Improving Query Execution on Object-based Computational Storage(OCS) System

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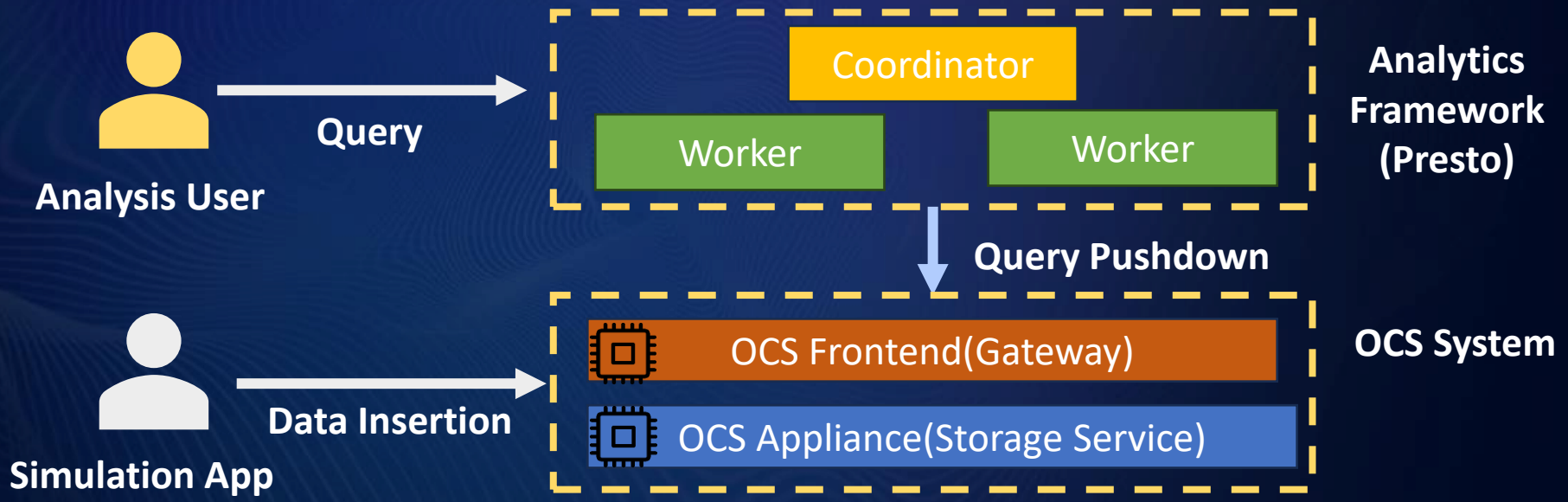
OCS System

Approach

Enabling vertical query pushdown in Object-based Computational Storage(OCS) system[1] within LANL analytics ecosystem[2]

- OCS system is composed of OCS Frontend(OCS-FE) and OCS Appliance(OCSA) with pushdown interface.
- Scientific query is vertically offloaded to the OCS system to reduce data movement.



[1] Kim, J. (2023). Accelerating Data Analytics Using Object Based Computational Storage in a HPC. Presented at the SC23 International Conference for High Performance Computing, Networking, Storage, and Analysis.
[2] Qing et al, Toward Standardized, Open Object-Based Computational Storage For Large-Scale Scientific Data Analytics, Work-In-Progress (WIP) Presenation in the 8th International Parallel Data Systems Workshop (PDSW) held in conjunction with SC23, Denver, CO, November 2023

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OCS System's Objective

Objective

Utilizing the rich resources in the OCS system with pushdown decision making, not simply pushdown query to the storage!

- Data transfer reduction is important since the size of data for analytics is getting bigger.
- The resources in the OCS System implies **the opportunity for vertical pushdown** not only **at the worker level to storage**, but also **inside the storage system level itself.**
- Q) Is the data movement the one and only important factor?
  - Scientific fields has unpredictable query patterns from users.
  1. Since data transfer reduction is the first factor, OCS system does not allow round-trip of intermediate results between layers.
  2. Computation should be considered for pushdown point decision.

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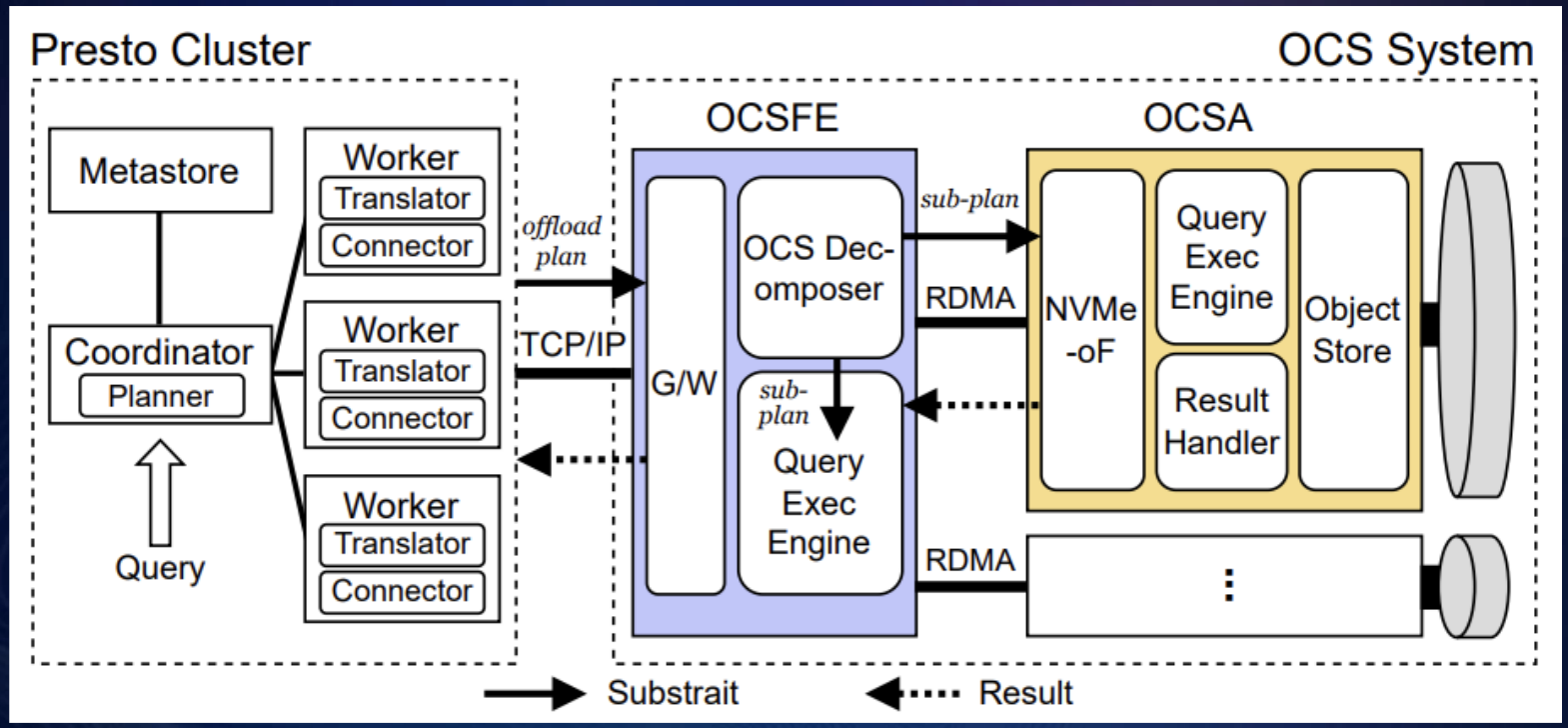
OCS System Design



Goal) Identify the optimal point for query pushdown **from the analytics framework to the OCS system**, and **within the OCS system itself**, taking into account both data reduction and computation

- Vertical Pushdown Framework at OCS System level
- Pushdown Decision Maker at Presto level

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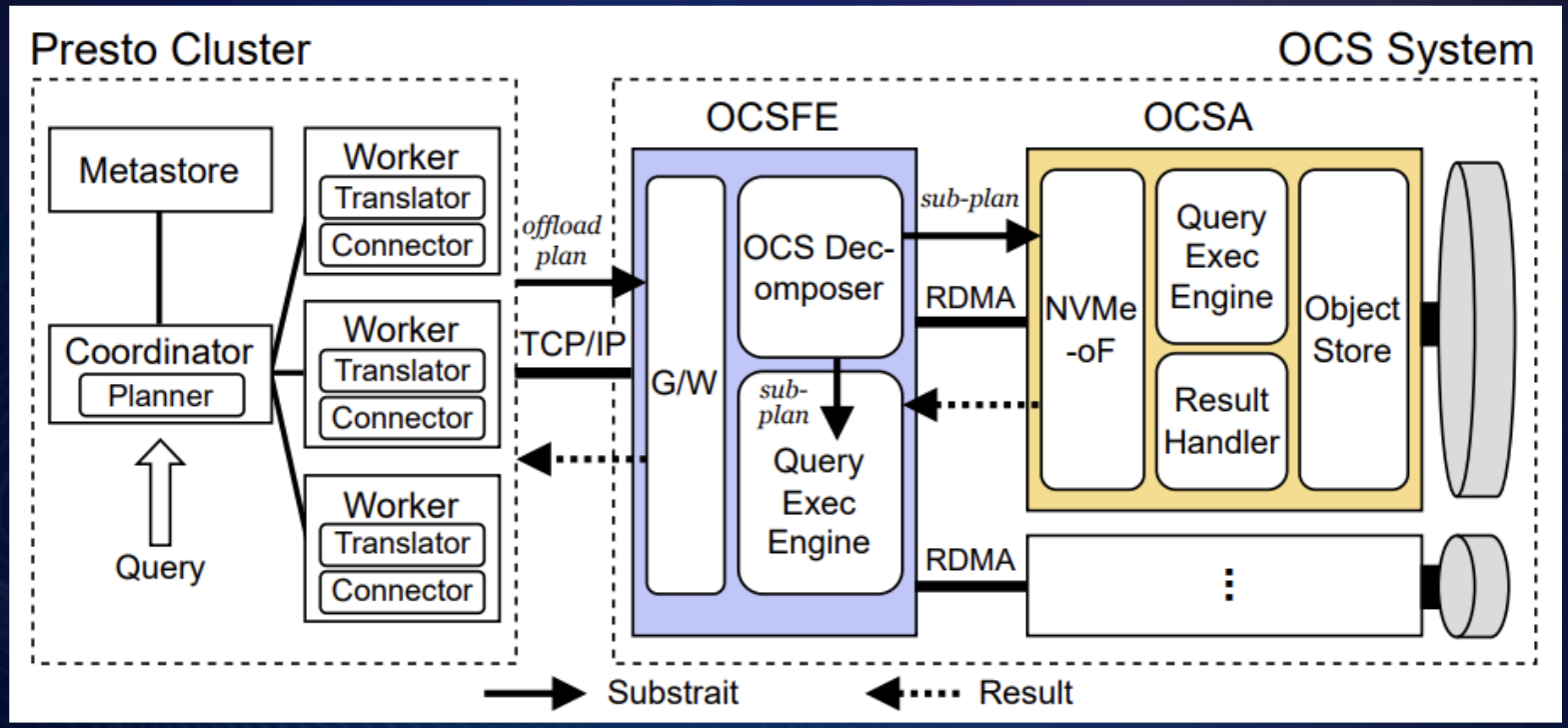
Vertical Pushdown Framework at OCS System



- Vertical Pushdown Framework at OCS System level
  1. Data Movement & Computation Cost-based Algorithm
  2. OCS Decomposer for decomposing plan into OCS-FE and OCSA sub-plan

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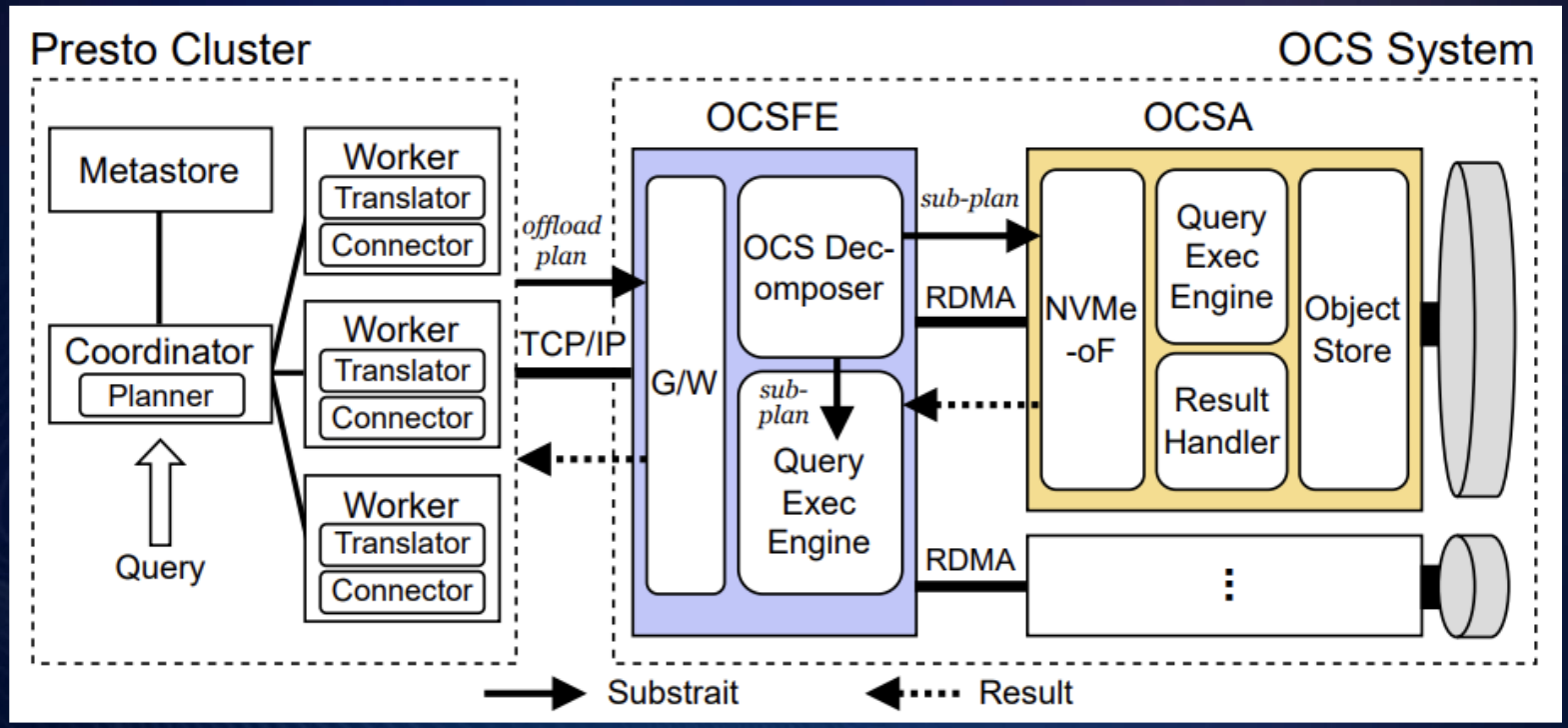
Pushdown Decision Maker at Presto Level



- Pushdown Decision Maker at Presto(Analytics platform) level
  1. Connector-level pushdown decision maker
  2. Connector-level Substrait translator

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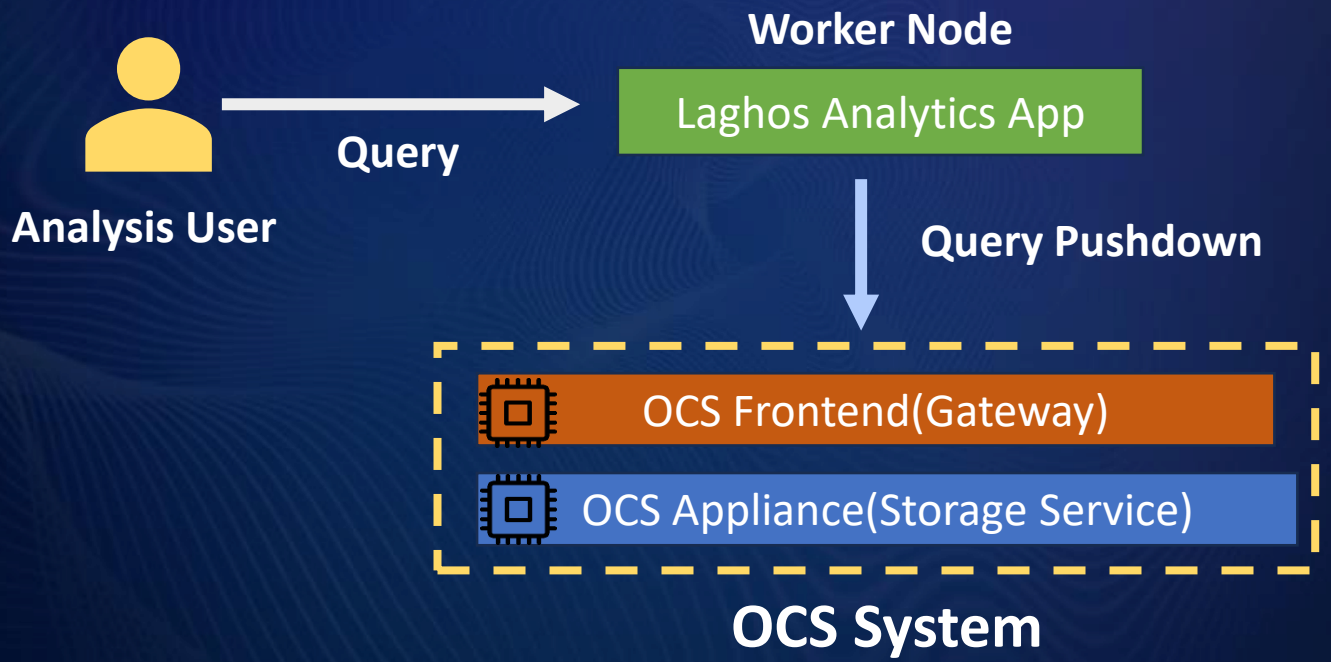
Preliminary Results

Laghos sample query and dataset are used for evaluation**[3].**

Laghos[4] is hydrodynamics simulation miniapp with unstructured mesh, 2D and 3D elements.



[3]Lanl-Ocs, “Sample Laghos dataset for system prototyping and benchmarking,” GitHub. https://github.com/lanl-ocs/laghos-sample-dataset
[4] Ceed, “GitHub - CEED/Laghos: High-order Lagrangian Hydrodynamics Miniapp,” GitHub. https://github.com/CEED/Laghos

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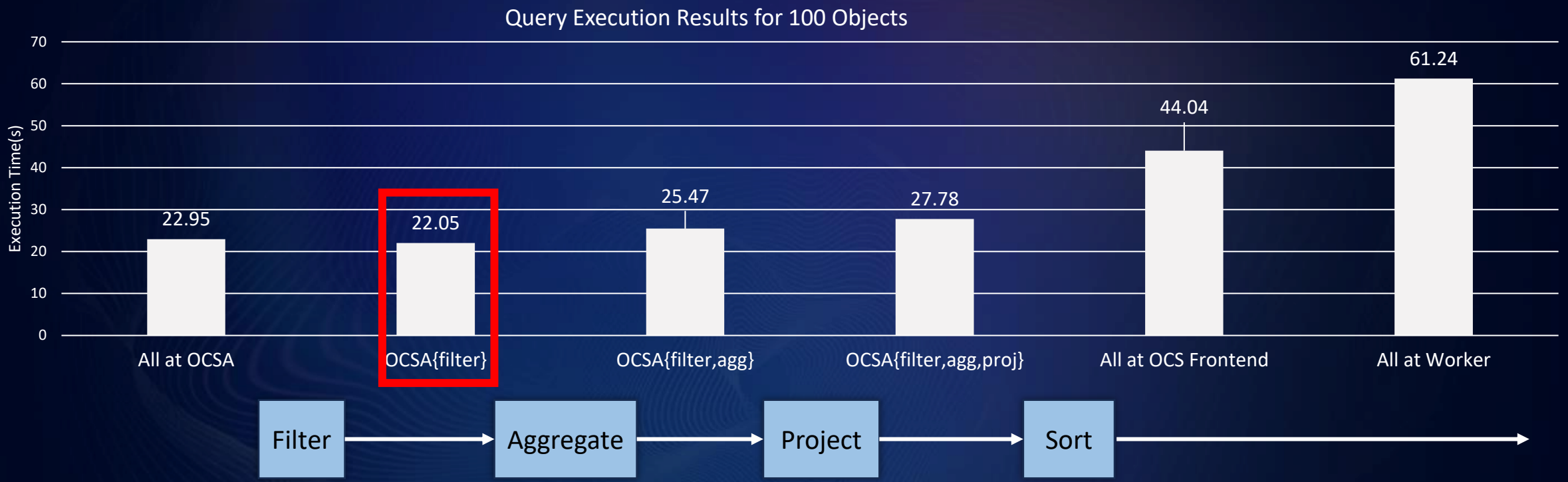
Preliminary Results



- Results with varying query decomposing point shows that vertically pushdown inside the OCS system can be effective.
- **Ongoing work**
  - **Evaluation**) Scientific queries with more computation cost
  - **Implementation**) Presto integration with the OCS system
    Reinforce cost-based algorithm

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