Decentralised Configuration of Neighbouring Cells for Radio Access Networks

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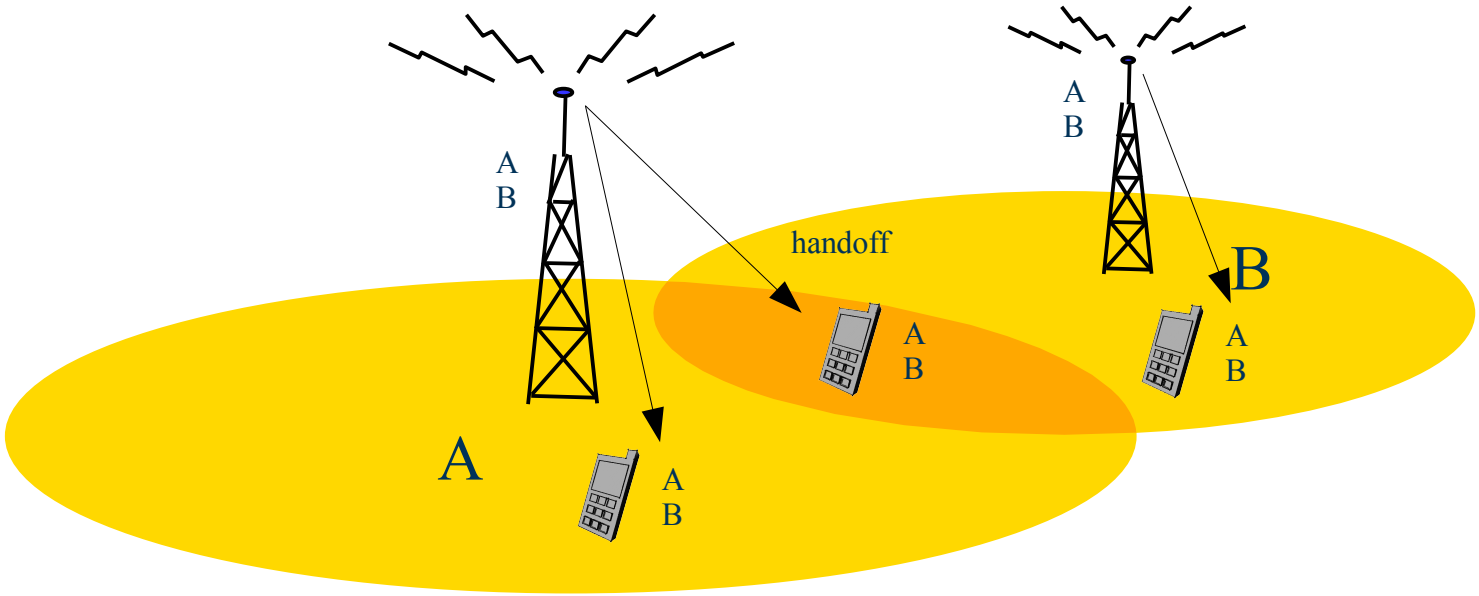
Neighbouring Cells



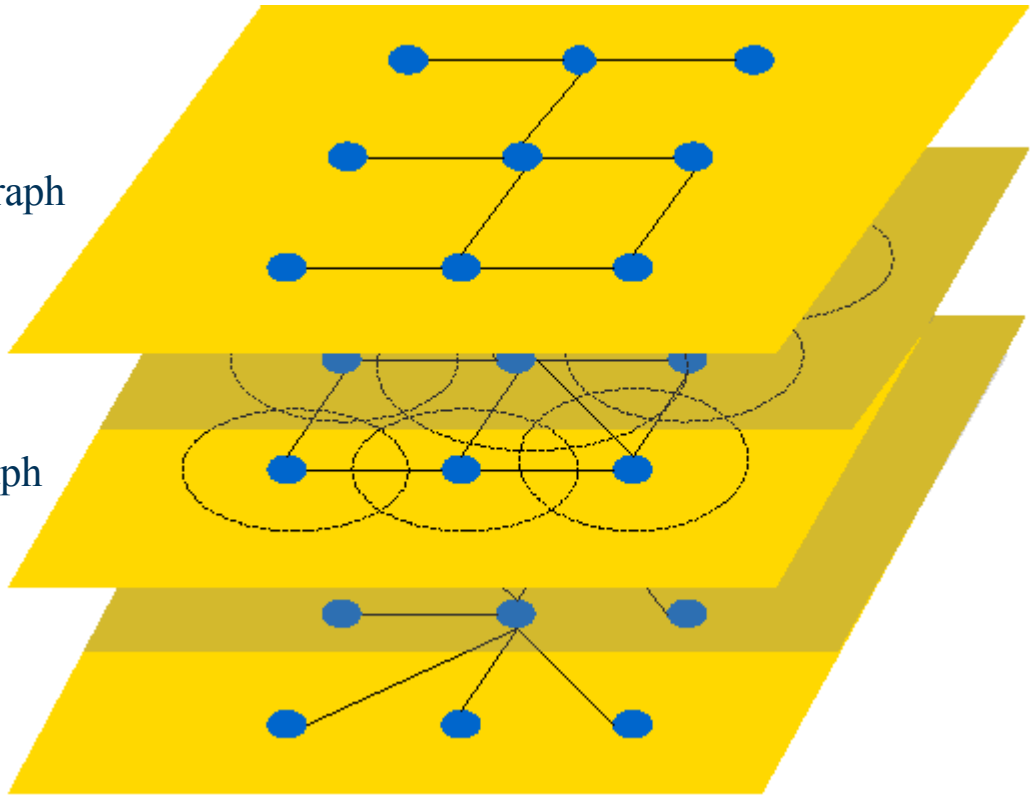
- List of neighbouring cells enable both the intra- and inter-system handover processes.
- Today they are an output of the network planning process.
- This is a problem in front of unexpected events or failures.
- In LTE they will be probably in the RBS.

Three Layers Framework

Neighbouring Cells Graph

Overlapping Cells Graph

Management Overlay



Three Layers Framework

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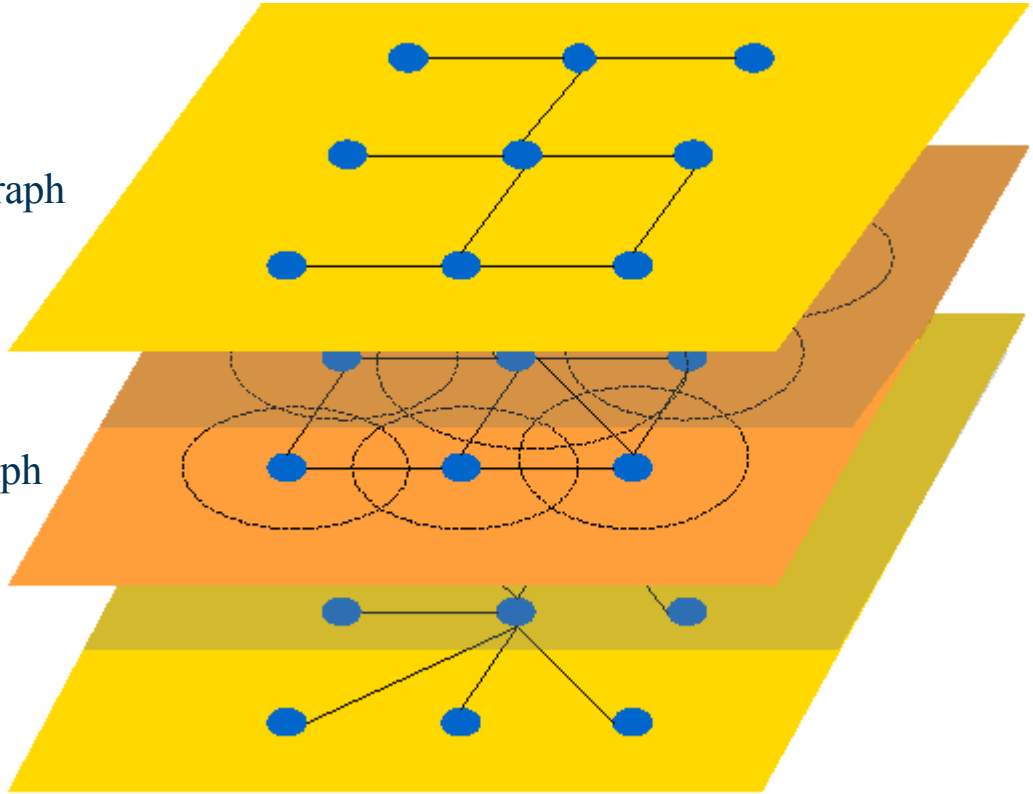
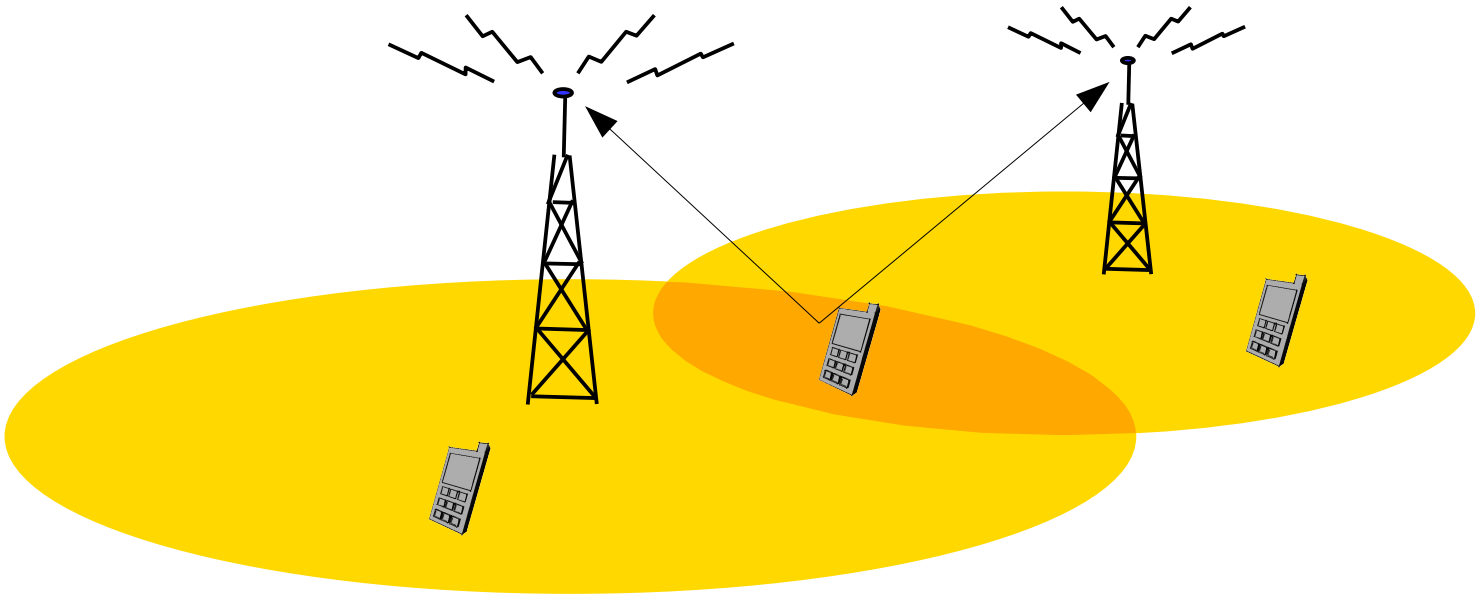
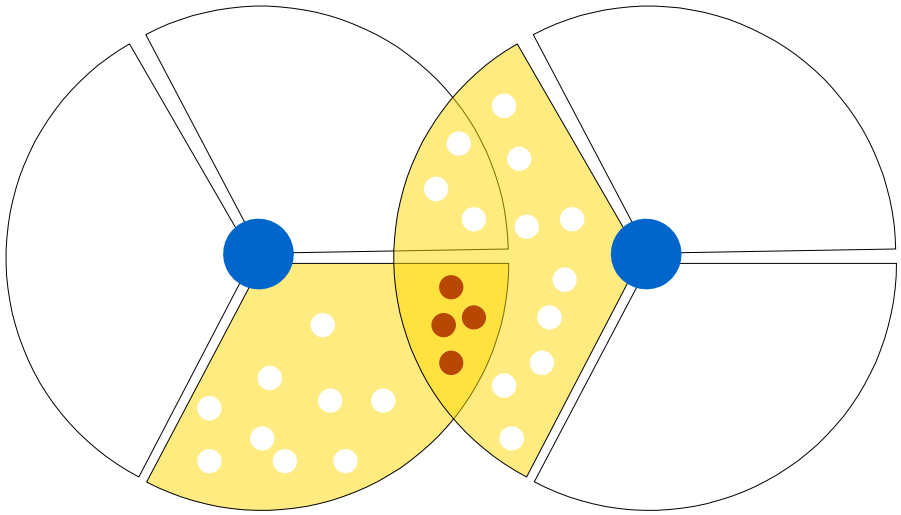


Protocol for Discovery of Overlapping Cells

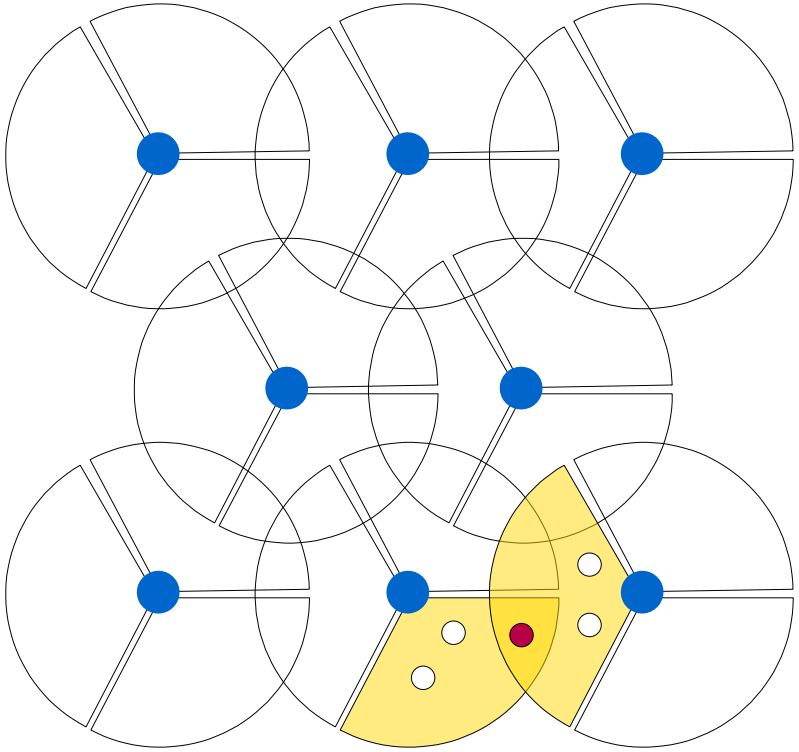


Overlapping Cells Definition



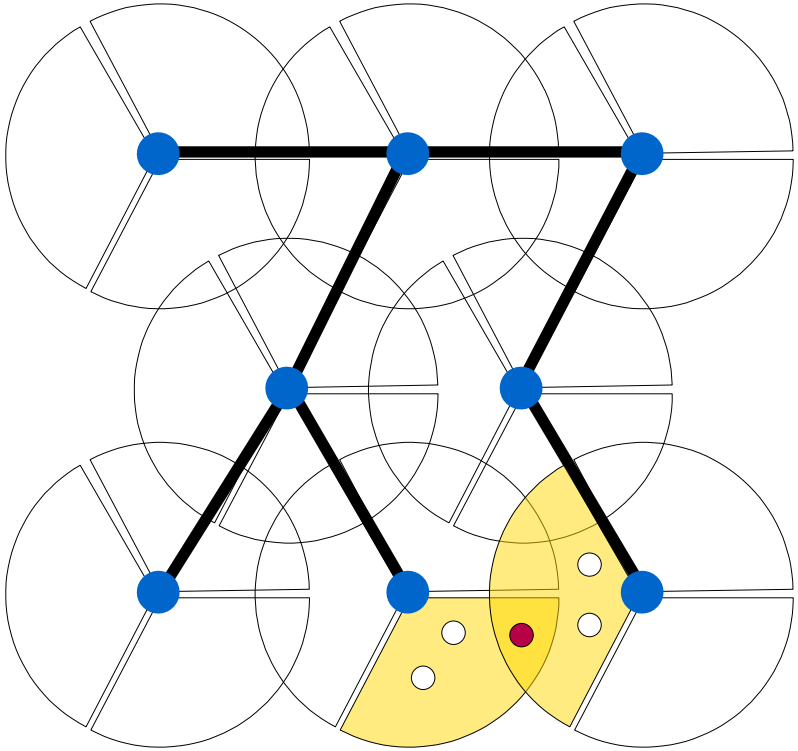
$$Overlap_{ij}(t) = \begin{cases} 1, & if\ |U_i(t) \cap U_j(t)| > H, H \in \mathbb{N} \\ 0, & else \end{cases}$$

Sharing Views



○ = UE
● = UE in an overlap

Sharing Views



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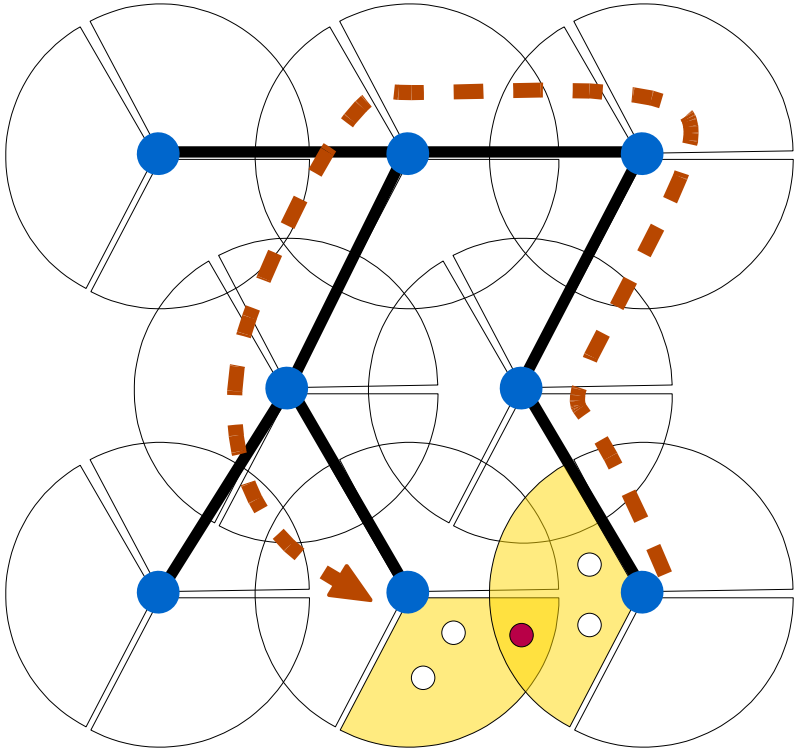
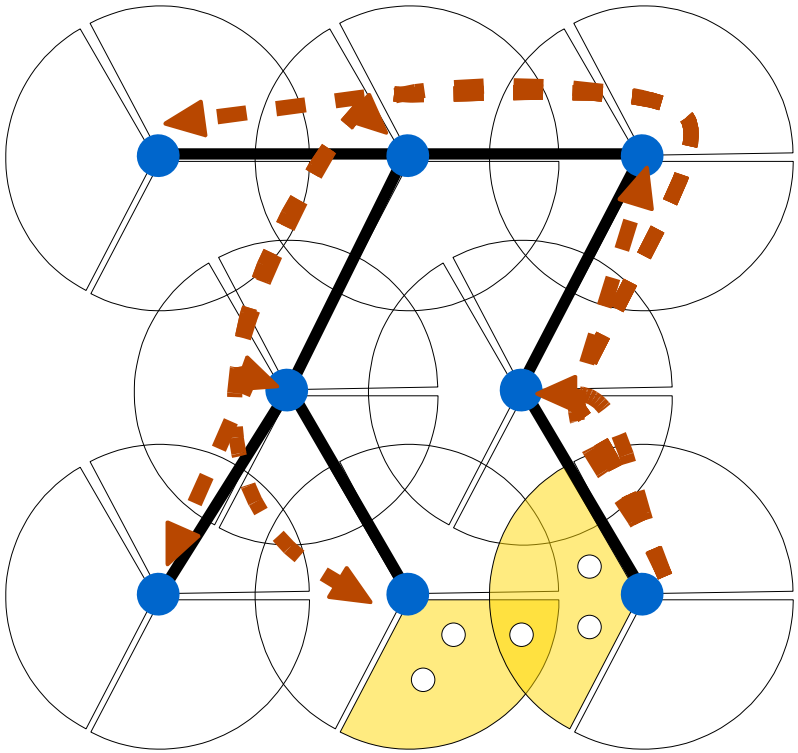
Sharing Views



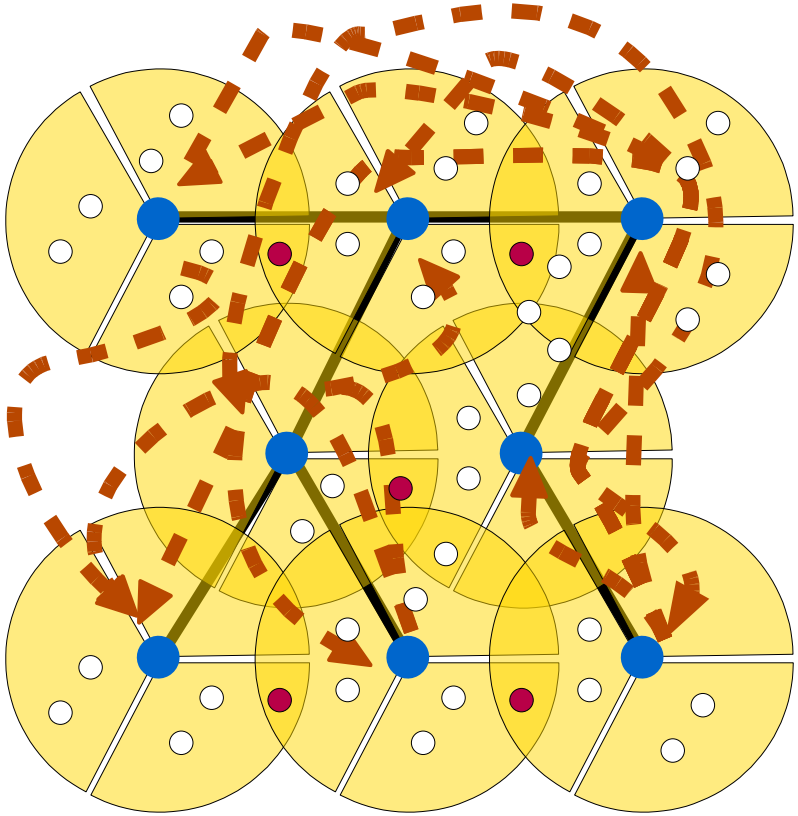
= UE
= UE in an overlap

Sharing Views



= UE
= UE in an overlap

Sharing Views



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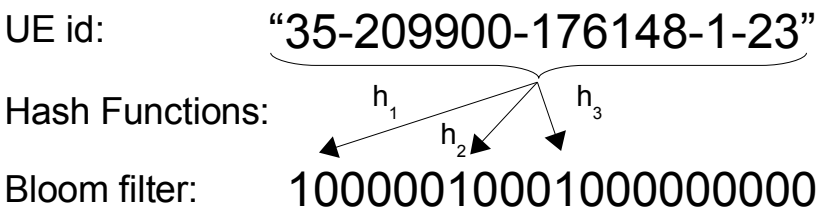
Bloom Filters
Probabilistic Set Summarization

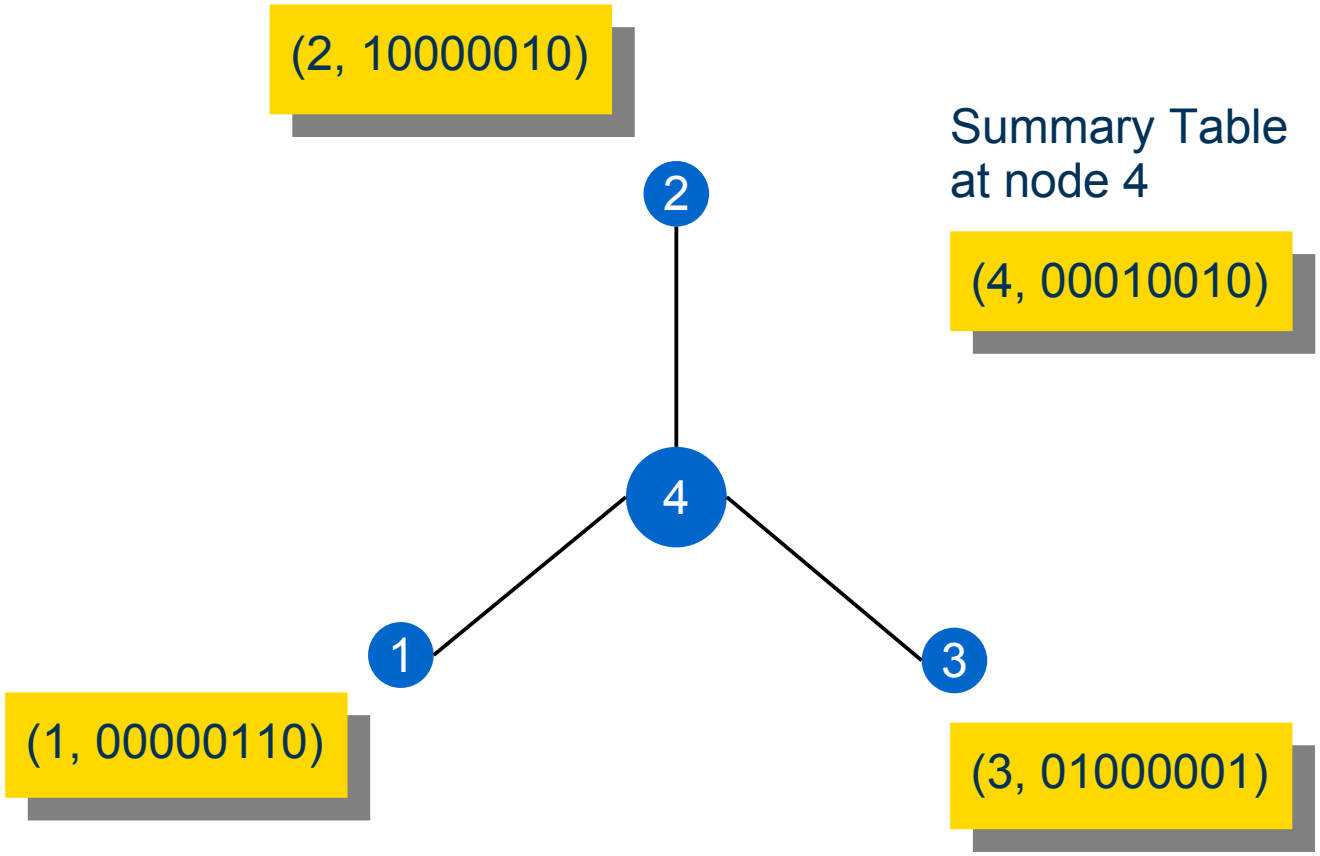


Bloom Filters
Probabilistic Set Summarization

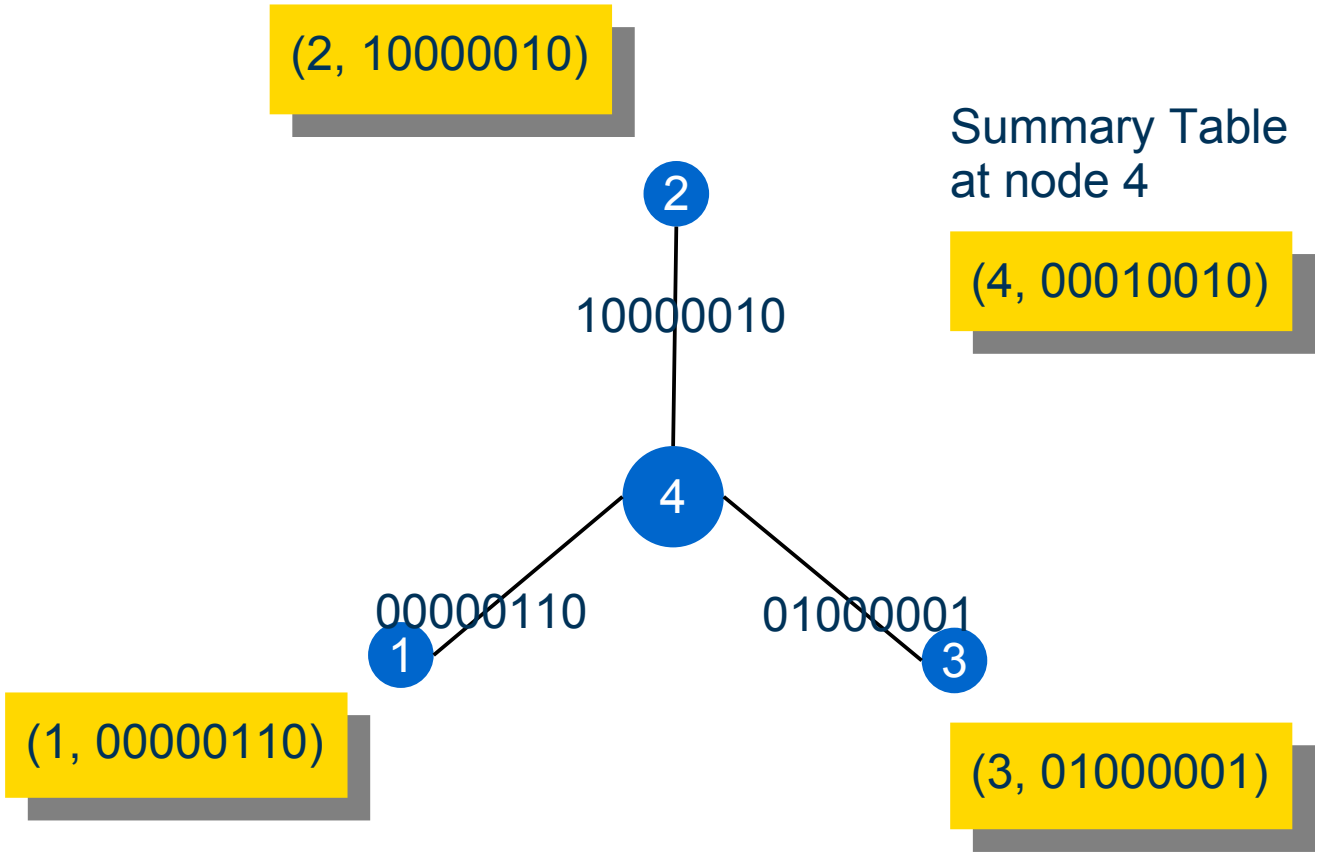
- BF are a compact and size-bounded way of representing sets.
- It is possible to tell for sure that an element is NOT in a BF.
- The opposite is not true. FALSE POSITIVES.
- The BF of an union is the OR of their respective BFs.
- Therefore, you can easily aggregate several sets into single BFs

bf(A)	10000010001000000000
bf(B)	00000010000010000001
bf(A U B) = bf(A) OR bf(B)	10000010001010000001

Aggregating Summaries



Aggregating Summaries



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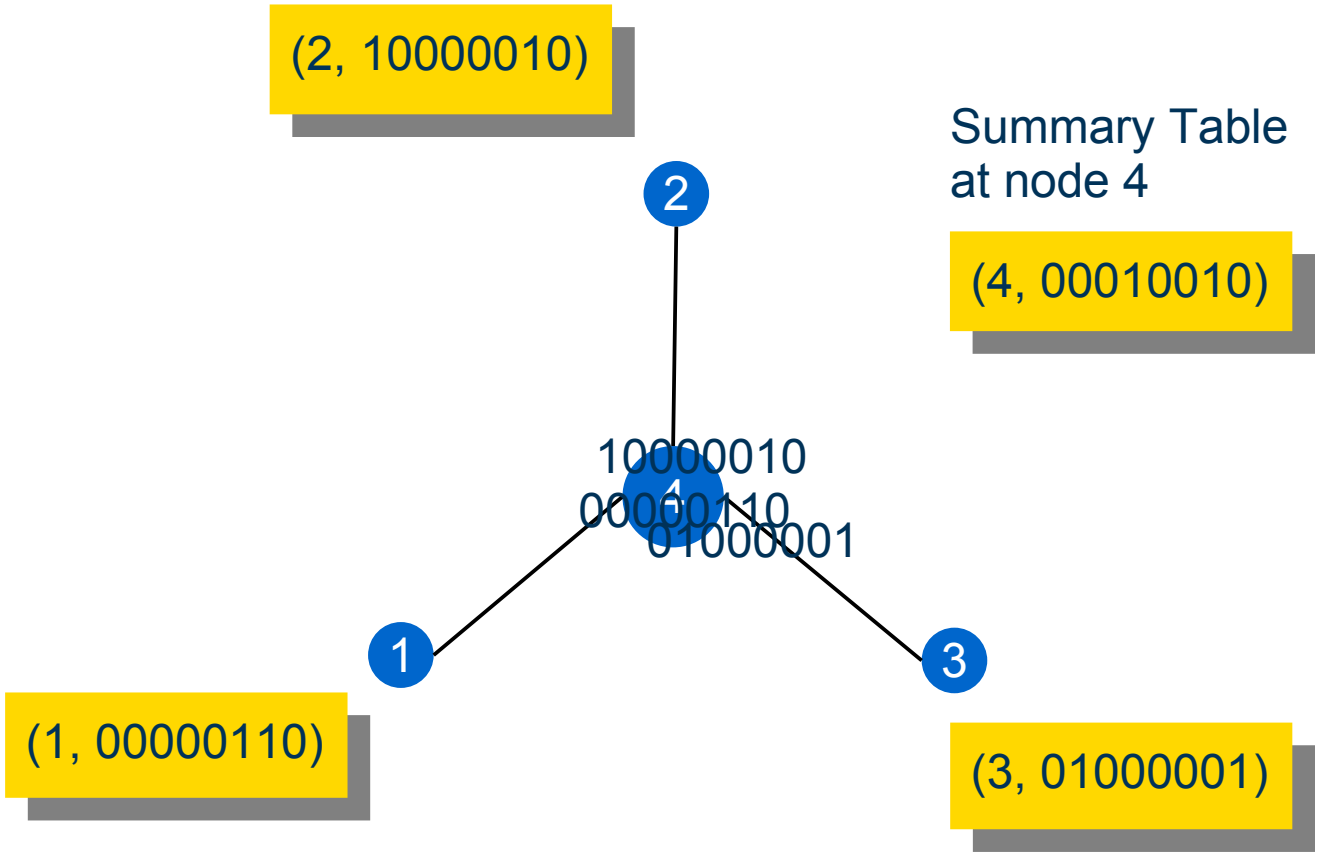

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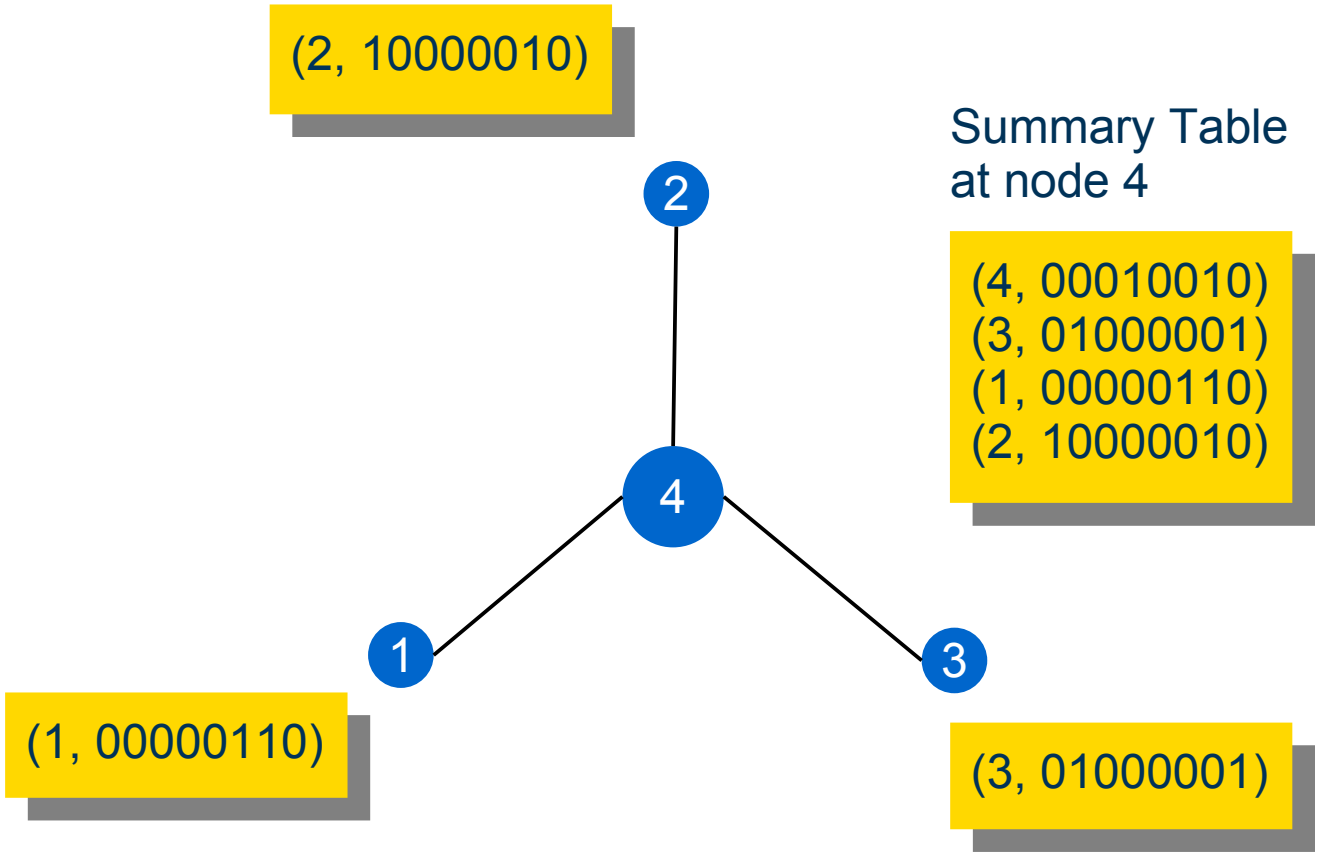

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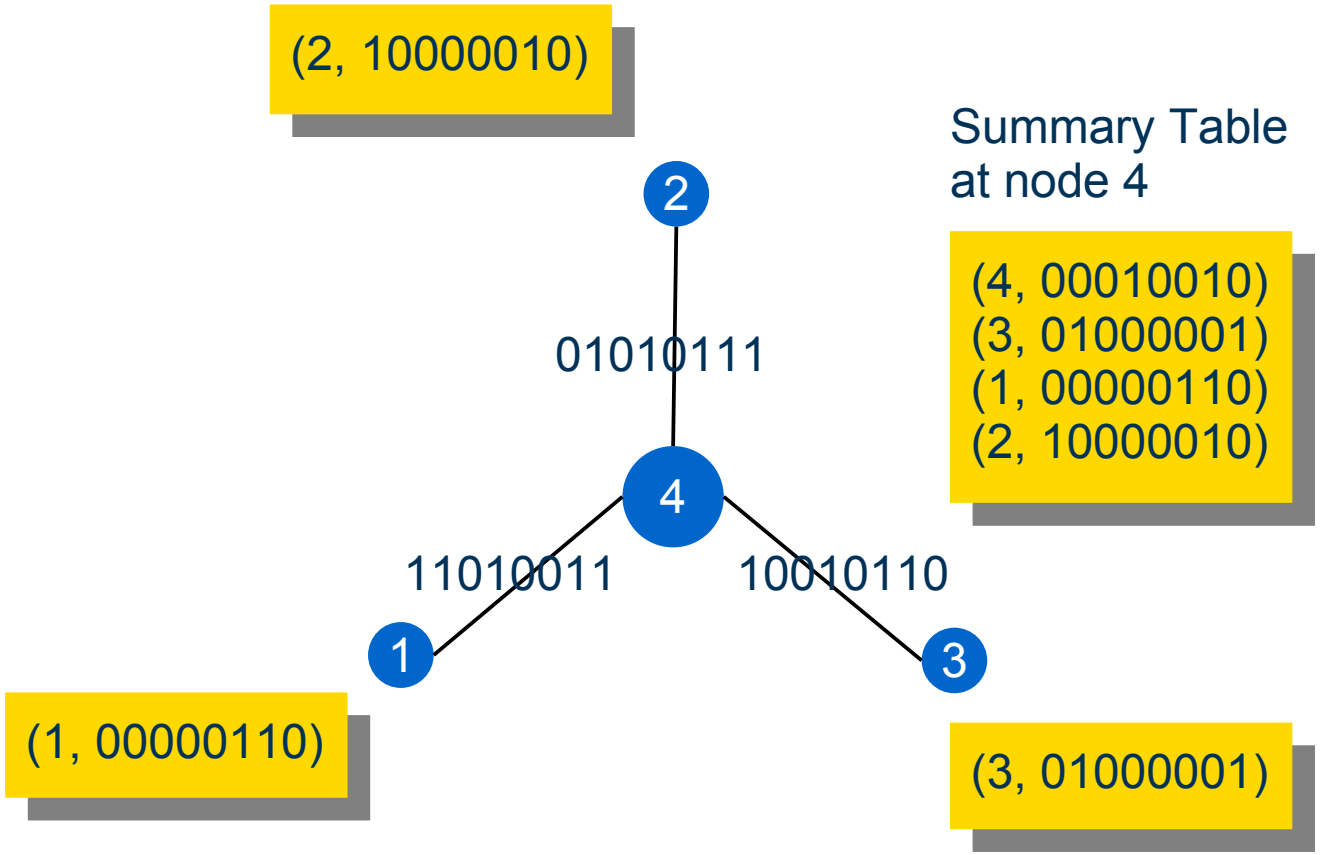

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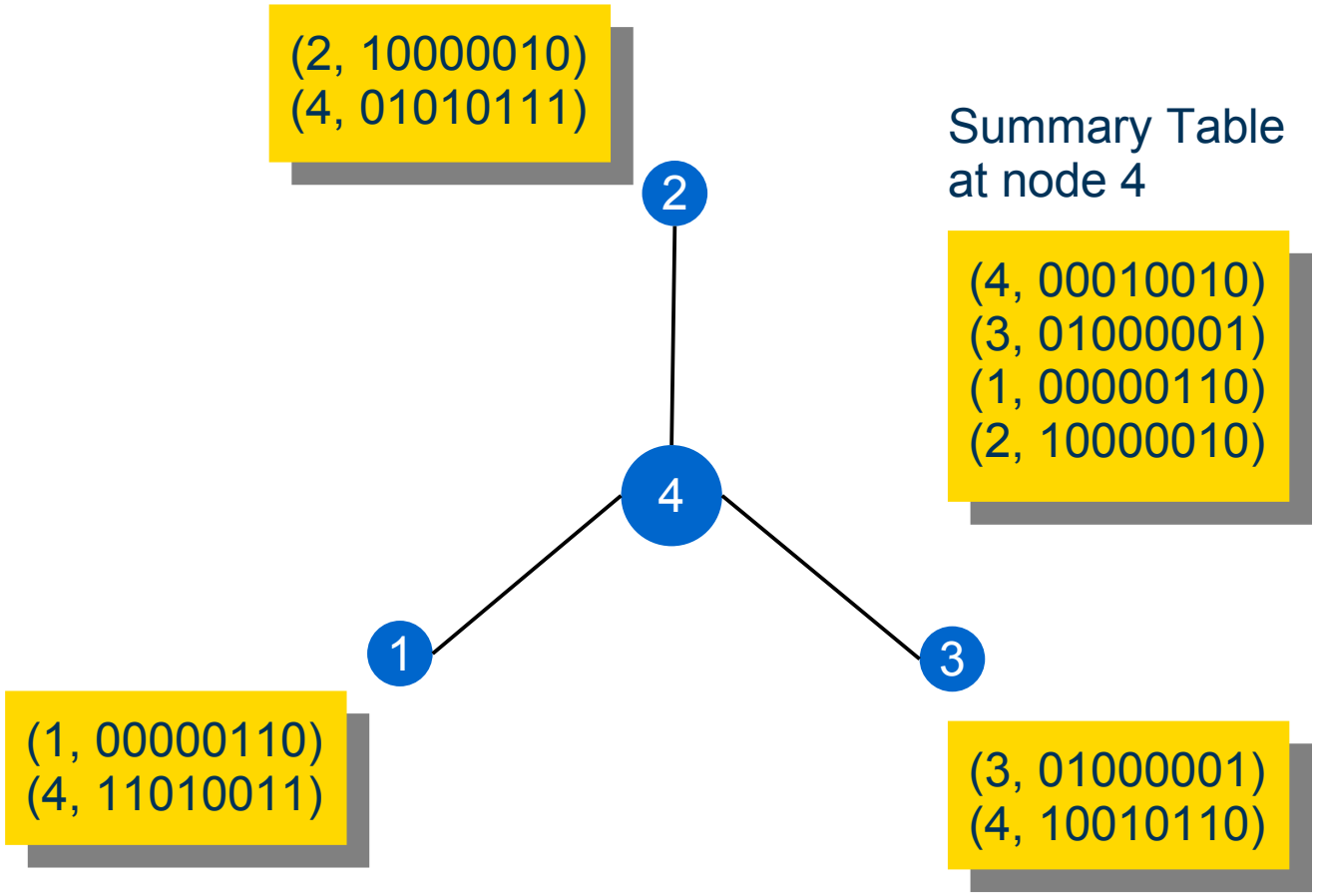

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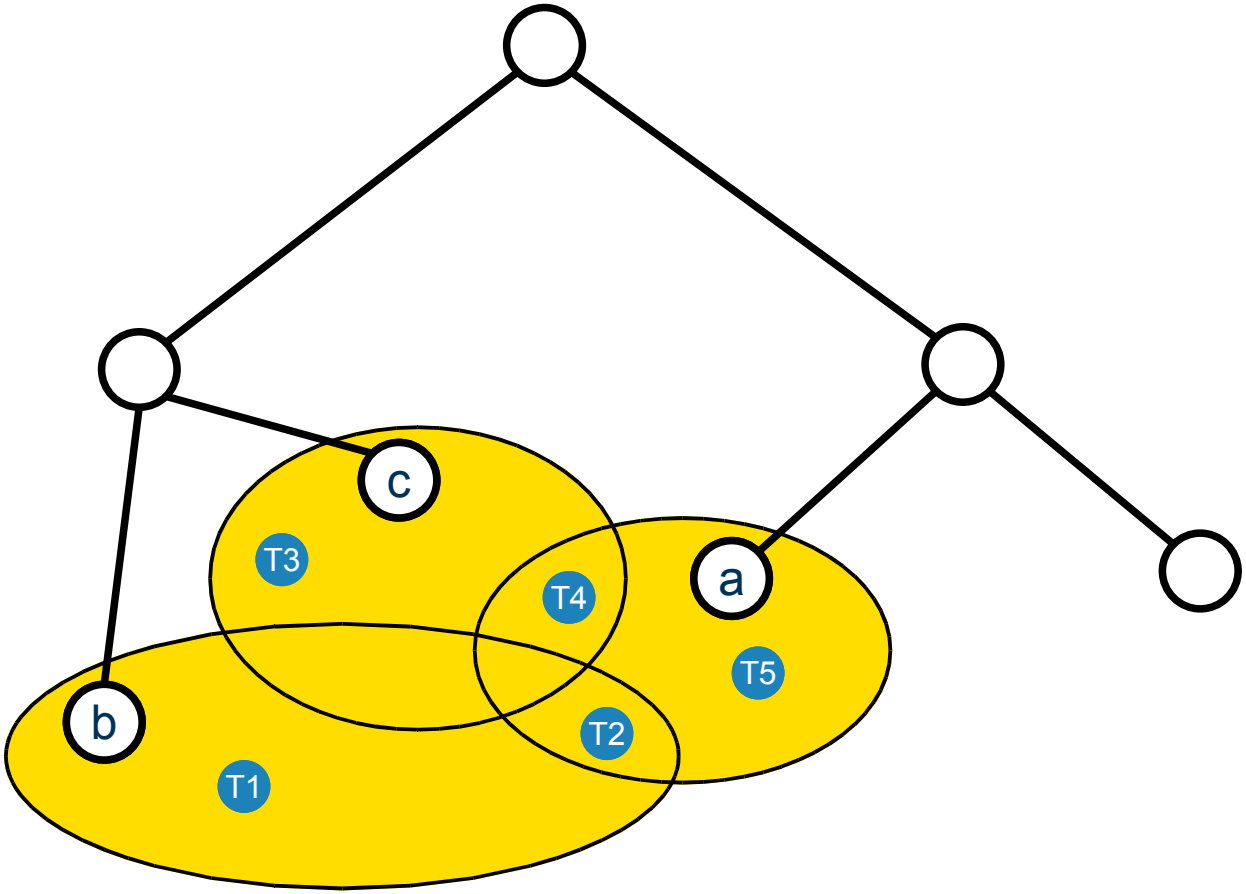

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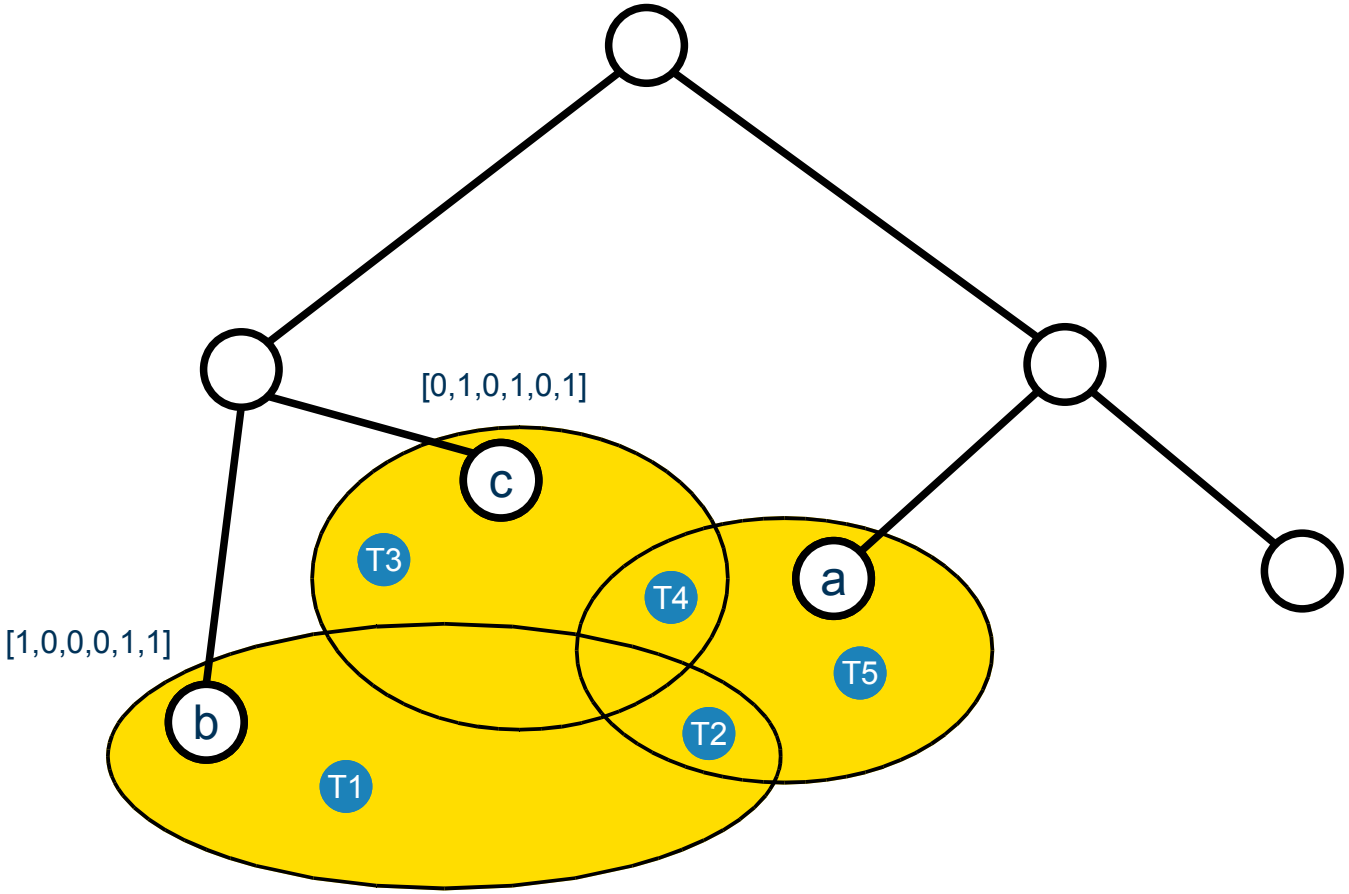

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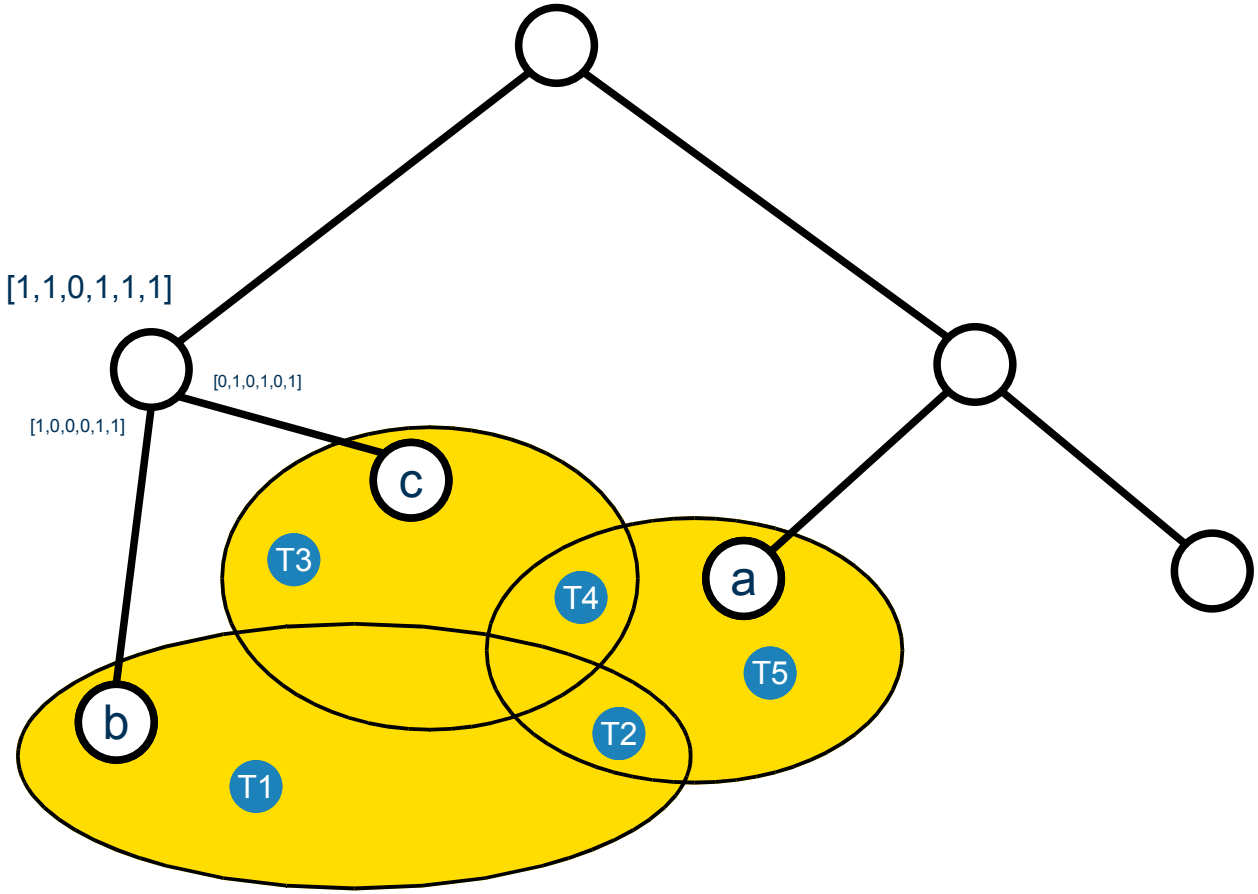

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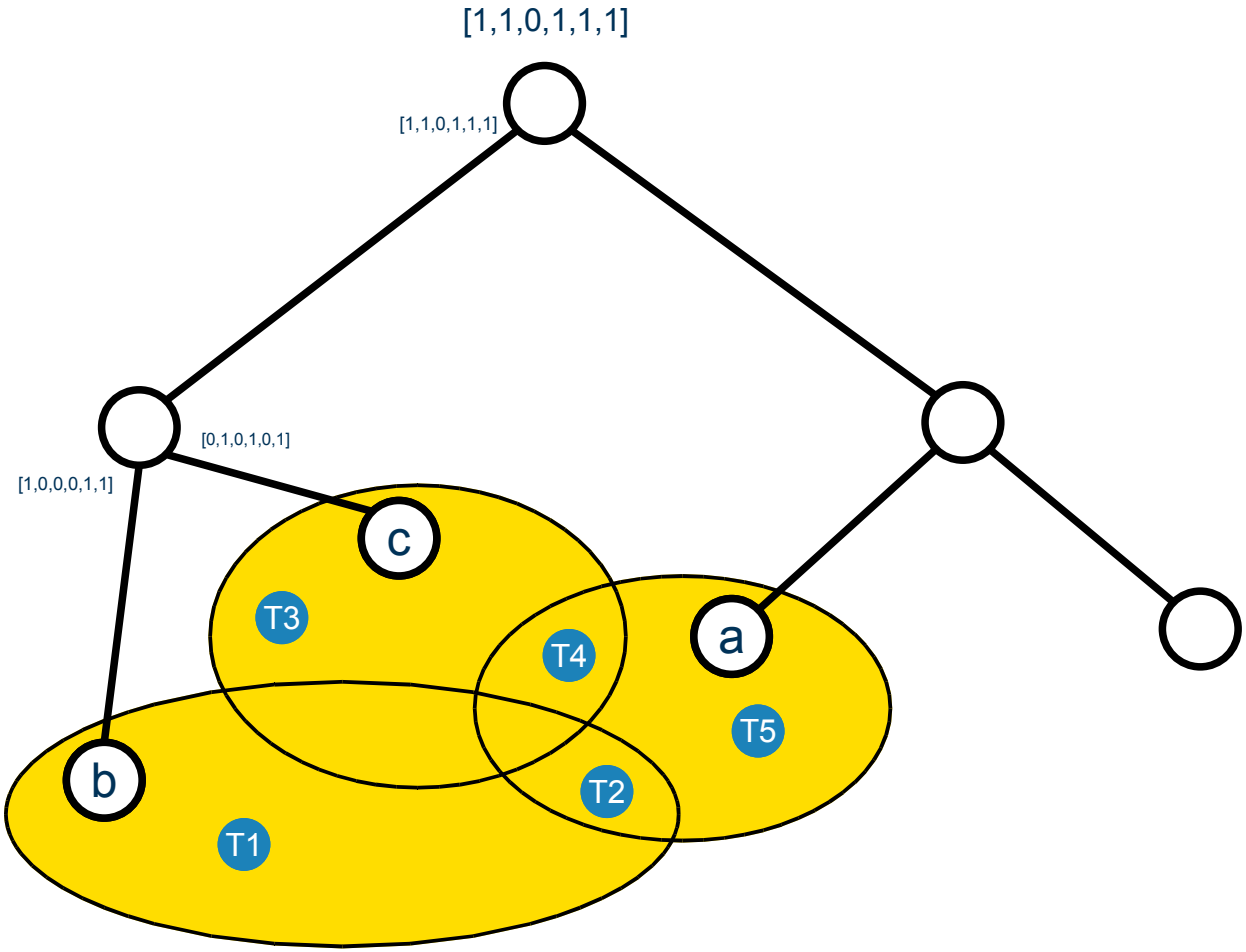

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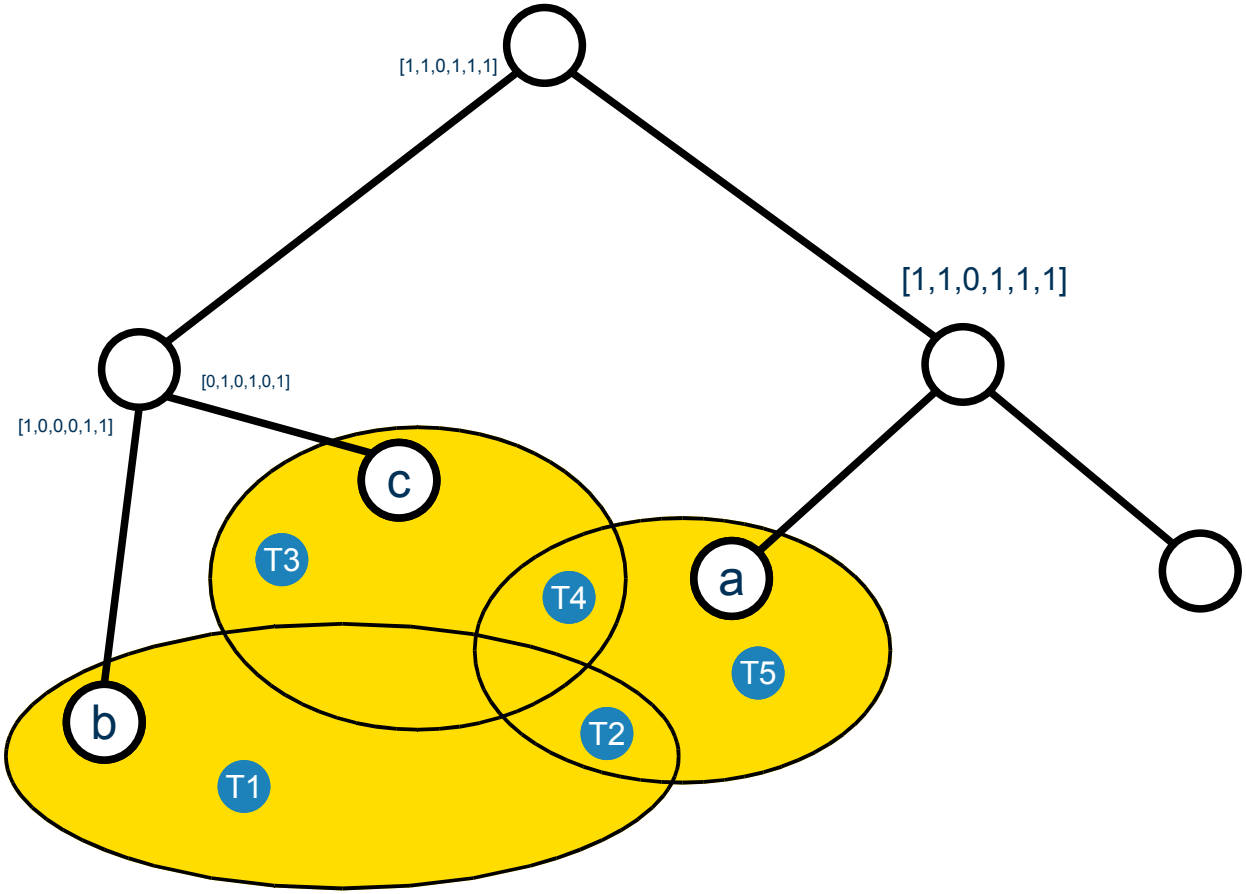

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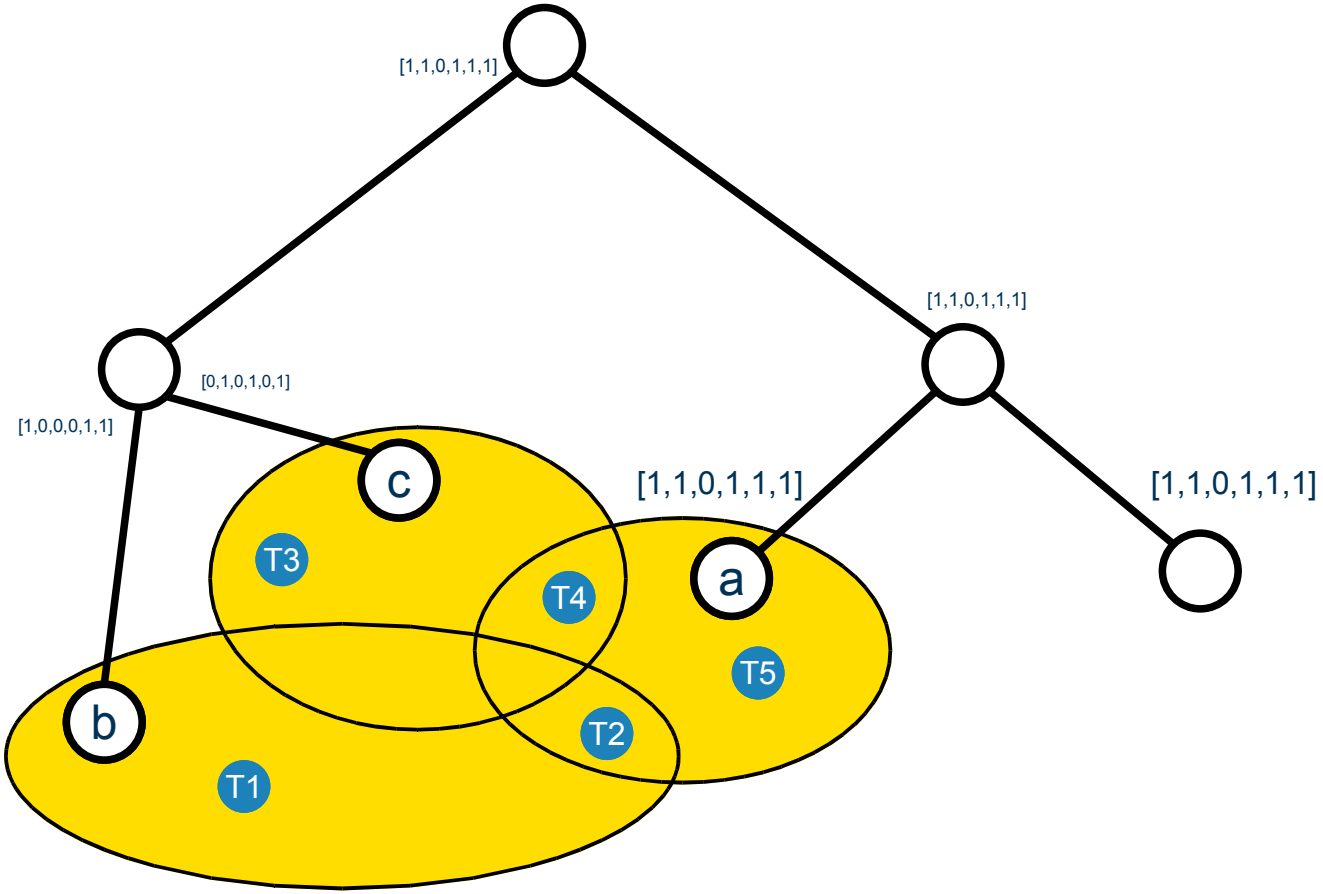

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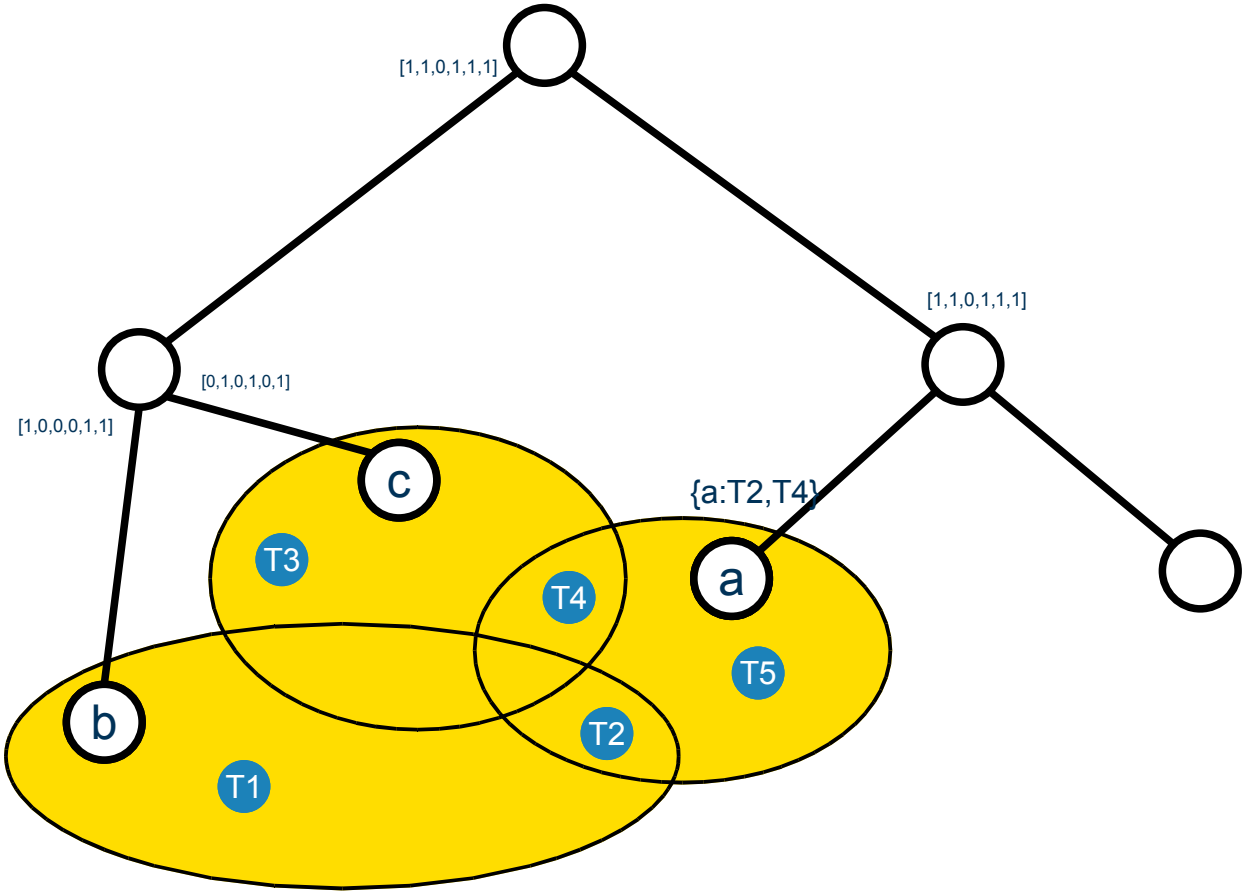

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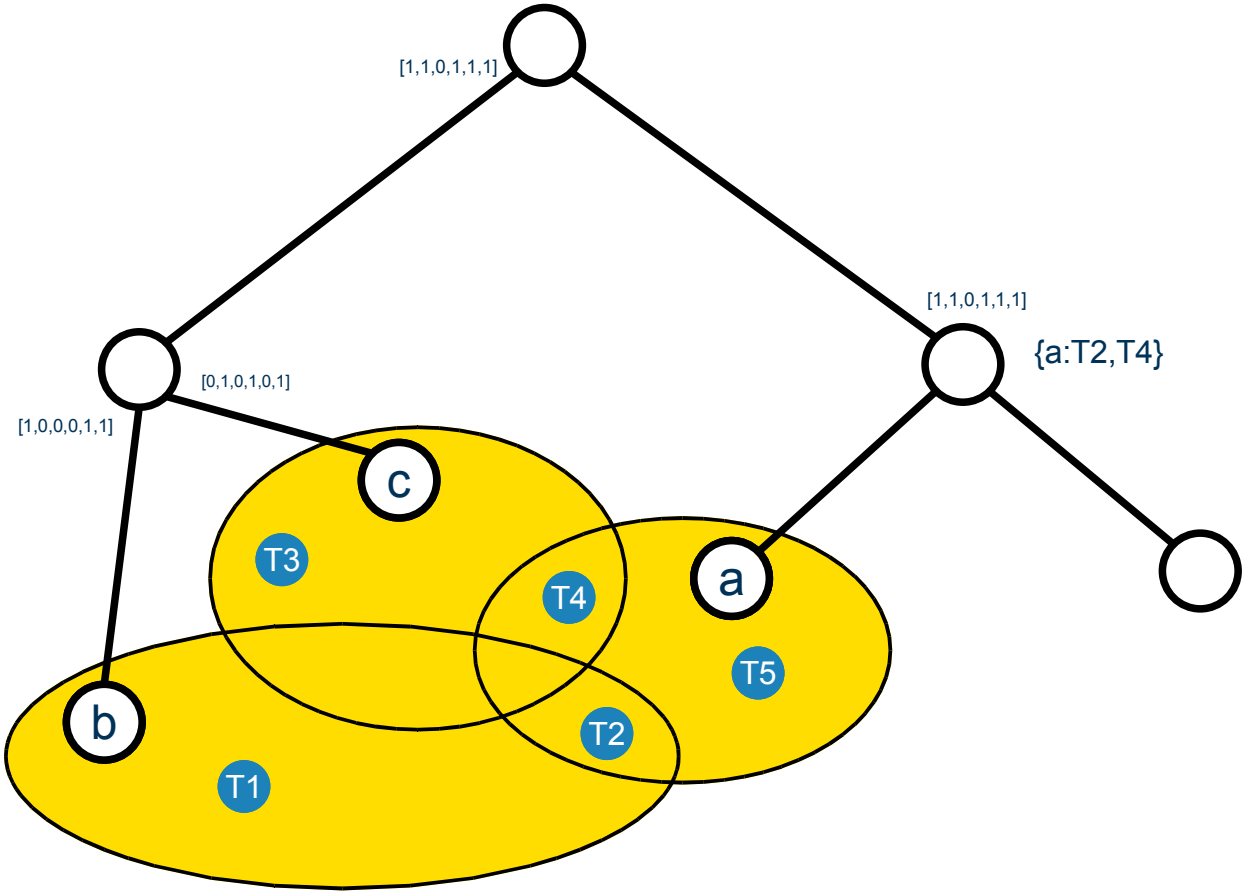

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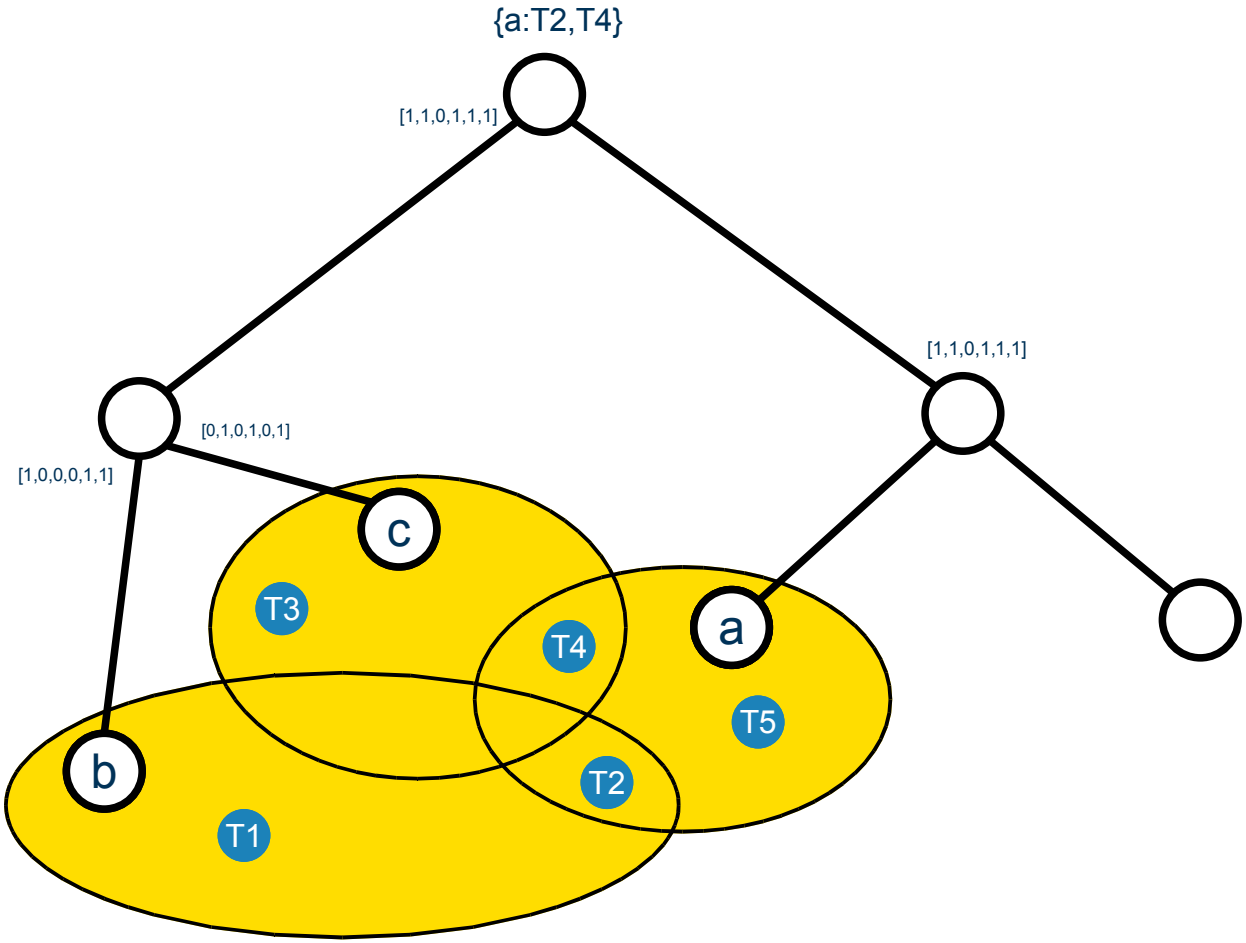

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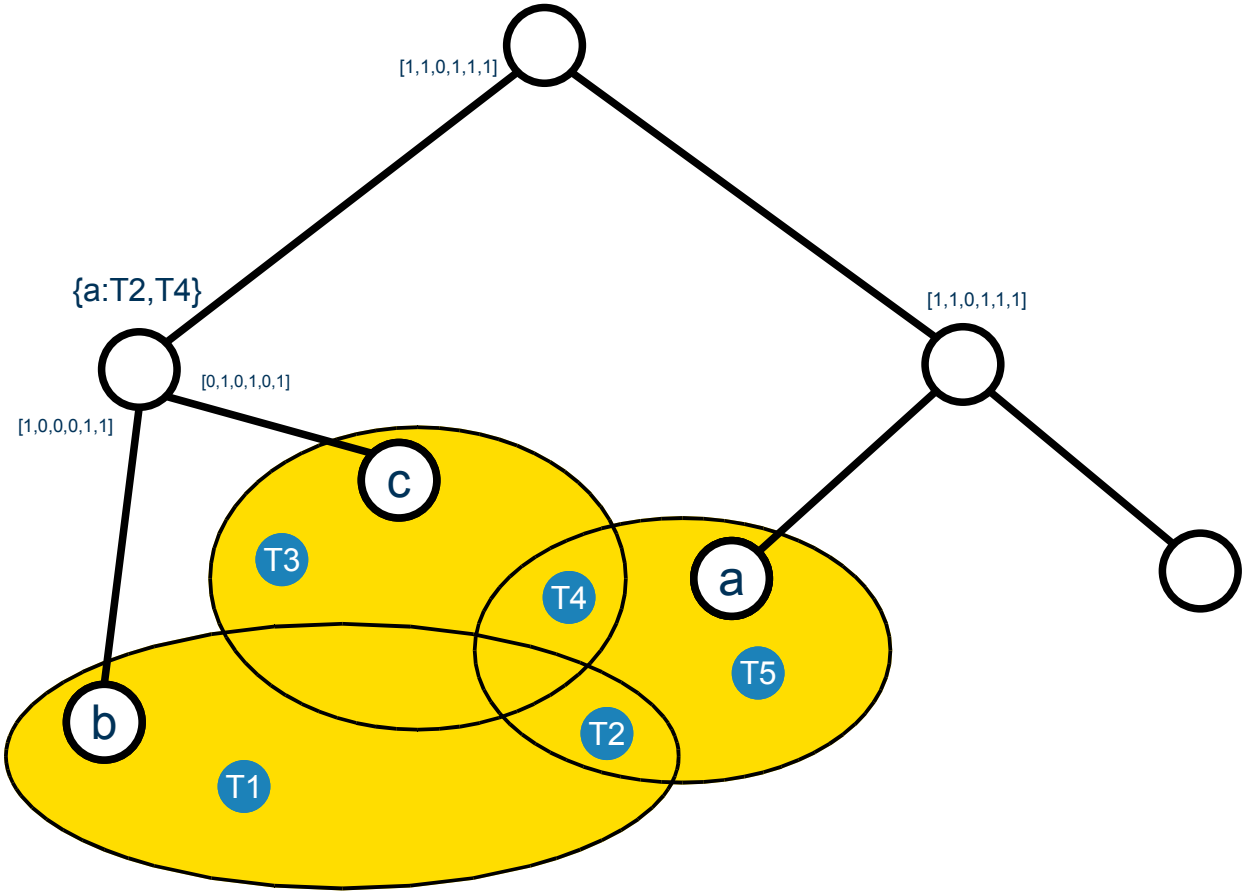

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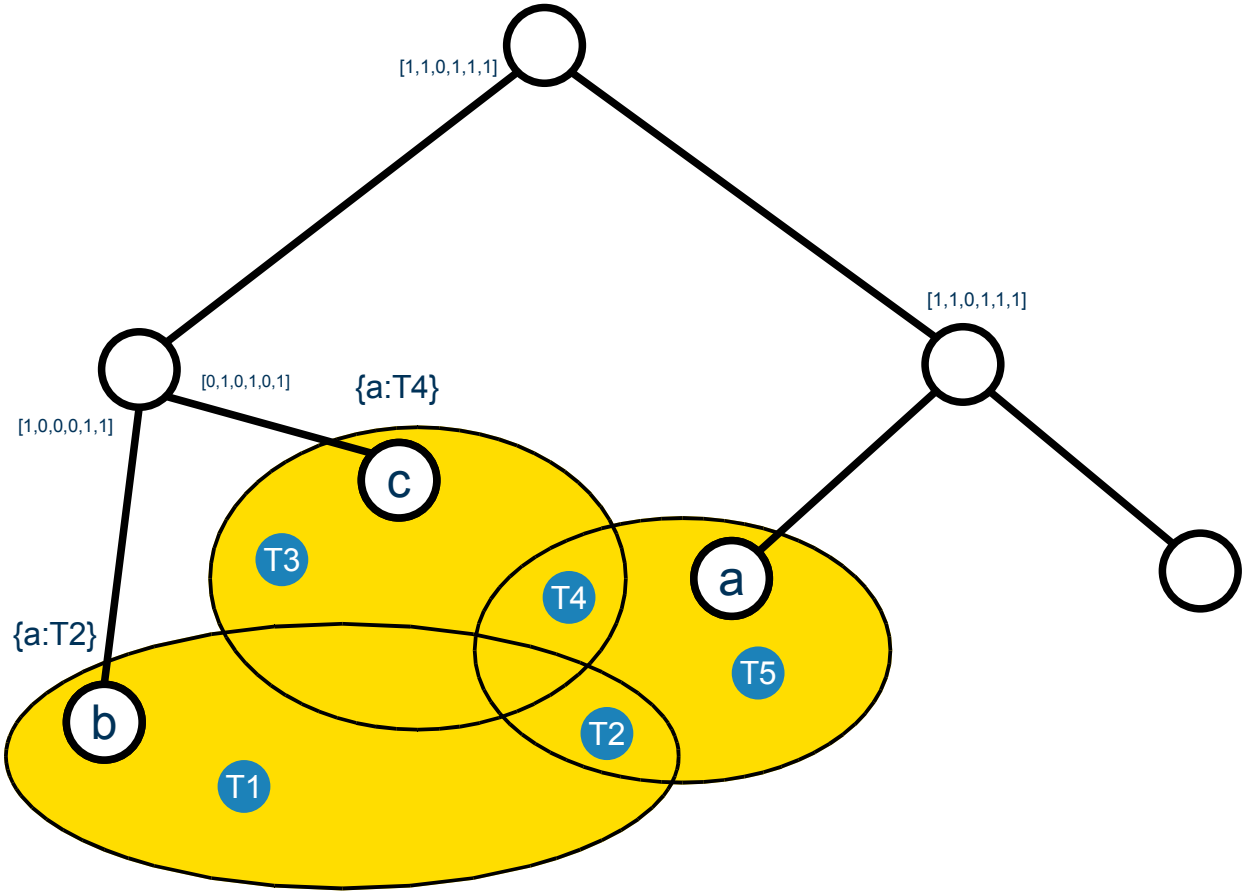

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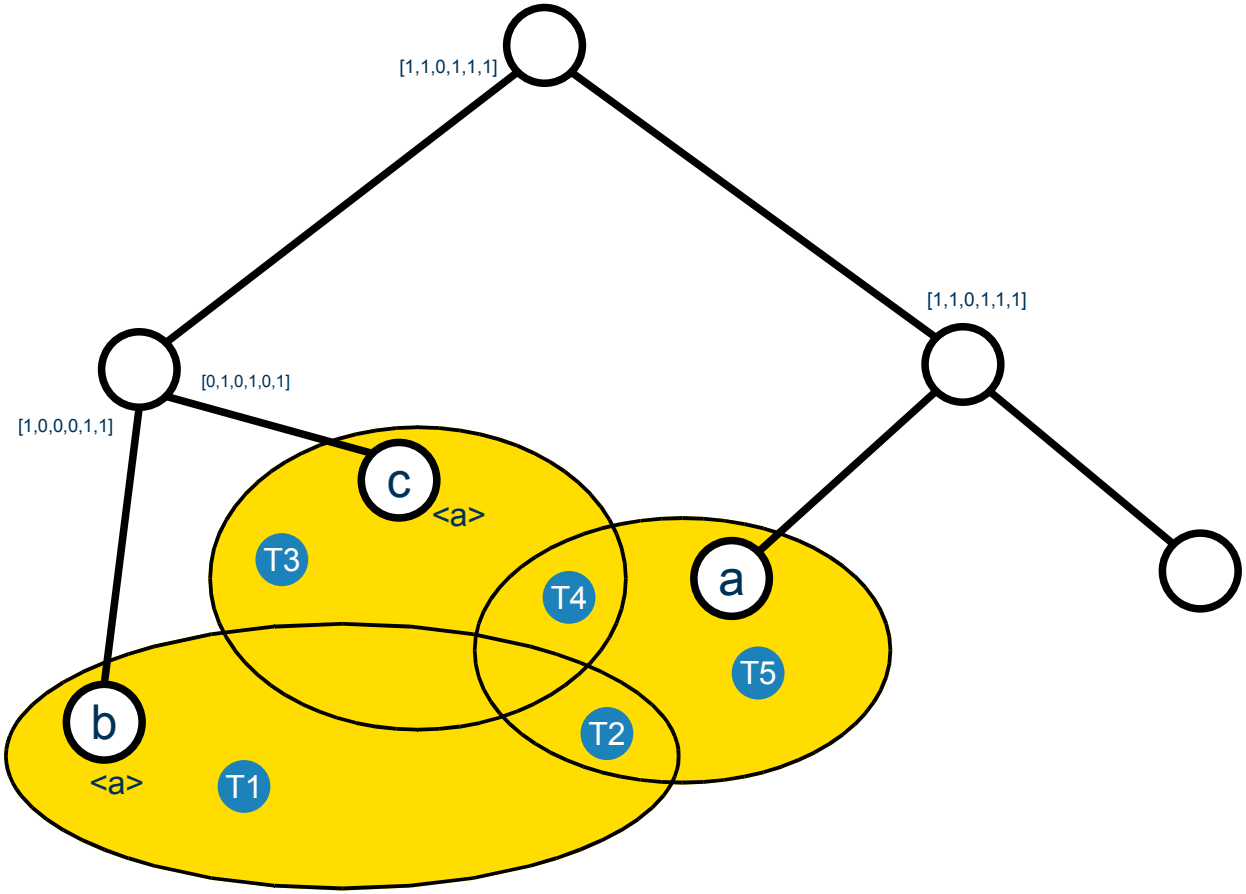

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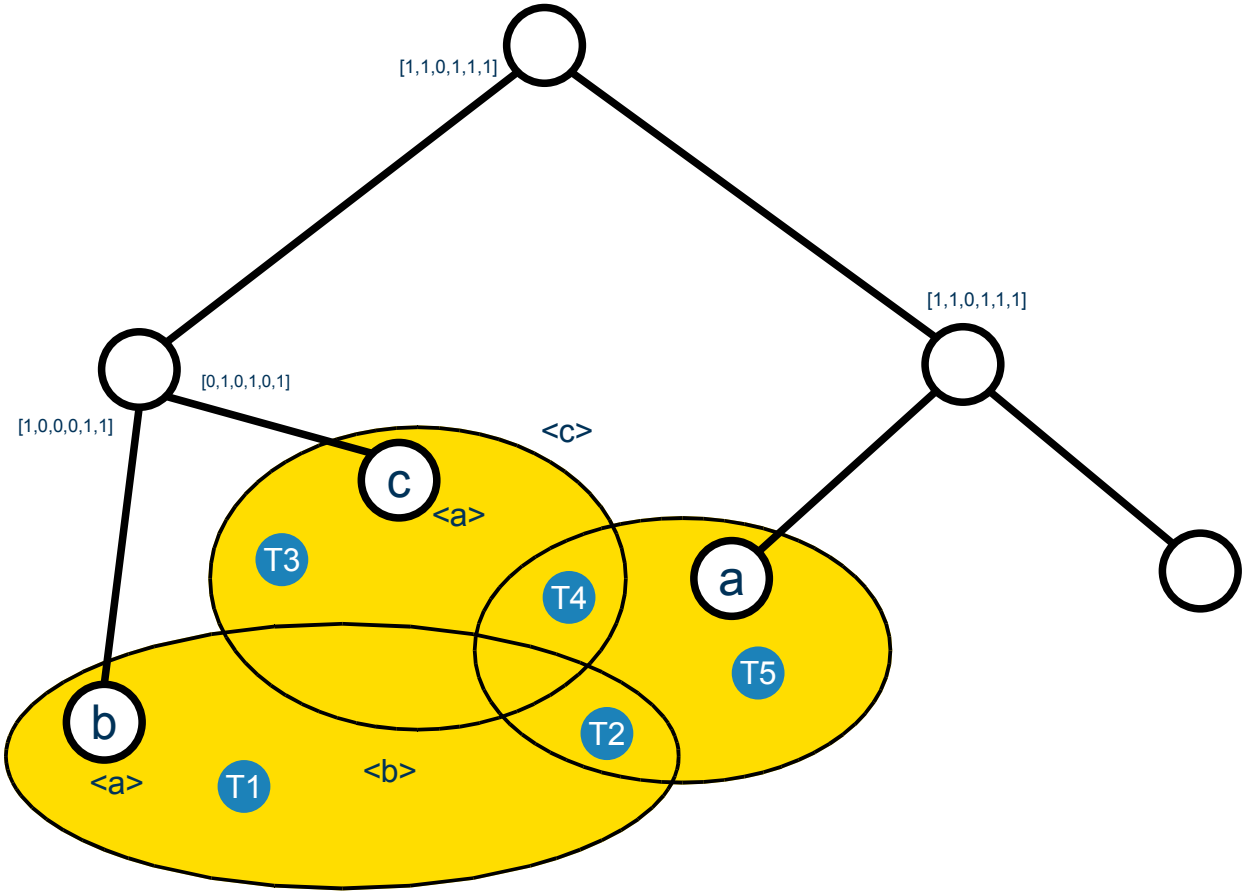

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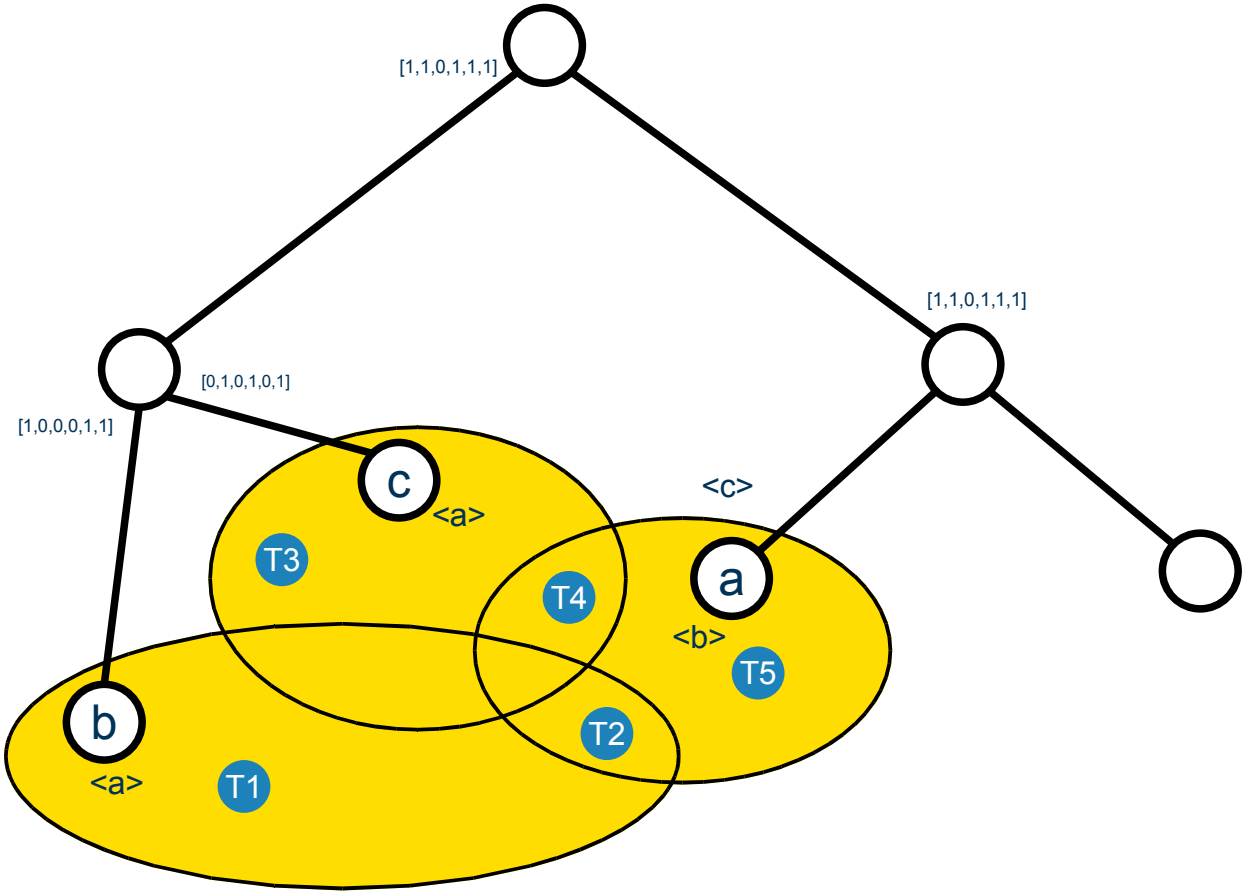

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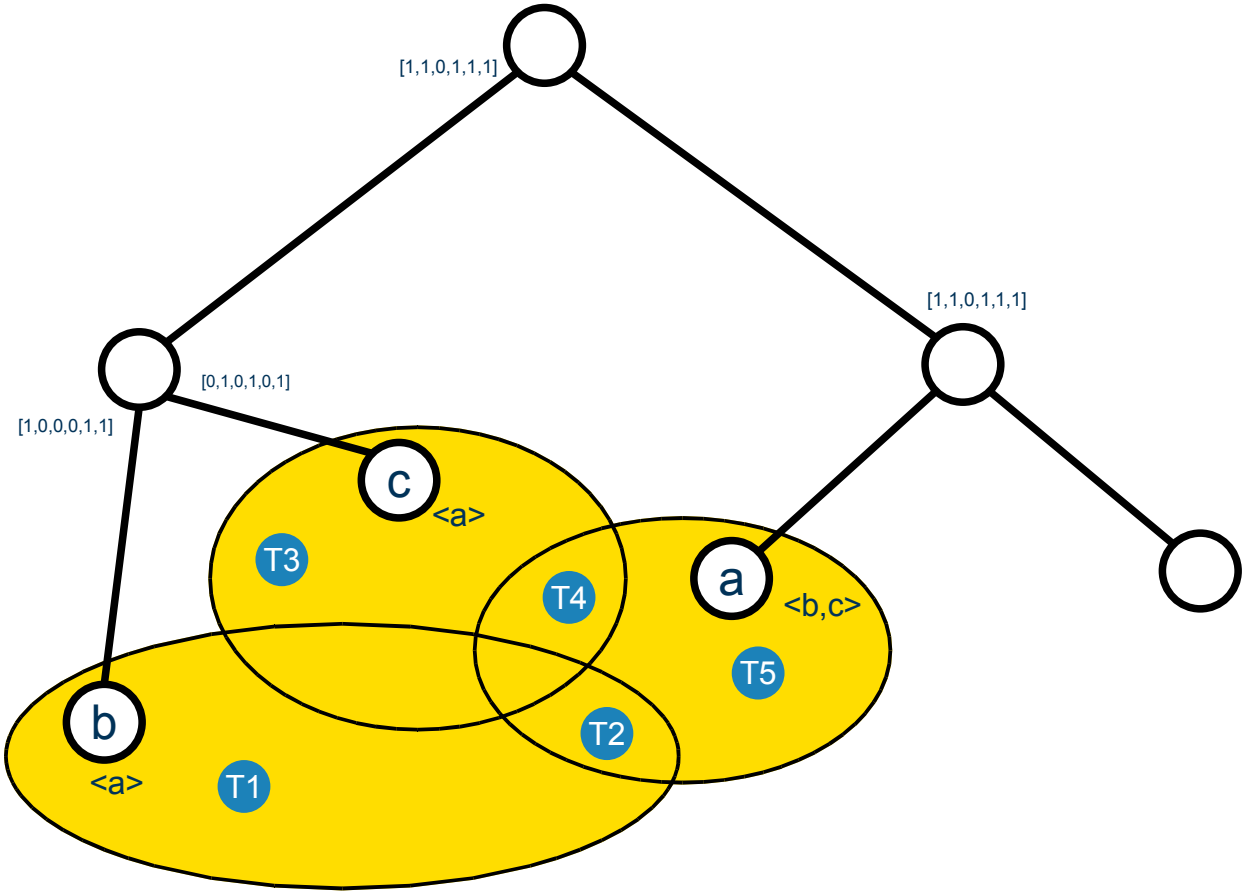
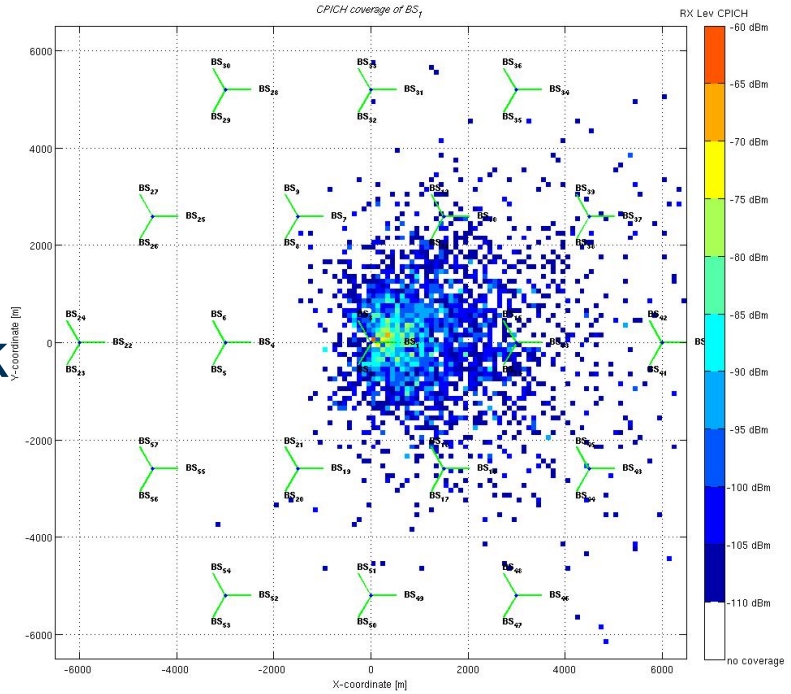
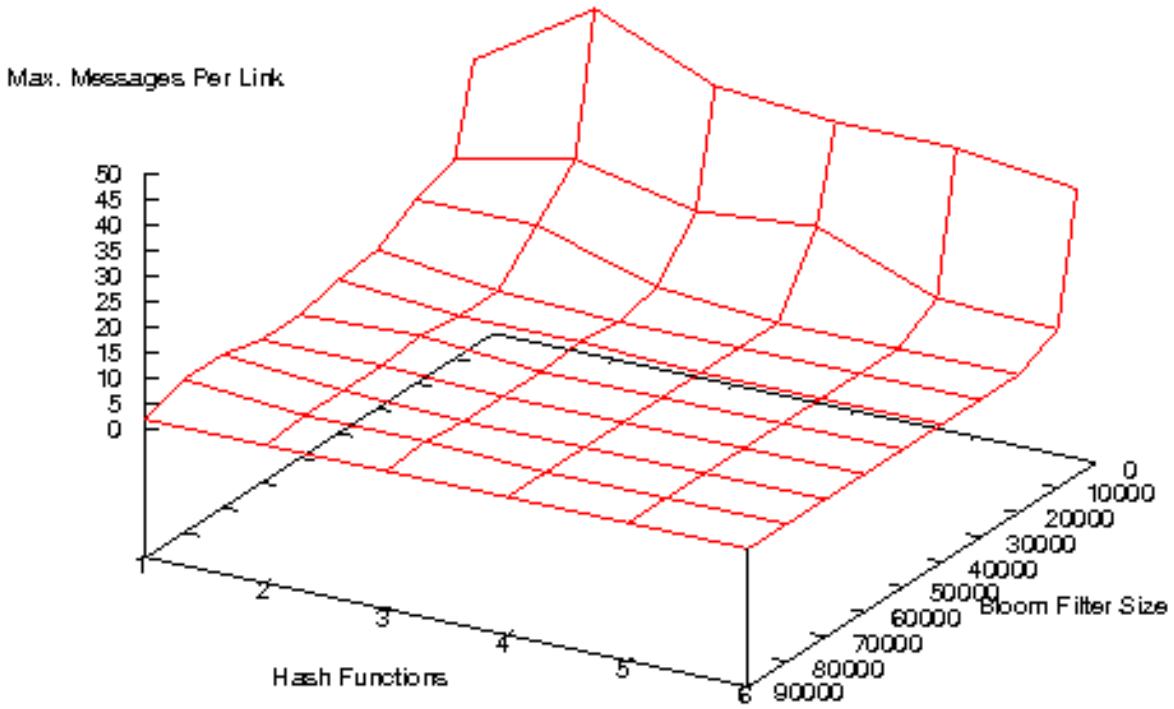


Evaluation

- Simulators:
  - Discrete Events: **javaSimulation**
  - WCDMA: **NPSW**
  - Mobility: **BonnMotion**
- Scenario:
  adding a new BS to the network (3 cells)
- Mobility model:
  - Manhattan.
    (A mesh of parallel streets every 150m.)
- 3 x 90° Antennas per BS

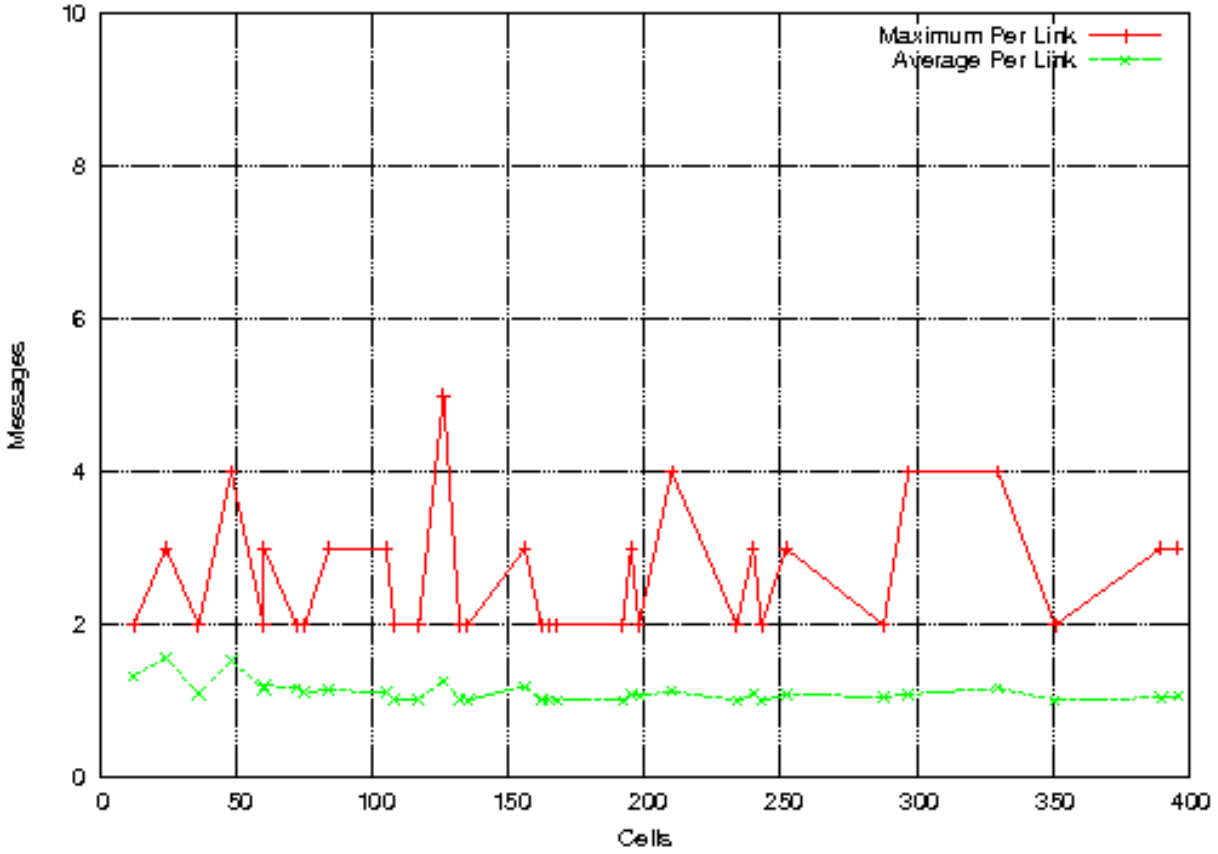


Dimensioning the Bloom Filter
Adding a Cell



147 cells
20000 terminals

Scalability on the System Size
Adding a Cell

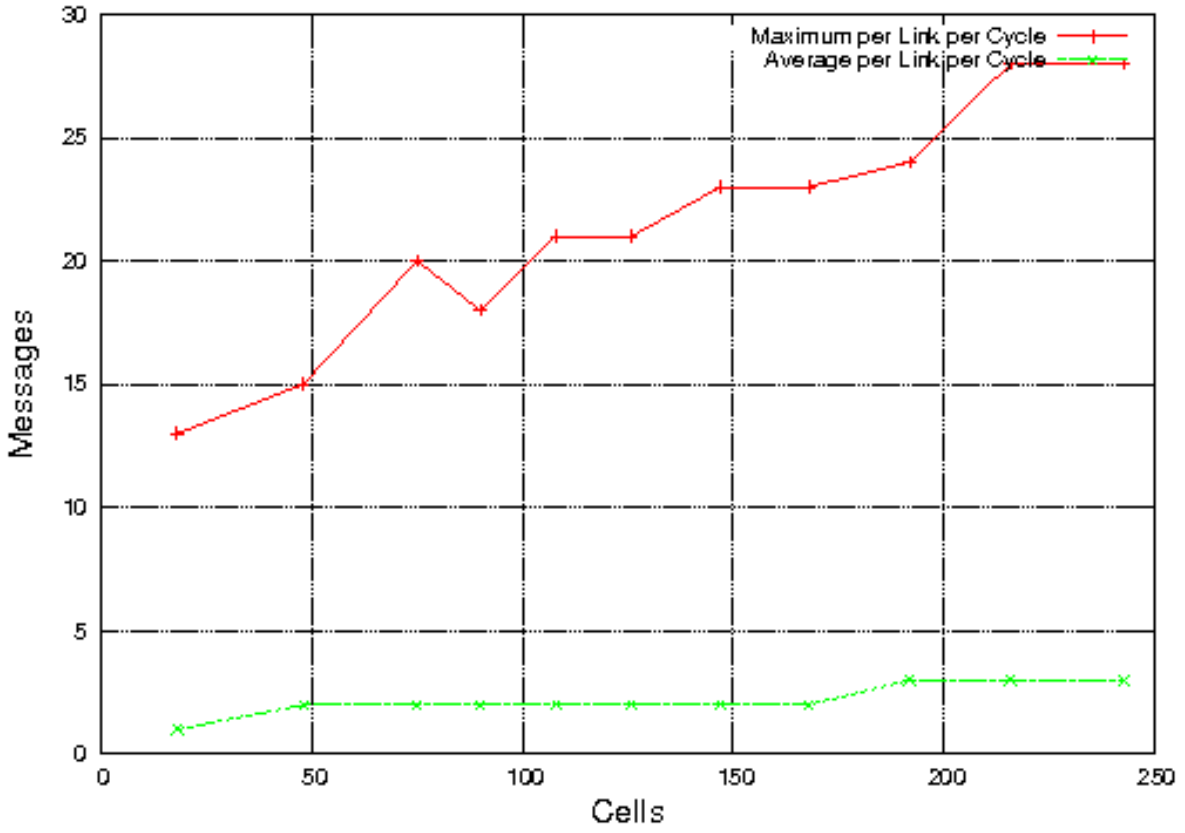


100 terminals per cell

Bloom filter parameters:
- array size of 30,000
- 2 hash functions.

Scalability on the System Size

Adding a Cell – With Terminal Mobility



100 terminals per cell

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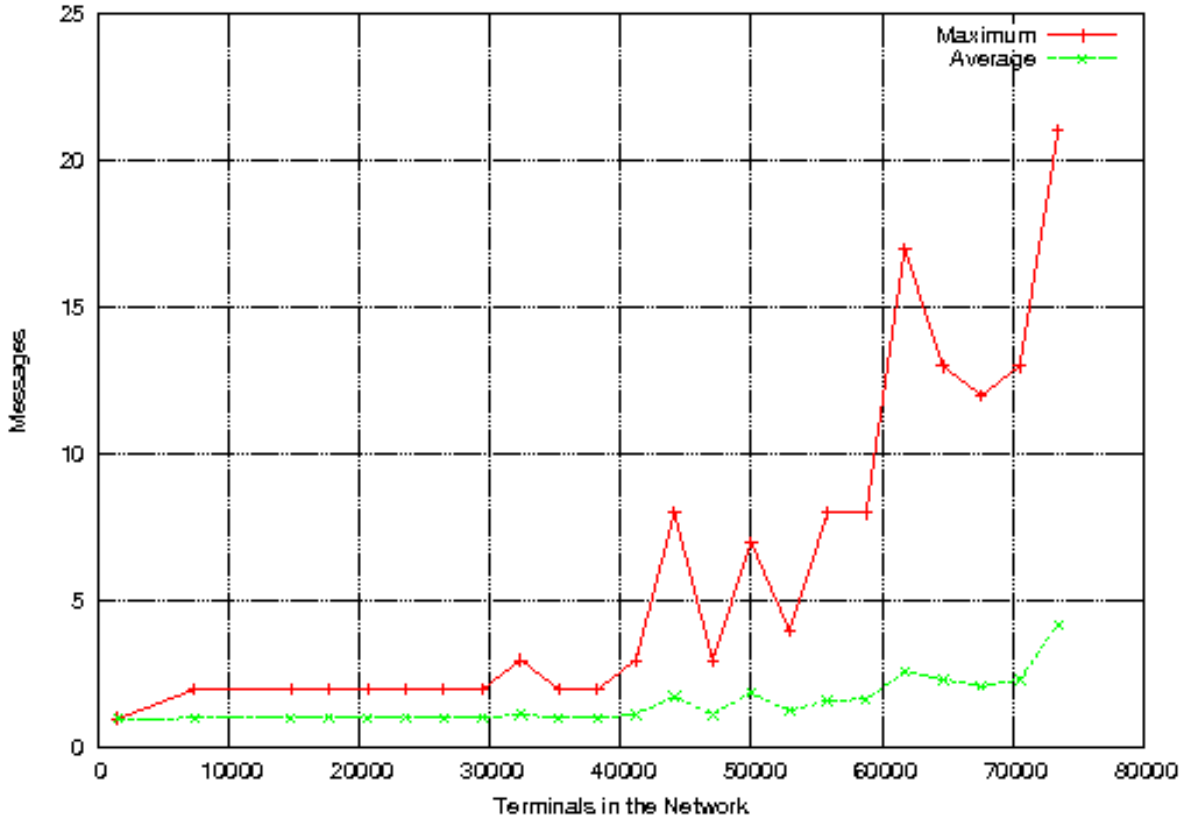
Scalability on the Number of Terminals
Adding a Cell



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Bloom-filter parameters:
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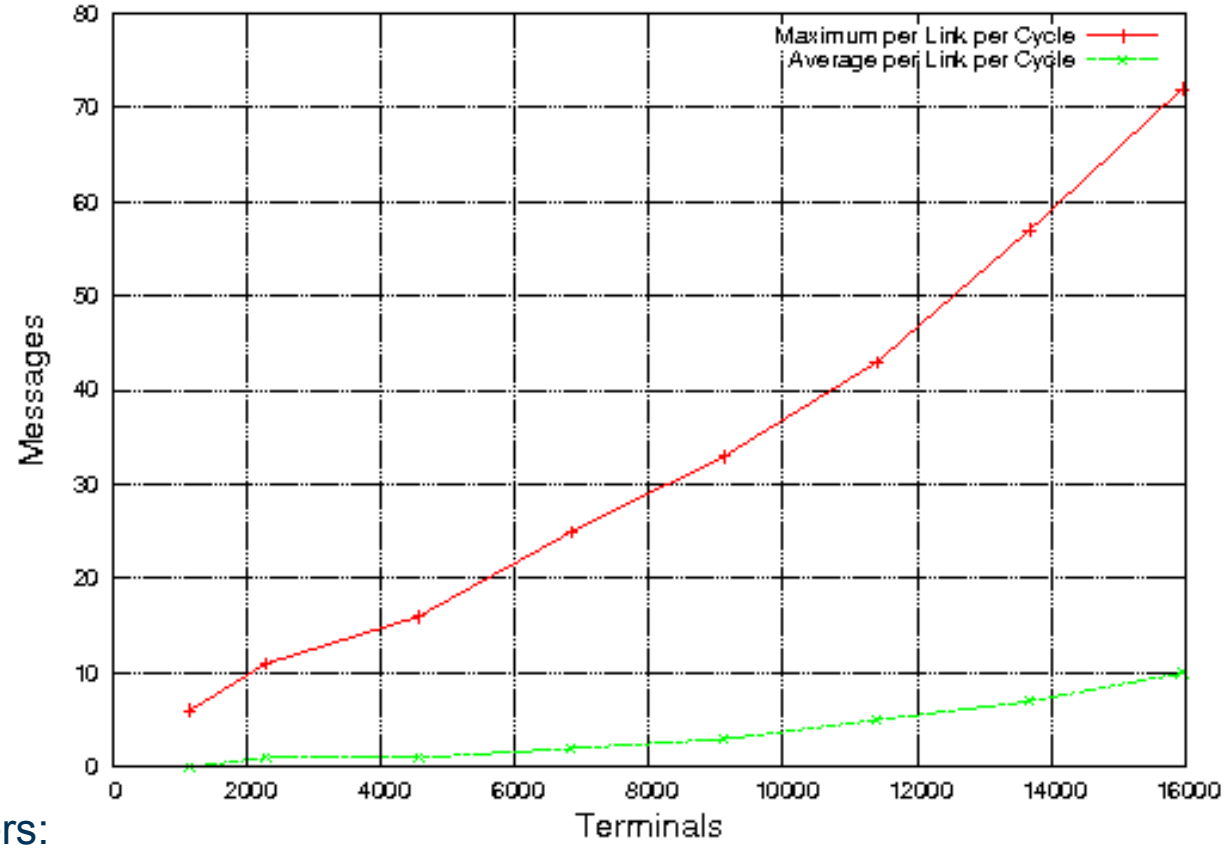
Scalability on the Number of Terminals

Adding a Cell – With Terminal Mobility



57 cells

Bloom-filter parameters:
· array size of 30,000
· 2 hash functions.

Conclusions

- A **decentralized,** three-layered framework for configuring neighbouring cells of radio access networks.
- DOC, a novel probabilistic protocol that **detects** and continuously tracks the **coverage overlaps** among cells.
- Enables **self-configuration** (i.e., reduced op costs)
- Increases **robustness**.
- Has **low** traffic and computational **overhead**.
- It is **scalable** inside big ranges, not forever.
- It is **neutral** to technologies (GSM, UMTS...)

Ongoing and Future Work

- Non-tree dynamic topology for the overlay.
- Propagation of summaries geographically restricted.
- Policy-based mechanism that configures the neighbouring cell lists.
- Extension of the framework to include other autonomic functions, such as self-healing and self-optimization, which may involve dynamically configuring radio parameters.

Thank you