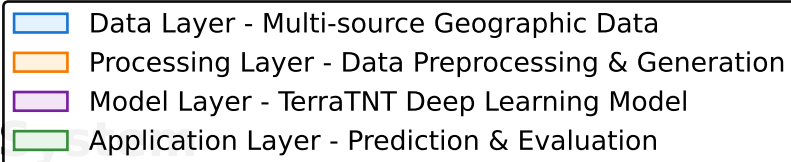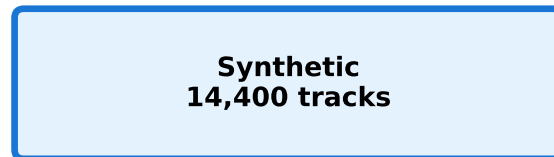# TerraTNT: Environment-Constrained Ground Target Trajectory Prediction
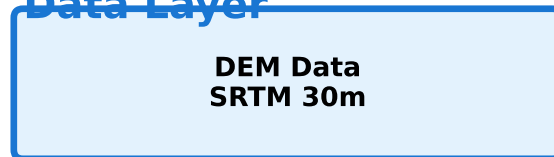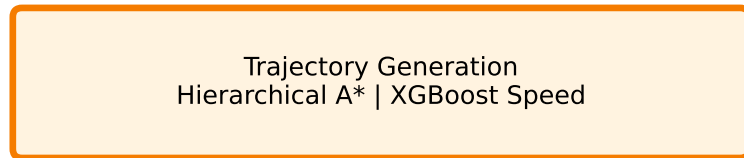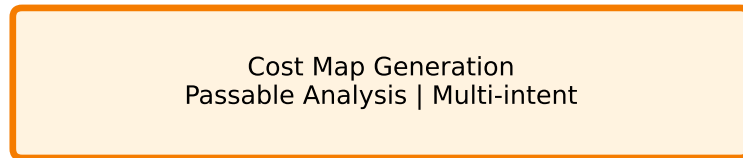
Key Features

✓ Multi-region

✓ Parallel

✓ GPU Accel.

✓ Real-time

✓ Scalable
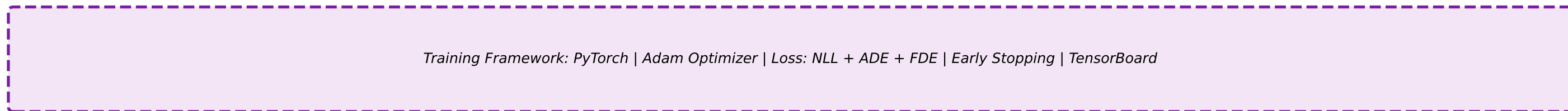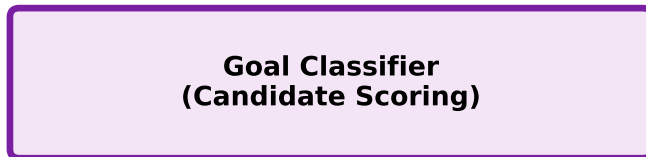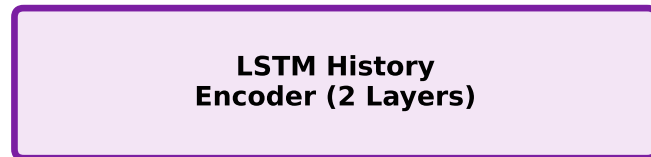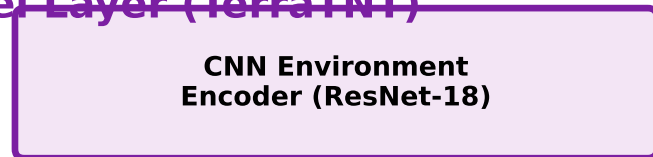
Data Layer

| **DEM Data** SRTM 30m | **LULC Data** ESA WorldCover | **OSM Roads** 6 Countries | **OORD Tracks** Real Data | **Synthetic** 14,400 tracks |

Processing Layer

| Environment Preprocessing Projection \| Terrain Features | Cost Map Generation Passable Analysis \| Multi-intent | Trajectory Generation Hierarchical A* \| XGBoost Speed | Data Augmentation 18-channel Maps \| Train/Val/Test |

Model Layer (TerraTNT)

| **CNN Environment** Encoder (ResNet-18) | **LSTM History** Encoder (2 Layers) | **Goal Classifier** (Candidate Scoring) | **LSTM Decoder** (Hierarchical) |

Training Framework: PyTorch | Adam Optimizer | Loss: NLL + ADE + FDE | Early Stopping | TensorBoard

Application Layer

| **Prediction Service** Real-time \| Batch Processing | **Visualization Interface** Map Display \| Comparison | **Evaluation System** ADE/FDE \| Ablation Study |

User Interface: Web Dashboard | REST API | Command Line Tools