

On Extending a Full-Sharing Multithreaded Tabling Design with Batched Scheduling

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Yap Prolog: *<http://www.dcc.fc.up.pt/~vsc/Yap>*

Project SIBILA: *<http://cracs.fc.up.pt/>*



Prolog and SLD Resolution

- Prolog systems are known to have good performances and flexibility, but they are based on SLD resolution, which limits the potential of the Logic Programming paradigm.
- SLD resolution cannot deal properly with the following situations:
 - ◆ **Positive Infinite Cycles** (insufficient expressiveness)
 - ◆ **Negative Infinite Cycles** (inconsistence)
 - ◆ **Redundant Computations** (inefficiency)

SLD Resolution: Infinite Cycles

```
c1)    a(X) :- b(X).  
c2)    a(2).  
  
c3)    b(X) :- a(X).  
c4)    b(1).
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1.a(X)
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Infinite Cycle

Tabling in Prolog Systems

- **Tabling** is an **implementation technique** that **overcomes** some of the **limitations** of **Prolog** systems:
 - ◆ Tabled subgoals are evaluated by storing their answers in an appropriate data space, called the **table space**.
 - ◆ Repeated calls to tabled subgoals are resolved by **consuming** the answers already stored in the table instead of **being re-evaluated** against the program clauses.

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- Implementations of **Tabling** are currently available in systems like:
 - ◆ XSB Prolog, **Yap Prolog**, B-Prolog, ALS-Prolog, Mercury, Ciao Prolog and more recently Picat.
- **Multithreading** combined with **Tabling**:
 - ◆ XSB Prolog
 - ◆ **YapTab-Mt** [ICLP 2012].

YapTab-Mt - Advantages

- An **Abstraction layer** with **high-level constructors** that provide access to the **dynamic programming (tabling)** support:
 - ◆ Instruction: **`:- table predicate/arity.`**
 - ◆ Scheduling: **`:- tabling_mode(predicate, batched).`**

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- **Thread API** is **POSIX Threads compliant**:
 - ◆ **Management** - creating, joining , yielding, etc.
 - ◆ **Monitoring** - statistics, properties, etc.
 - ◆ **Synchronization** - mutex creation, statistics, etc.

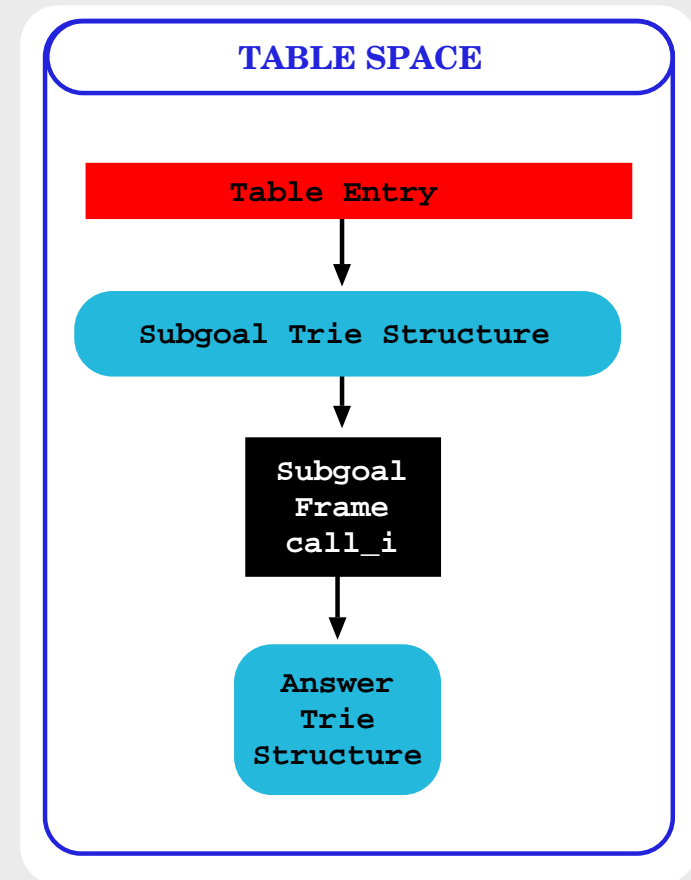
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- Write complex **dynamic programming** applications using the **Prolog** programming language.
 - ◆ **Procedures** in **Prolog** can be written as **logical specifications**, which are closer to **mathematical notation**.

Internal Table Space Architecture

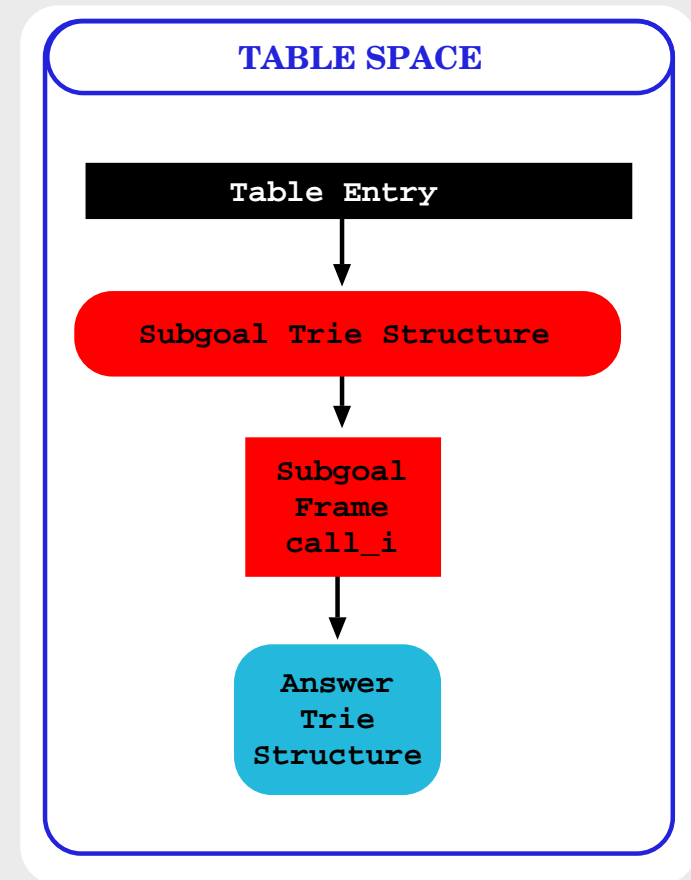
➤ **Table Entry**: stores generic about the predicates.

◆ **table predicate/2**.



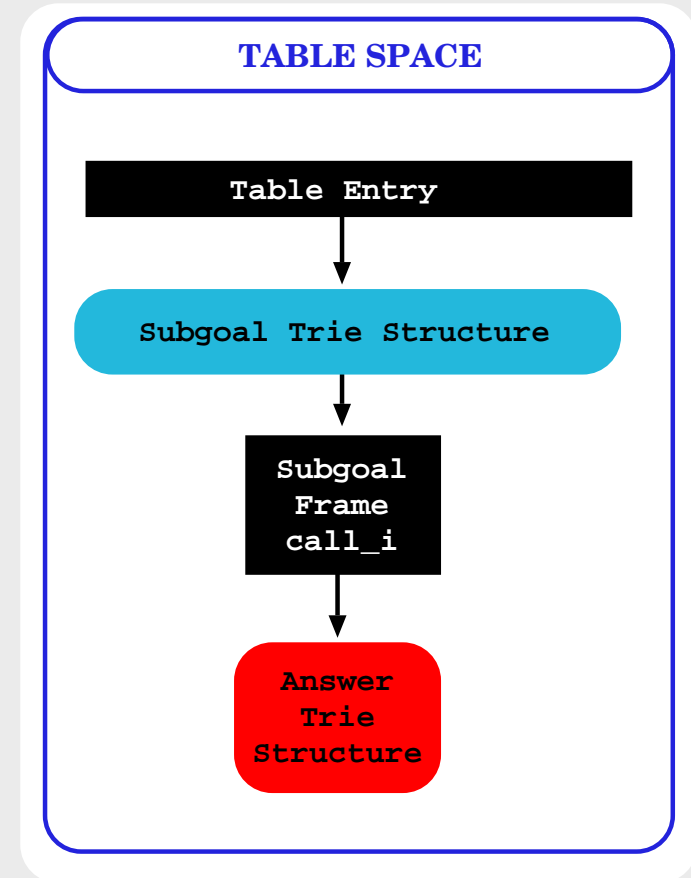
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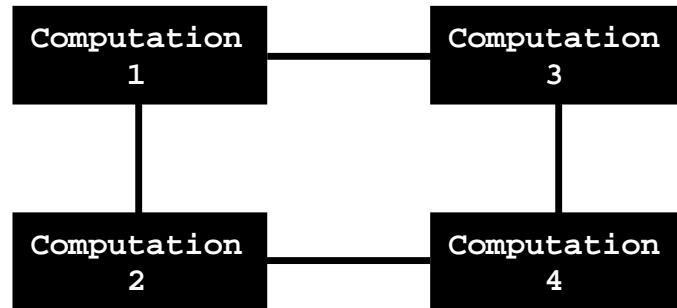
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- **Answer Trie Structure**: stores the **answers** of the computations.
 - ◆ **predicate(computation_id, Answer)**.



Tabling Scheduling Strategies - Local vs Batched

LOCAL SCHEDULING

Cluster of Dependent Computations



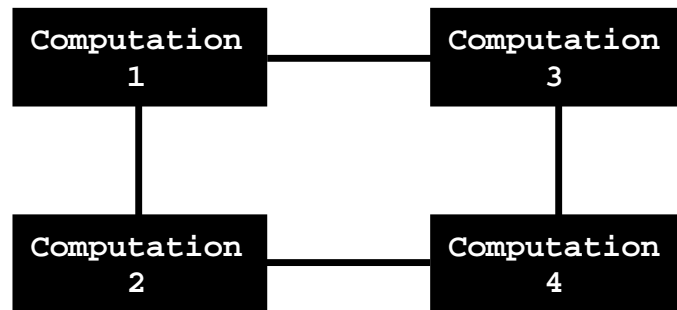
Answer
Propagation

After All Answers Found

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LOCAL SCHEDULING

Cluster of Dependent Computations

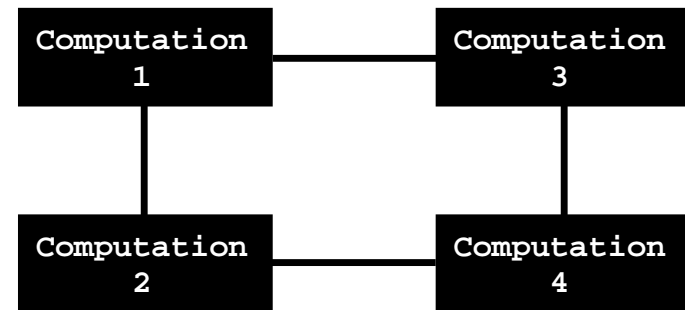


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BATCHED SCHEDULING

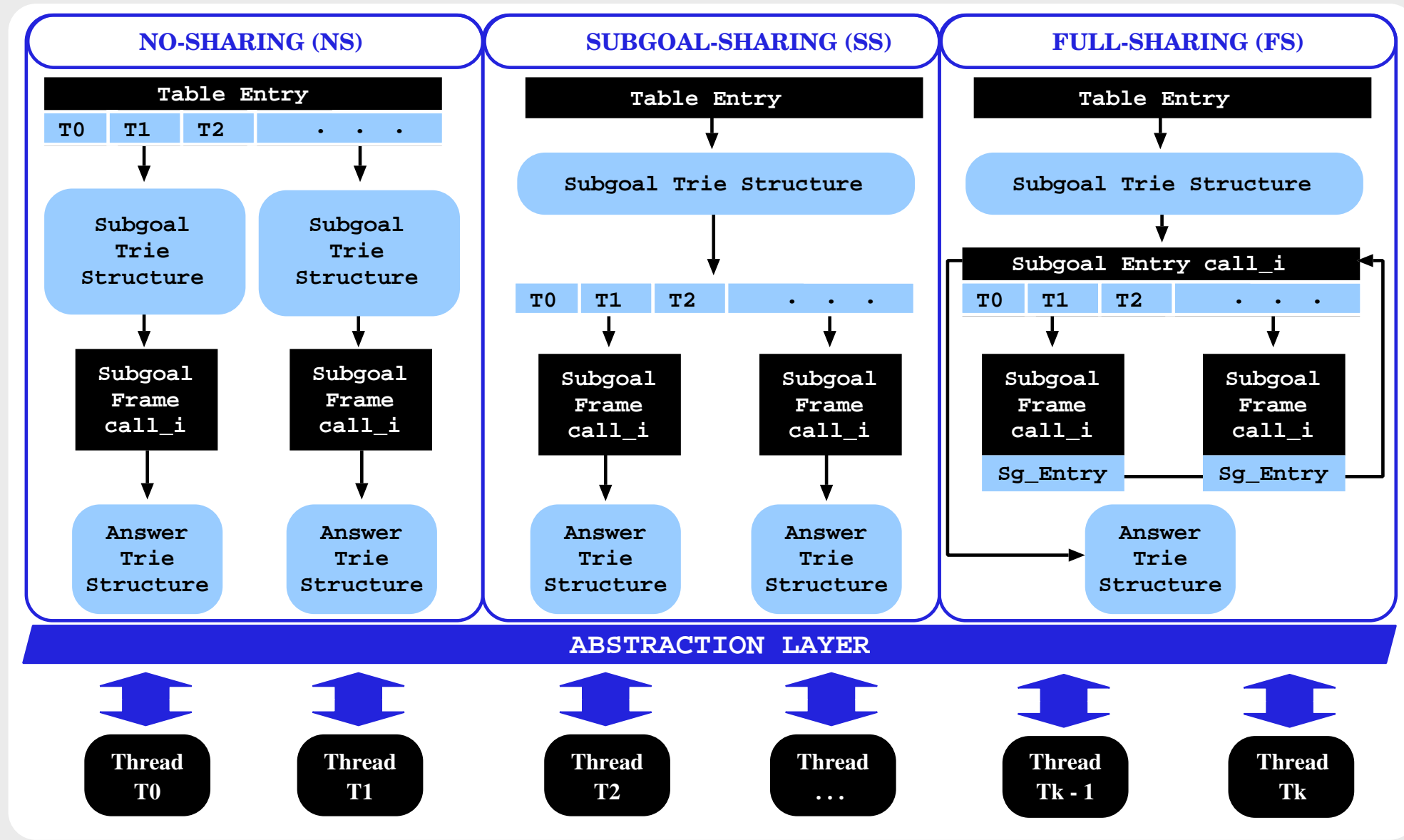
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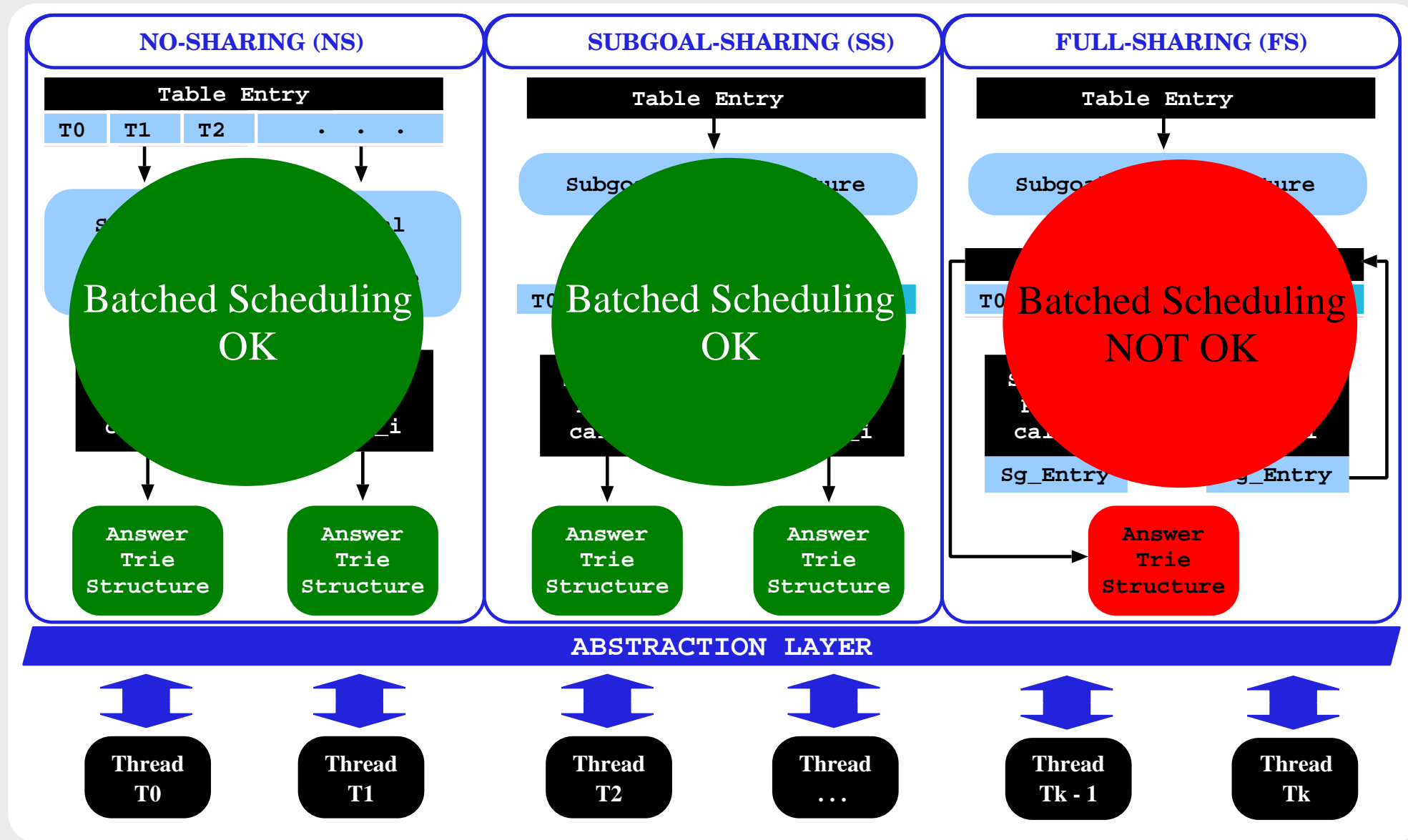
Answer
Propagation

Whenever a New Answer is Found

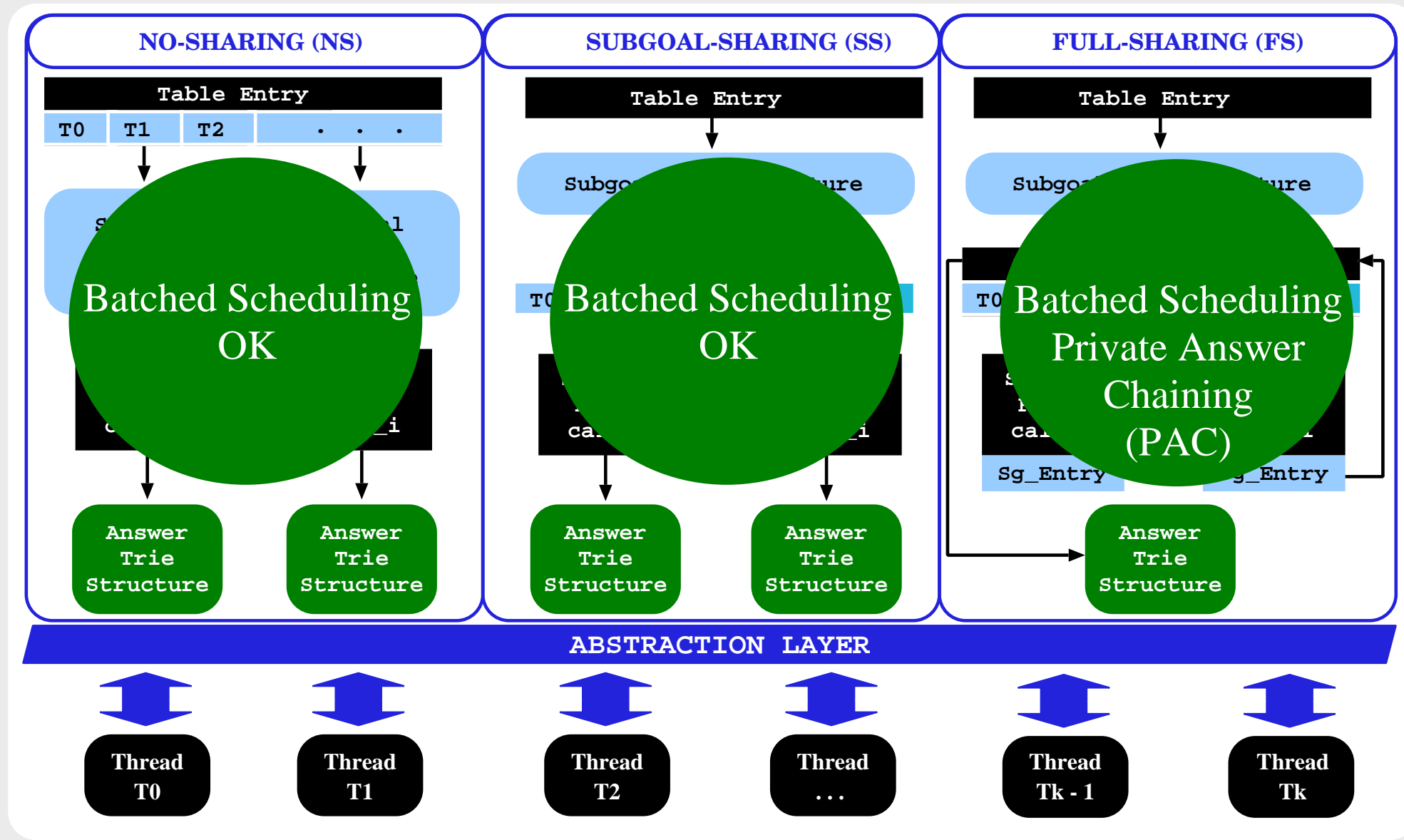
YapTab-Mt - Internal Architecture



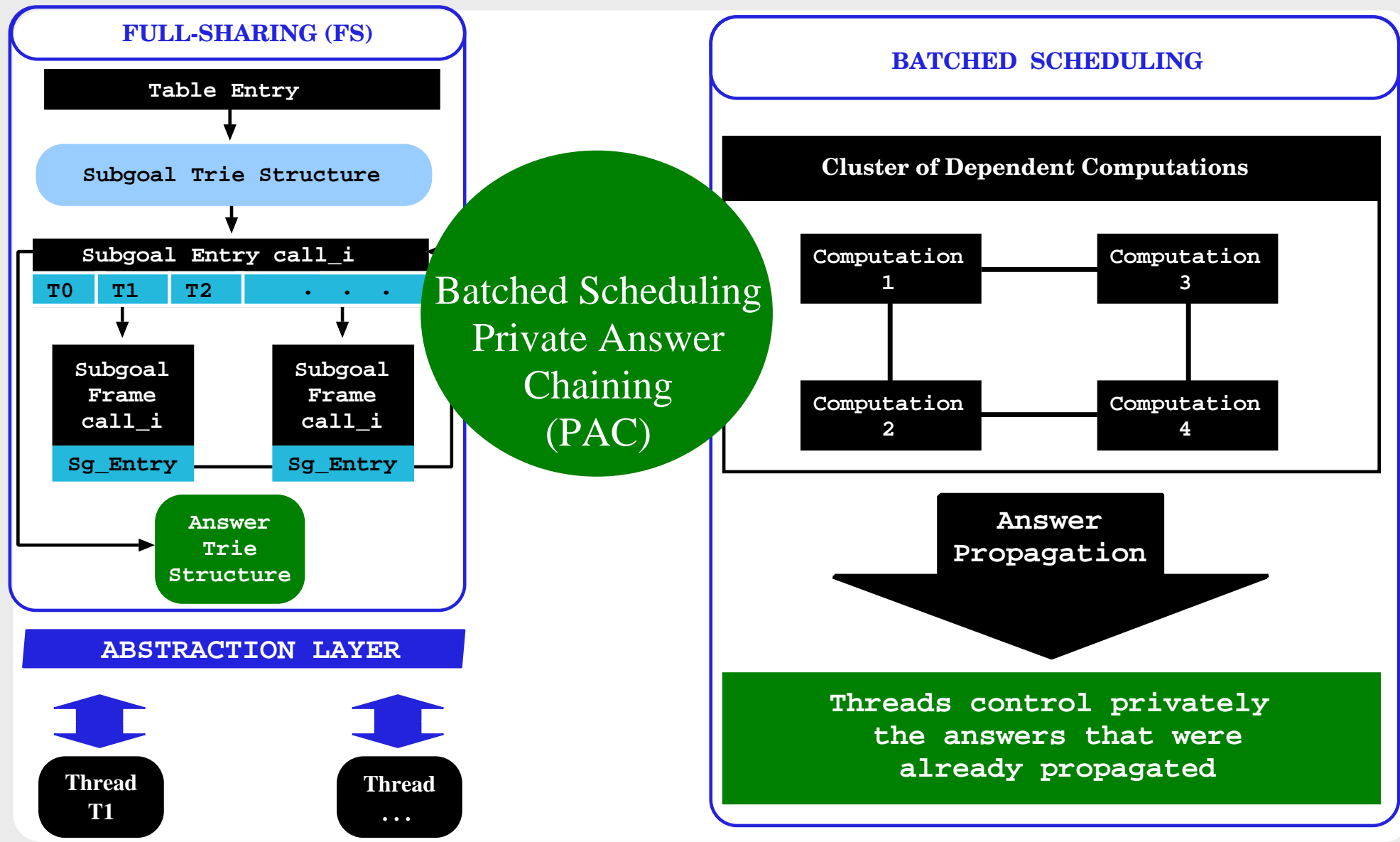
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Private Answer Chaining - Key Idea



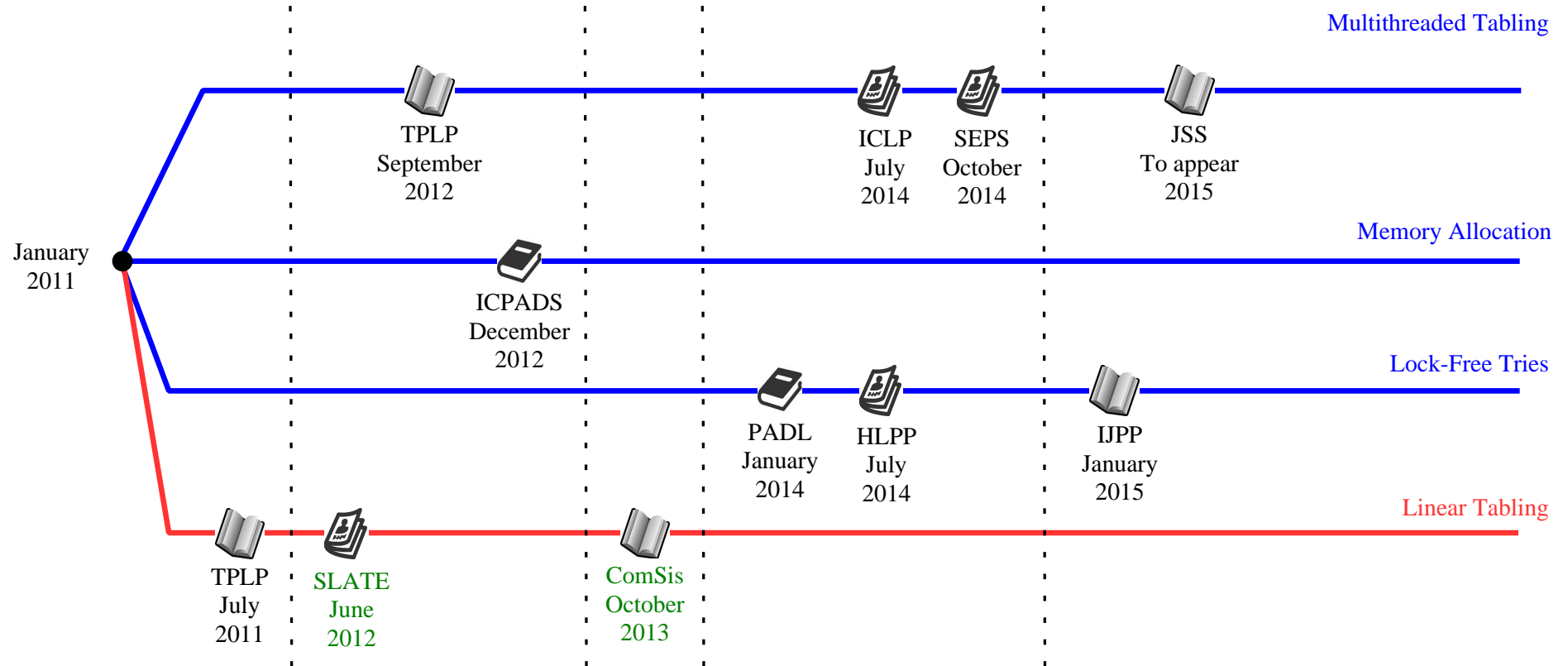
Private Answer Chaining - Internals

Experimental Results - Worst Case Scenarios

| Threads | | NS | | FS | |
|---------|-----|-------|---------|-------|---------|
| | | Local | Batched | Local | Batched |
| 1 | Min | 0.53 | 0.55 | 1.01 | 0.95 |
| | Avg | 0.78 | 0.82 | 1.30 | 1.46 |
| | Max | 1.06 | 1.05 | 1.76 | 2.33 |
| 8 | Min | 0.66 | 0.63 | 1.16 | 0.99 |
| | Avg | 0.85 | 0.88 | 1.88 | 1.95 |
| | Max | 1.12 | 1.14 | 2.82 | 3.49 |
| 16 | Min | 0.85 | 0.75 | 1.17 | 1.06 |
| | Avg | 0.98 | 1.00 | 1.97 | 2.08 |
| | Max | 1.16 | 1.31 | 3.14 | 3.69 |
| 24 | Min | 0.91 | 0.93 | 1.16 | 1.09 |
| | Avg | 1.15 | 1.16 | 2.06 | 2.19 |
| | Max | 1.72 | 1.60 | 3.49 | 4.08 |
| 32 | Min | 1.05 | 1.04 | 1.33 | 1.26 |
| | Avg | 1.51 | 1.49 | 2.24 | 2.41 |
| | Max | 2.52 | 2.63 | 3.71 | 4.51 |

Conclusions and Further Work

Research Outline



Work related:



3 Journals



2 Book Series



3 Workshop Proceedings

Others:



2 Journals

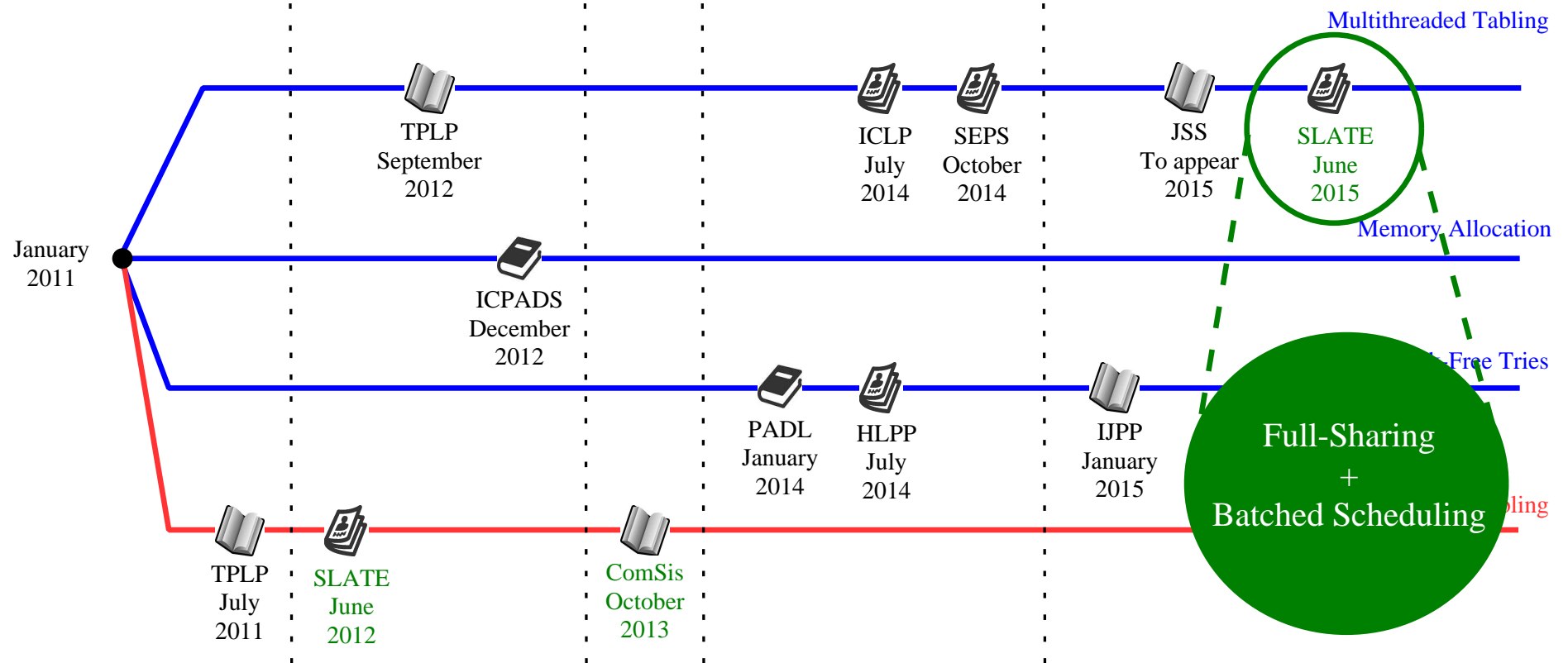


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Thank You !!!