Blog Post 1: Architecting the PANTHEON Secure Data Repository

Introduction In the realm of Smart City Digital Twins, the visualization layer often gets the glory, but the Data Persistence Layer (Layer 1) does the heavy lifting. Under Work Package 7 (Task 7.4), the PANTHEON project has developed a federated Secure Data Repository designed to support Disaster Risk Management (DRM) for two of Europe's most distinct urban environments: the seismic and fire-prone landscape of Athens/Attica, and the heat-island and infrastructure-dense city of Vienna.

The Scope: Beyond Simple Storage This isn't just a database; it's a high-throughput infrastructure managing over 1,000 heterogeneous datasets. It serves as the single source of truth for the entire PANTHEON ecosystem, enabling simulations that range from immediate response (seconds) to strategic planning (72-hour horizons).

- Geographic Scale: From the 2,500 km² expanse of Attica (23.3°E–24.0°E) to the dense 415 km² urban core of Vienna.
- Temporal Scale: Integrating historical climate data (ERA5 from 1979) with sub-second real-time sensor feeds.

The Federated Architecture The repository rejects a monolithic approach in favor of a federated architecture. This means different types of data are stored in engines optimized for their specific characteristics, all unified under a single API and security layer:

1. PostgreSQL/PostGIS: For structured and geospatial vector data.
2. MinIO: For massive unstructured objects (satellite imagery, simulation logs).
3. Neo4j: For complex relationship graphs (critical infrastructure dependencies).
4. Apache Kafka: For real-time data streaming and event-driven architecture.

Why This Matters By placing the Secure Data Store at the foundation (L1), PANTHEON decouples data storage from processing. This ensures that whether a simulation is running a smoke dispersion model or calculating an evacuation route, it pulls from a consistent, validated, and secure dataset, ensuring the "Digital Twin" remains an accurate reflection of reality.