Name : Ved Naik
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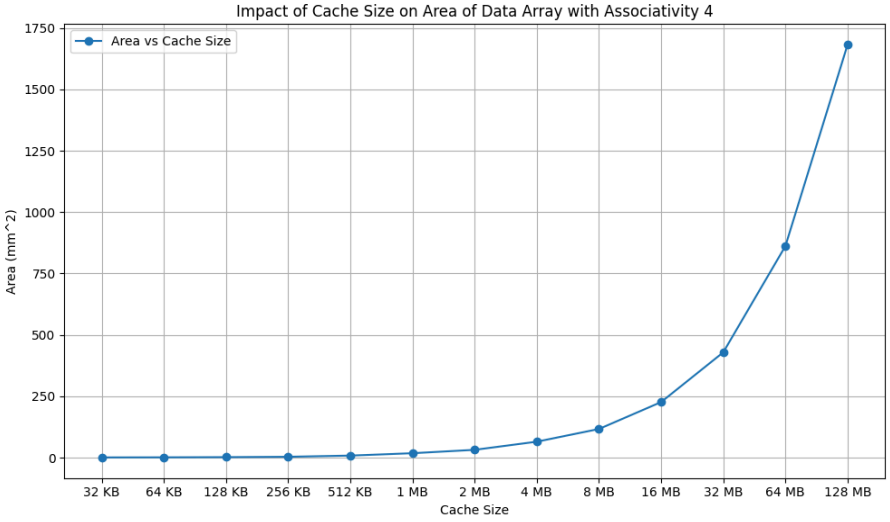
Assignment: 2

Google Drive Link for Scripts, graphs and log files:
https://drive.google.com/drive/folders/1H8GKxQ5GLlZQs6VJHpn3JVlT6PWEPtoZ?usp=sharing

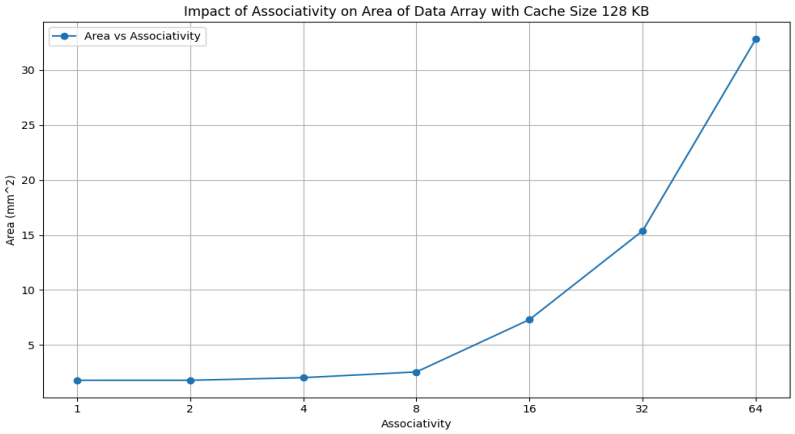
Area:

Impact of Increasing Cache Size on the Area of Data Array with Fixed Associativity (4):



As cache size increases, the area of the data array also increases exponentially. This is because larger cache sizes require more memory cells and more memory cells require more physical footprint.

Impact of Increasing Associativity on the Area of Data Array with Fixed Cache Size (128 KB):



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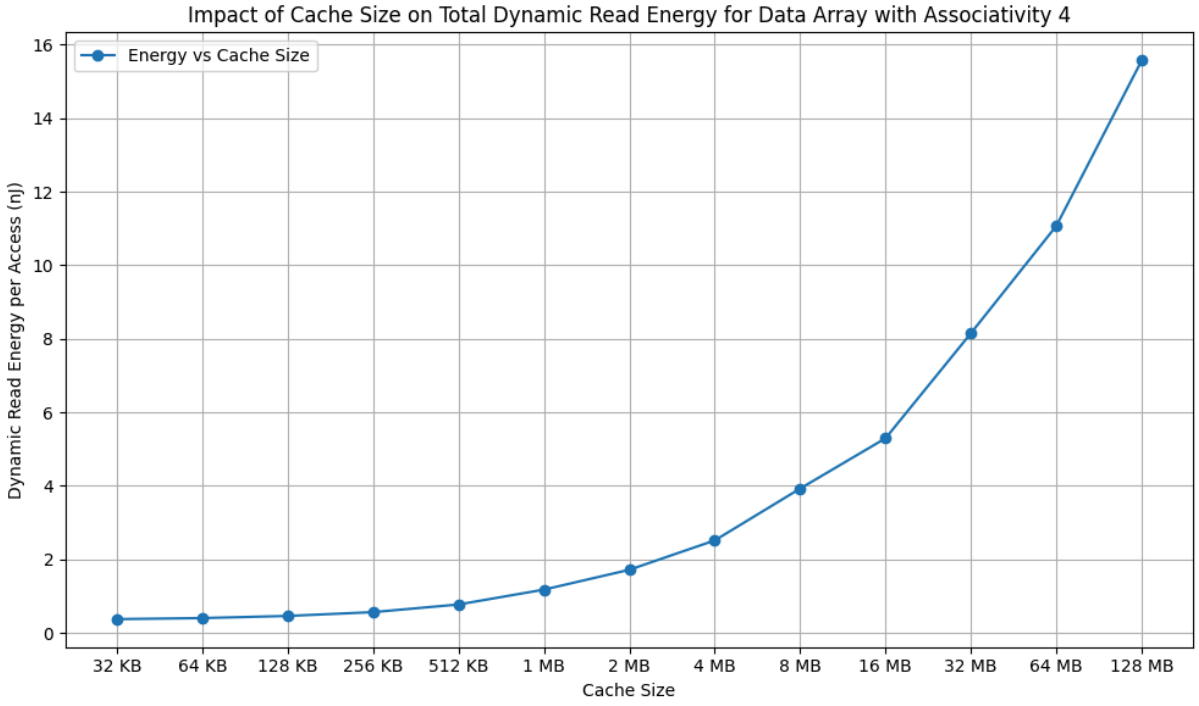
As the associativity increases, the area of the data array increases. The relationship between associativity and area is linear initially, then it appears exponential. This is because higher associativity means more sets in the cache. Each set needs its own control mechanisms which take up space. Managing a larger number of sets increases the complexity of the control logic which adds to the physical size of the cache.

Energy

Impact of Increasing Cache Size on Total Dynamic Read Energy per Access for the Data Array with Fixed Associativity (4):



As the cache size increases, the total dynamic read energy per access also increases almost exponentially. This is because larger caches have more memory cells and each of these cells needs to be accessed during a read operation. Also, in a larger cache the word lines which connect the memory cells in a row are longer and longer word lines have higher capacitance which means they need more energy to be charged and discharged during read operations. Thus requiring more energy to drive the signals needed for reading data.

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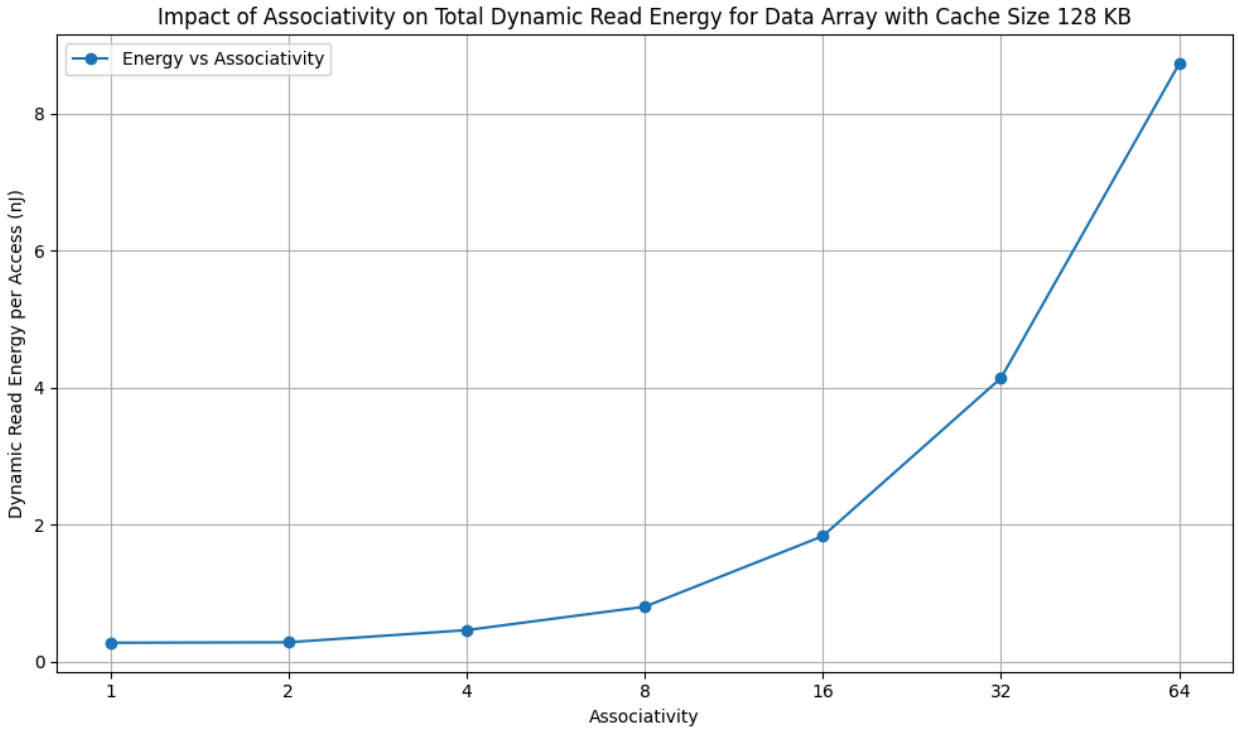
Impact of Increasing Associativity on Total Dynamic Read Energy per Access for the Data Array with Fixed Cache Size (128 KB):



As associativity increases, the total dynamic read energy per access increases from roughly linear to exponential at higher associativity. This is because increasing associativity leads to more comparators and larger multiplexers which in turn add to the dynamic energy consumption due to more active components during a read operation. Comparators verifies if the incoming address matches any stored address in the cache. So more comparators mean more components are active during each read, consuming more energy. Multiplexers are used to select which data to read from the multiple possible ways. Larger multiplexers have more inputs and thus consume more energy.

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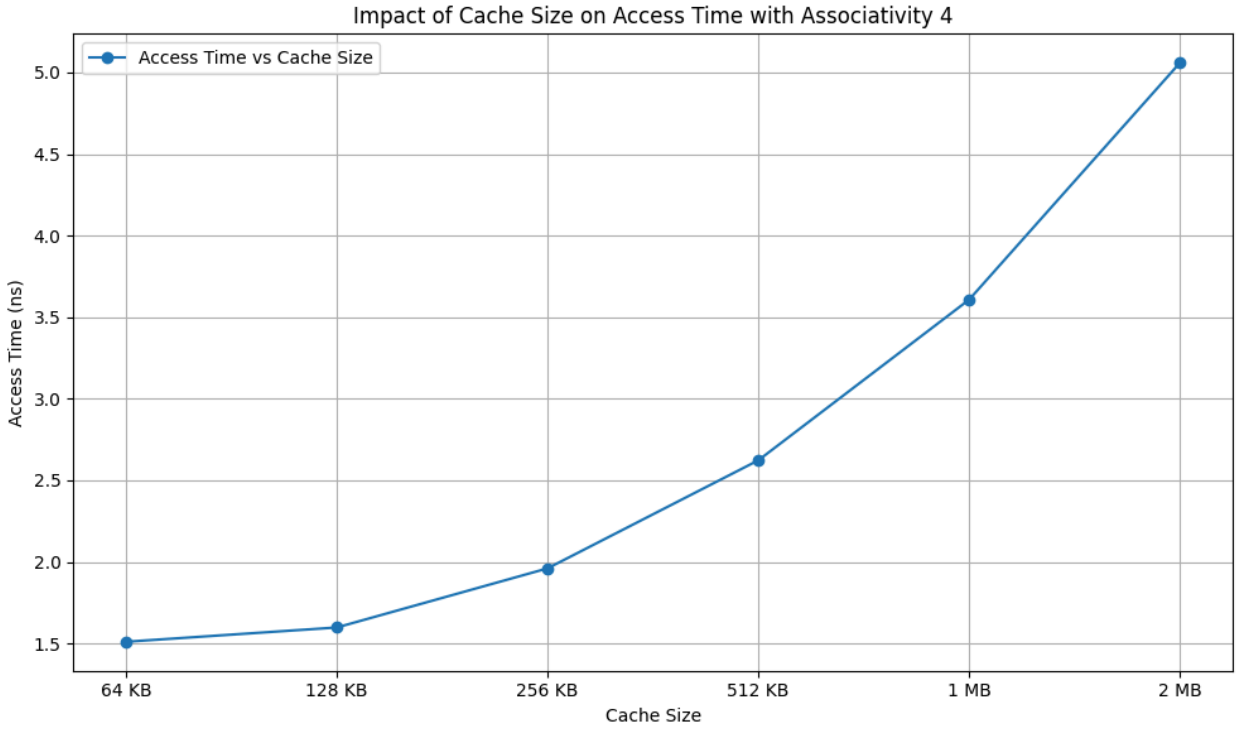
Access time

Impact on Access Time with Varying Cache Size (Range: 64 KB to 2 MB) and Fixed Associativity (4):



As cache size increases, the access time increases almost linearly. This is because larger caches have longer bit lines and word lines. Longer lines take more time to carry signals which increases the delay in accessing data. Also a bigger cache means more addresses to manage and decoding these addresses to find the correct data takes more time which leads to increase in the overall access time.

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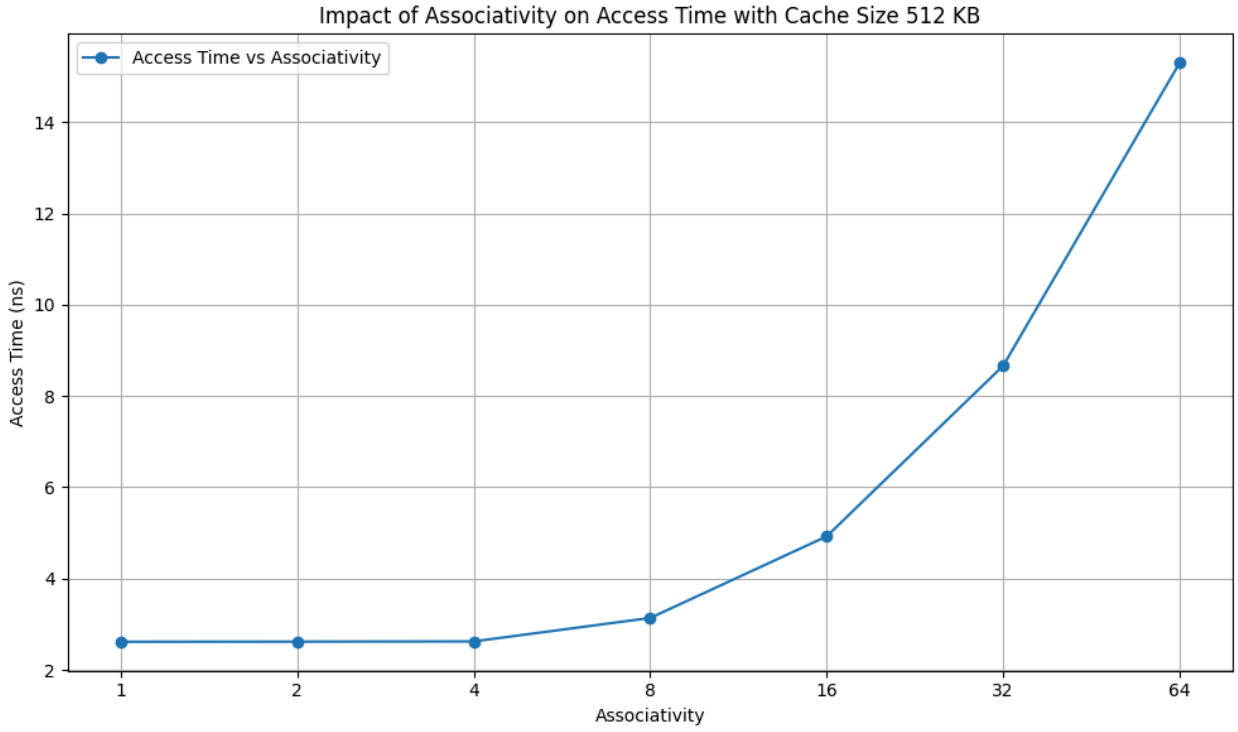
Impact on Access Time with Varying Associativity and Fixed Cache Size (512 KB):



As associativity increases, access time increases from roughly linear to exponential at higher associativity. This is because higher associativity leads to more complex addressing and data retrieval mechanisms to determine where the data is stored, which increases the access time due to more stages in the critical path. The critical path is the sequence of steps needed to complete a read or write operation. Higher the associativity more are the number of stages to this path because the cache has to check more possible ways where the data might be stored which adds to the overall access time.