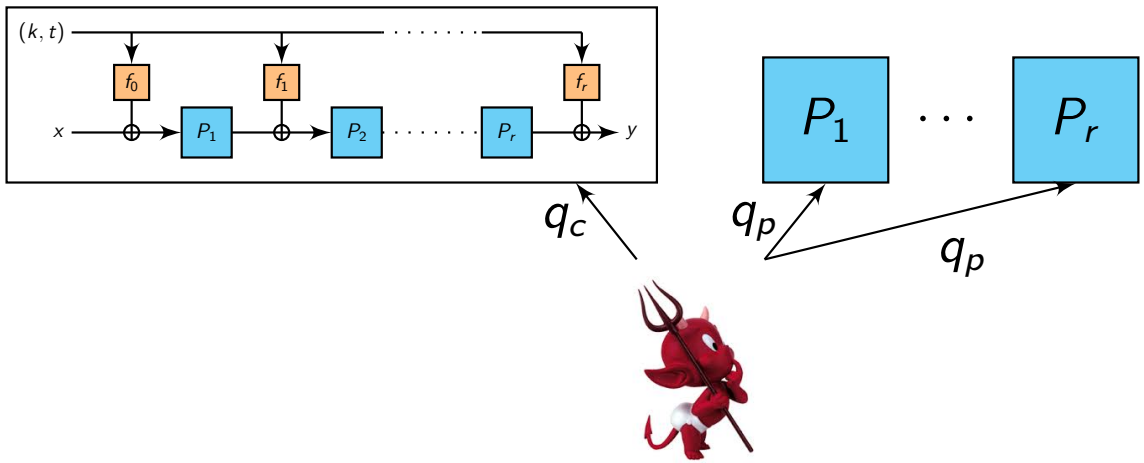

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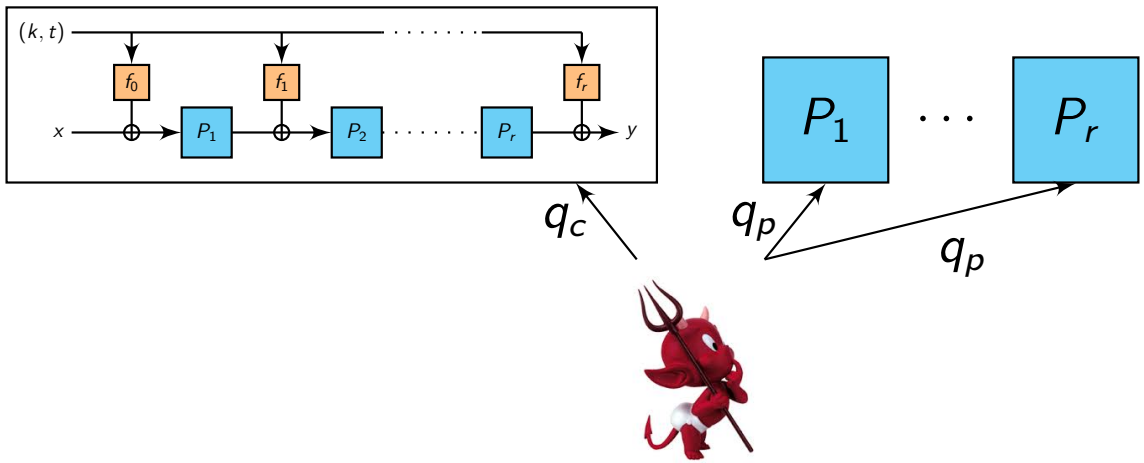

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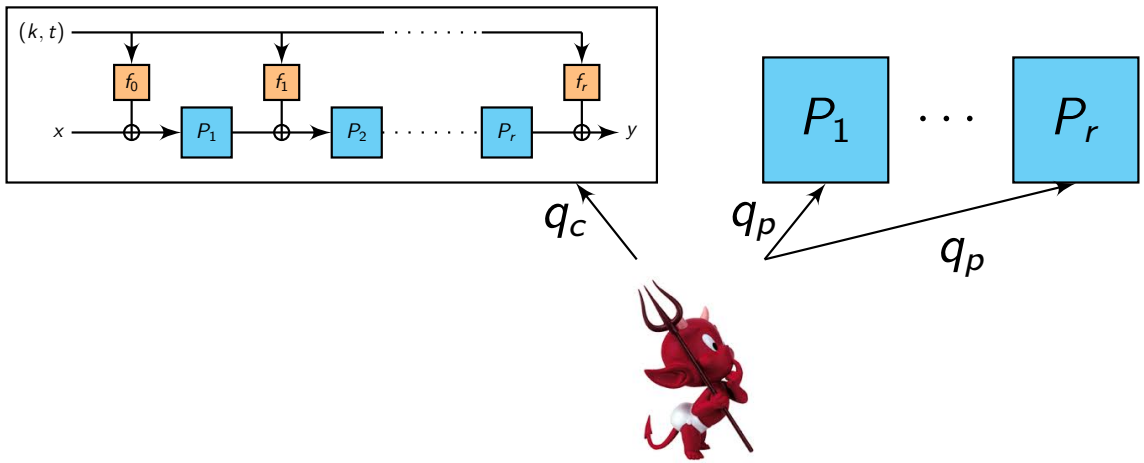

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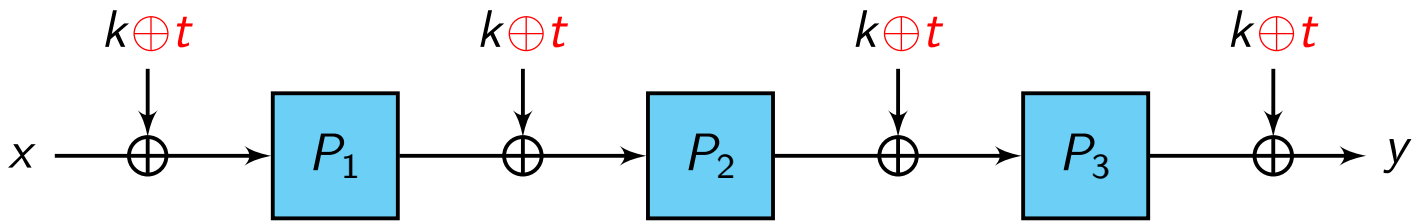

- provably secure in the RPM up to $\sim 2^{n/2}$ queries [CS15, FP15]
- can be written $\widetilde{E}(k, t, x) = E(k \oplus t, x)$ where E is the conventional 3-round EM cipher with trivial key-schedule
- $\Rightarrow$ secure up to $2^{n/2}$ queries *at best* by a simple collision attack

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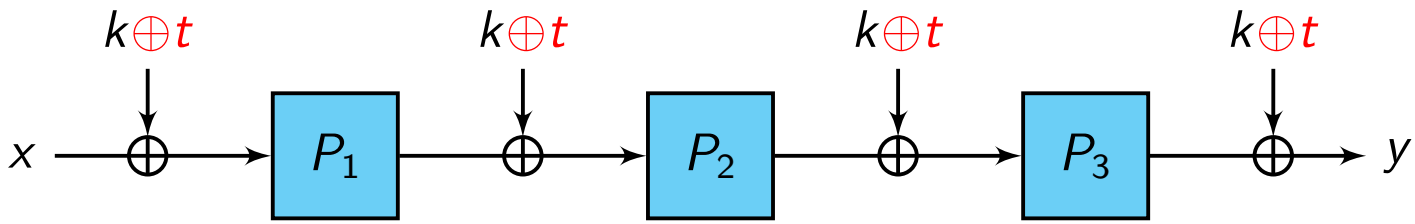

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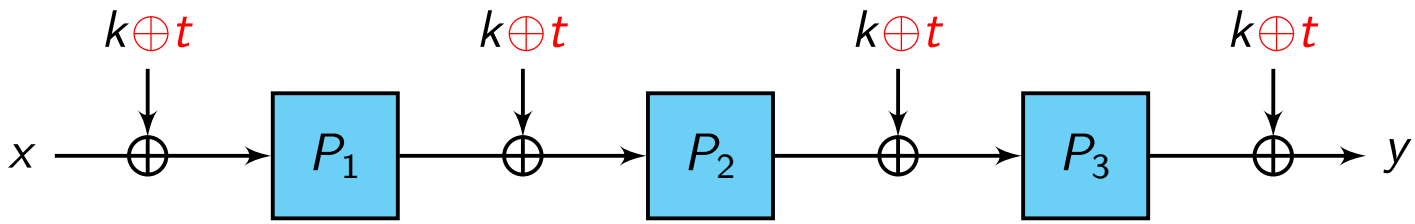

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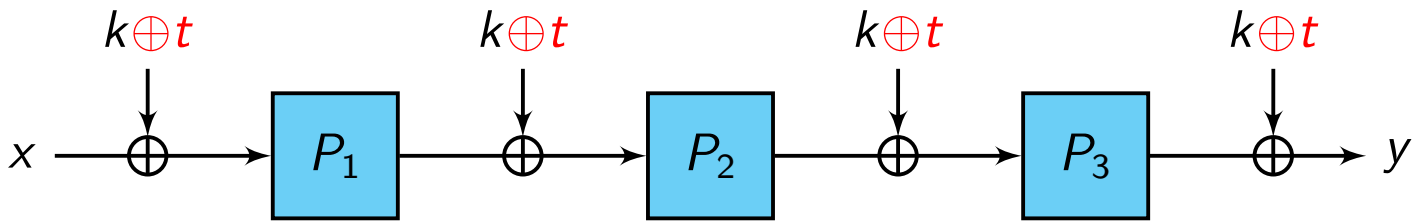

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Question

How can we obtain a construction with security beyond the birthday-bound?

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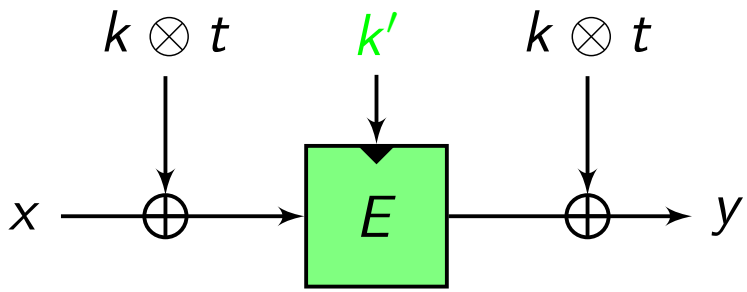

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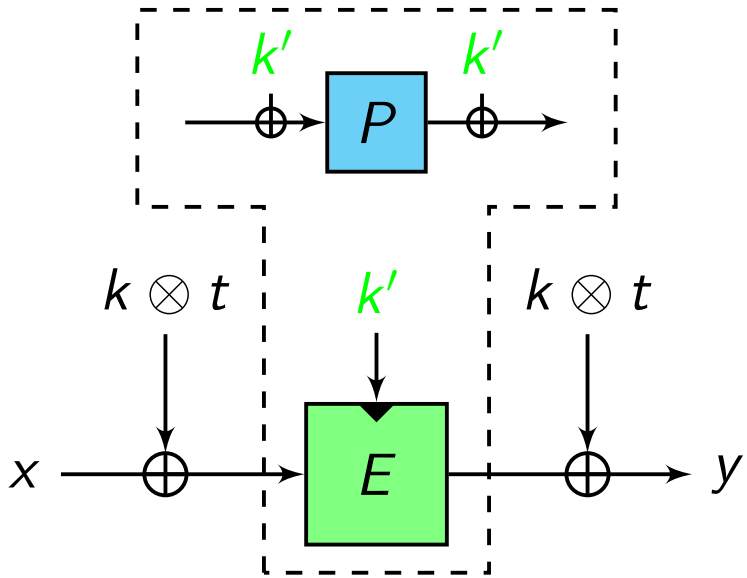

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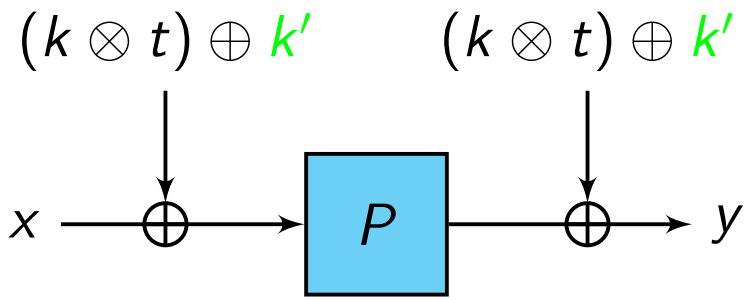

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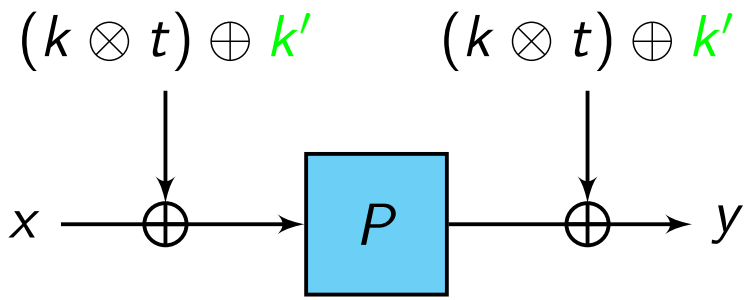

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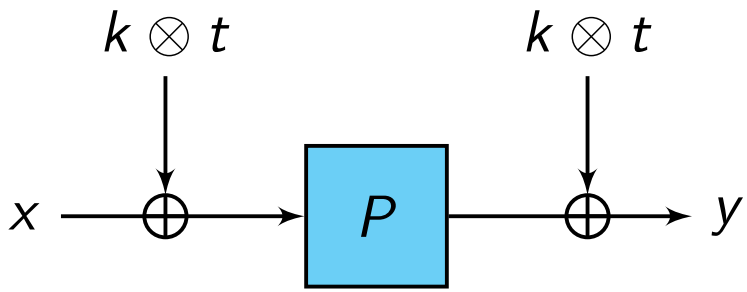

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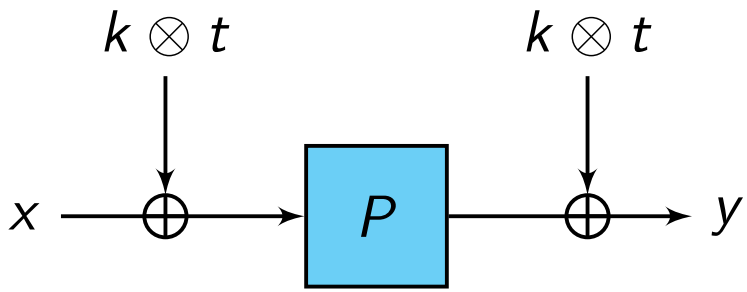
(1-round) Tweakable Even-Mansour (TEM) construction



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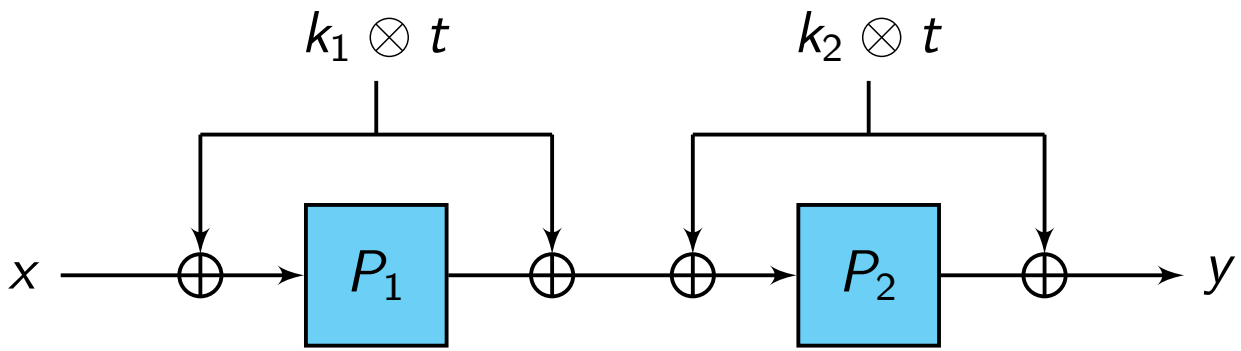
- k_1, k_2 independent n-bit keys



- our main result: secure up to $\sim 2^{2n/3}$ queries in the RPM:

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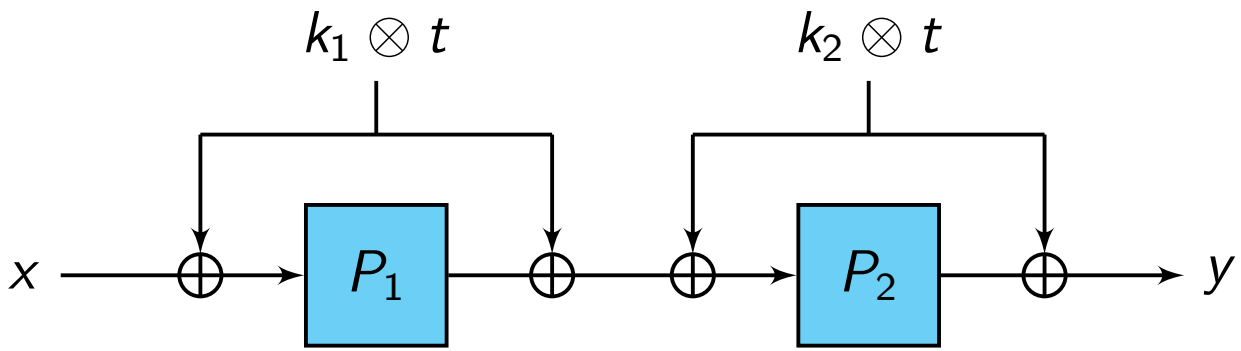

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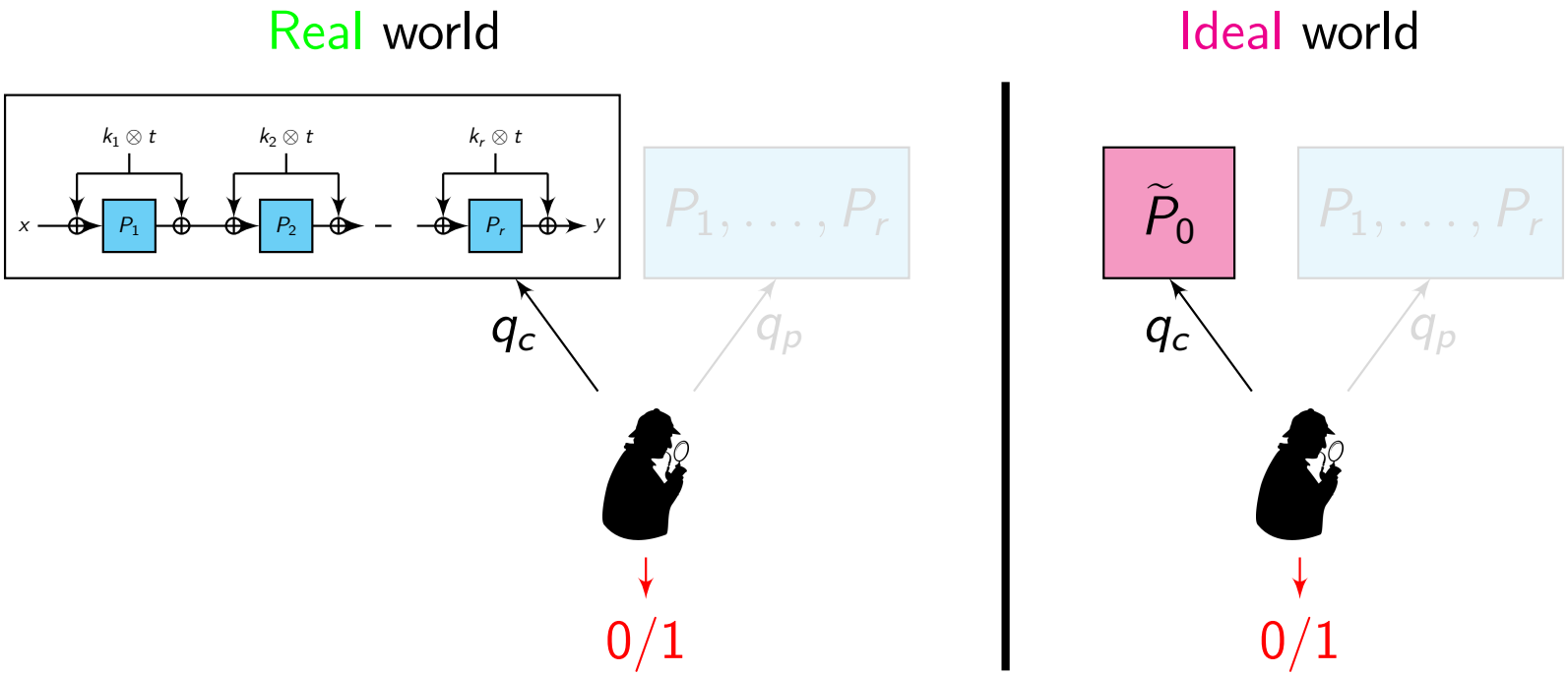

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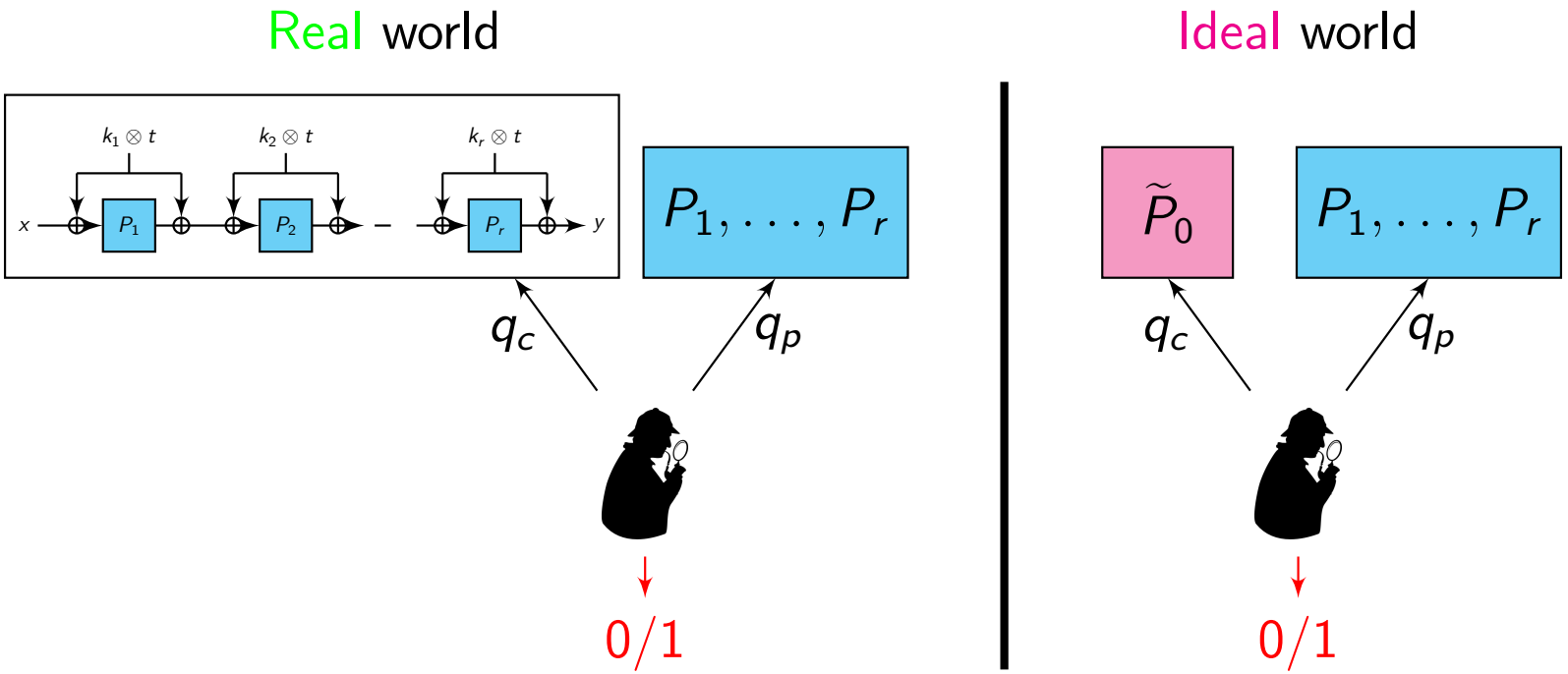

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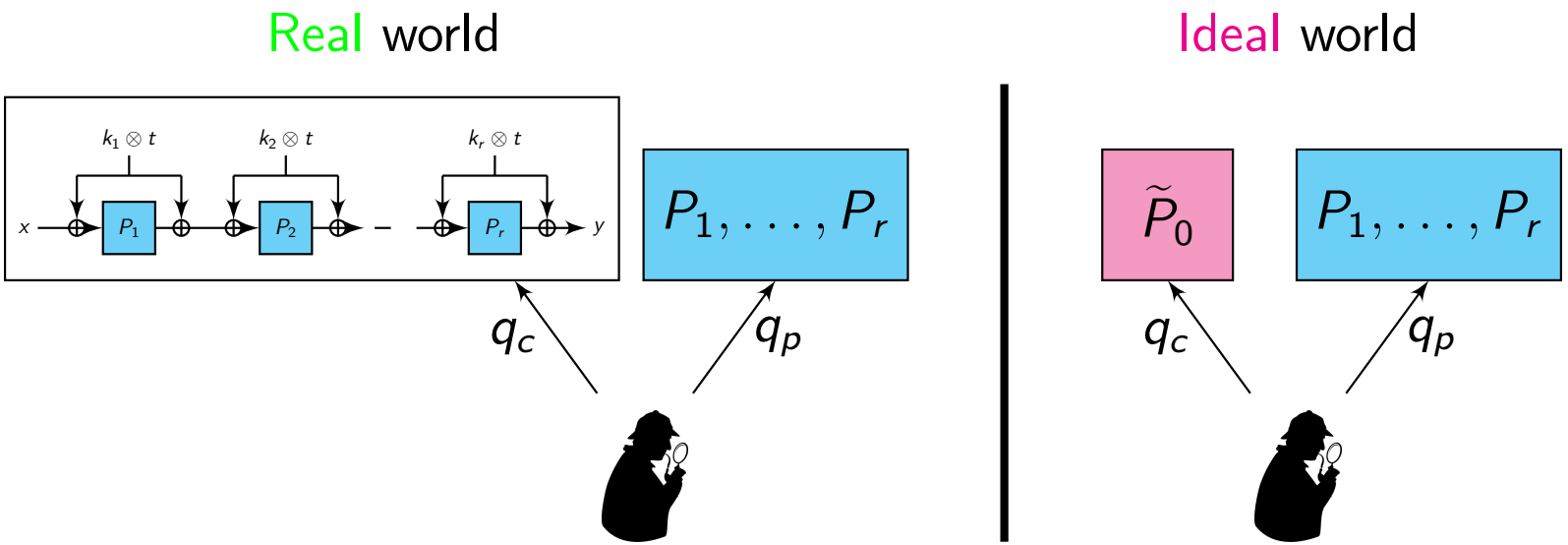

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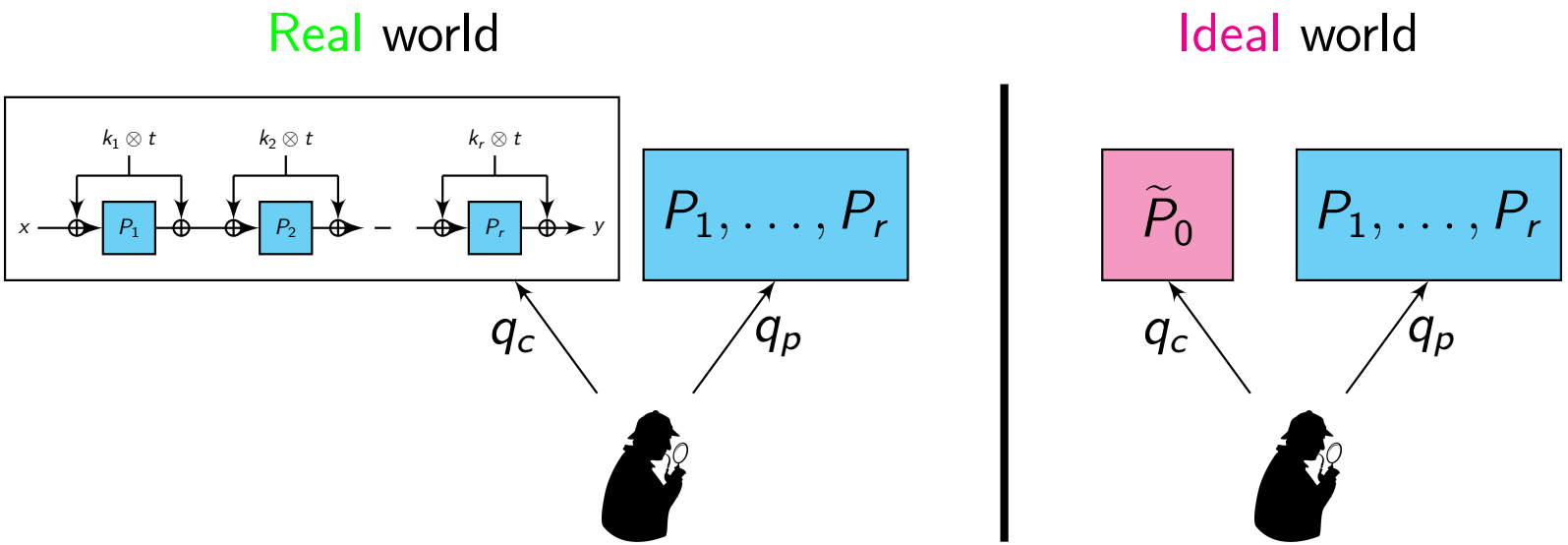

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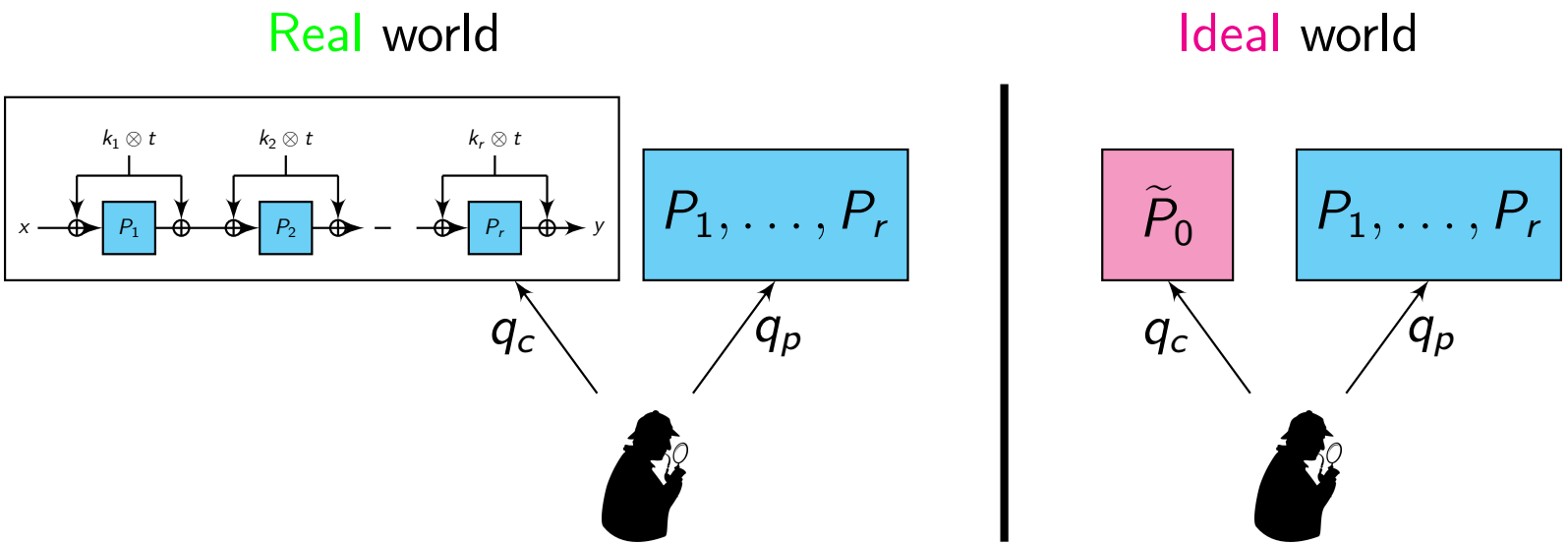

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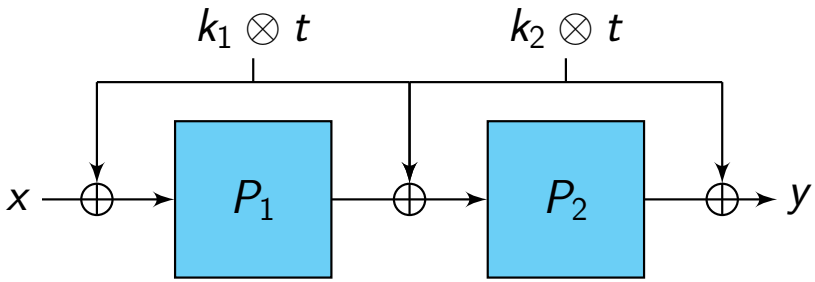

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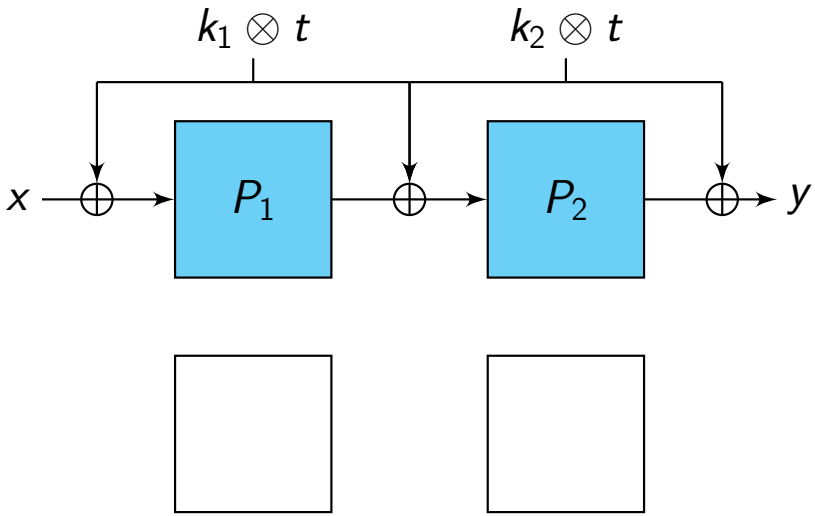

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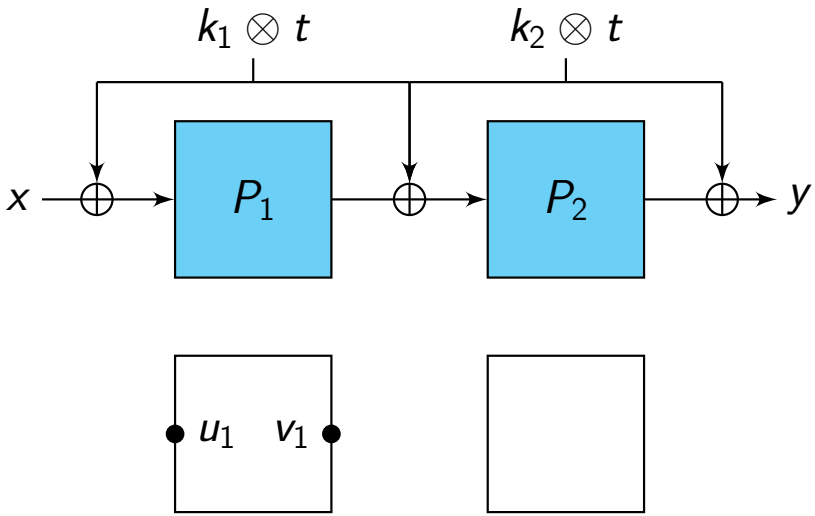

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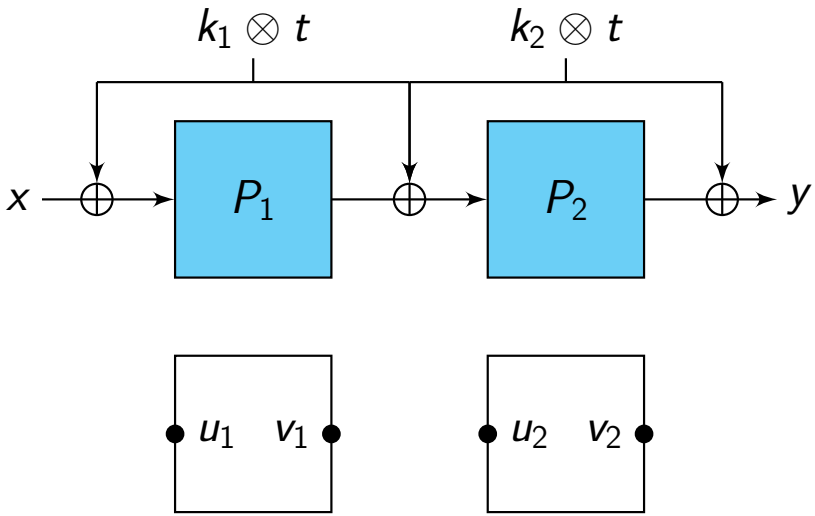

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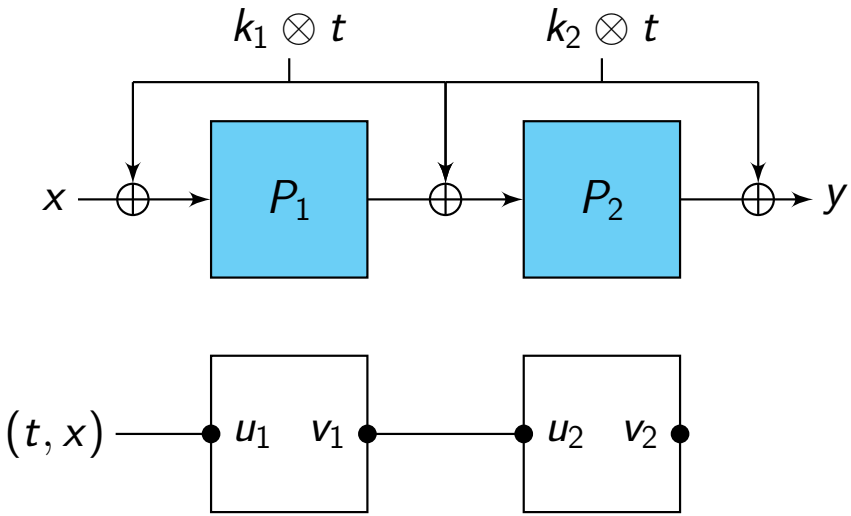

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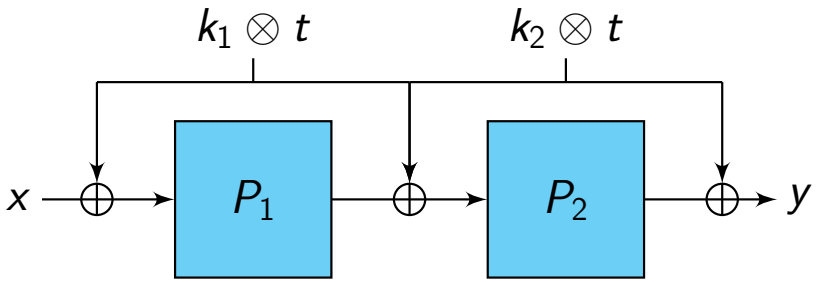

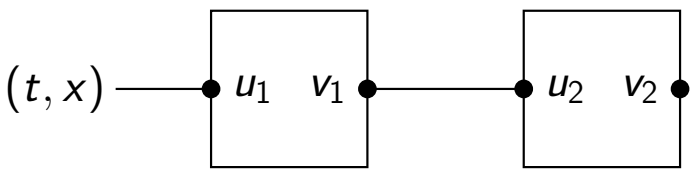

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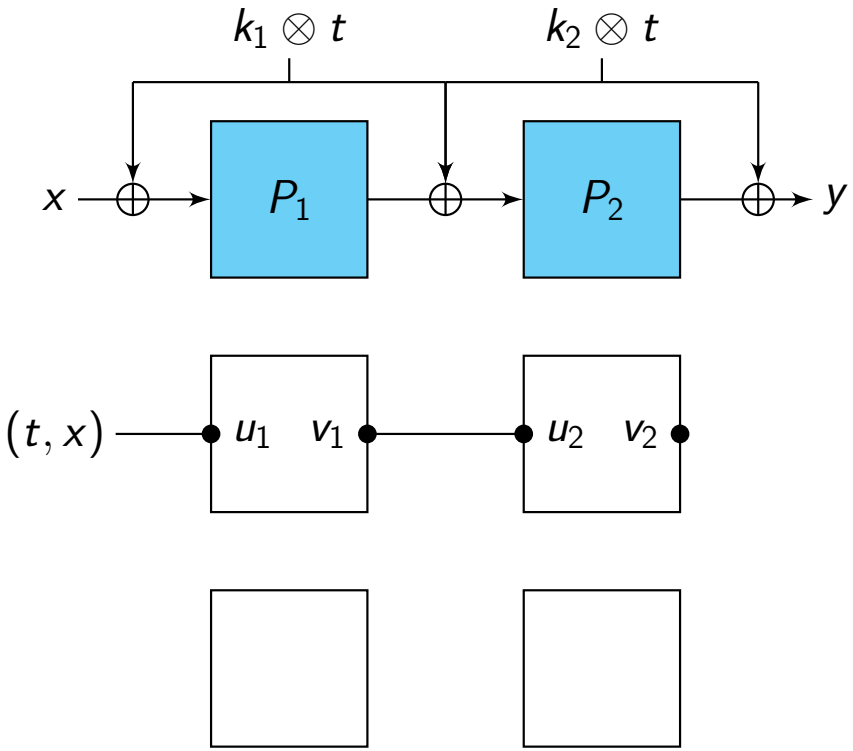

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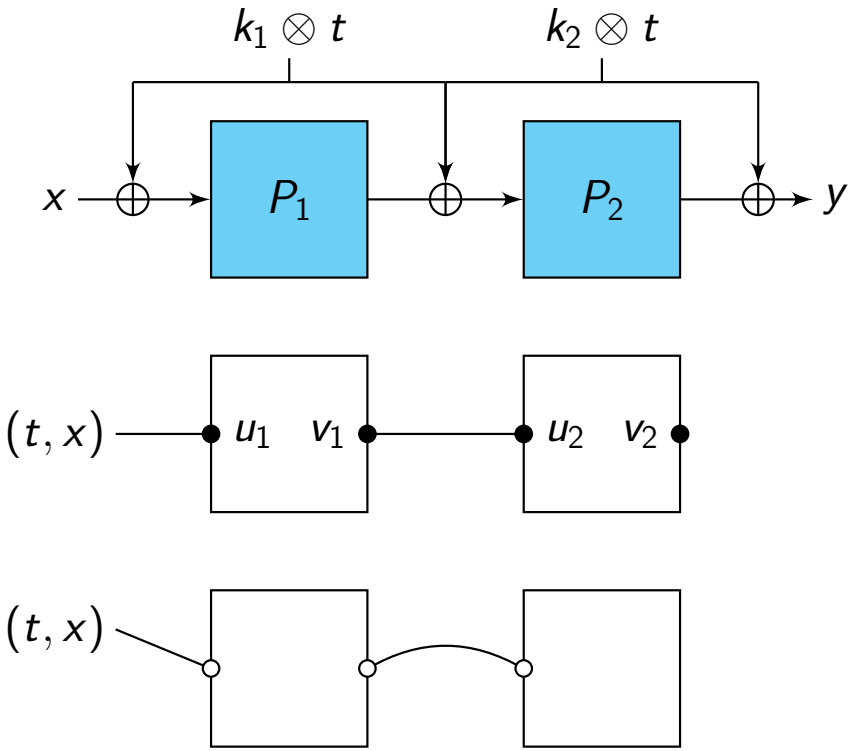

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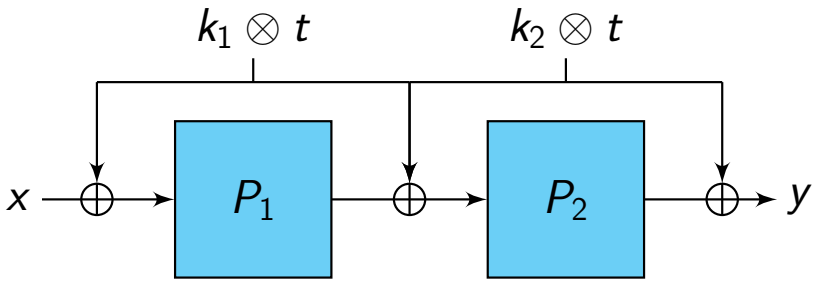

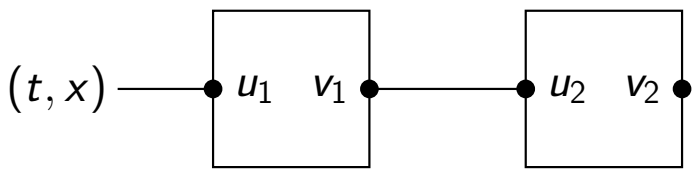

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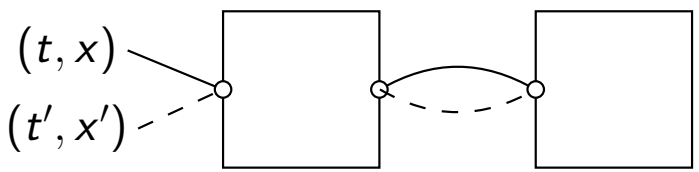

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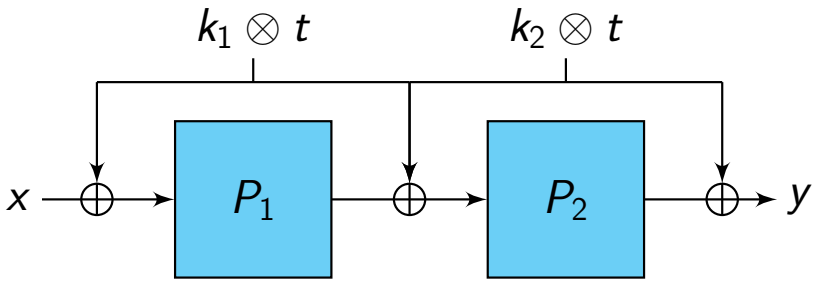

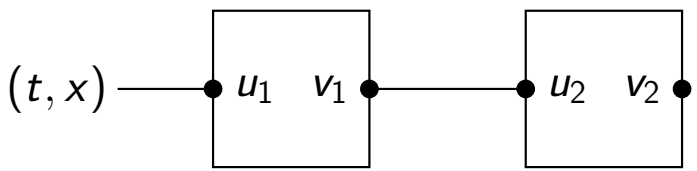

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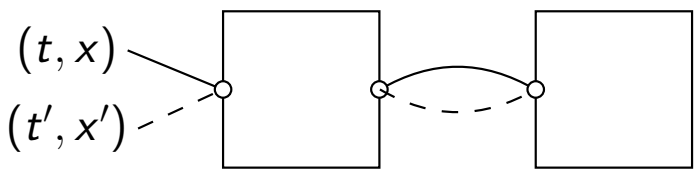

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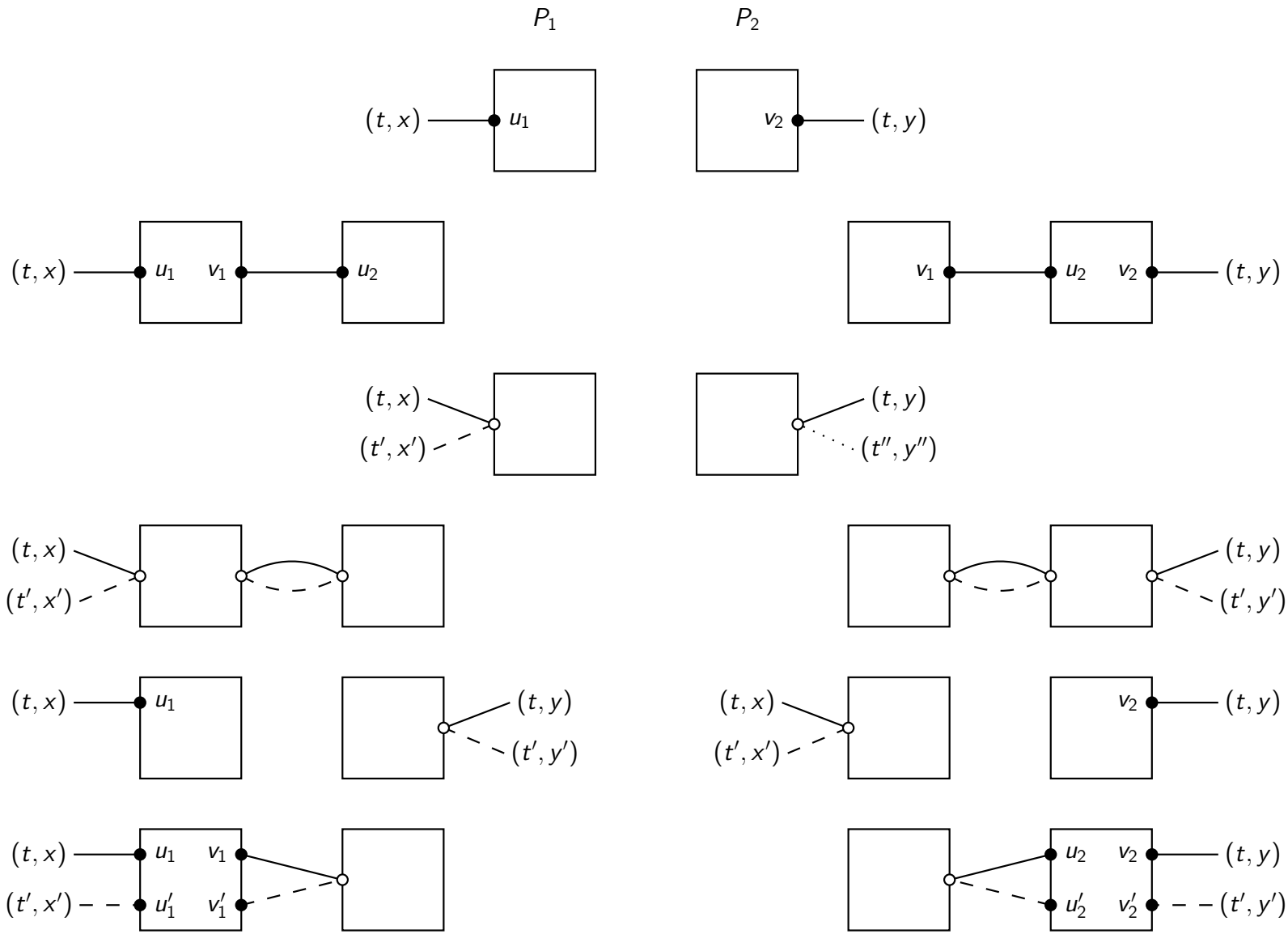

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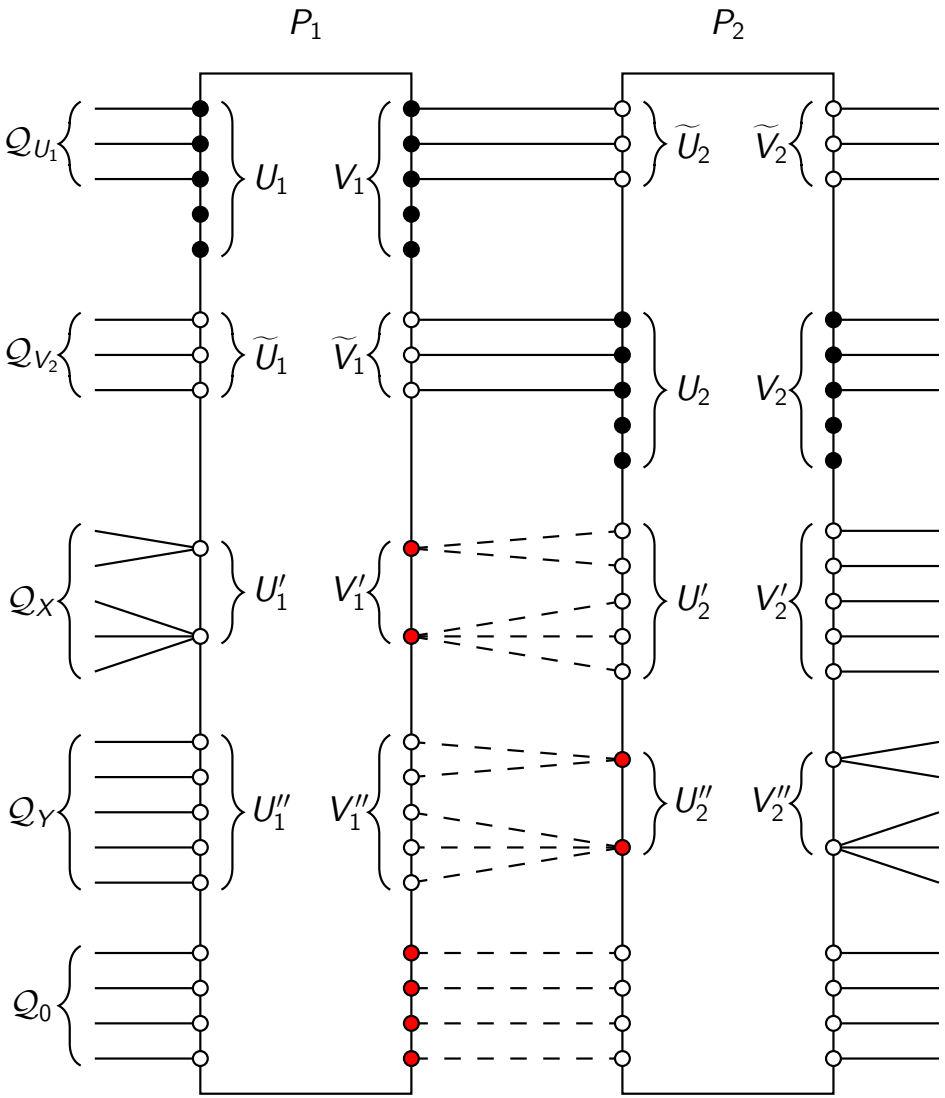

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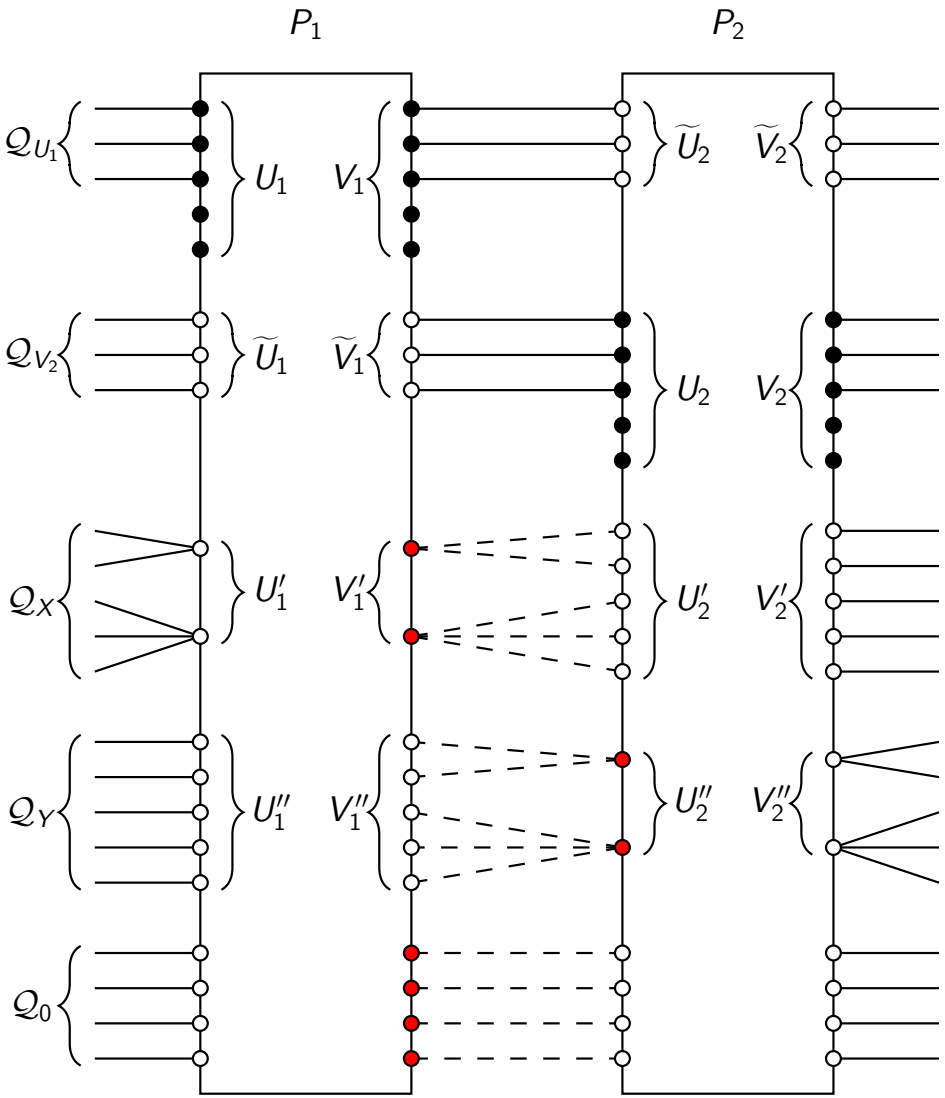

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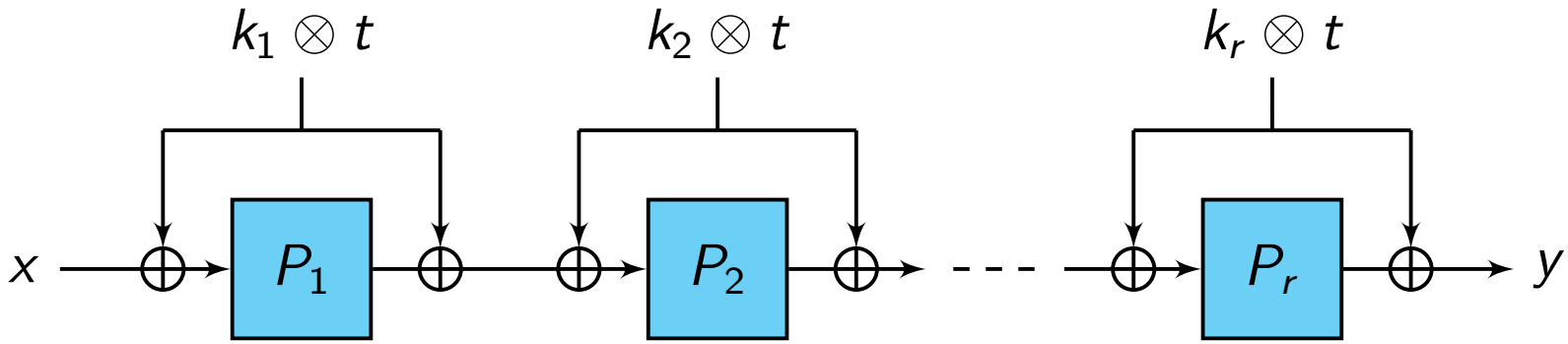

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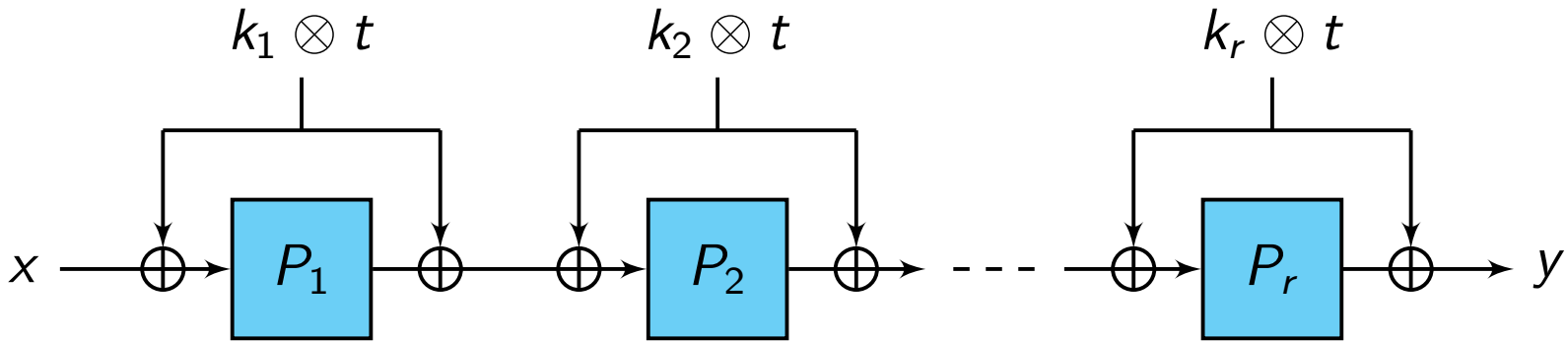

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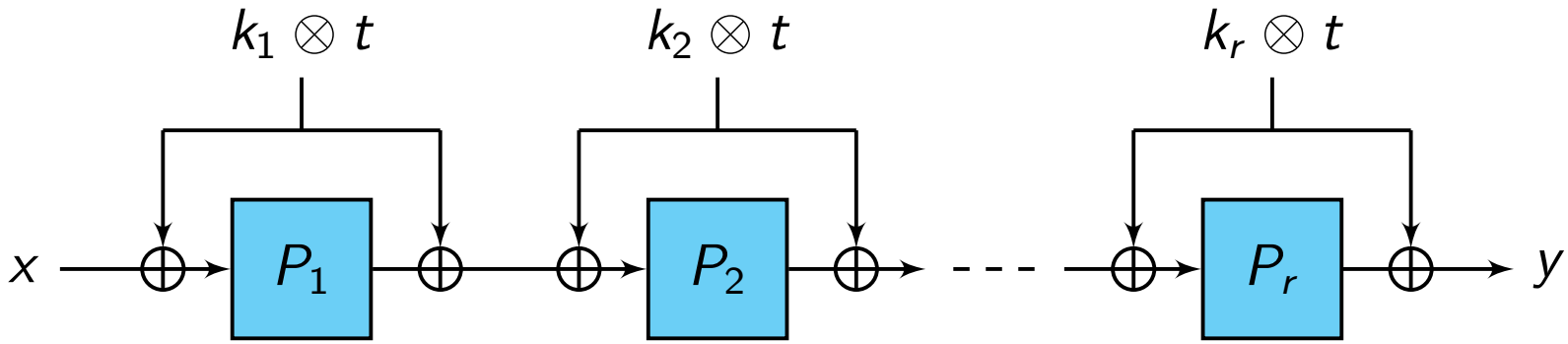

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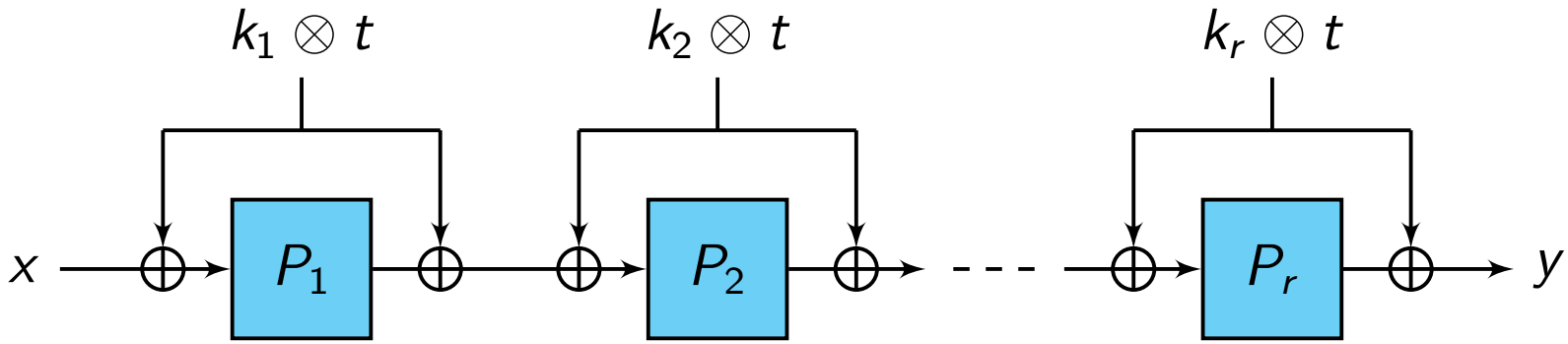

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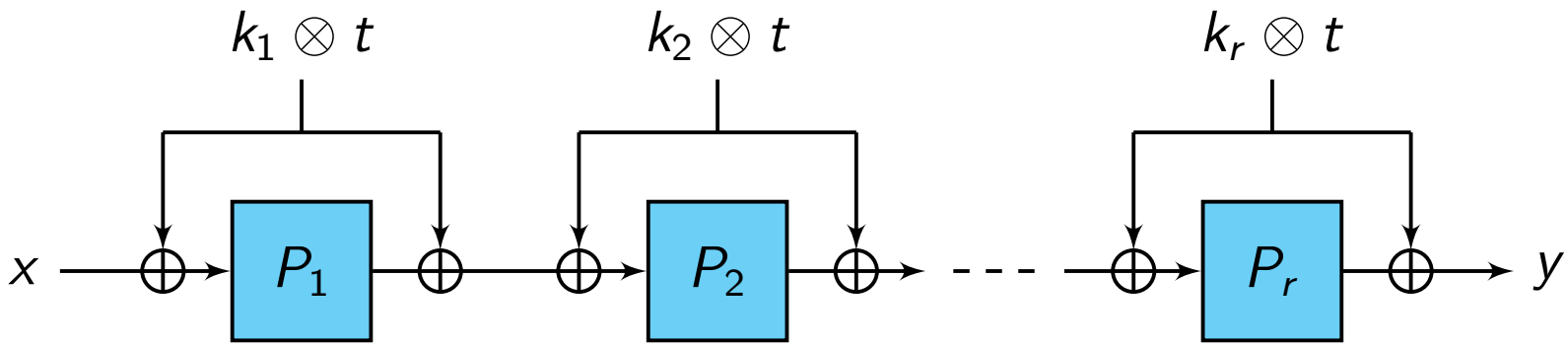

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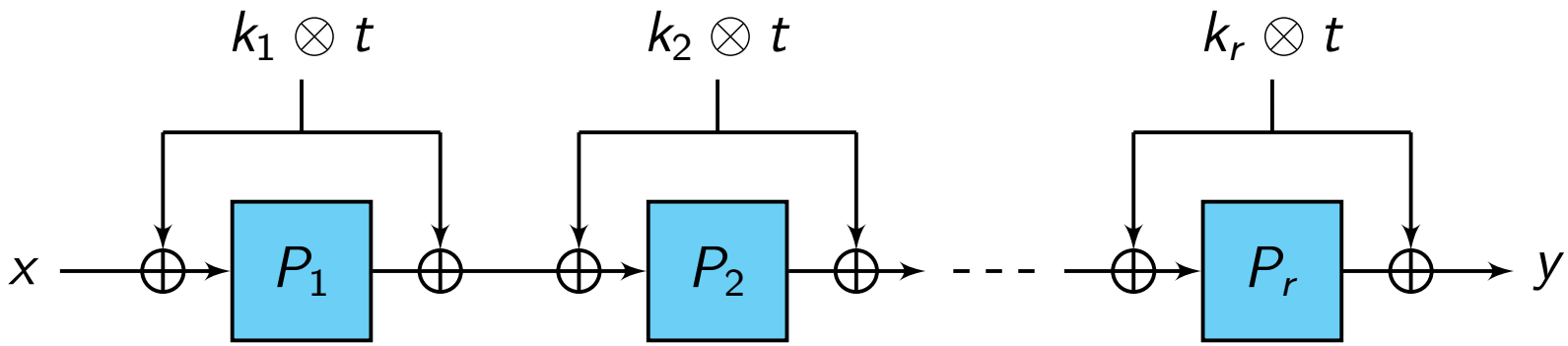

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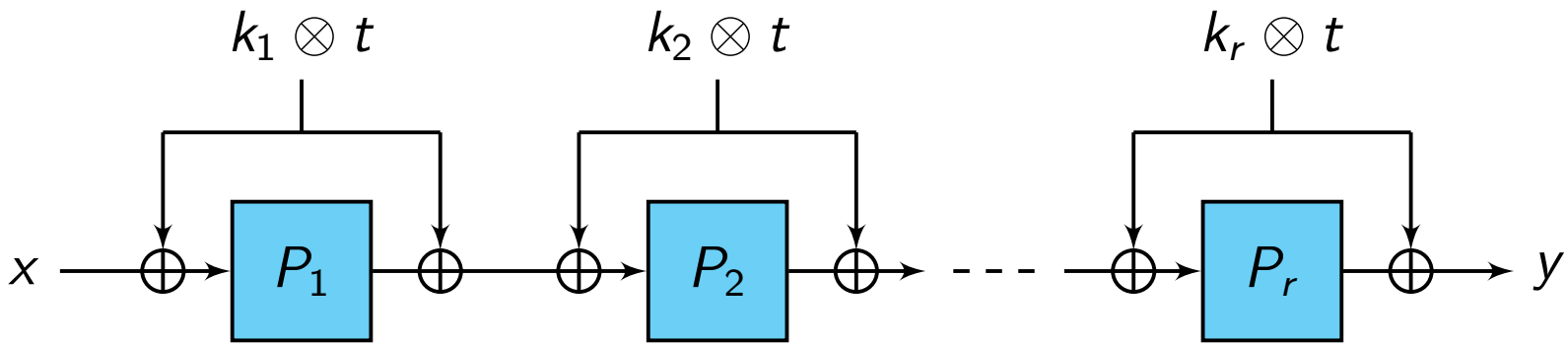

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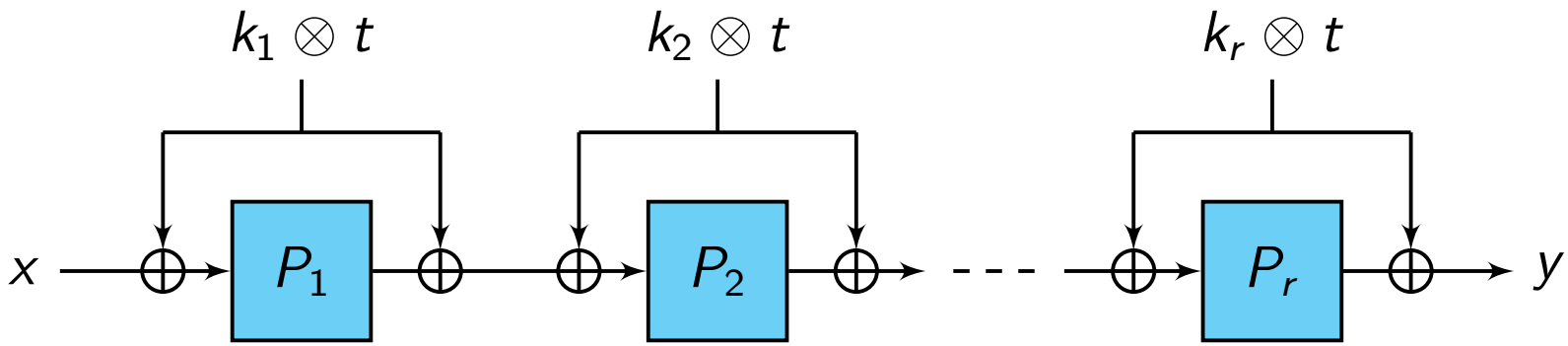

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- proposed by Jean, Nikolić, and Peyrin [JNP14]
- Superposition TWEAKEY (STK) constructions:

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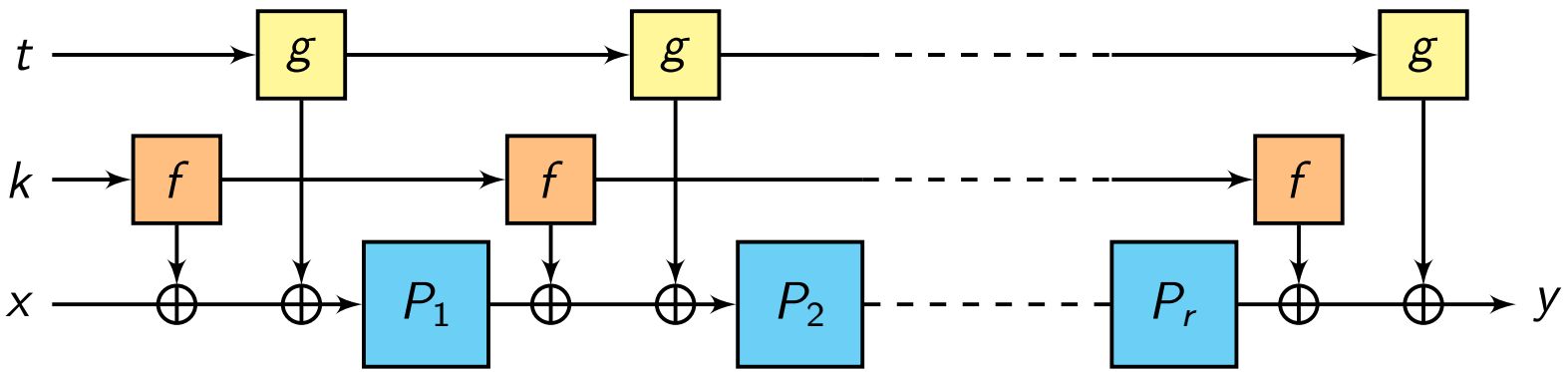

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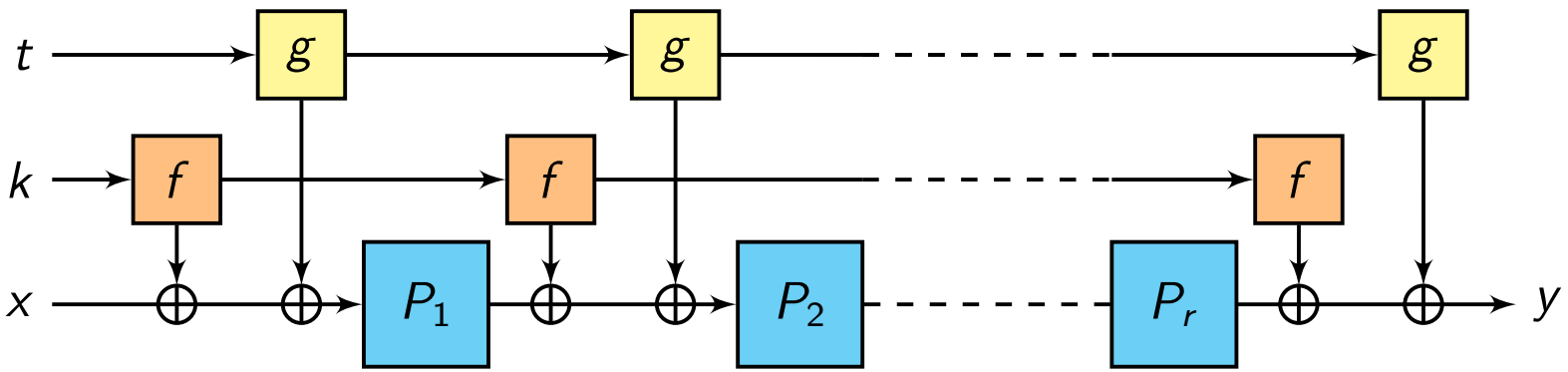

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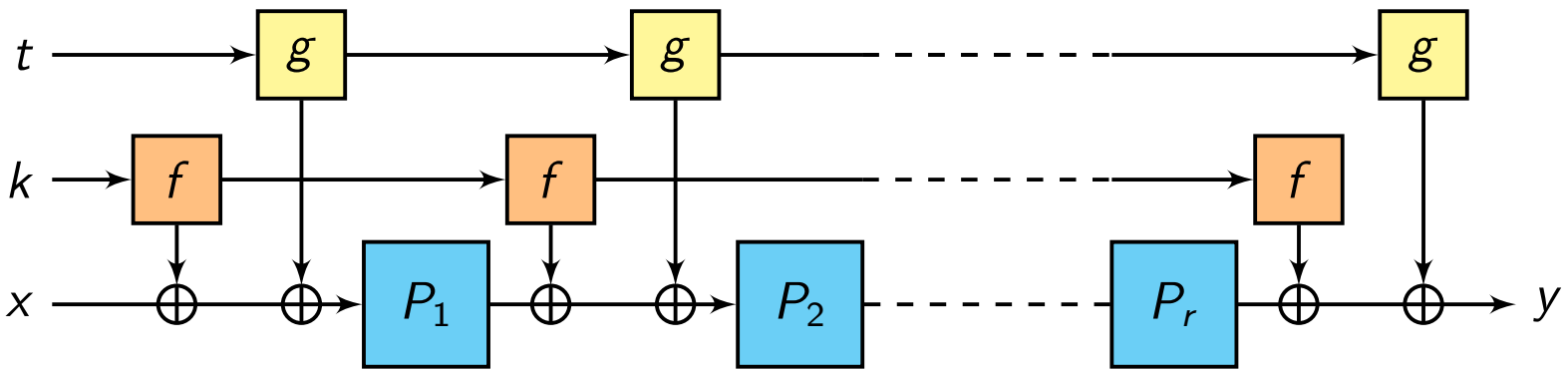

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The end...

Thanks for your attention!

Comments or questions?

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