The XOR Cache: A Catalyst for Compression

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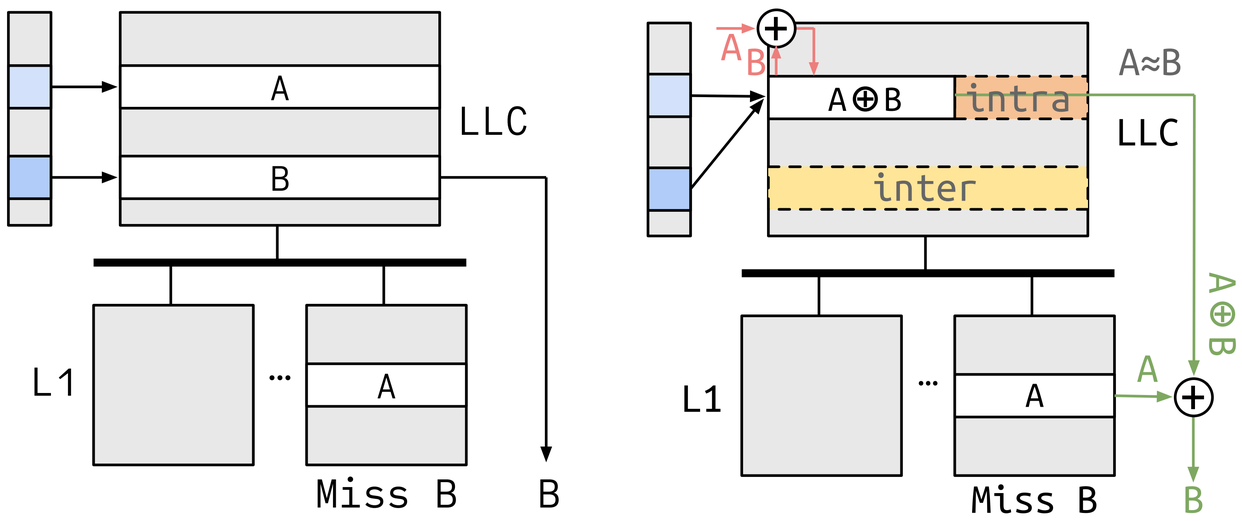
Architecture

Unlike traditional caches that store lines individually, XOR Cache stores the bitwise XOR result of line pairs.



Conventional cache. XOR Cache.

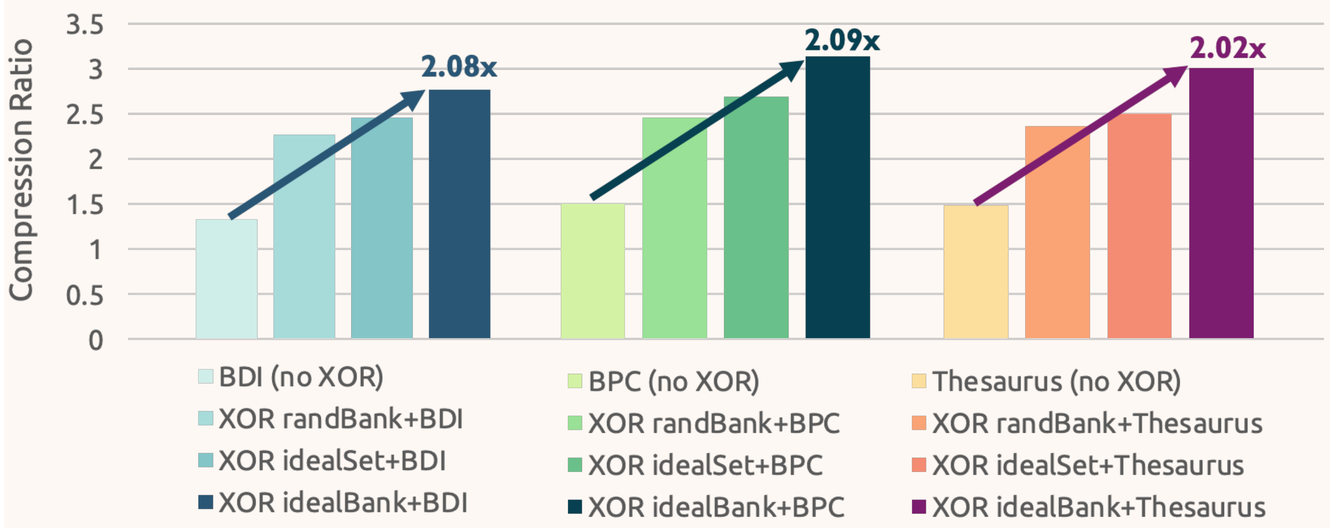
Compression

Inter-line compression With every line pair co-located as one, XOR Cache achieves a compression ratio of 2.

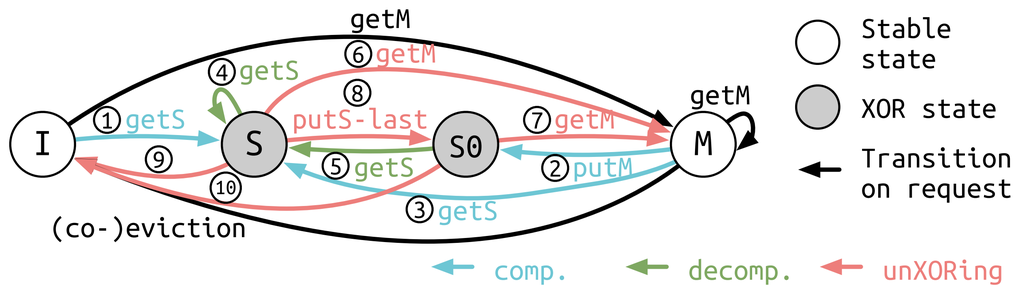
Inter-line compression XORing similar lines reduces entropy, enabling further compression.

Line A	0020	003C	6D7F	0000	7C20	003C	6D7F	0000	7C20	003C …
Line B	0020	004C	6D7F	0000	7C20	004C	6D7F	0000	7C20	004C …
Line A⊕B	0000	0070	0000	0000	0000	0070	0000	0000	0000	0070 …

Two example lines from running bodytrack benchmark in PARSEC.

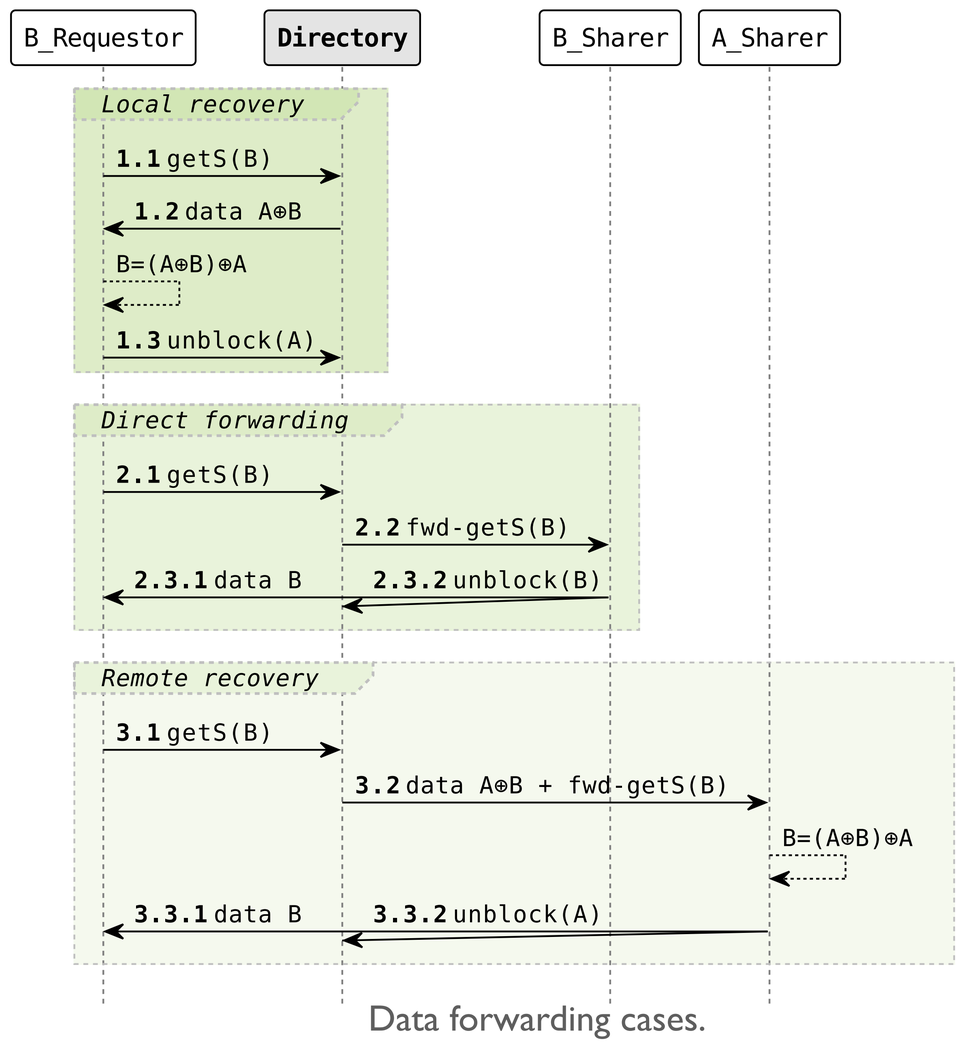


Coherence

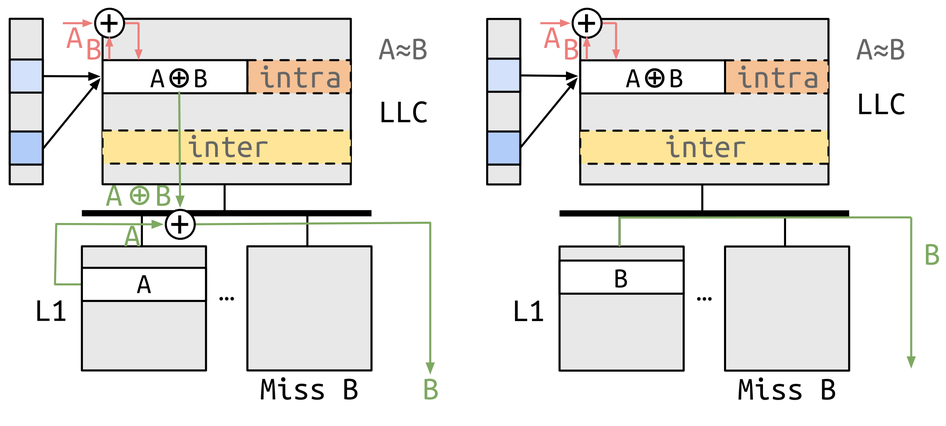


LLC stable state transition.

Case	A state (S/S0)	B state (S/S0)	B requestor shares line A
Local recovery	S	S/S0	Yes
Direct forwarding	S/S0	S	No
Remote recovery	S	S0	No



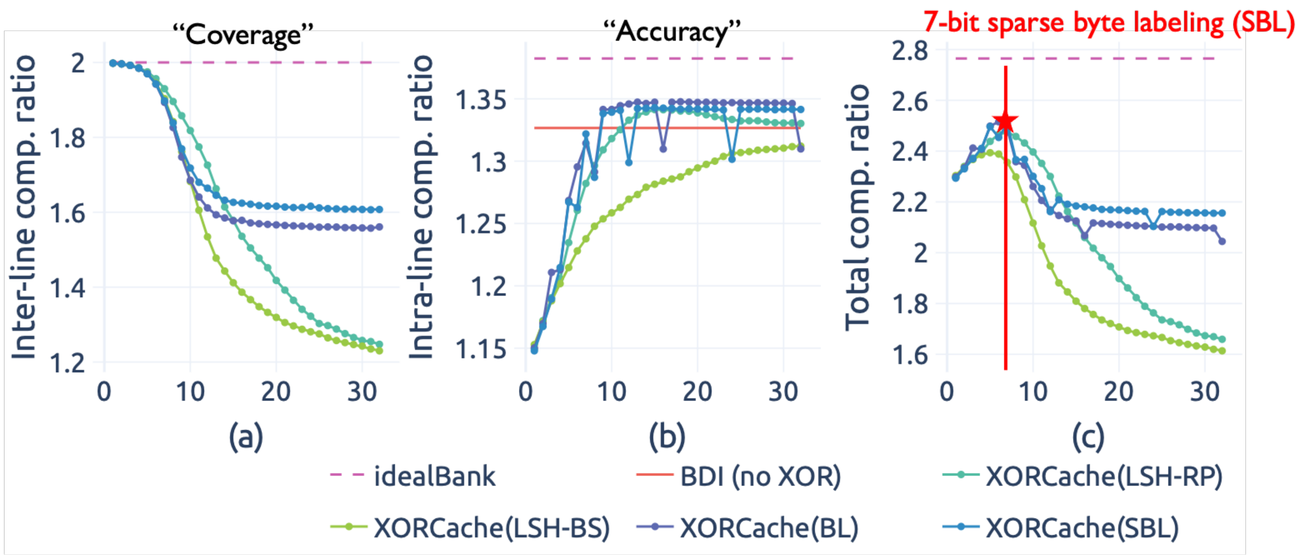
Data forwarding cases.



Remote recovery. Direct forwarding.

Evaluation

Map function design



Compression ratio improvements

XOR Cache boosts compression ratio by 23% and 35% on multi-threaded and multi-programmed workloads.

Area and power improvements

XOR Cache reduces area by 1.93x, power of LLC by 1.92x and power of hierarchy by 1.46x.

Performance and EDP

XOR Cache incurs a performance overhead of 2.06% while still reducing EDP by 26%.

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