

A Zero-Trust National Framework for Modular OMOP ETL Deployment and Scalable Analytical Execution in Portugal

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Background

Portugal’s universal healthcare system generates highly heterogeneous clinical data, creating an ETL engineering bottleneck for distributed research^{1,2,3}. Reframing ETL as a portable, version-controlled artifact within a zero-trust framework, enables scalable, real-world evidence generation while ensuring patient-level data on-premises.

Methods

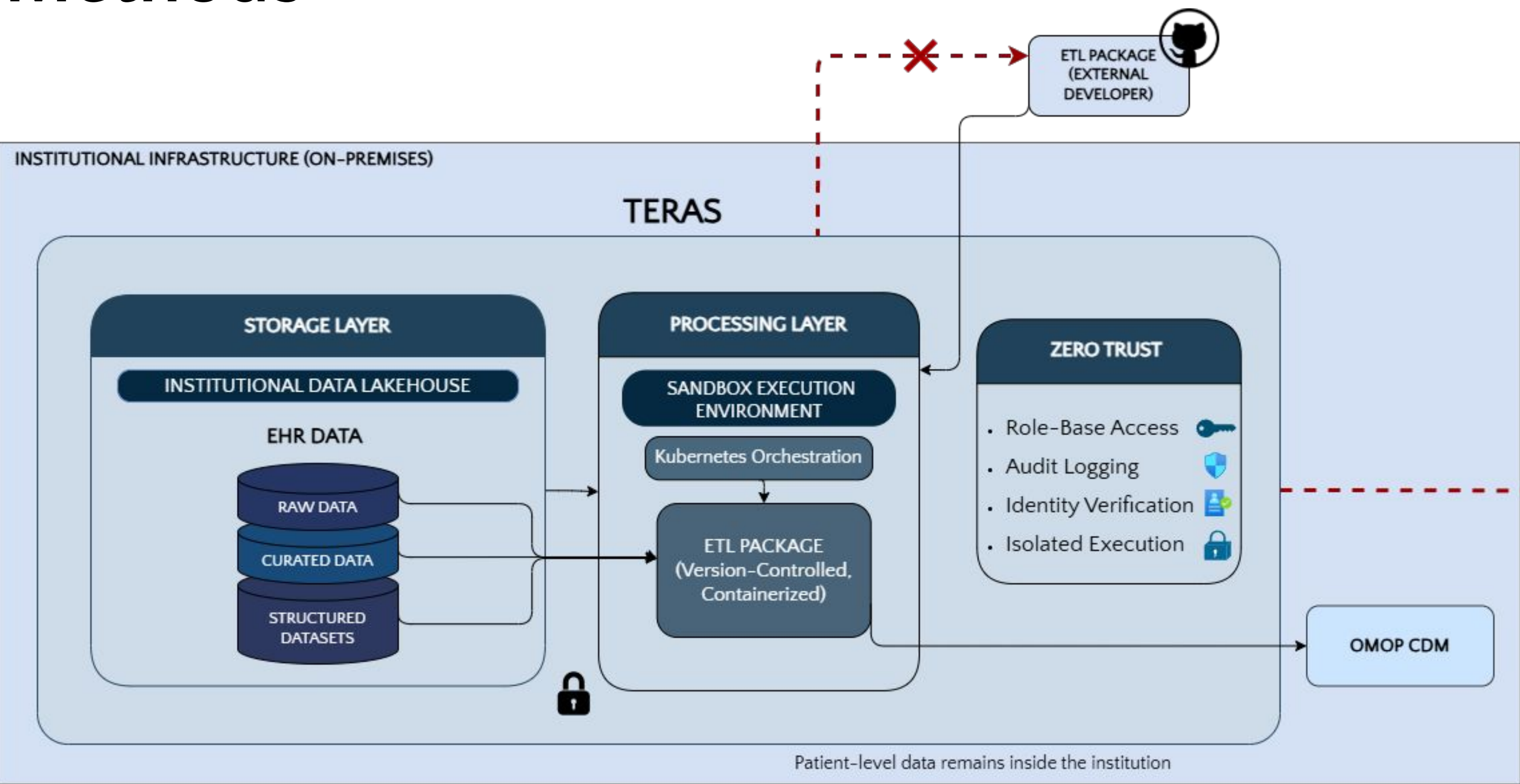


Figure 1. Modular ETL execution within the institutional zero-trust infrastructure.

- **Local Deployment:** Version-controlled, containerised ETL packages are deployed directly to the institution's infrastructure.
- **Zero-Trust Execution:** Packages run locally within an isolated sandbox environment.
- **In-House Transformation:** EHR data is safely transformed into OMOP CDM.
- **Guaranteed Privacy:** Controls ensure that no patient-level data is exported.

Results

High Adoption: 612 automated re-execution ETL cycles completed across 9 distinct source systems (Hospital, Lab, Pharmacy, etc.).

Regional Maturity: The North and Center regions drive 85% of executions (519 total) and have produced 11 studies.

National Impact: 15 completed studies, 30 authorized, and 11 new Local Health Units (ULS) currently onboarding.

Evolution: Shifted from isolated deployments to a continuous, reproducible framework since Q3 2025.

Table 1. Deployment status of modular ETL packages and OMOP-based analytical activity in Portugal, since the third quarter of 2025

	Total
Healthcare institutions (ULS) with Infrastructure Setup	21
Hospitals covered	39
Primary care centers (USF) covered	356
Population covered (estimated)	6.3–7.1M
ETL executions completed	612
OMOP-based studies executed	15
OMOP-based studies authorized	33

ETL: Extract-Transform-Load; M: Millions; OMOP: Observational Medical Outcomes Partnership; ULS: Unidade Local de Saúde; USF: Unidade de Saúde Familiar

Conclusion

The Portuguese experience demonstrates that modular ETL deployed through automated zero-trust pipelines enables scalable OMOP transformation without data extraction or external patient-level access.



References

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