Vallum: Database Privacy, Confidentialy and Access Rights for Sensitive Data in Cloud Environments

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INTRODUCTION

- **Sensitive data** management and protection is a growing concern. Examples of such data are medical records, biometric data, buyer information, query logs and even business-related information.
- In cloud environments there is no external control on who has **physical access to the infrastructure**, or whether there are no security flaws in the software stack.
- It is essential to guarantee that no unwanted third party has access to sensitive data, i.e., to provide secure **access control.** In many times, in **multiple granularities.**
- Even when compliant to access restrictions, sensitive data might also have **privacy constraints**, i.e., identification of data subjects.
- Even with data encryption at rest, during main memory processing sensitive data is **vulnerable** to main memory sniping.

THREAT MODEL

Infrastructure Level Adversary

- Controls software stack.
- RAM Manipulation and Reading.
- May have physical host access.
- Is not able to decrypt TLS connection

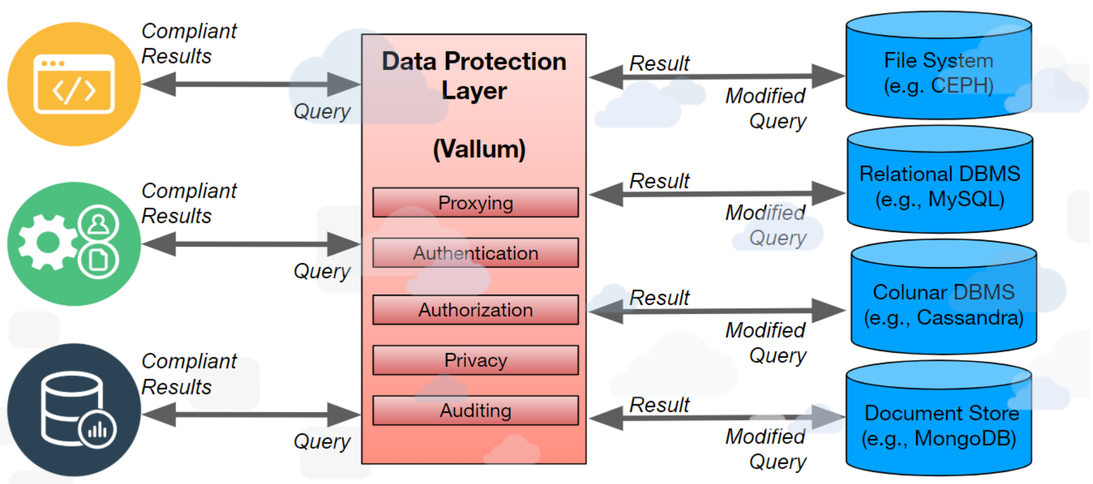
May read or modify sensitive data through main memory attacks

User Level Adversary

- Has valid credentials.
- No abnormal control over system or host
- Has total control over client side.
- May have the highest credentials in the system.

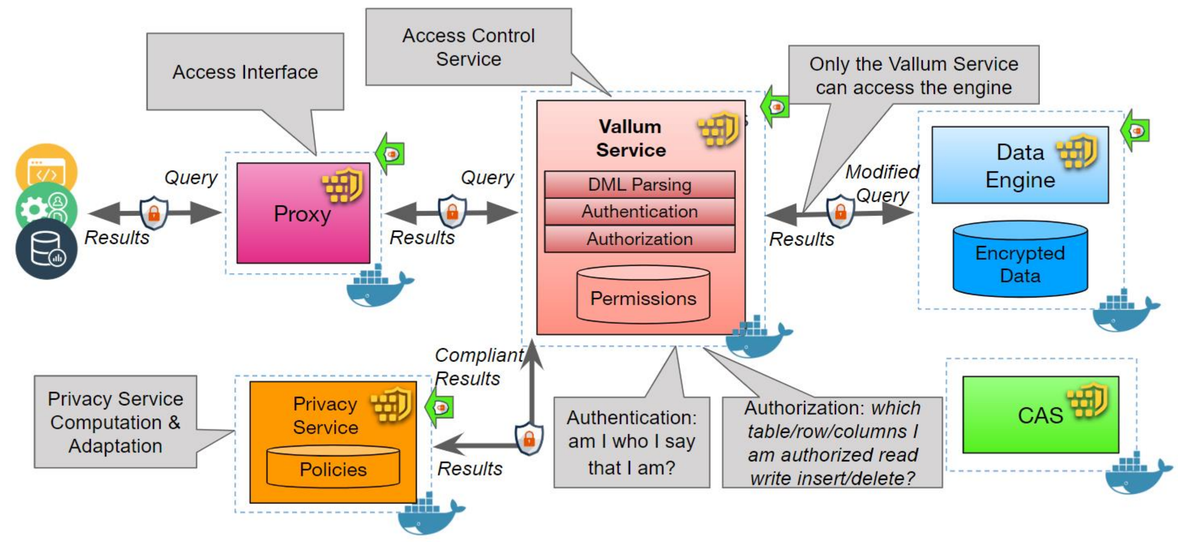
May access private data through the use of finely-crafted queries

VALLUM



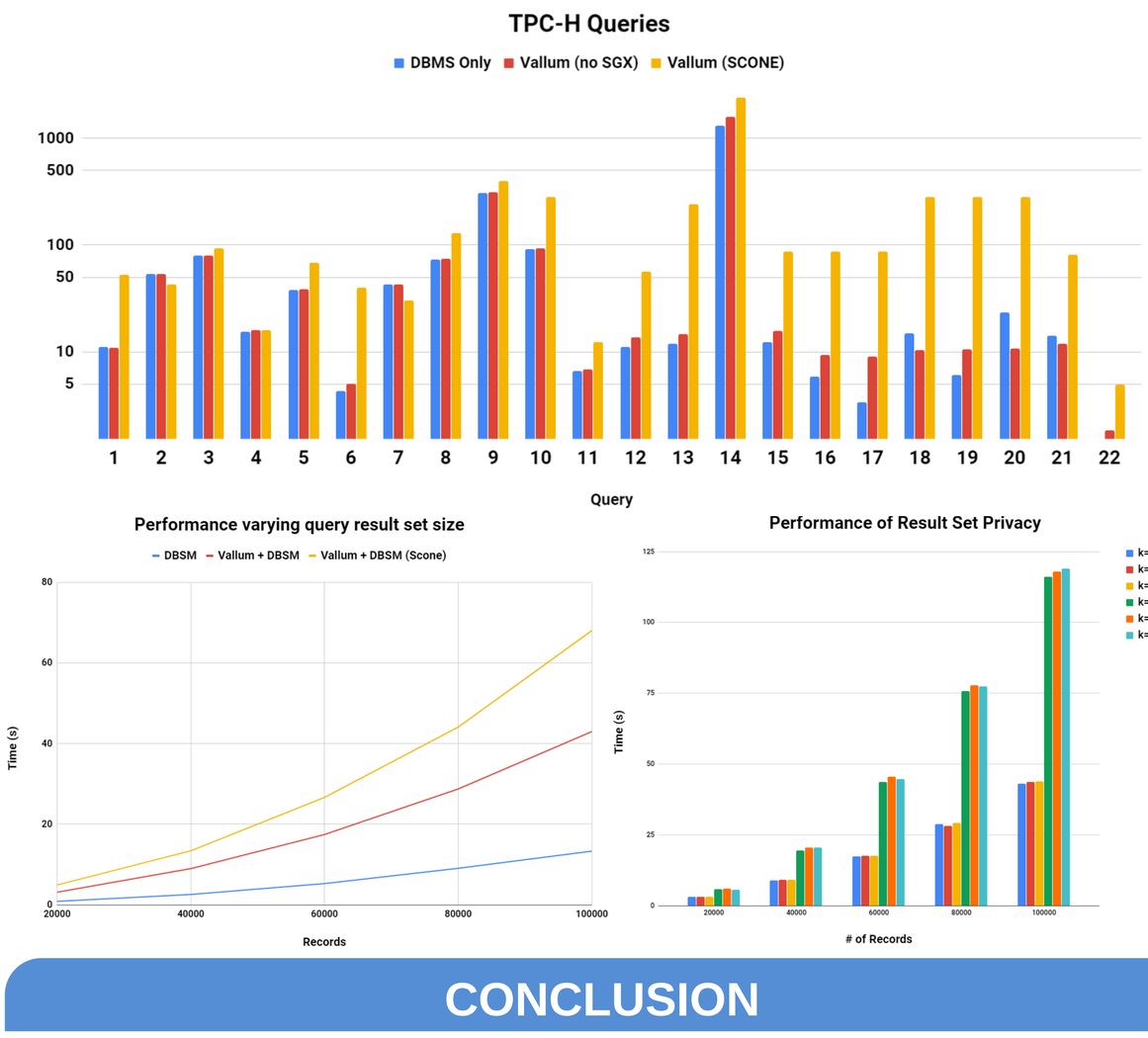
- **Data processing protection layer,** where the users communicate with the layer instead of directly with the data source.
- **Isolating the data source**, by guaranteeing that it only accepts queries from Vallum.
- All communications between modules done through secure TLS connections.
- Vallum is responsible for:
  - Verifying if user has valid credentials.
  - Verifying whether the user is **authorized** to perform the query.
  - **Modifying** issued query for compliance with **access constraints**.
  - Verifying if the query results are compliant to **privacy constraints** (k-anonymity, l-diversity, among others).
  - **Modifying** query results in order to comply to privacy constraints
- In order to guarantee that sensitive data is not vulnerable for a infrastructure level adversary, during this processing, all modules will be run in **SGX enclaves [1]**.
  - Guaranteeing that they are safe from memory-sniping attacks.
- Implementation: **SCONE Containers [2]**.

ARCHITECTURE



PERFORMANCE EVALUATION

- Experiments to evaluate the impact of using Vallum in system performance:
  - **TPC-H** queries to show impact on different queries.
  - Varying **result set size. S**how the impact of memory usage on the enclave.
  - Secure result set modification for privacy compliance, regarding varying levels of k-anonymity.
  - Tested methods: DBMS only (not secure), Vallum without SGX, Vallum on SCONE containers (SGX).



CONCLUSION

- Vallum is a trustworthy method to process sensitive data.
  - It isolates the user from data processing, assuring that no access or privacy constraints are violated
  - Its use of SGX Enclaves via SCONE containers protects the sensitive data against memory sniping and other physical-access based attacks,
  - Those protections come at a cost on extra computational time, however our experiments show that those are non-prohibitive.

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