

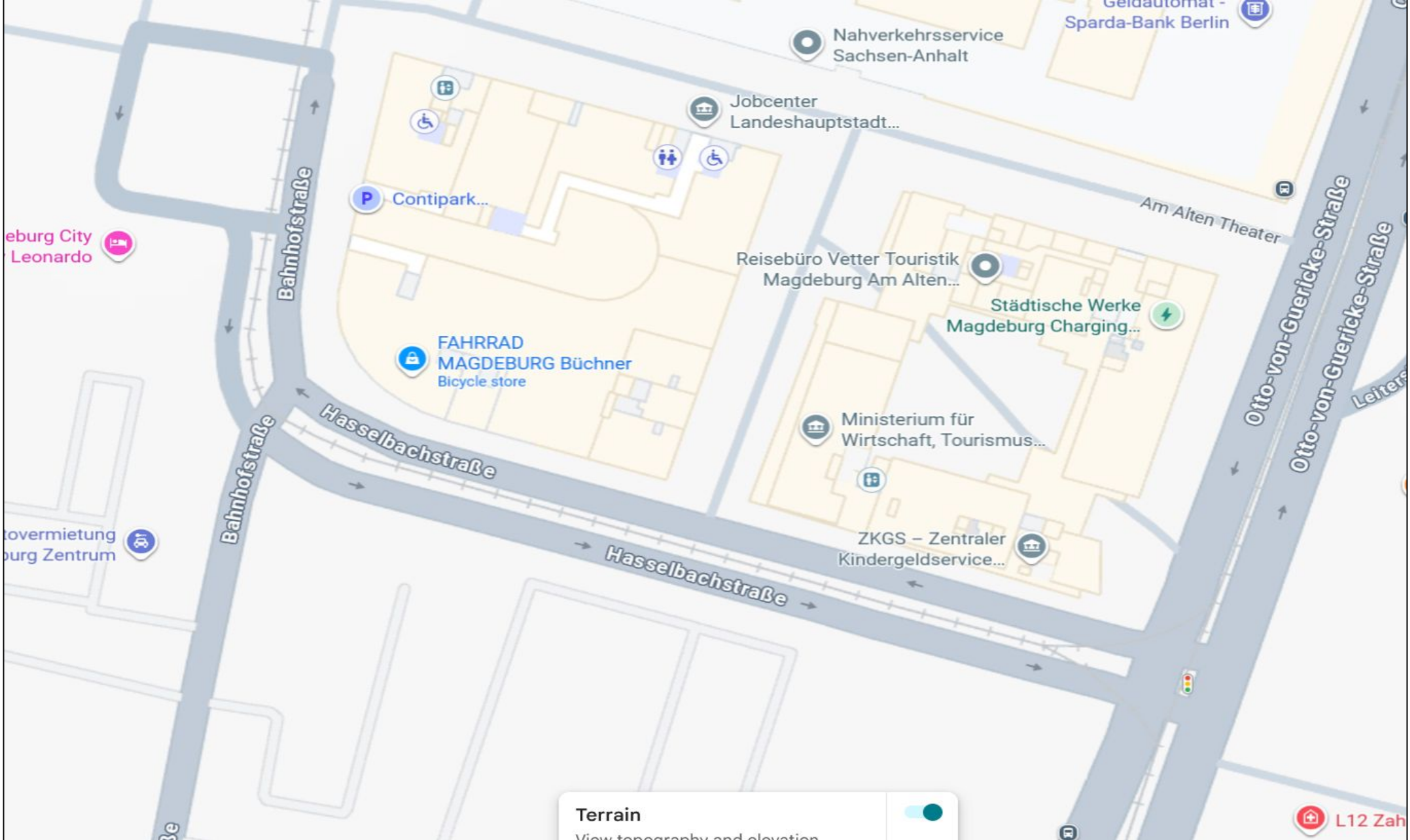


Simulation Project – Milestone III

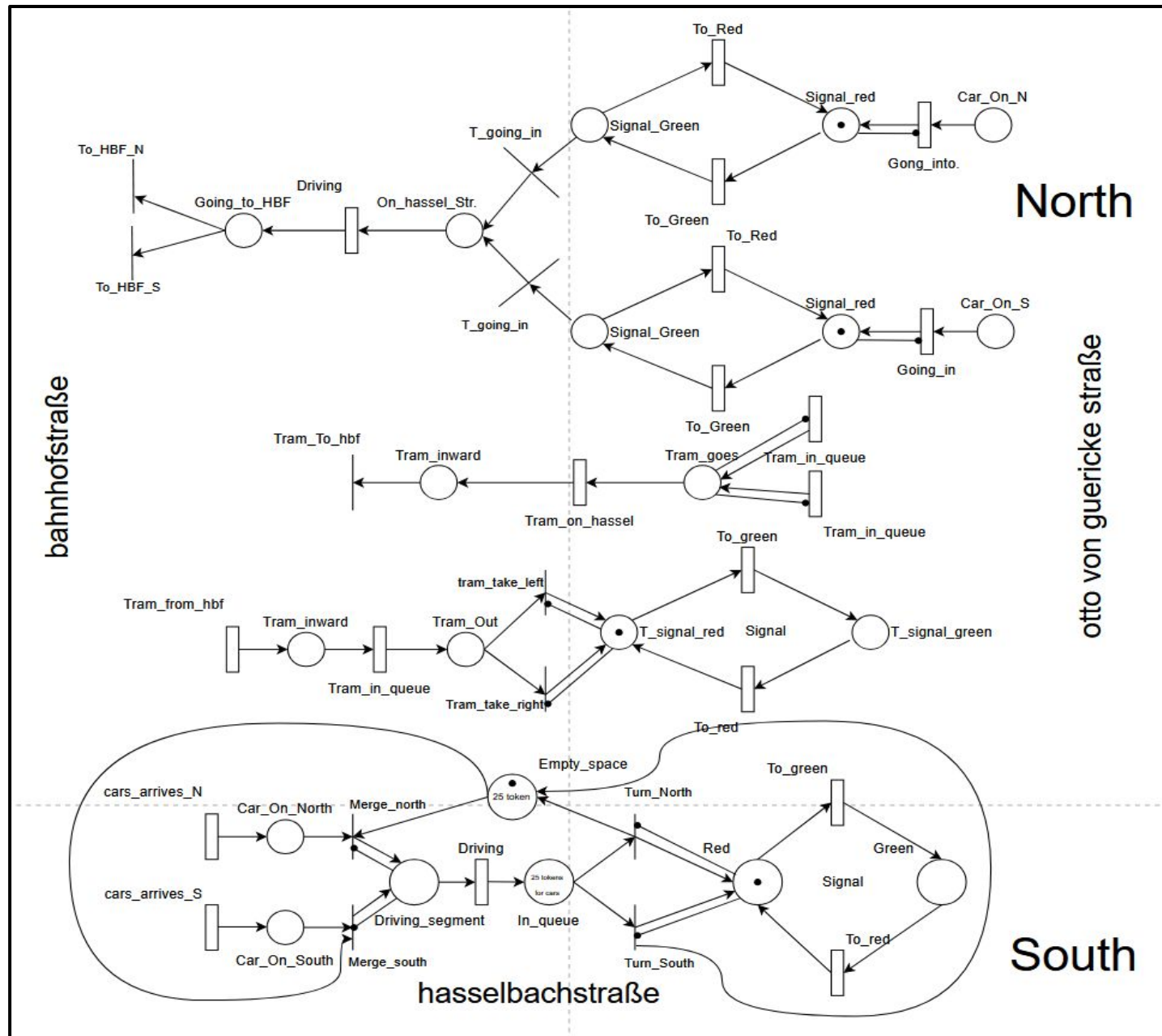
Team A



Zusammen die Welt
neu denken



PetriNet Model



Assumptions

- **Buses & trucks treated as cars (low share)**
- **Pedestrians excluded (non-conflicting signal phase)**
- **Parking & construction ignored (temporary effects)**
- **Trams not modeled separately (non-conflicting signal phase)**
- **Yellow phase ignored (negligible impact)**

Modeling System Events & Data Basis

System Events

- **Arrivals:** Cars (North/South) & Trams on track.
- **Merging:** North/South cars entering single lane.
- **Movement:** Driving Hasselbachstraße; Trams crossing.
- **Signals:** Traffic light transitions (Red/Green).
- **Exit/Routing:** Cars turning left or right.

System Events

Primary Events

- Car Arrivals
- Tram Arrivals
- Traffic Light Timers

Secondary Events

- Merging
- Waiting at signal
- Exiting

Modeling System Events & Data Basis

Underlying Distributions

Stochastic Modeling

- Car arriving

Time-less events

- Cars/trams turning left or right
- Cars merging into one lane

Empirical Data

- Signal timing
- Tram arrival frequency

Data Basis

- **Vehicle Counts:**
Raw hourly flow data (North vs. South).
- **Turning Ratios:**
Observational percentages of left vs. right turns.
- **Road Geometry:**
Hasselbachstraße length ÷ avg car length.
- **Signal Timings:**
On-site stopwatch recordings of light phases.

Experiment 1: Merging Two Lanes

Objective: Quantify the direct impact of lane reduction under current and projected demand.

Merge lanes to see the effect on the current scenario and projected vehicle increase.

Scenarios

- **S1.1:** Current layout (2 lanes)
- **S1.2:** Merged layout (1 lane)

Variables

Independent: Lane configuration

Dependent: Delay, queue length, throughput

Key Assumptions

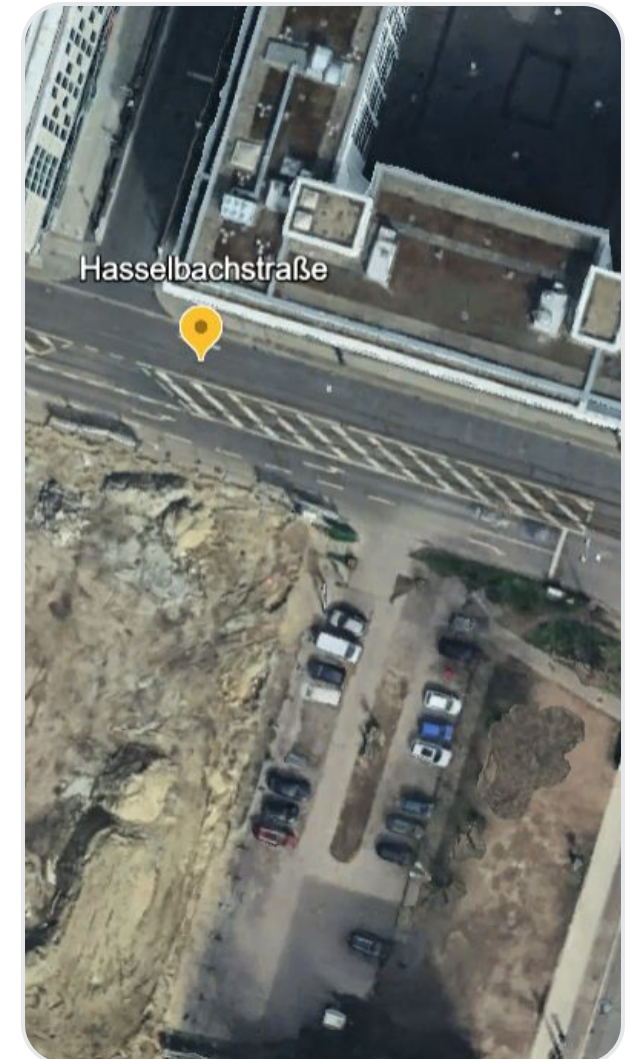
- No demand change except growth
- No buses
- Tram doesn't affect scenario

Expected Outcome

- Increased delay and queue length
- Higher probability of spillback

Insight Goal

Determine if merging alone causes system instability.



Experiment 2: Tweaking Traffic Signaling

Objective: Evaluate if signal optimization compensates for capacity loss.
Optimizing signal timings to decrease queue size and waiting periods.

Scenarios

- S2.1: Default signal
- S2.2: Increased green
- S2.3: Turning phase
- S2.4: Adaptive control

Variables

- Signal Timing:** Green time, cycle length
- Structure:** Phase structure

Key Assumptions

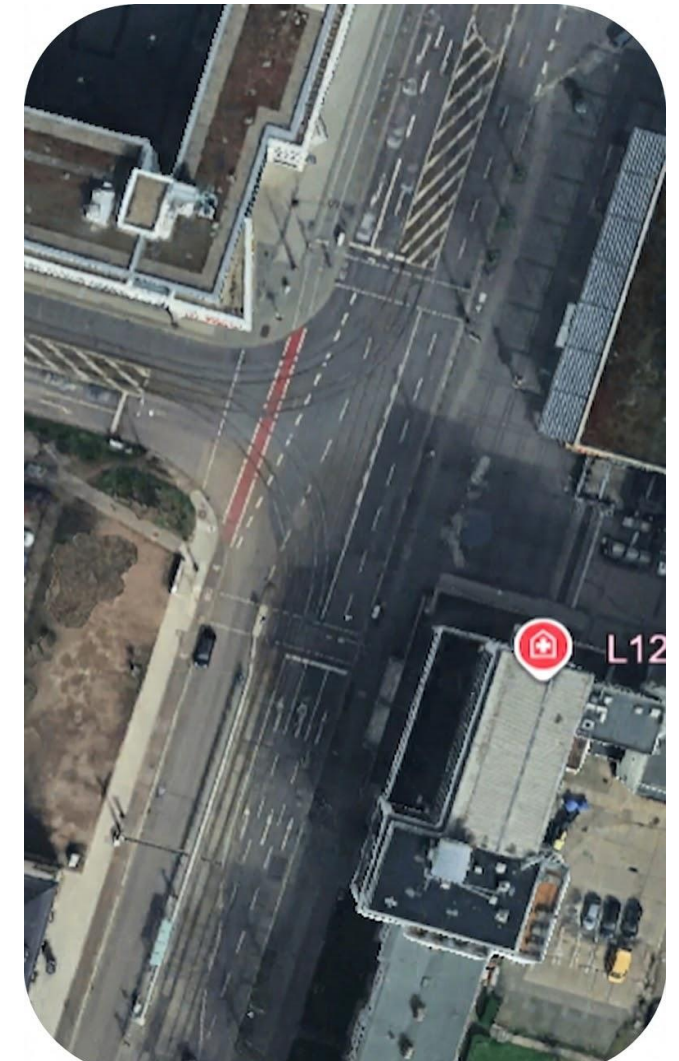
- Geometry unchanged (1 lane)
- Demand unchanged

Expected Outcome

- Reduced delay for turning traffic
- Trade-off: increased delay elsewhere

Insight Goal

- Measure how much capacity can be recovered via control.



Experiment 3: Time-Dependent Turn Restrictions

Objective: Reduce demand on merged lane during peak hours.
Restrict one of the turnings based on peak congestion times to reroute traffic via Bahnhofstraße.

Scenarios

S3.1: Left turn restriction

S3.2: Right turn restriction

Variables

Demand: Turning demand
(restricted vs allowed)

Key Assumptions

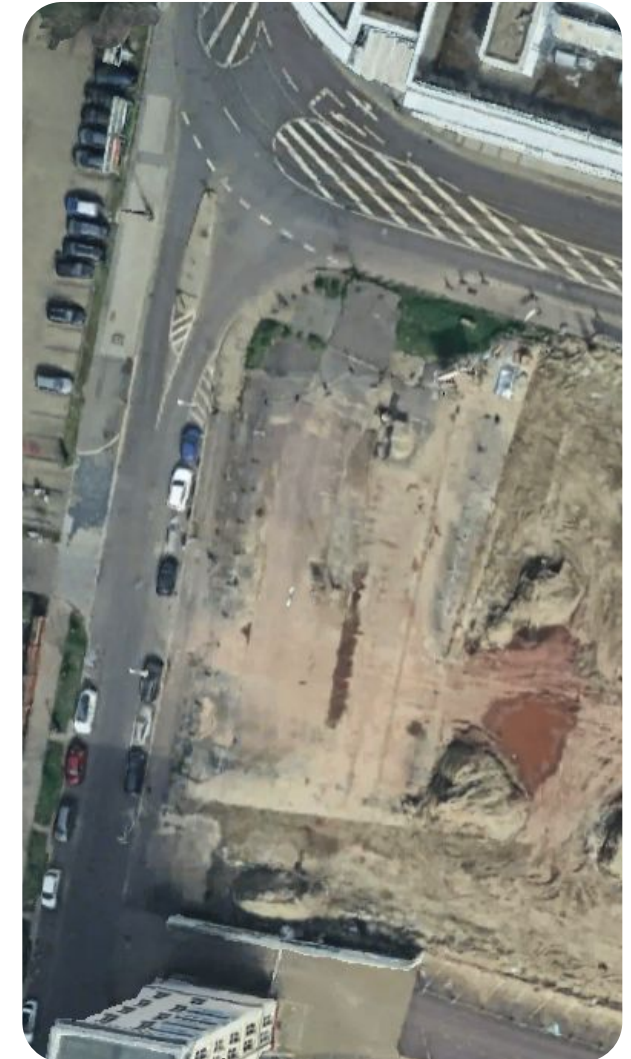
- Rerouted vehicles stay in network
- No signal changes
- No impact from trams

Expected Outcome

- Reduced congestion at intersection
- Better overall traffic flow

Insight Goal

Find the minimum restriction required to effectively stabilize flow.



Experiment 4: Roundabout

Objective: Evaluate a structural alternative to signal control.

Scenarios

S4.1: Signalized intersection (merged lane)

S4.2: Roundabout

Variables

Intersection control type

Key Assumptions

Trams modeled as priority interruptions

Single-lane roundabout (simplification)

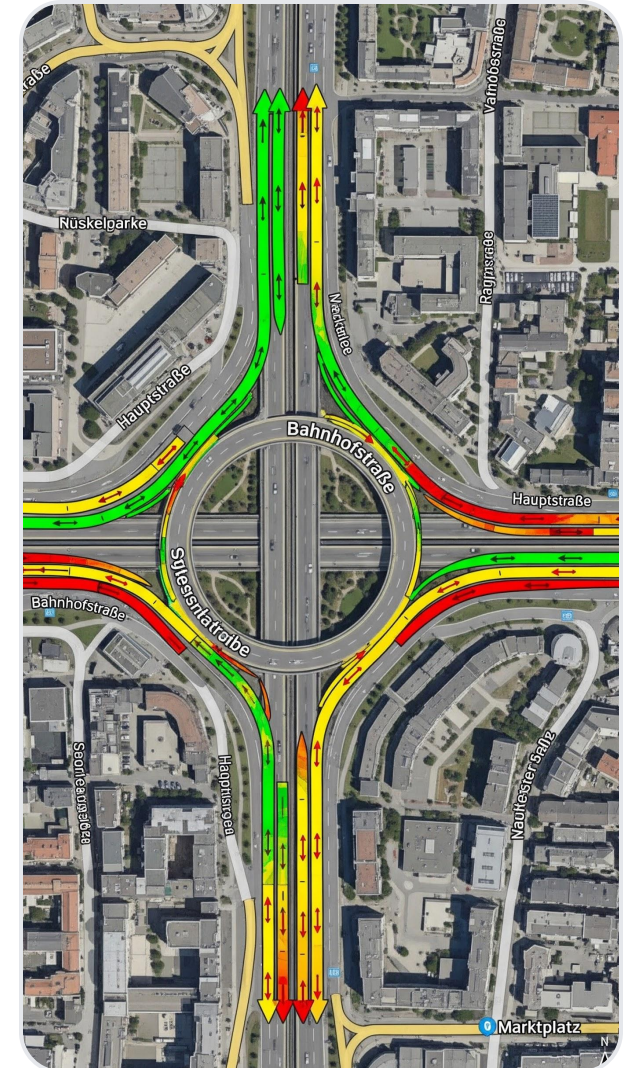
Expected Outcome

Better flow at moderate demand

Reduced performance under high demand due to pedestrian entry conflicts

Insight Goal

Assess feasibility of replacing signals with roundabout under constraints.



EXPERIMENT-SPECIFIC OUTPUTS

Exp 1: Merging Two Lanes

Additional Metrics:

- Capacity drop (%) (2 vs 1 lane)
- Queue growth rate & build speed

Key focus:

System breakdown after merge

Exp 2: Signal Tweaking

Additional Metrics:

- Green time utilization (%)
- Delay per movement (Turn vs Straight)

Key focus:

Trade-offs between movements

Exp 3: Turn Restrictions

Additional Metrics:

- Turning volume reduction (%)
- Rerouted traffic volume
- Network travel time

Key focus:

Demand reduction vs performance

Exp 4: Roundabout

Additional Metrics:

- Entry delay (gap acceptance)
- Circulation time inside
- Queue at each entry arm

Key focus:

Entry congestion vs continuous flow

Output Metrics

Primary

Average delay per vehicle
(s/veh)

Average queue length
(m or vehicles)

Maximum queue length

Throughput
(veh/hr)

Secondary

Number of stops per vehicle

Travel time through intersection

Spillback occurrence
(yes/no + duration)

Data Requirements

Traffic Demand Data

- Vehicle flow (veh/hr) per approach
- Turning movement proportions (% left/right/straight)
- Peak vs off-peak variation
- 2027 projected demand (+20% growth)

Public Transport

- Tram frequency (veh/hr)
- Tram priority rules

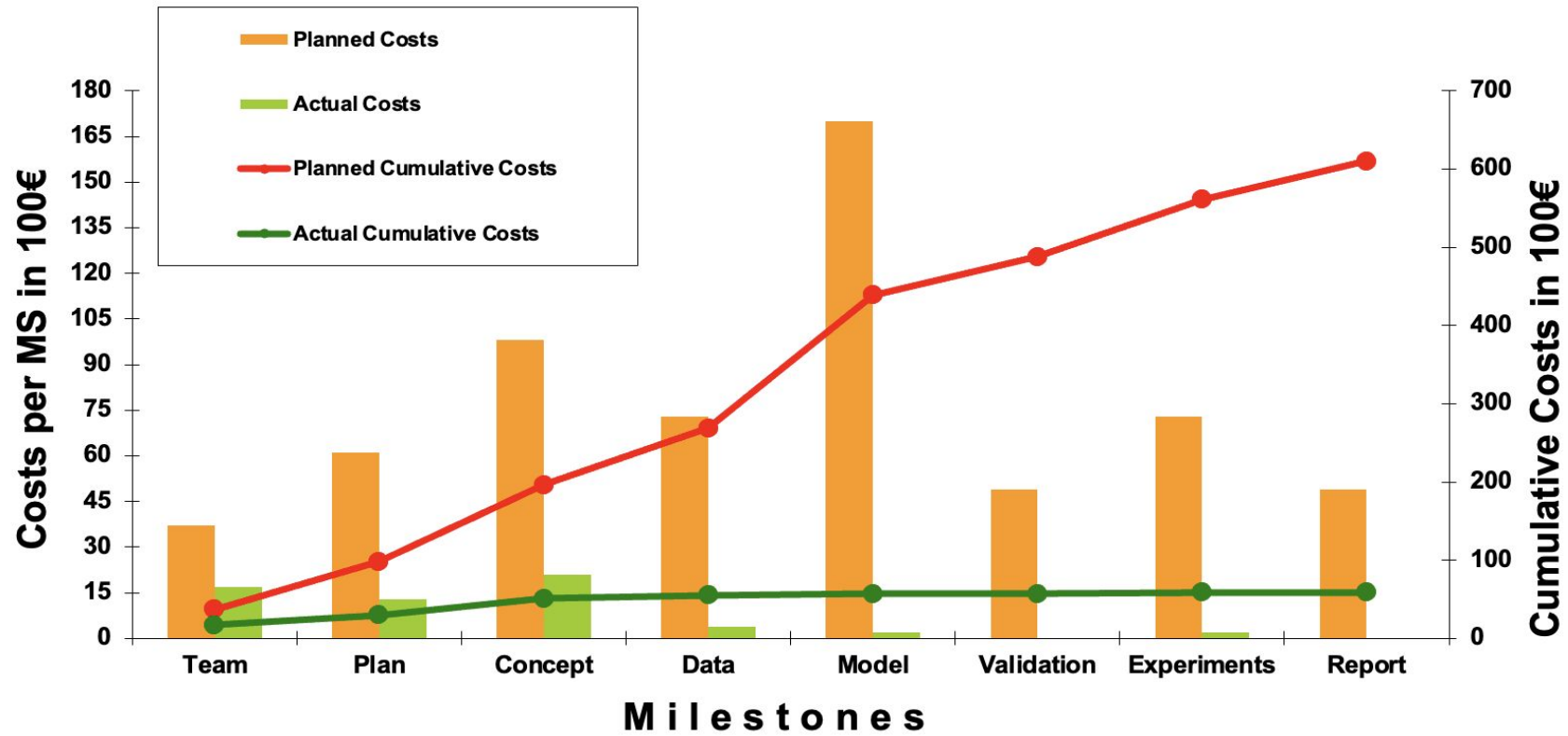
Geometric Data

- Number of lanes
- Lane lengths (turning pockets)
- Merge location and length
- Speed limits

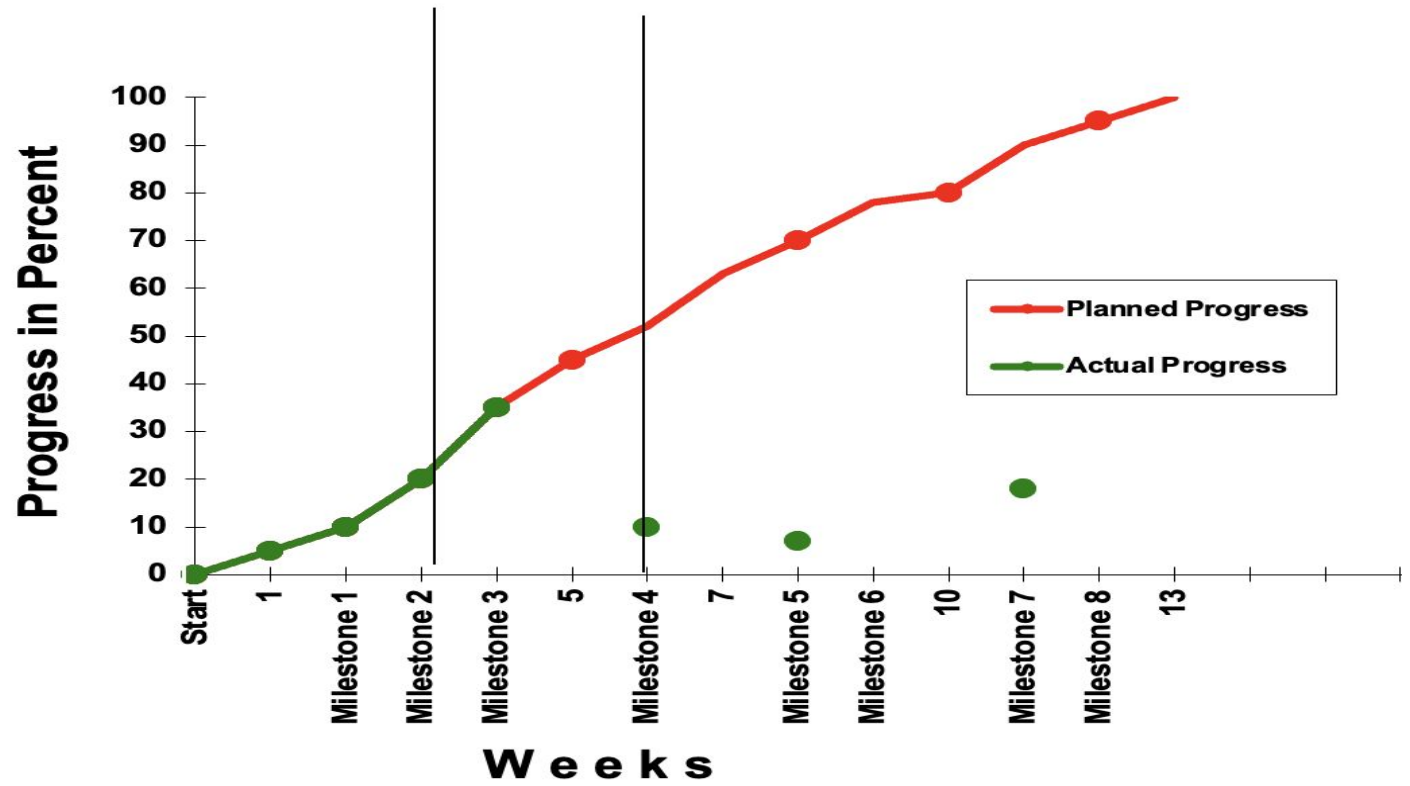
Signal Data

- Current signal cycle length
- Phase sequence
- Green/red times per movement

Cost Progress



Project Progress



Estimate of Future Milestone Completion

Milestone 4 - Data Analysis (20%)

- initial information on road layout, traffic flow, and system characteristics gathered.

Milestone 5 - Simulation Program(10%)

- Developed the basic model structure and initial setup in AnyLogic.

Milestone 6 - simulation experiments (10%)

- key experiment ideas defined and partially structured for implementation.

Milestone 7- Validation (0%)

- Work has not yet commenced

Milestone 8 - Final Report (10%)

- Project plan integration into the final reporting structure initiated.

