
Cockpit Perspective
60
"The Unintelligent Swarm"
Traffic oscillations in dynamic navigation
and how to circumvent them
P
R
N
D
S
353.8km
11.0°c
6328km
80
40
120
0
160
1560m
0:02:58
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Martin Treiber, TU Dresden

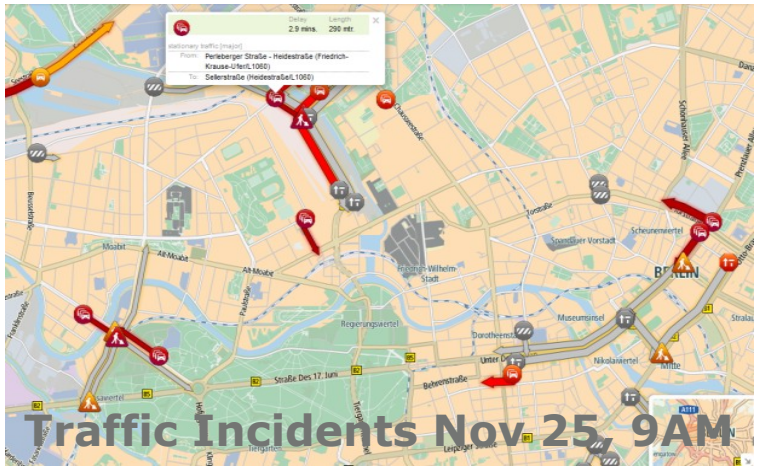
Who’s TomTom – What’s in Berlin?

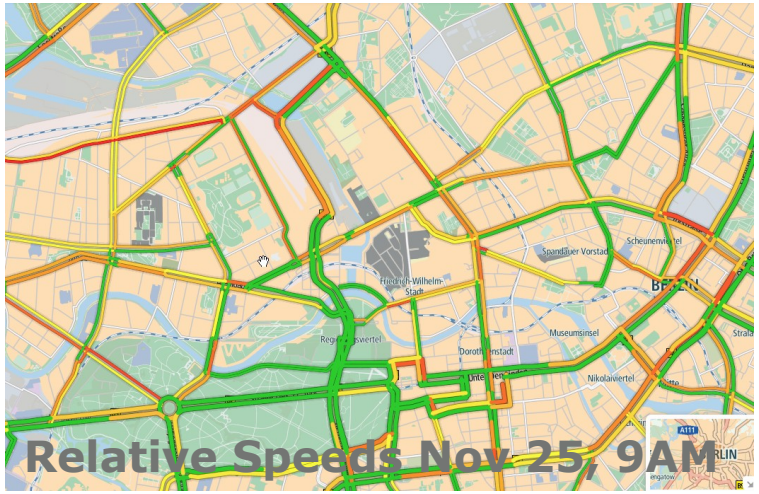
About 90 developers for Navigation and Traffic Information Software

Live Traffic Service for Dynamic Navigation

GPS data gathered from probe vehicles for real-time traffic infomation

1. Collect GPS data from probes
2. Match data to map for path and speed estimations
3. Traffic state estimation (instantaneous speed)
4. Delivery to clients for dynamic routing





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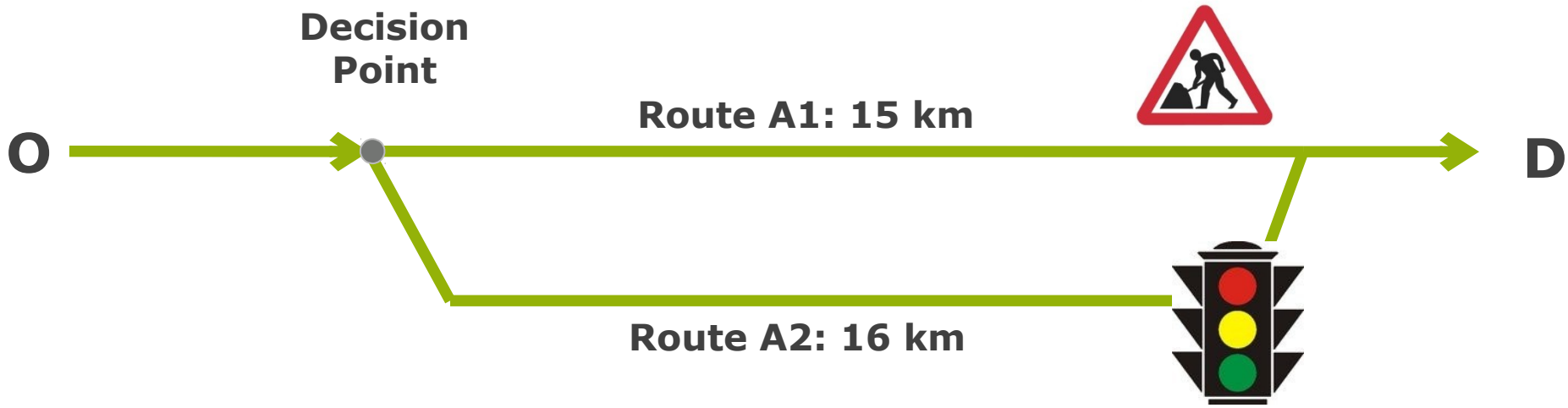
Feedback+Delay -> Routing Oscillations

Microscopic simulation of traffic dynamics and routing (worst-case scenario)



Traffic Demand

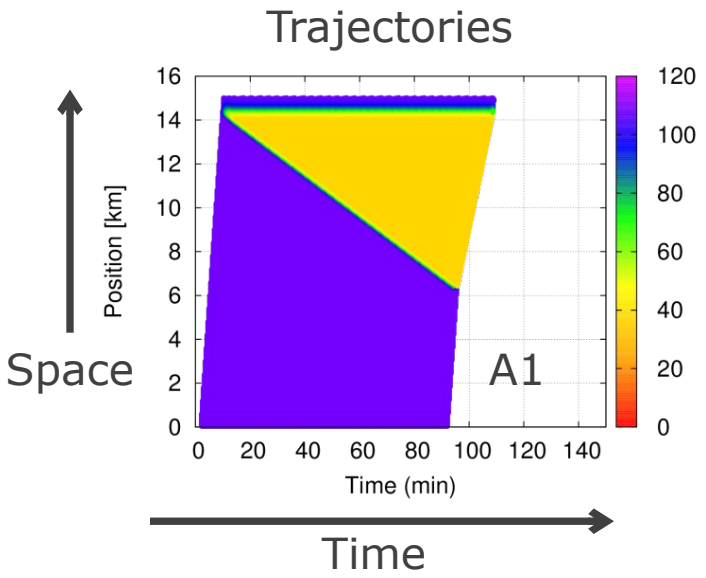
- 1800/h for 90 min
- Drop to 0 later

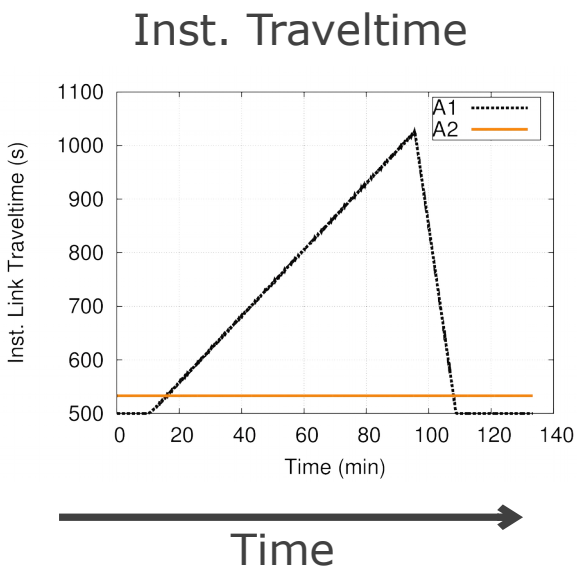
Service Provider Model

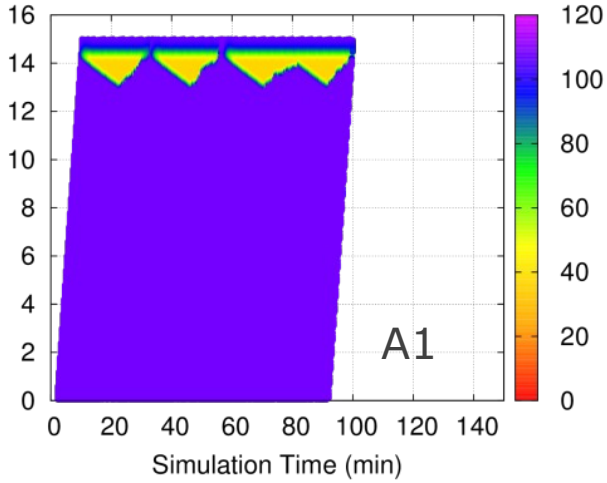
- Instantaneous speed estimation
- Default speed on all links 108 km/h
- Traveltime A1 ~ 8.3 min
- Traveltime A2 ~ 8.9 min

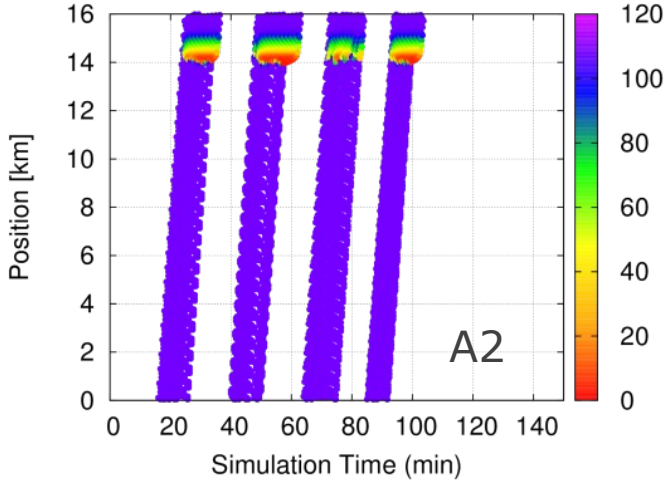
Small percentages beneficial for Traffic System

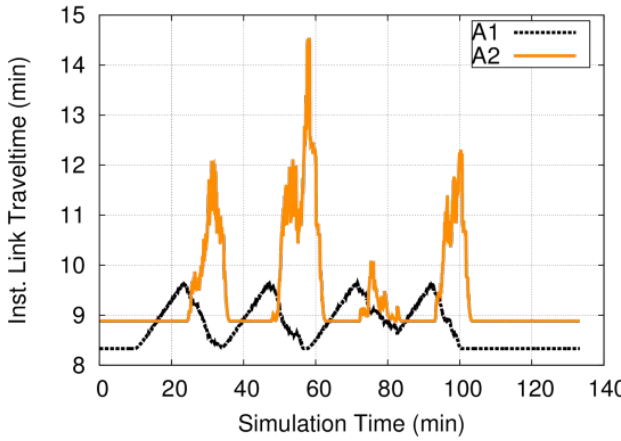
Simulations for **0%** and **20%** of vehicles receiving link traveltimes for routing











TomTom‘s Traffic Manifesto

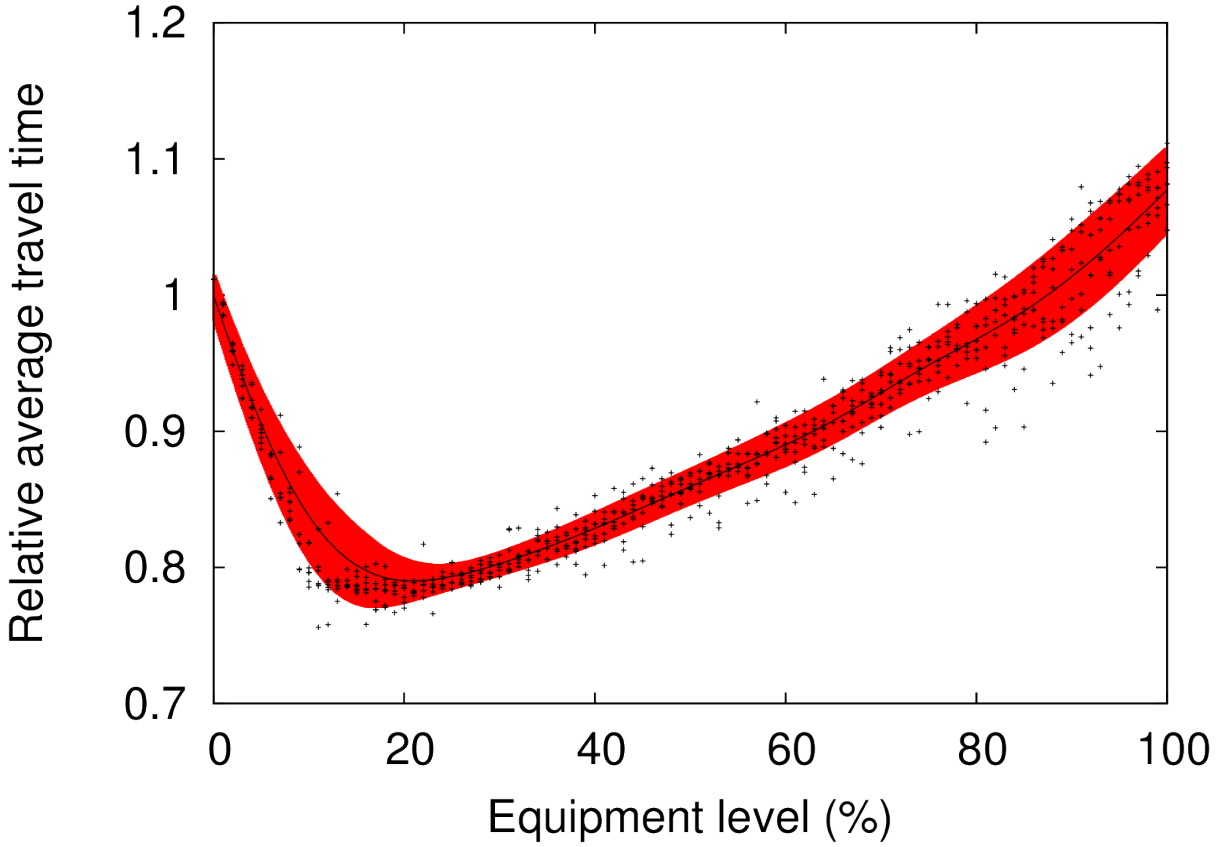
Visionary claim when launching TomTom Traffic in 2010

Harold Goddijn
Chief-Executive Officer

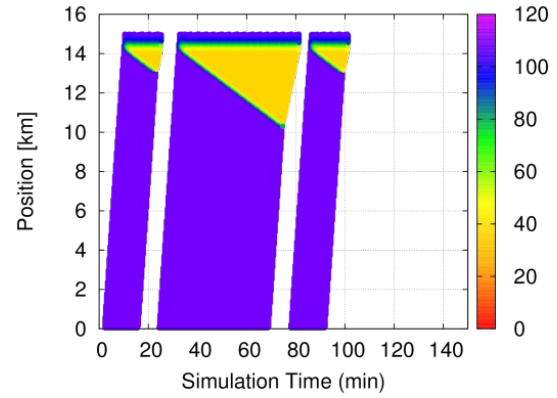
In the future, when **10% of drivers** use TomTom's HD Traffic™ navigation system there will be what experts are calling a '**collective effect**'. Essentially, our road networks will start to **balance out** and we will reduce traffic congestion for everyone.

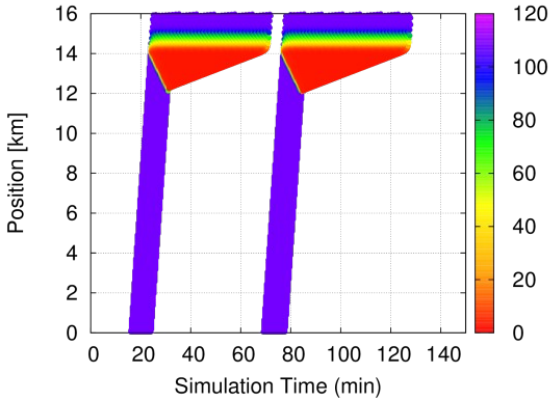
What happens for large Equipment Levels?

Information leads to **routing instabilites** in worst-case scenario



100% guided





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How to overcome Instability?

Load balancing strategies needed but system dynamics difficult to predict

Requirements for Load Balancing in Ideal World:

- All capacities in road network known
- Ability to predict *onset* of congestion in advance
- Server-side routing for individual route assignment
- Only one provider serving all drivers

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How to overcome Instability?

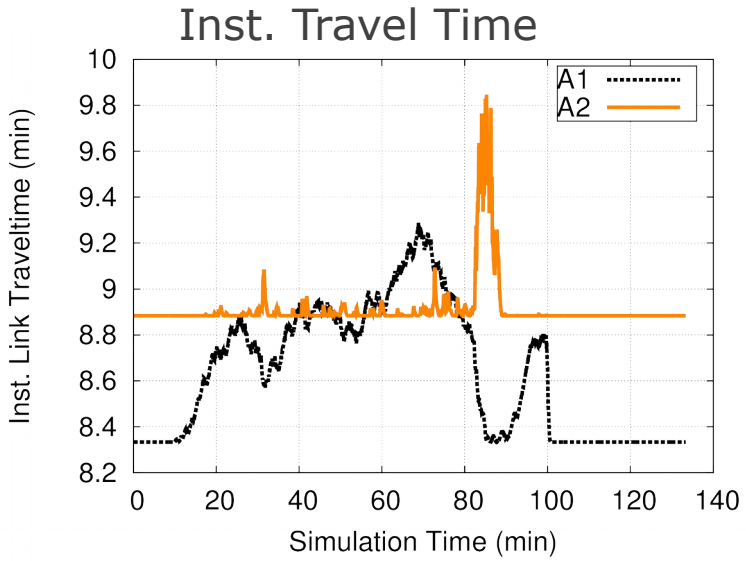
Stochastic route choice model based on Discrete Choice Theory (LOGIT)

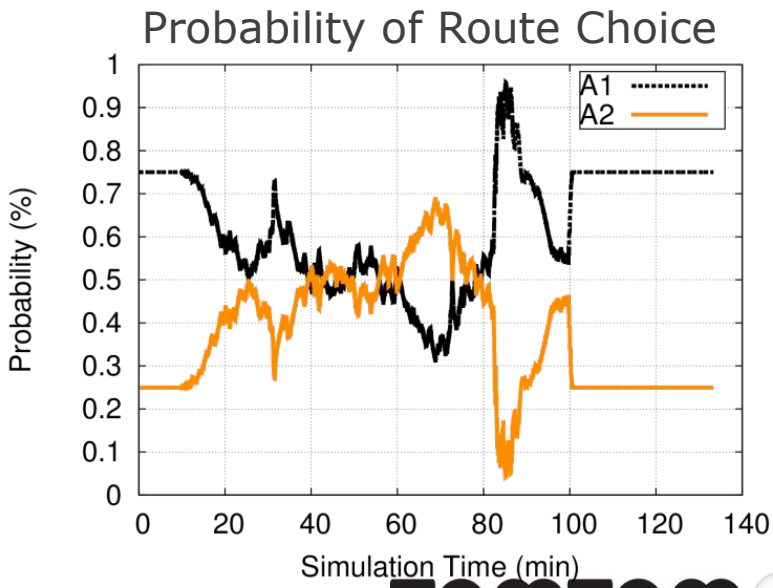
No *perfect* information about traffic system

=> Incorporate uncertainty in route-choice decisions

McFadden (Nobel Prize 2000) and Ben-Akiva

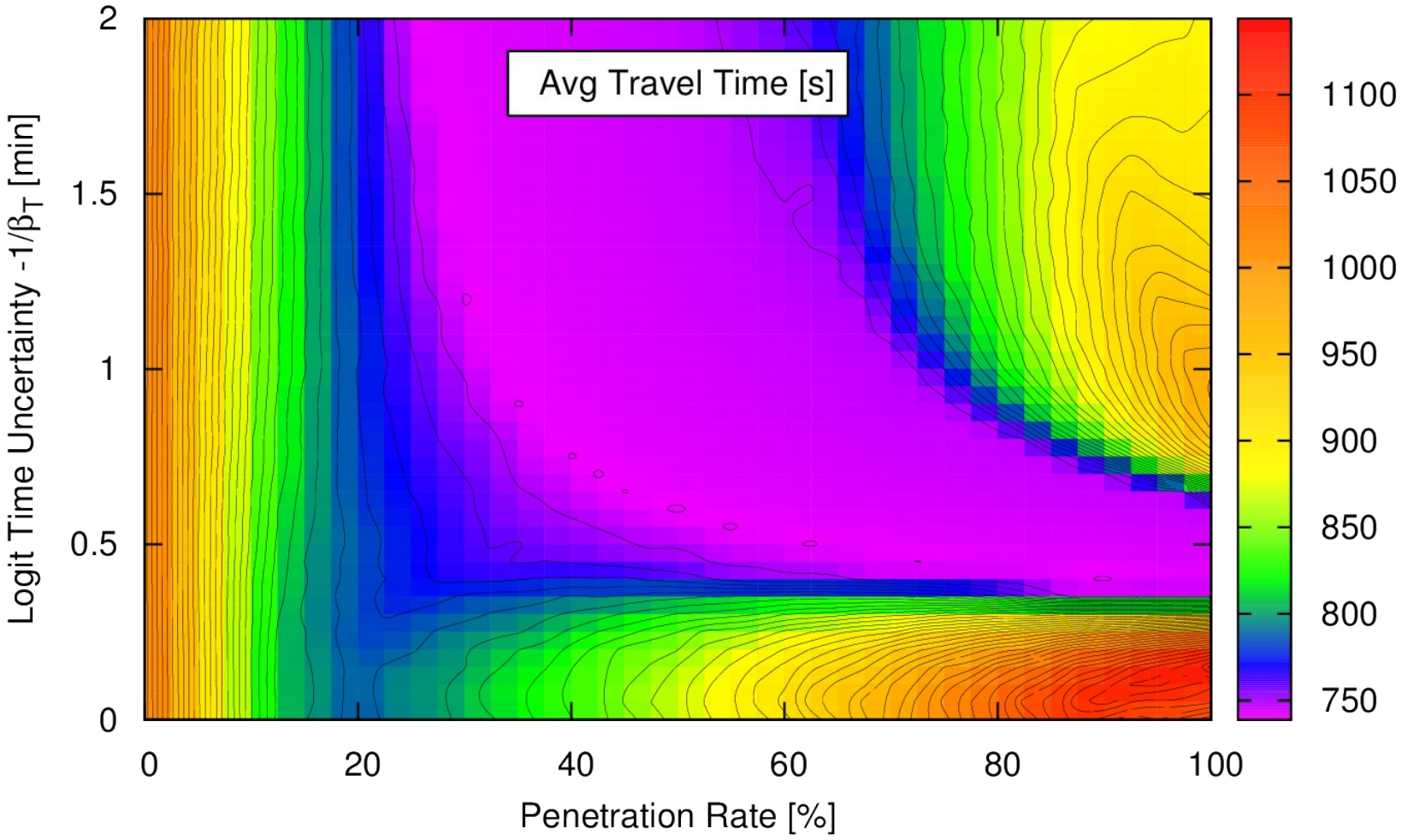
- Instantaneous traveltime as deterministic utility
- Plus stochastic component for *individual* utility
- Parameter: Uncertainty of utility, e.g. 2 minutes





System Dynamics with Stochastic Route Choice

Systematic variations of equipment percentage and uncertainty parameter



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Summary & Discussion

Routing oscillations as collective phenomenon

- Experienced in real-world (e.g. radio broadcast)
- Simulation of „worst-case“ scenario

High percentage of vehicles sharing same traffic information

- All providers measure the same speeds

Load-balancing strategies needed for coordination

- Prediction (capacities/routing) remains difficult
- Stochastic component improves system dynamics

Thank you

Any questions?

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