CS531: Memory Systems and Architecture
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Topic: Important Research Areas of Cache Memory

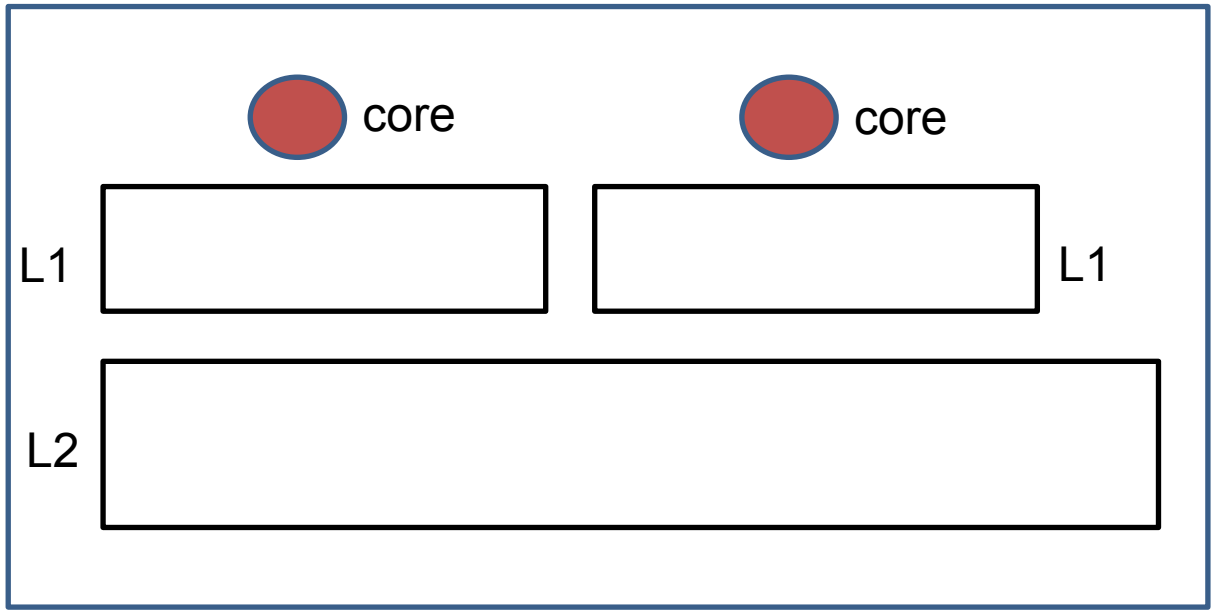
Cache Replacement

- **Cache Replacement:**
  1. **Insertion**
  2. **Promotion**
  3. **Eviction**

- **Important Terms:**
  1. **Dead blocks**
  2. **Scanning Application**
  3. **Threshing Application**
  4. **Security Issues.**

- **Issues with LRU**
  1. **Dead block**
  2. **Less effective in LLC**

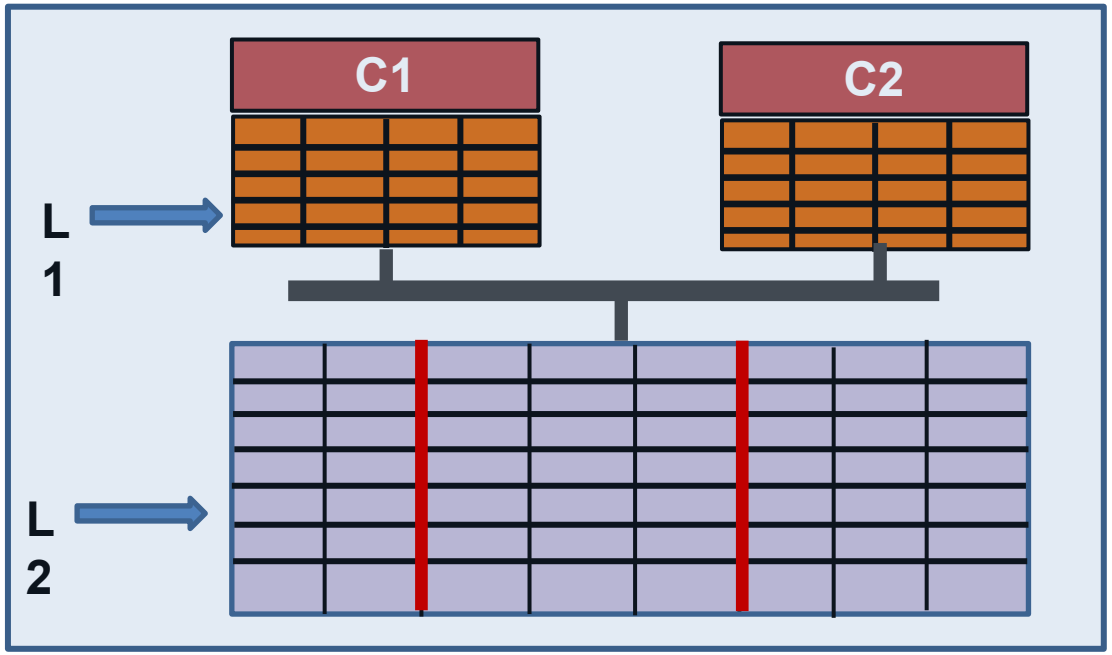
- **Optimal replacement Policy.**
- **LLC based replacement polices.**



Multicore Processor

Cache Partitioning

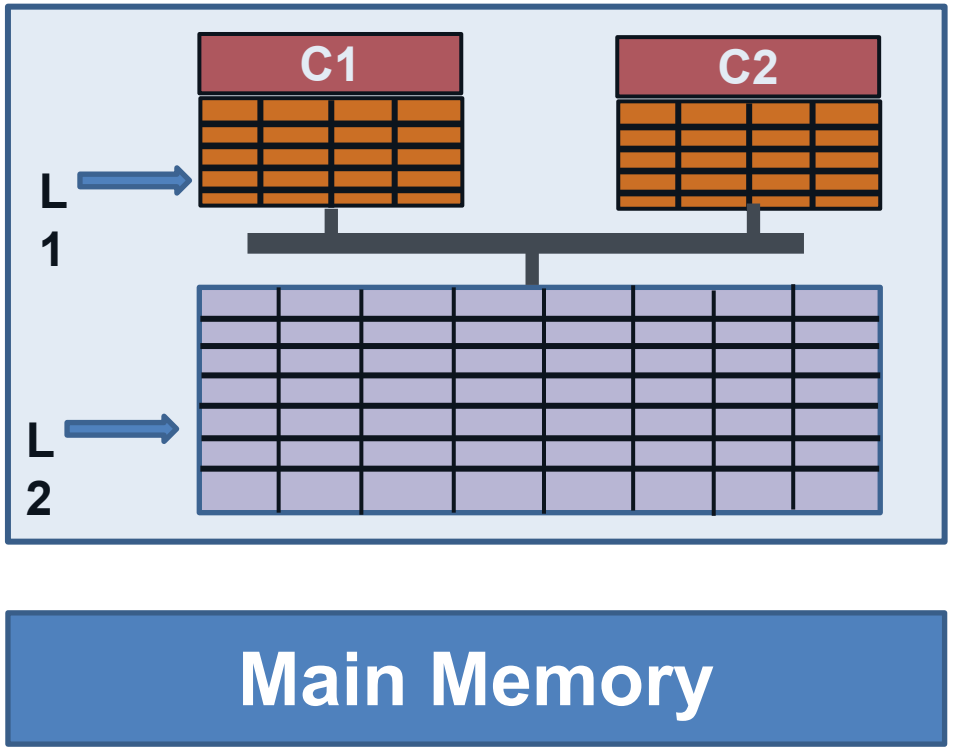
- **Shared Cache:**
  - Unified shared cache
  - Distributed shared cache (TCMP)
- **Cache Partitioning:**
  - Static partitioning.
  - Dynamic partitioning.
- **Way-partitioning vs Set-partitioning.**
- **Challenges in cache partitioning:**
  - How to record application's behaviour.
  - The overhead of training unit.
  - Maintaining fairness.



Prefetching

- **Prefetching:**
  - Spatial locality.
  - Traditional prefetchers:
    - Stride prefetcher
    - Next line prefetcher

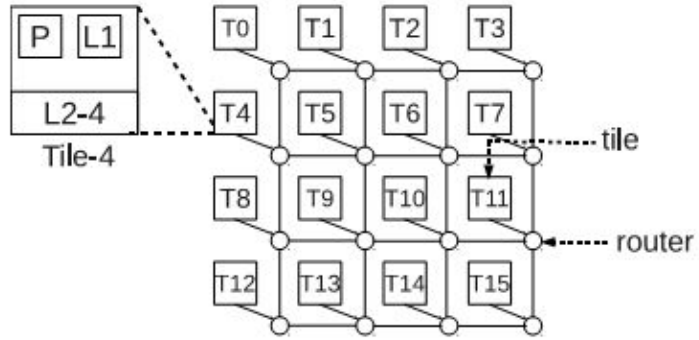
- **Challenges in prefetching:**
  - Prefetch accuracy.
  - Prefetch pollution.
  - Learning techniques.
  - Complex application behaviour.
  - Prefetch on different cache levels.

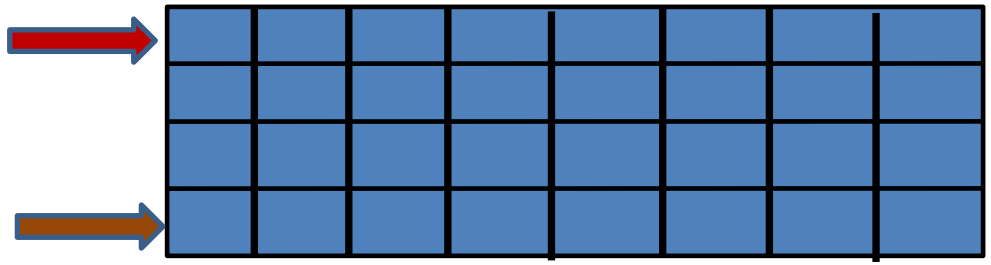


Cache Utilisation

- **Though the LLC has larger size it cannot utilize the whole storage properly.**
- **Better utilization of LLC reduces the miss rate and hence improve performance.**

- **Current LLC utilization issues:**
  - Local issue (*local to each bank*)
    - The sets within a bank are not used uniformly.
  - Global issue (*considering all the banks*)
    - The banks are not loaded uniformly.





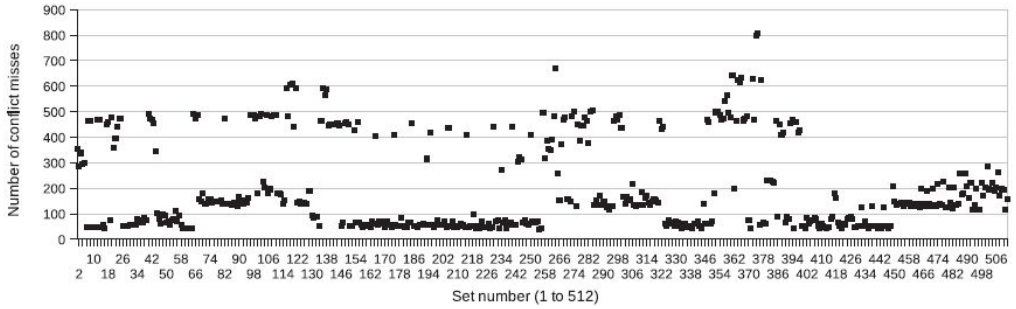


Figure 2: Non uniform load distribution within a bank.

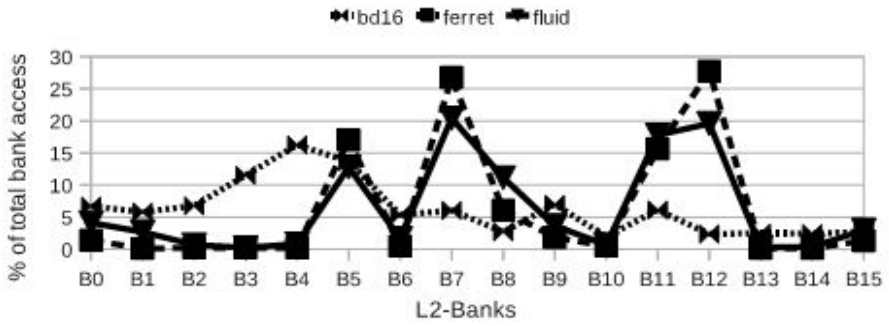


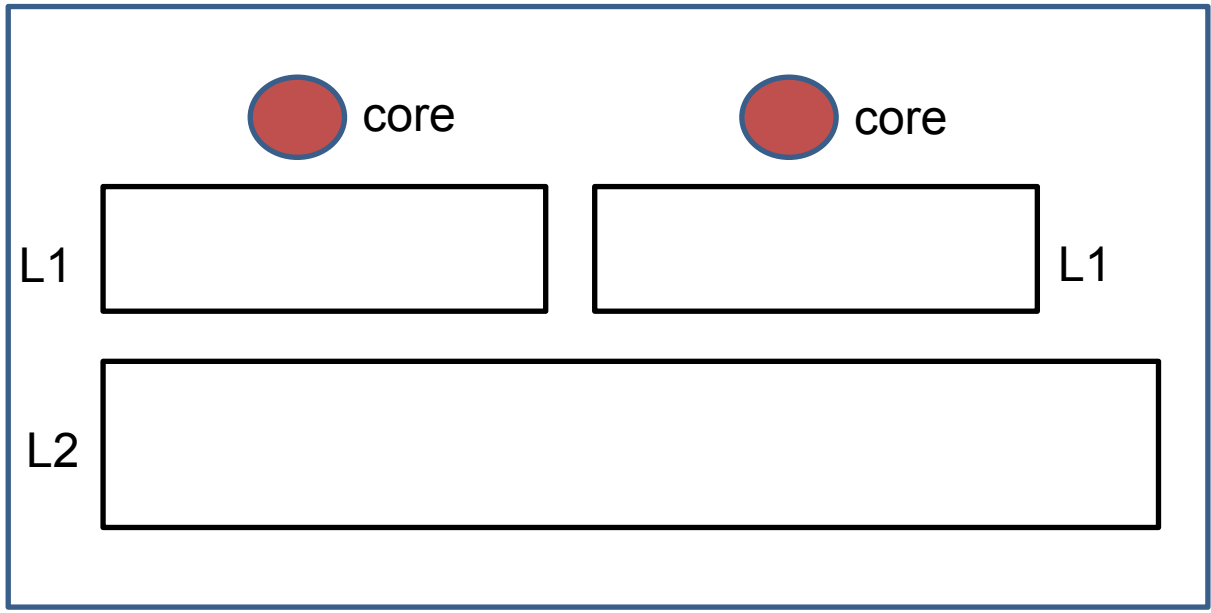
Figure 3: Non uniform load distribution among all the banks.

Security Issues

- **Performance Attacks (DoS attack):**
  - Designing an application that can misuse the property of the following policies to degrade the performance of the system.

- **Replacement Policy**
- **Cache Partitioning**
- **Cache Utilization**

- **Countermeasure of Performance Attacks:**
  - How to prevent performance attacks.



Multicore Processor

Important Resources for Cache Coherence

Thank You