**🛤️ PHASED ROADMAP: NON-VC SIMULATION OF SELECTED SWISS ROUTES**

**Phase 1: Real-World Route Selection (✅ Completed)**

**Goal: Identify real-world Swiss railway routes (IC/IR only) to simulate in SUMO.**

**Steps Taken:**

* **✅ Extracted GTFS route summary using extract\_routes\_from\_gtfs.py**
* **✅ Filtered high-frequency IC/IR candidates using select\_top\_ic\_ir\_routes.py**
* **✅ Selected 3 InterCity + 2 InterRegio routes for simulation**

**Inputs:**

* **GTFS files from: data/raw/swiss/gtfs\_ftp\_2025/**
* **Cleaned summary: data/processed/routes/cleaned\_routes\_summary.csv**

**Next Output Goal:**

* **List of 5 selected route IDs and corresponding trip IDs**
* **Extract full stop sequences (origin → destination) for each**

**Phase 2: Route Data Extraction for Simulation**

**Goal: Extract stop sequences, times, and trip metadata for the selected routes**

**Tasks:**

* **Extract from stop\_times.txt, trips.txt, and stops.txt**
* **Match selected route\_id values with corresponding trip\_id**
* **For each trip, get ordered stop sequences, stop IDs, station names, and optionally times**

**New Script to Create:**

* **📄 extract\_selected\_routes\_data.py**

**Inputs:**

* **GTFS files:**
  + **stop\_times.txt**
  + **stops.txt**
  + **trips.txt**
* **Selected routes from Phase 1**

**Expected Outputs:**

* **data/processed/routes/selected\_route\_stop\_sequences.csv (trip\_id, stop\_id, stop\_name, arrival\_time, departure\_time, stop\_sequence)**
* **Optionally: Geo-coordinates for visualization/debug**

**Phase 3: Generate SUMO Route (.rou.xml) Files**

**Goal: Simulate randomized train traffic for selected routes**

**Features:**

* **Assign randomized but realistic vehicle types (based on SBB train formation data)**
* **Use randomized stop dwell times (e.g., 30–90 sec range)**
* **Optionally randomize departure times across the day**

**New Script to Create:**

* **📄 generate\_randomized\_sumo\_routes.py**

**Inputs:**

* **selected\_route\_stop\_sequences.csv**
* **Vehicle type definitions (existing or to be created in vehicle\_types.veh.xml)**
* **SUMO-ready net file: sumo/inputs/april\_2025\_swiss/april\_2025\_swiss.net.xml**

**Output:**

* **data/processed/routes/selected\_intercity\_routes.rou.xml**
* **data/processed/routes/vehicle\_types.veh.xml**

**Phase 4: Define KPIs and Run Non-VC Simulations**

**Goal: Define and collect Key Performance Indicators (KPIs) for non-VC simulation**

**Example KPIs:**

* **Travel time (per train)**
* **Stop delay (planned vs actual dwell)**
* **Occupancy simulation (optional)**
* **Network congestion metrics (if feasible)**
* **Train throughput**
* **Emissions (if vehicle types include diesel/electric distinctions)**

**New Scripts to Create:**

* **📄 define\_kpi\_metrics.py**
* **📄 run\_non\_vc\_simulations.py**
* **📄 analyze\_kpi\_outputs.py**

**Inputs:**

* **Route and vehicle files from Phase 3**
* **SUMO network**
* **SUMO simulation configuration file (.sumocfg) to be created dynamically**

**Output:**

* **outputs/kpi\_results/non\_vc\_kpis\_summary.csv**
* **Visualization plots (optional): emissions vs. time, average delays, etc.**

**📌 Master AI PROMPT to Continue from Here**

**I am working on a railway simulation project in SUMO as part of my PhD thesis titled “Analysis of Virtual Coupling in Operations Through Railway Networks.” I’ve completed the reconstruction of the full Swiss rail network in SUMO with human-readable node/edge names.  
Now I am entering the Non-VC Simulation Phase, where the goal is to simulate real-world Swiss intercity train routes before implementing Virtual Coupling (VC) later.**

**My current goal: Simulate selected real-world InterCity (IC) and InterRegio (IR) routes with randomized traffic parameters and collect KPIs.**

**Here's what I’ve already completed:**

1. **✅ Reconstructed full SUMO network (april\_2025\_swiss.net.xml) from SwissTNE data**
2. **✅ Extracted route summary from GTFS → cleaned\_routes\_summary.csv**
3. **✅ Selected 3 IC and 2 IR routes using select\_top\_ic\_ir\_routes.py**

**Now I want to proceed with:**

* **Phase 2: Extract full stop sequences for selected route IDs**
* **Phase 3: Generate .rou.xml route files with randomized stop dwell times and vehicle types**
* **Phase 4: Define meaningful KPIs and run SUMO simulations without virtual coupling**

**Please help me by:**

* **Writing all scripts to run locally in this directory: D:\PhD\codingPractices\progress-report-dec-2024\scripts\april\_2025\**
* **Ensuring all scripts are clean, modular, Pythonic, well-logged, and long-term maintainable**
* **Using inputs from: data/processed/routes/ and sumo/inputs/april\_2025\_swiss/**
* **Outputting all results to: data/processed/routes/ and outputs/kpi\_results/**

**Let's start from Phase 2 next if not done yet.**