1. Motivation: Standard L1 Cache

Wastes energy by reading 8 tags and 8 cache lines in parallel when only one cache line is needed.

2. Extended TLB with cache line way information

3. Overview

4. Optimizations

**eTLB Replacement**
Minimize forced cache line evictions due to eTLB replacement by evicting the page with least data.

**uPages (Sparse Data)**
Minimize area when increasing number of eTLB entries by using smaller pages (e.g. 1kB pages)

**uPage Banking**
Optimize eTLB => Data-array communication by banking the eTLB and the data-array on the same uPages.

**Last-value eTLB prediction**
Bypass eTLB on hits to save eTLB energy.

5. Results

**Performance**

**Energy**

-78%