Blog Post 5: The Engine Room – Technical Infrastructure & Performance

Choosing the Right Tools The PANTHEON repository employs a hybrid, polyglot persistence layer. We chose specific technologies to solve specific problems regarding data shape, size, and access speed.

1. PostgreSQL & PostGIS (The Structured Core)

- *Purpose:* Stores metadata, structured logs, and vector geometries.
- *Why:* We need ACID compliance (Atomicity, Consistency, Isolation, Durability) to ensure that critical transaction data—like an evacuation order—is never lost or corrupted. PostGIS provides the advanced spatial indexing (R-Trees) needed for fast geospatial queries.

2. MinIO (The Heavy Lifter)

- *Purpose:* S3-compatible object storage for large unstructured files.
- *Why:* Satellite imagery (GeoTIFFs), drone video logs, and massive simulation JSON dumps are too heavy for a relational database. MinIO allows us to store these efficiently while keeping them accessible via simple APIs.

3. Neo4j (The Graph Mapper)

- *Purpose:* Modeling infrastructure interdependencies.
- *Why:* In a Cyberattack scenario, understanding the *relationship* between assets is key. Neo4j allows us to query complex topologies (e.g., "Find all hospitals dependent on Substation Alpha") much faster than SQL joins.

4. Performance Metrics This architecture enables high-performance data retrieval critical for emergency response:

- Fire Propagation: Processed in < 10 seconds.
- Smoke Plume Modeling: Processed in ~1 second.
- Explosion Impact: Processed in ~30 seconds.
- Heatwave Allocation: Processed in 2–3 minutes (due to complex demographic/capacity optimization algorithms).