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Discussion 14: Understanding I/O Operations

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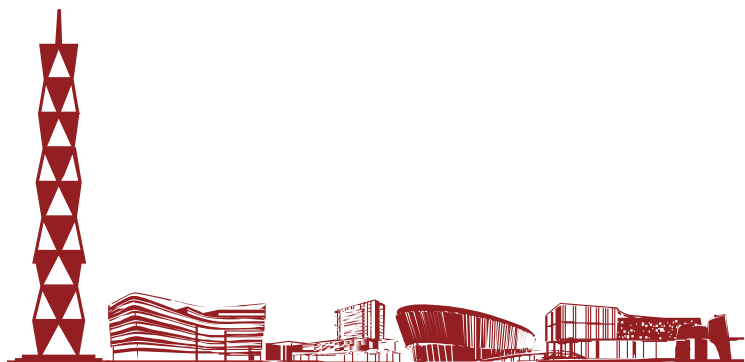
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Agenda Slide



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- CAS & LR/SC
- RISC-V Simulator:
 - Overview
 - How to load
 - Simulate
- Submission Requirements
- Q & A



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I/O Hierarchy Design

Definition of I/O: "Input/Output operations act as the interface between the computer and the external world"

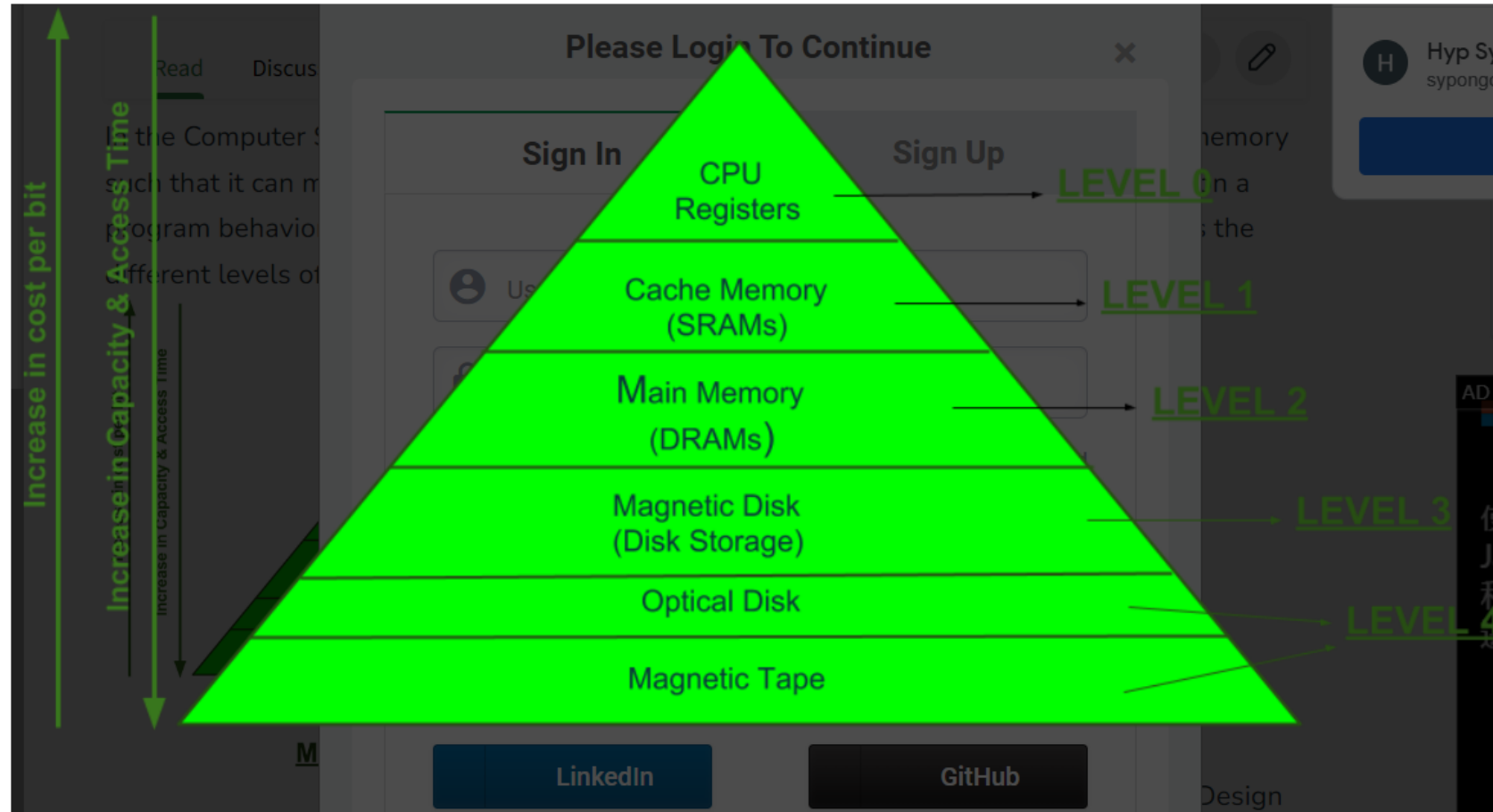


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Computer Architecture: Hierarchy Design



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Sync & Async



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Sync & Async



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- Synchronous I/O:
 - Define: "An I/O operation where the process waits for the I/O operation to complete before continuing"
 - Characteristics: Predictability, simplicity, potential for inefficiency
 - `fsync(fd)`
- Asynchronous I/O:
 - Define : "An I/O operation that allows a process to continue execution while the I/O operation is still in progress"
 - Characteristics: Greater efficiency, complexity in handling responses
 - `io_uring_submit();`



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Blocking & Non-Blocking



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Blocking & Non-blocking



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- Blocking I/O
 - Define blocking I/O: "An I/O operation that blocks the execution of the calling process until the operation is complete"
 - Characteristics: Simplicity, potential for idleness
- Non-Blocking
 - Define non-blocking I/O: "An I/O operation that returns control to the calling process immediately, whether the operation is complete or not"
 - Characteristics: Efficiency, complexity in error handling



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Blocking vs Sync



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- **Blocking and synchronous** mean the same thing:
 - You call the API, it *hangs up the thread until it has some kind of answer* and returns it to you.



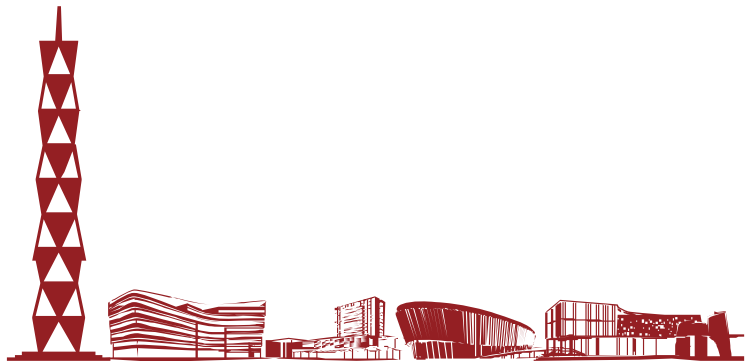
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Blocking vs Sync vs Non-Blocking



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- **Blocking and Synchronous** mean the same thing:
 - You call the API, it *hangs up the thread until it has some kind of answer* and returns it to you.
- **Non-blocking** means :
 - If an answer can't be returned rapidly, the API *returns immediately* with an error or part of the result.



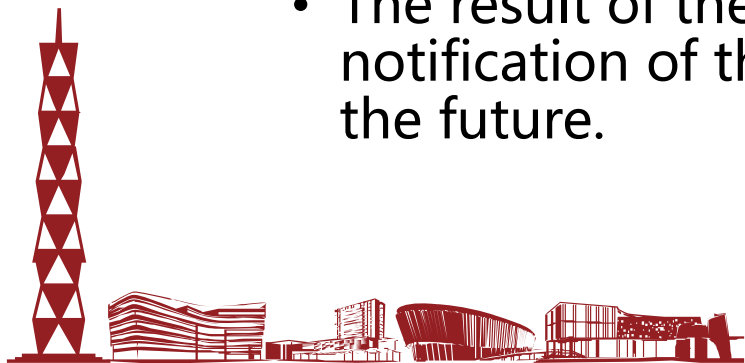
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Blocking vs Sync vs Non-Blocking vs Async



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- **Blocking and Synchronous** mean the same thing:
 - You call the API, it *hangs up the thread until it has some kind of answer* and returns it to you.
- **Non-blocking** means :
 - If an answer can't be returned rapidly, the API *returns immediately* with an error or part of the result.
- **Async** means:
 - The result of the asynchronous I/O system call `read()` must be complete, but notification of the completion of this operation can be delayed until a point in the future.



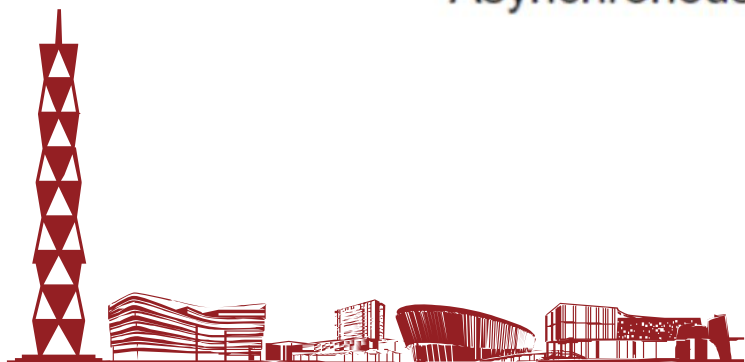
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More details



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	Blocking	Non-blocking
Synchronous	Read/Write	Read/Write (Polling)
Asynchronous	I/O Multiplexing (Select / Poll)	Asynchronous I/O



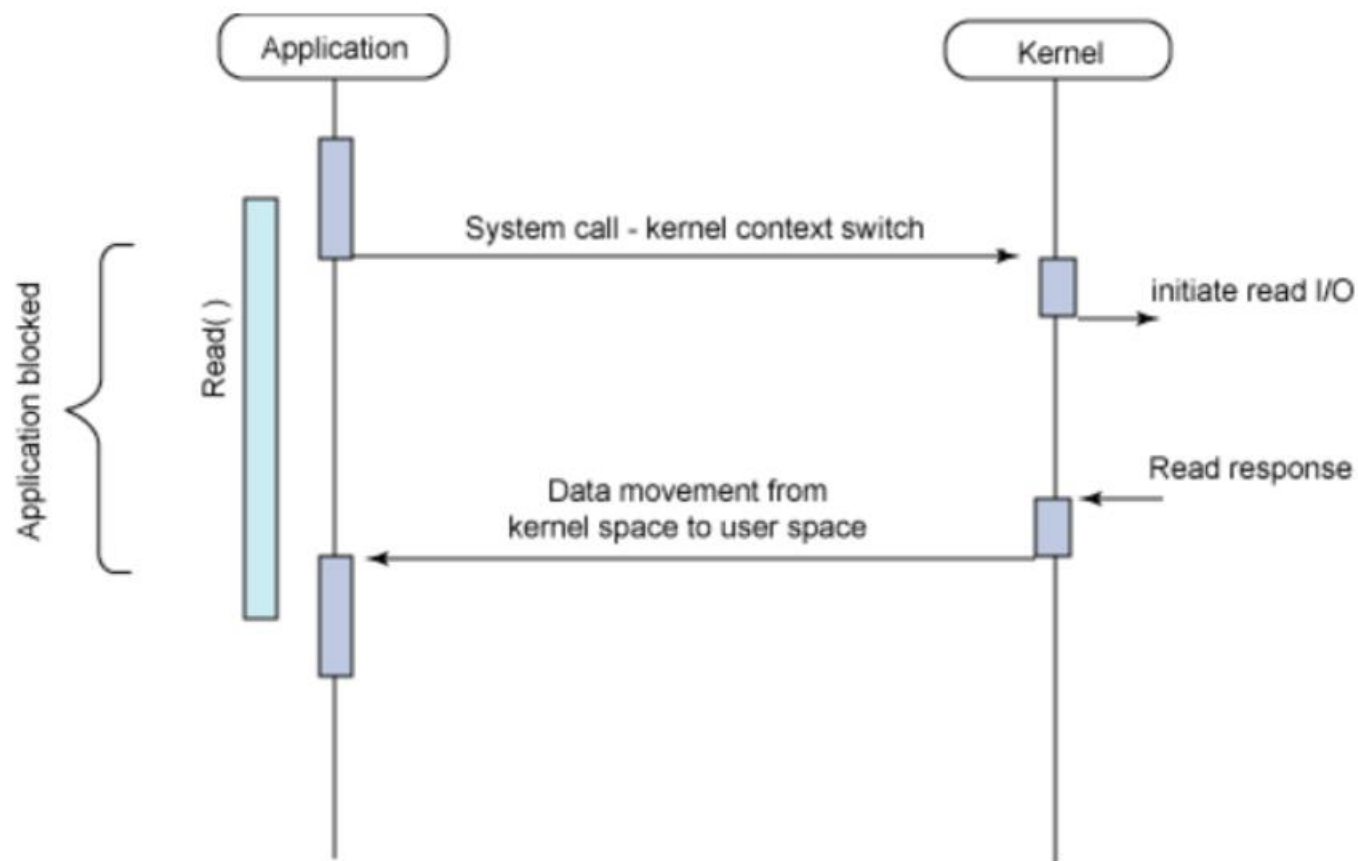
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Sync & Blocking



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- Sync & Blocking
 - sync/write/read



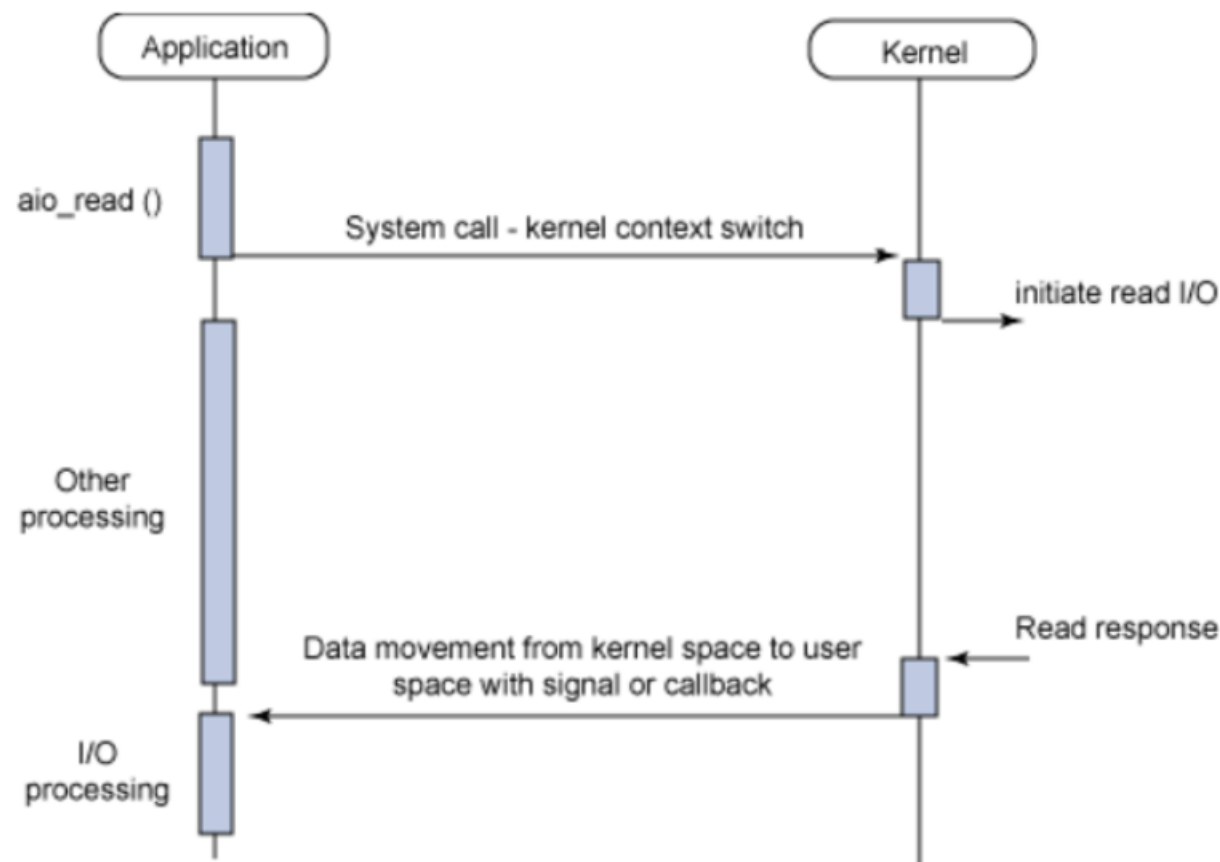
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Async & Non-Blocking



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- Async & Non-Blocking
 - AIO or io_uring



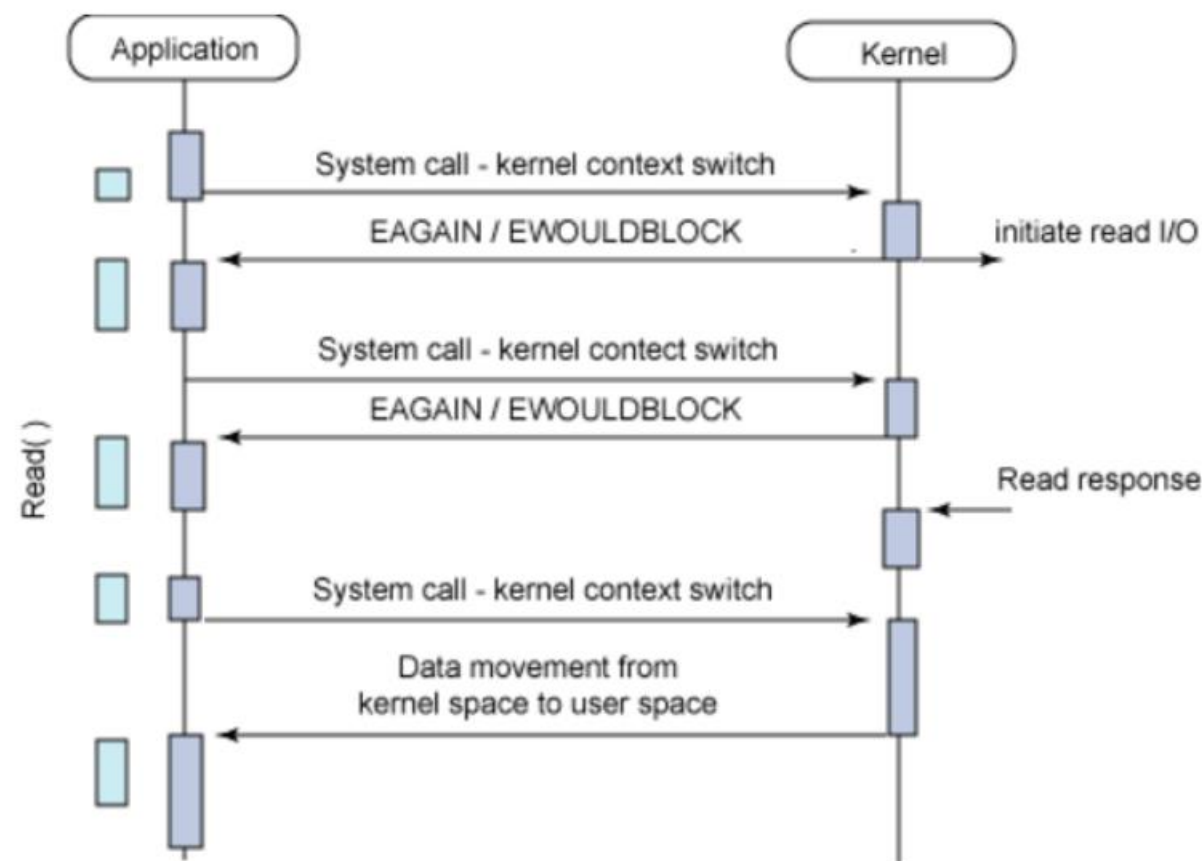
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Sync & Non-Blocking



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- Sync & Non-Blocking
 - polling (Network & Nvme)



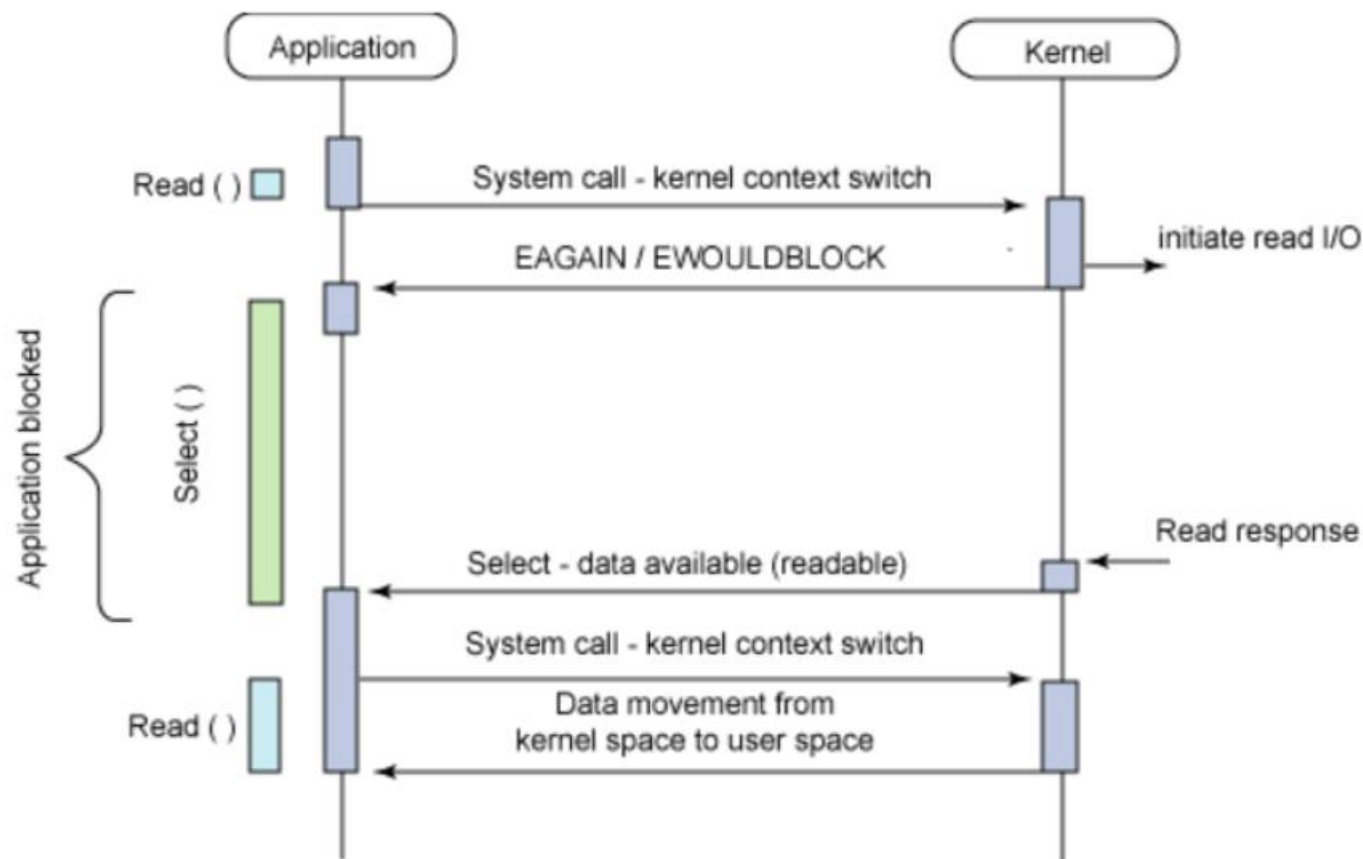
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Async & Blocking



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- Async & Blocking
 - I/O Multiplexing





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Q & A

Thanks



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