A Simple and Efficient Lock-Free Hash Trie Design for Concurrent Tabling

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Tabling in Prolog Systems

- **Tabling** is an implementation technique that overcomes some of the limitations of Prolog resolution:
  - Tabled subgoals are evaluated by storing their answers in an appropriate data space, called the **table space**
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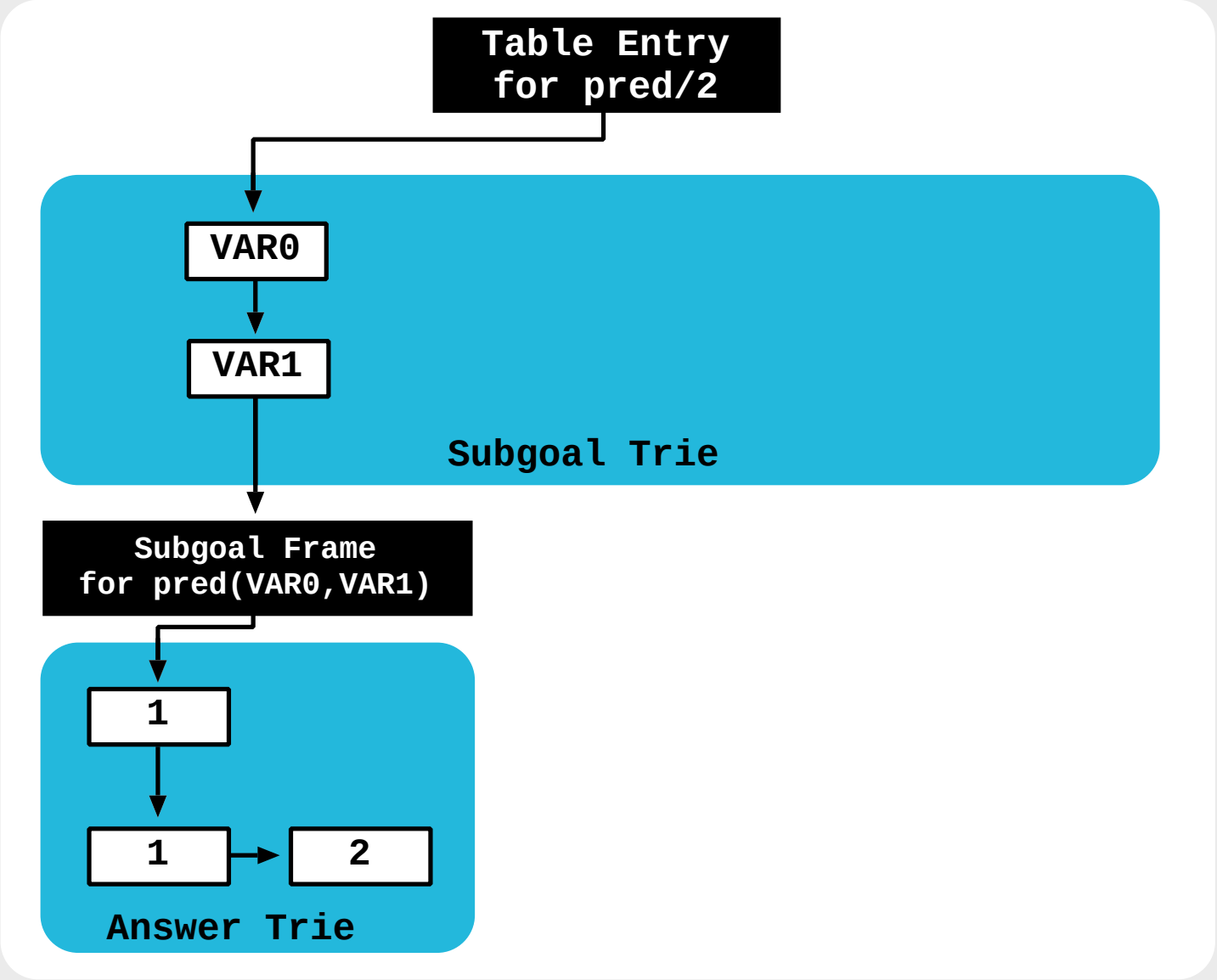
- **Multithreading** combined with **Tabling**:
  - XSB Prolog
  - **Yap Prolog [ICLP 2012]**.

Table Space - Example



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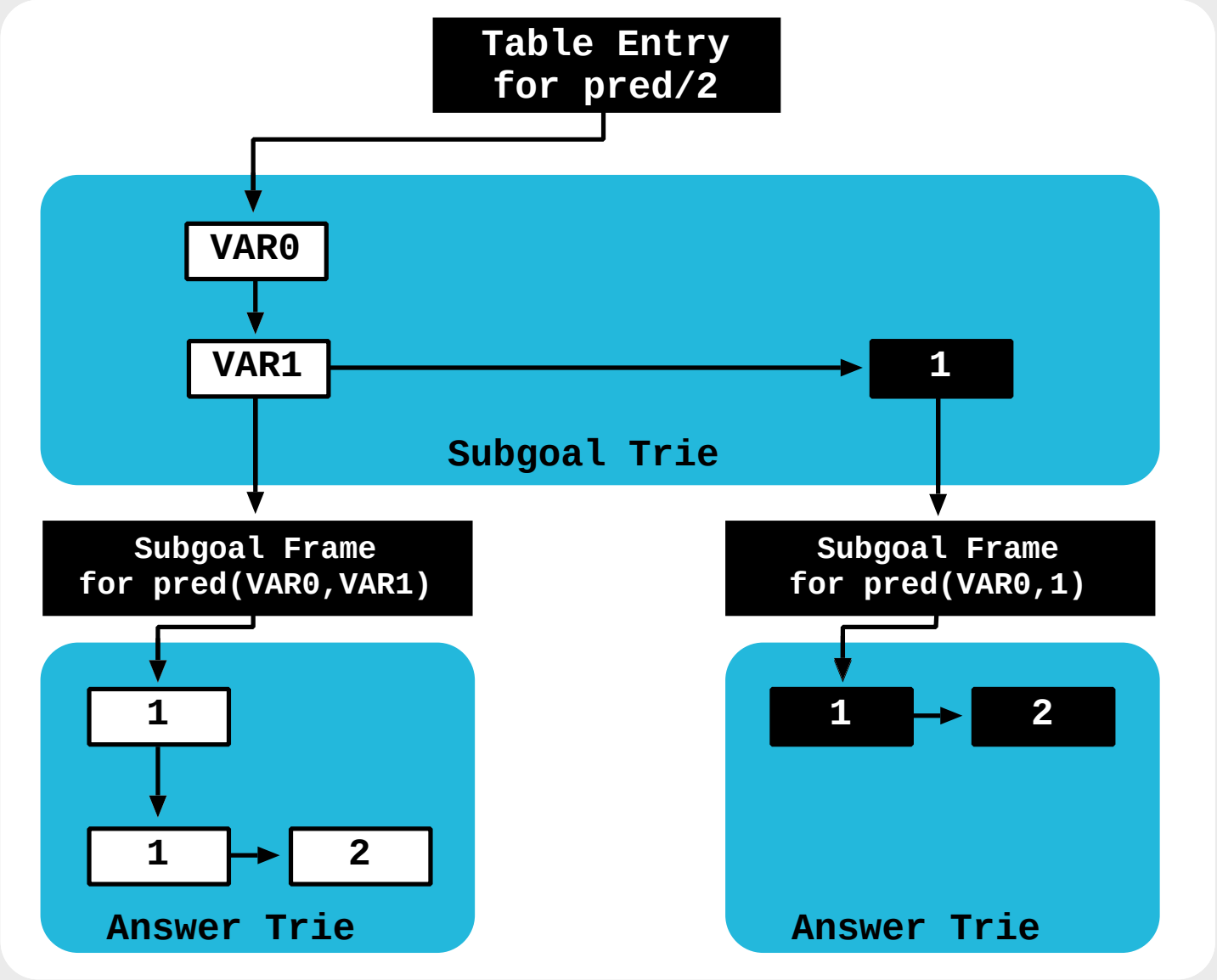

Table Space - Trie Level Internals

- A **trie level** is defined by a **parent (P)** node and at least one **child (K)** node.
- Only **lookup** and **insert** operations are executed.
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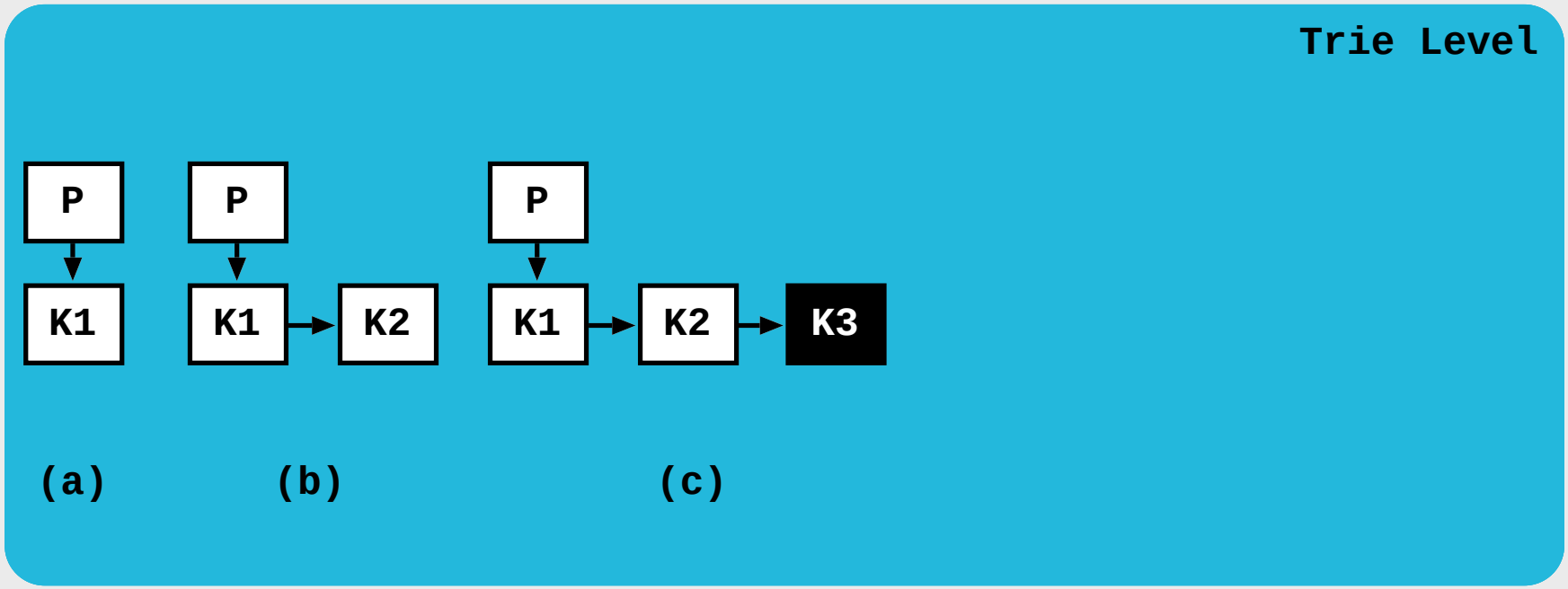

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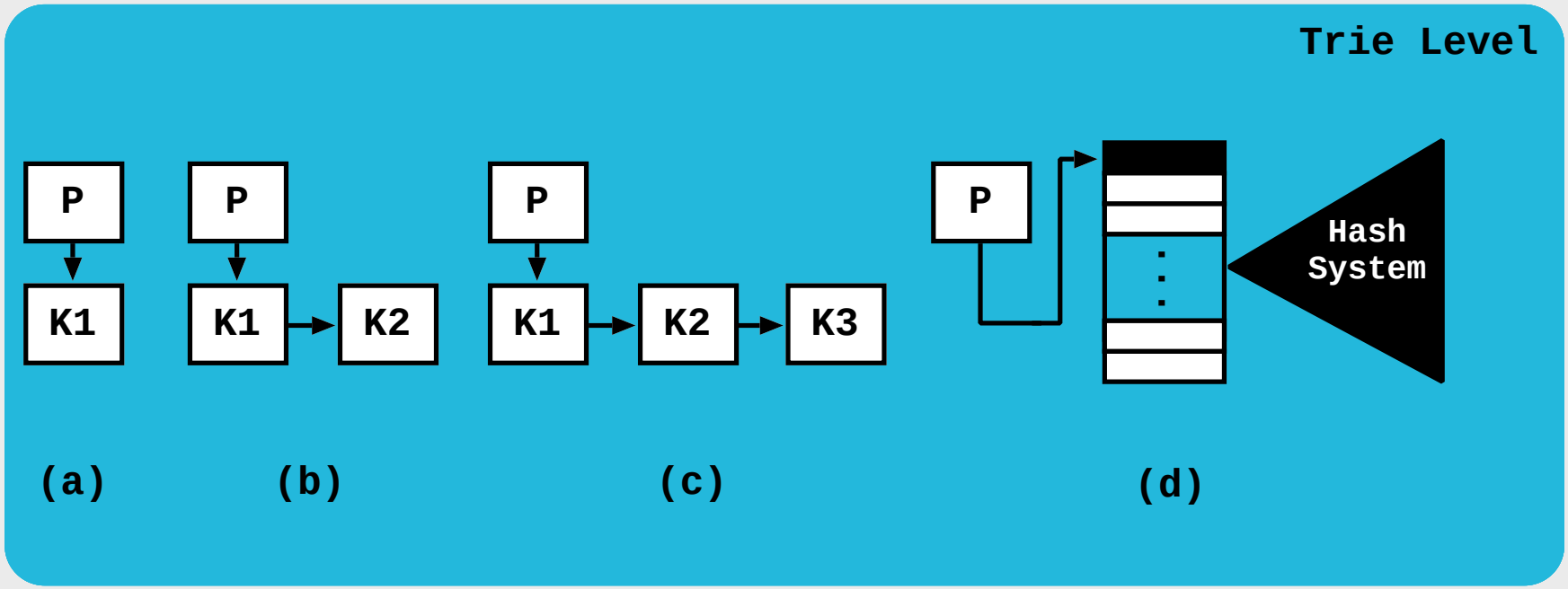

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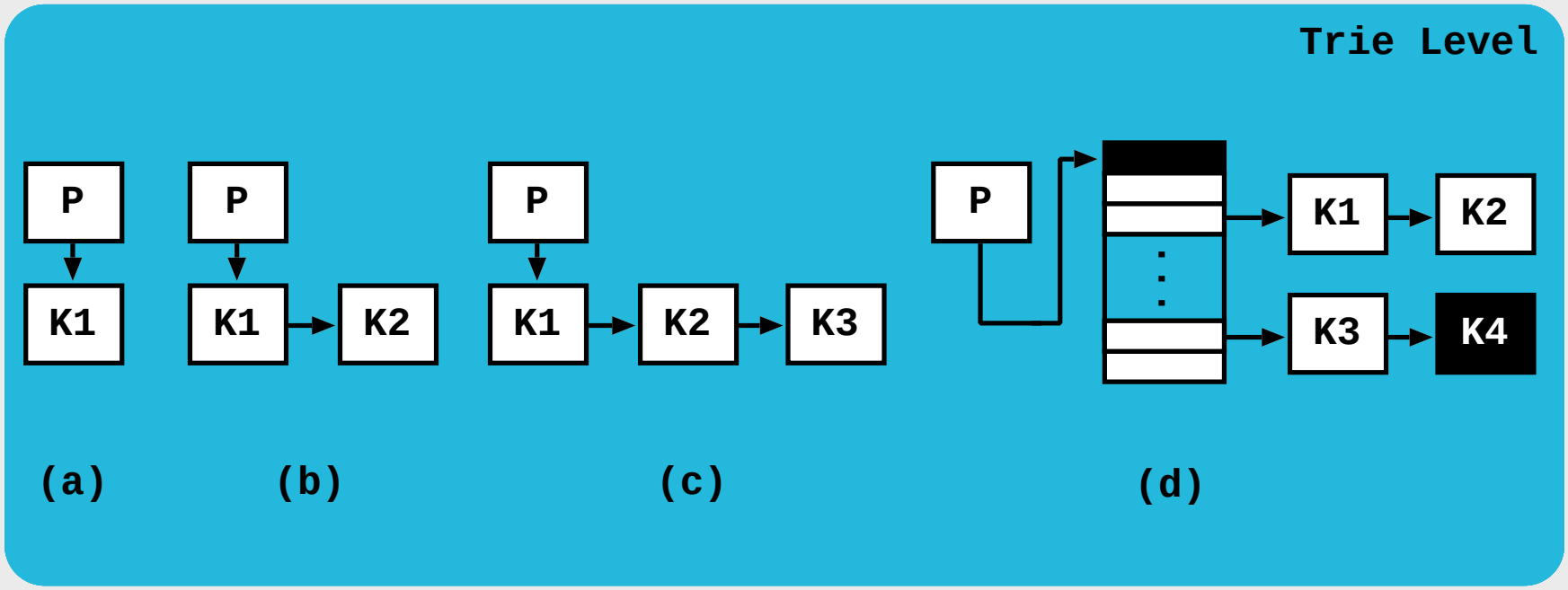

Our Approach - Motivation

- **Until now** to deal with **concurrency** we used the **following mechanisms**:
  - Standard Locking and Try Locking **[ICLP 2012]**
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- Create a new design (**LFHT Lock-Free Hash Tries**) that:
  - is as **efficient** as possible in **lookup and insert** operations
  - **minimizes** the **problems** associated with our **previous approaches**.

Lock-Free Hash Tries - Key Ideas

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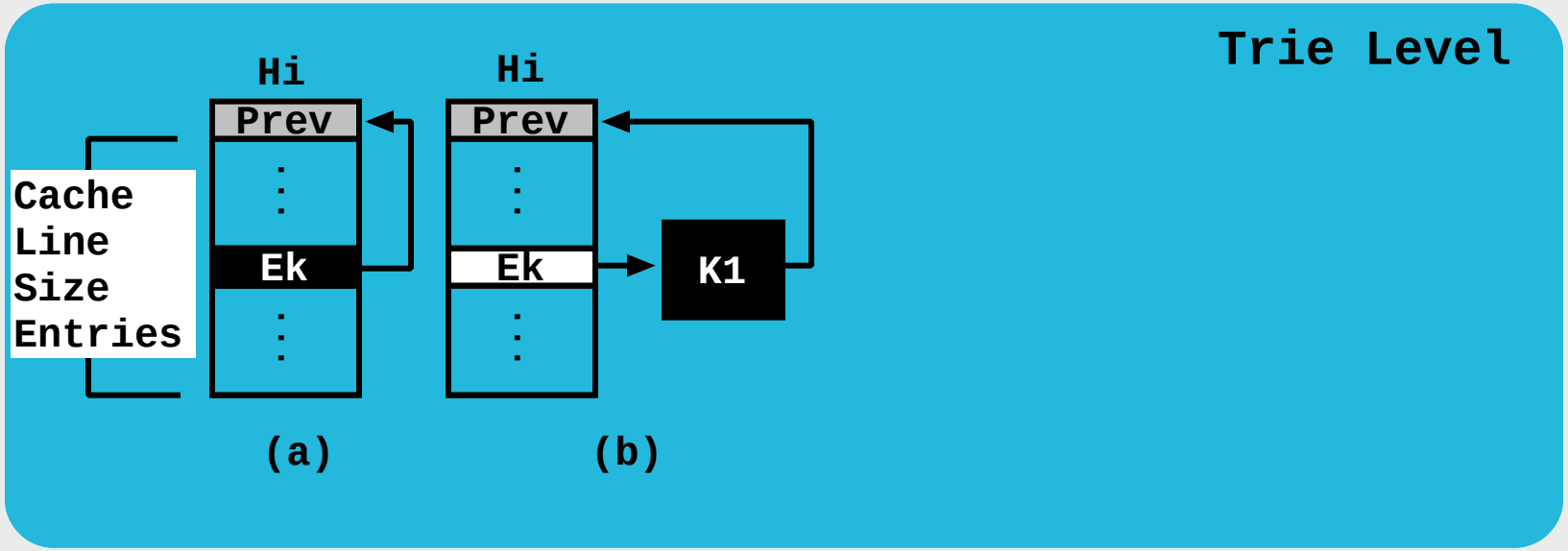

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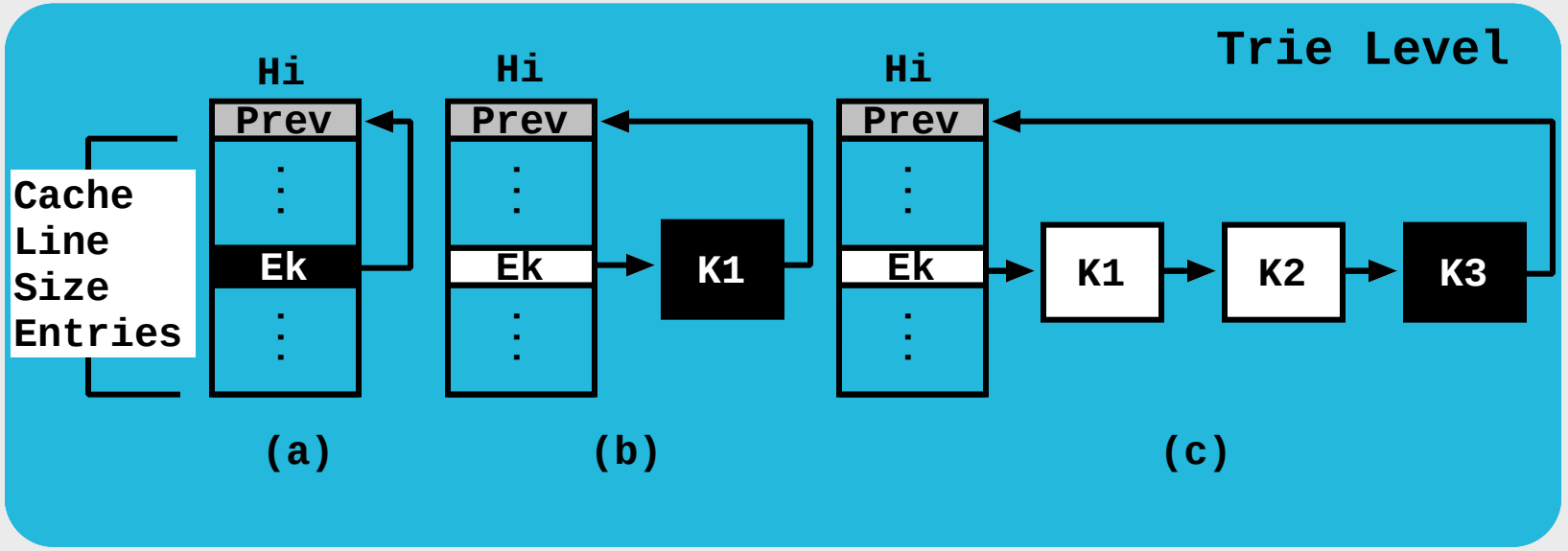

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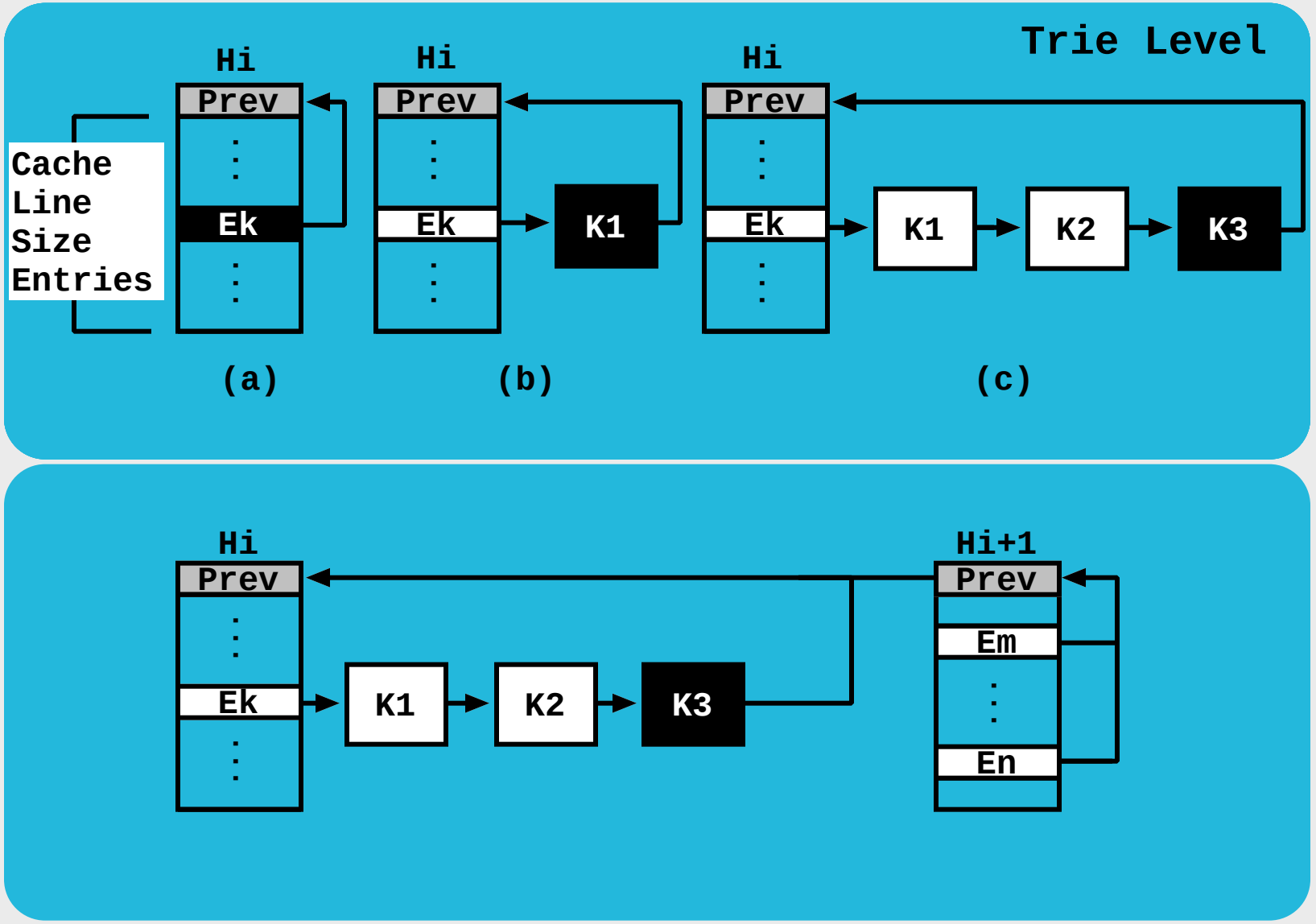

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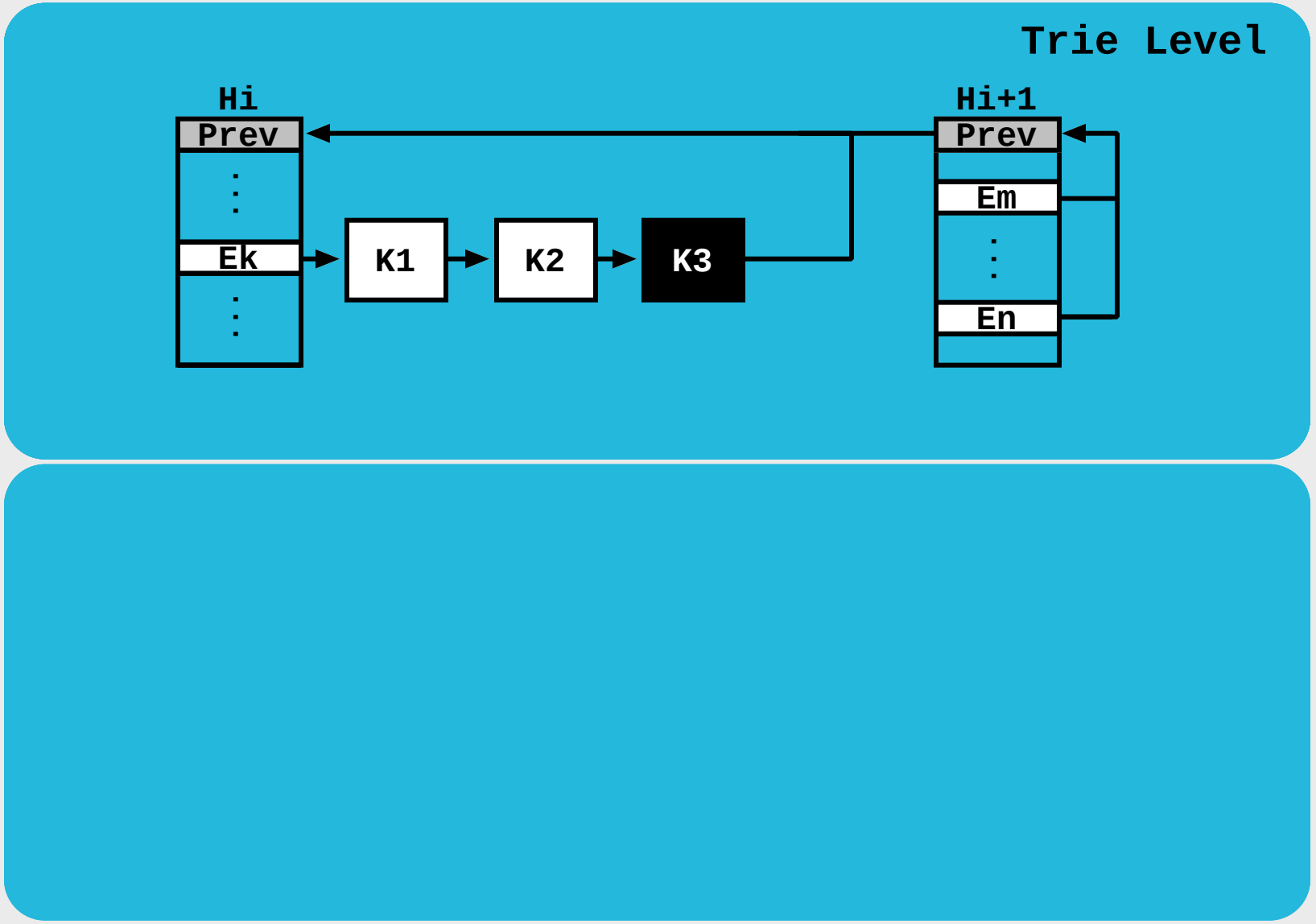

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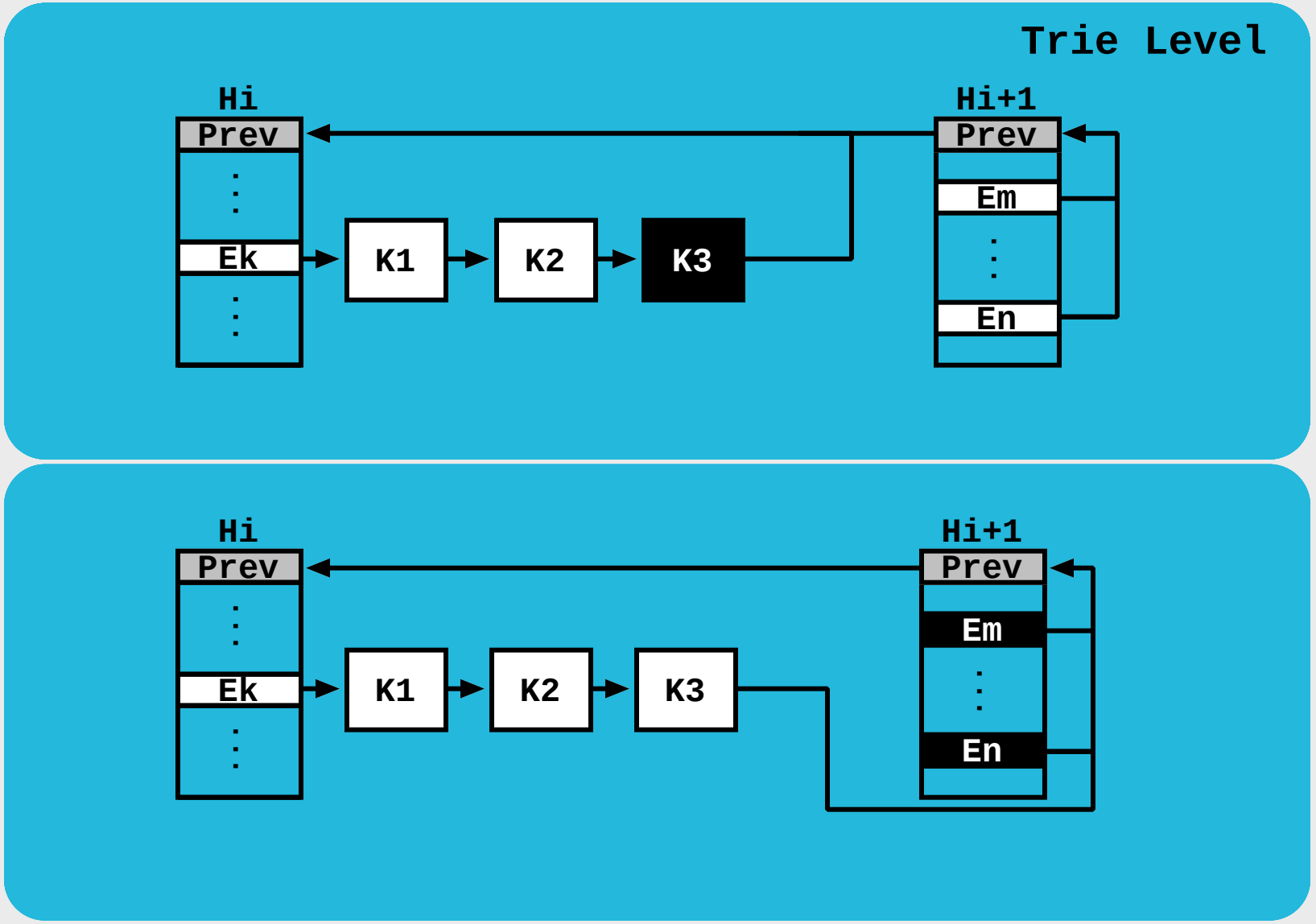

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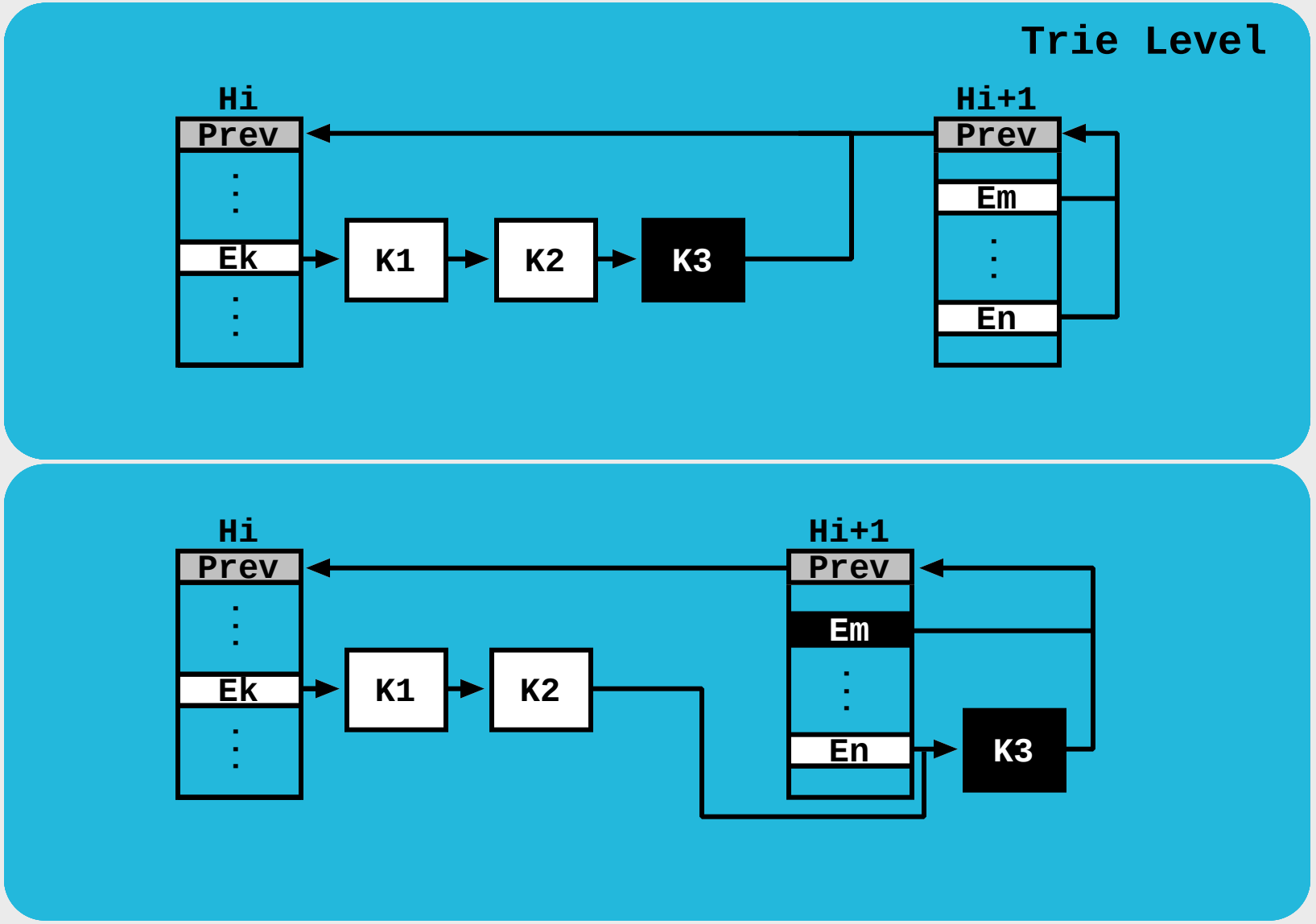

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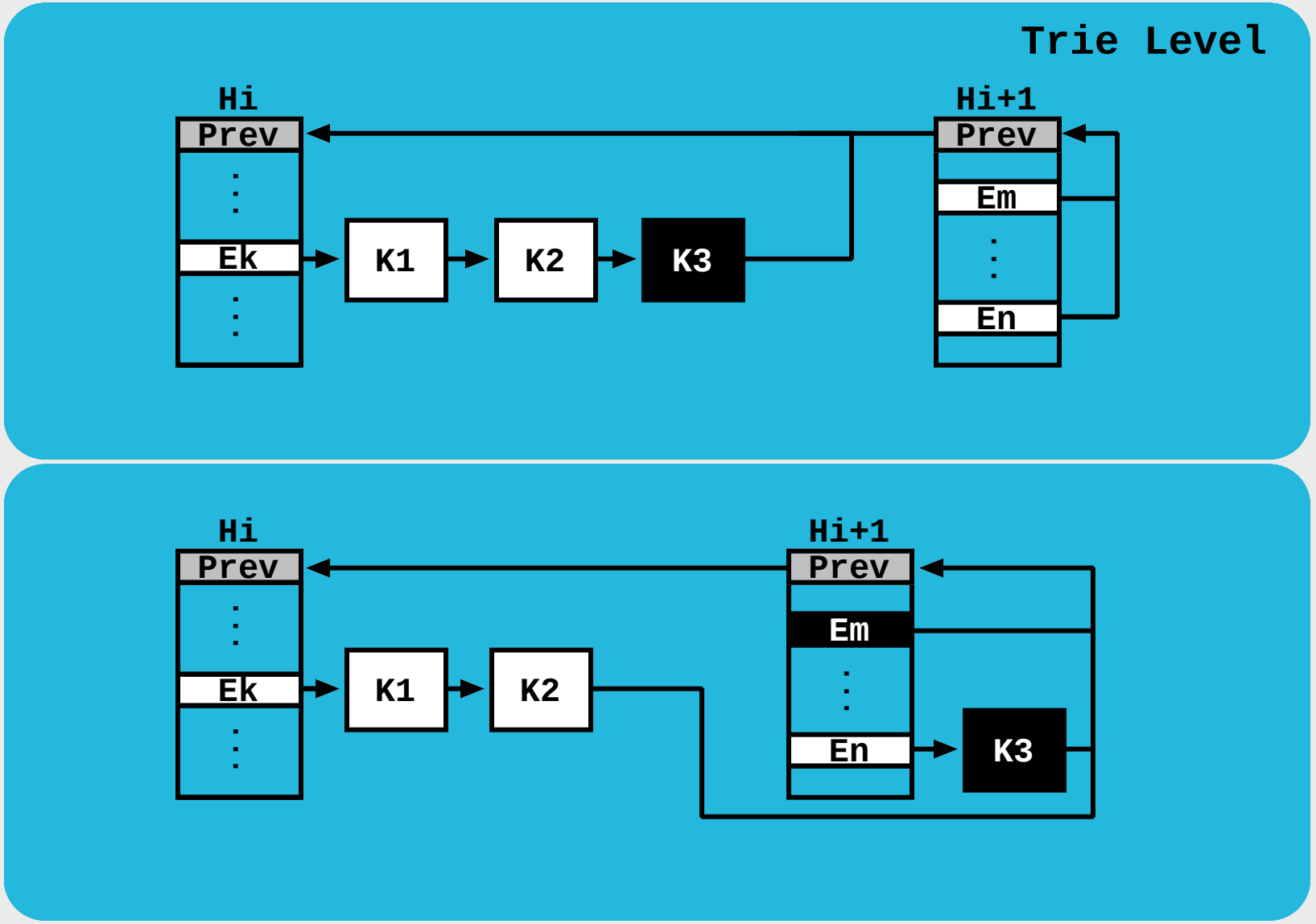

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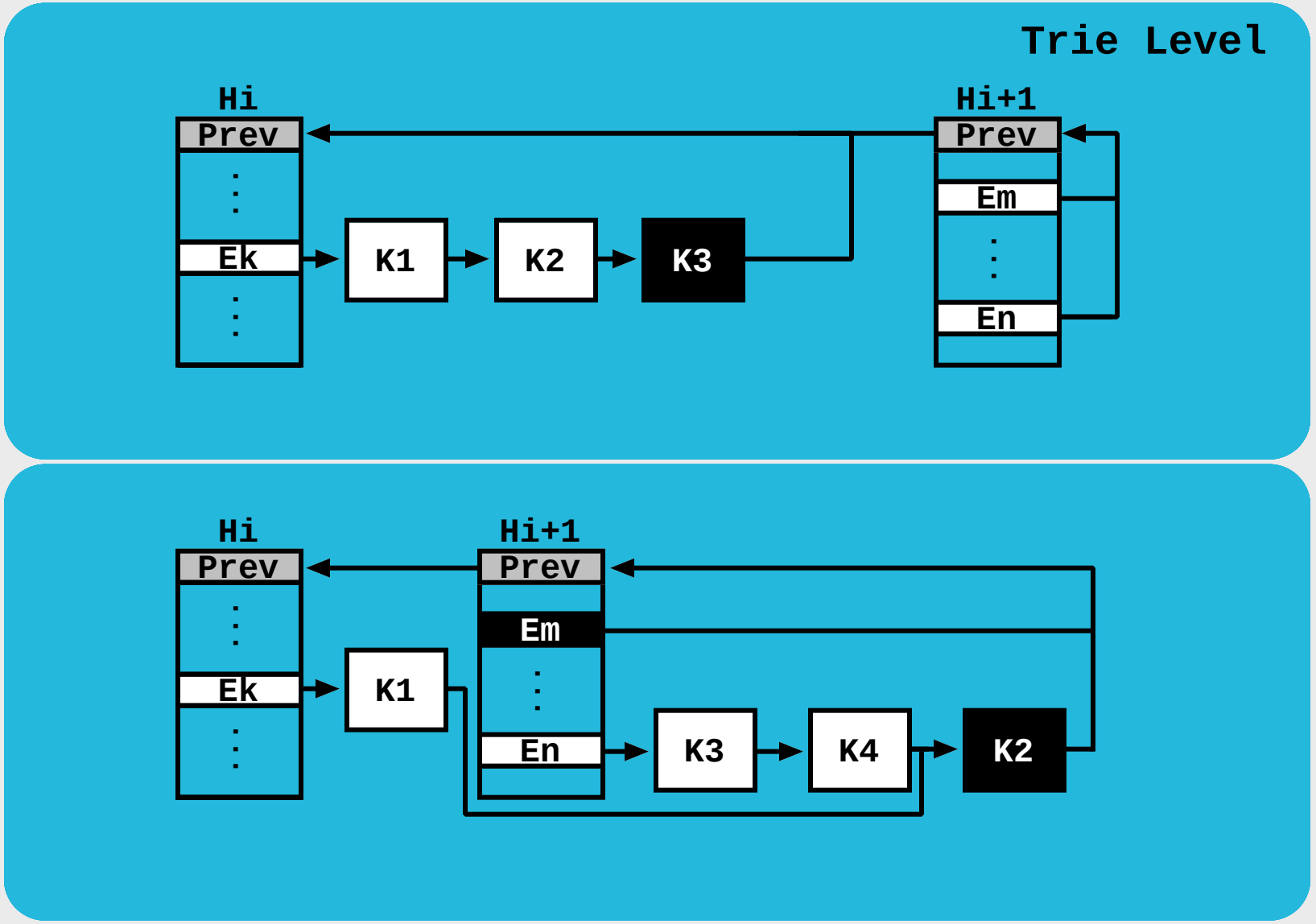

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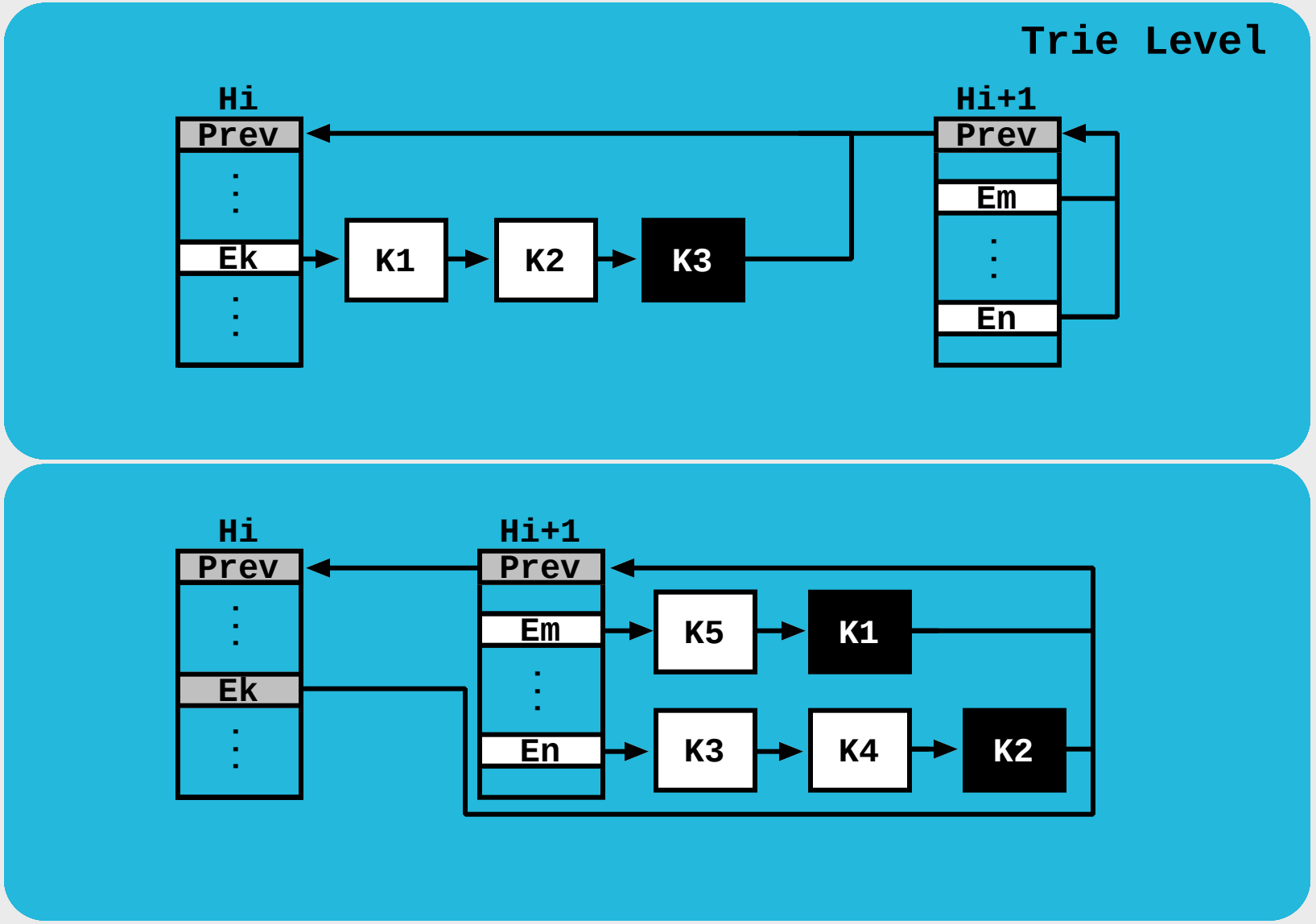

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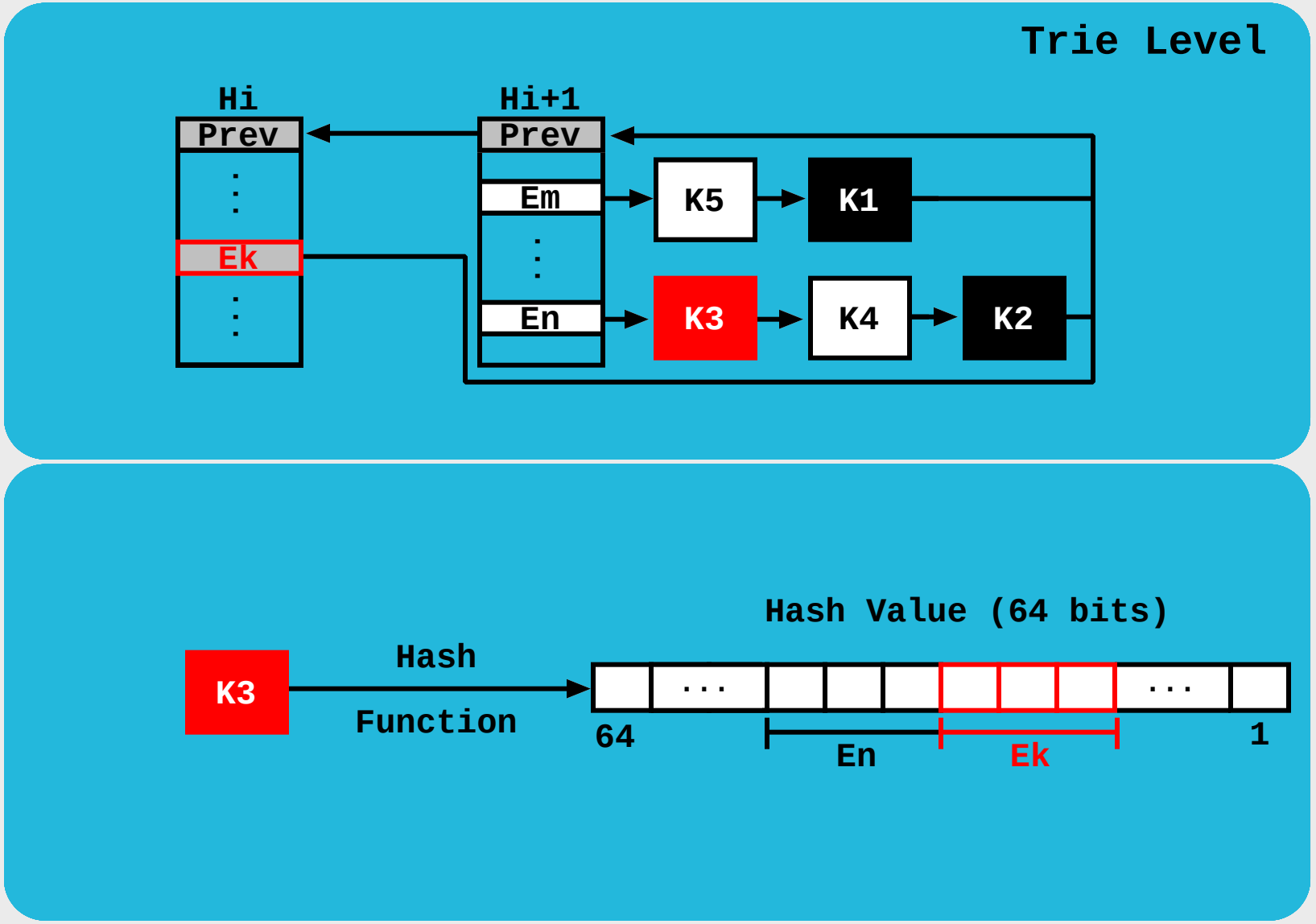

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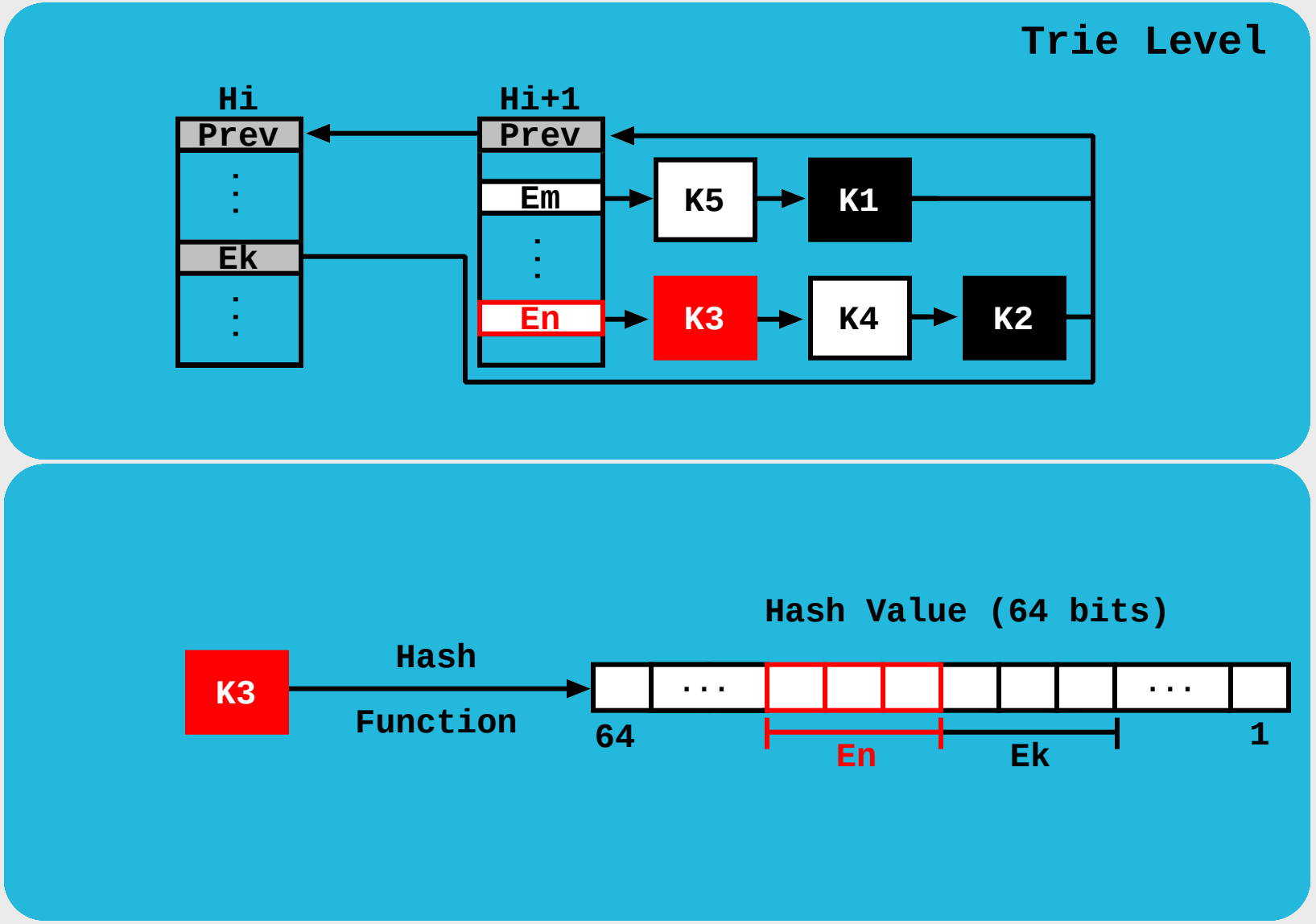
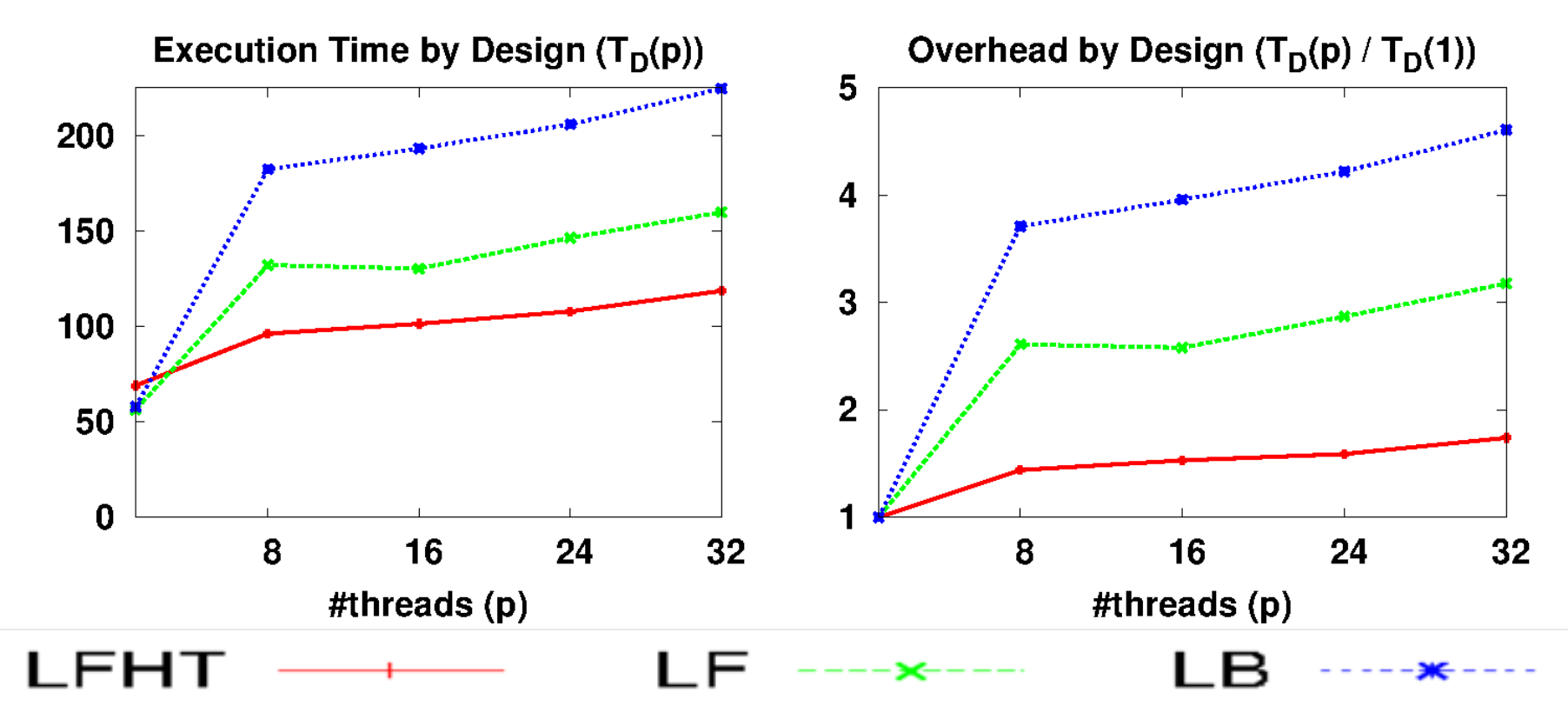


Experimental Results - Overhead Scenarios

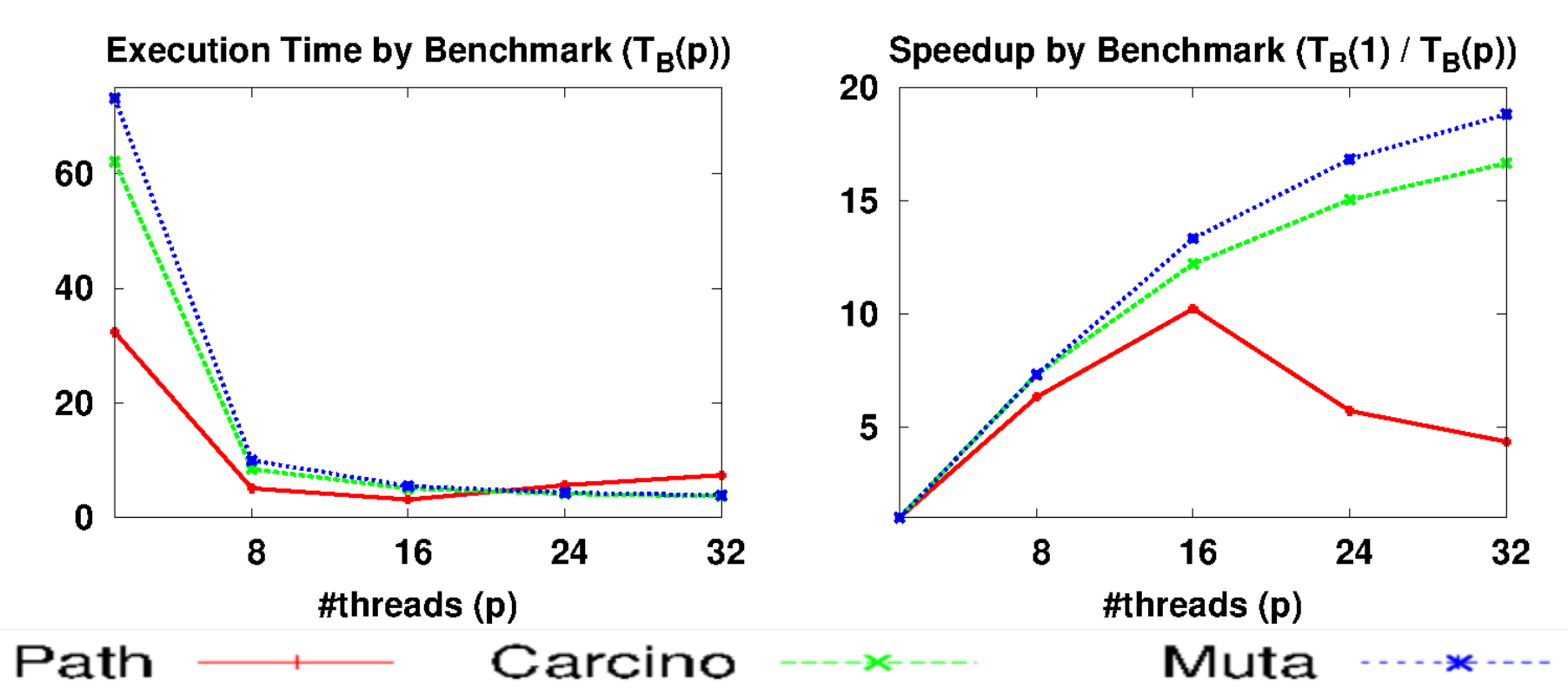
- Comparison in a **32 Core AMD** machine. **All threads** execute the **same sub-computations** (**Overall** values for **five sets** of **benchmarks**).



- **LFHT Lock-Free Hash Tries - LF Lock-Free (old approach)**
- **LB Lock-Based (old approach)**

Experimental Results - Speedup Scenarios

- Comparison in a **32 Core AMD** machine. **All threads** execute **different sub-computations** (**LFHT Lock-Free Hash Tries** + **Naive Scheduler**).



- **Path** Path problem using a graph with a grid configuration
- **Carcino / Muta** (genesis) Inductive Logic Programing Benchmarks

Conclusions and Further Work

- We have presented a **novel**, **efficient** and **lock-free** design for a trie hash data structure applied to the multithreaded tabled evaluation of logic programs:
  - Improves the **efficiency** of the **concurrent lookup** and **insert operations** even in **worst case scenarios**
  - **Paper discusses** the key ideas of the **design**. An extended version was already accepted in **HLPP 2014** and will be available soon in the **IJPP** journal.
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- **Further work** will include:
  - Support the **concurrent deletion** of trie nodes (**mode-directed tabling**)
  - **Extend** the usage of the design to other parts of the **Yap Prolog** system (**atom table**)
  - Explore the **full potentiality** of the design by using it in other **tabling applications** or as **stand alone framework**.

Thank You !!!

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Yap Prolog : *http://www.dcc.fc.up.pt/∼vsc/yap*

Projects SIBILA : *http://cracs.fc.up.pt/*

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