Bundesanstalt für Straßenwesen

Kann man mit einem Visum-Modell den innerstädtischen Parksuchverkehr abbilden?

PTV Mobility Anwenderseminar 2024

11. Juni 2024 | Peter Lubrich | BASt

Hintergrund

Smart Parking

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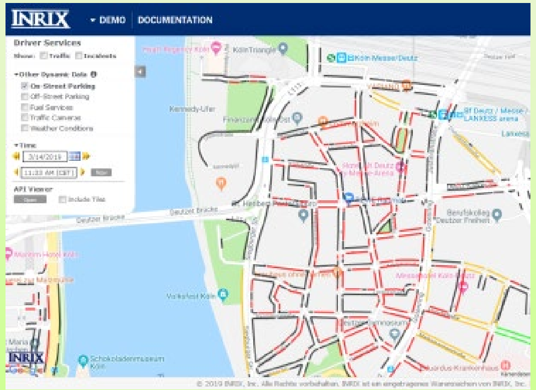

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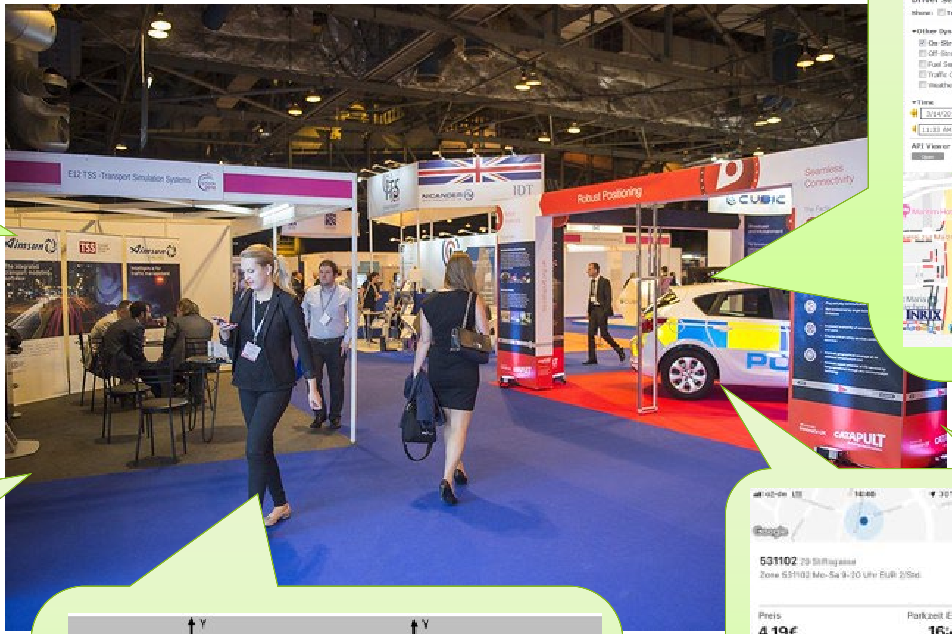

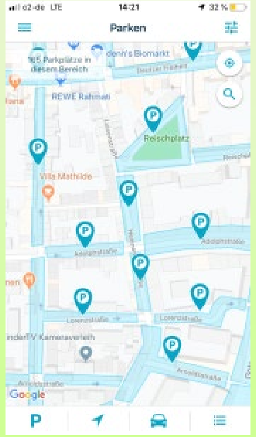

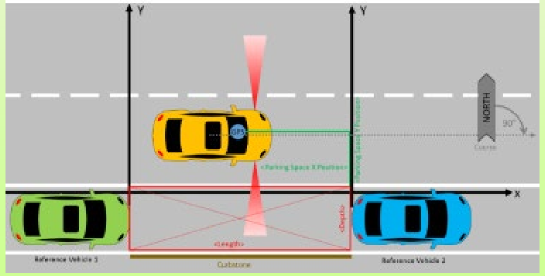

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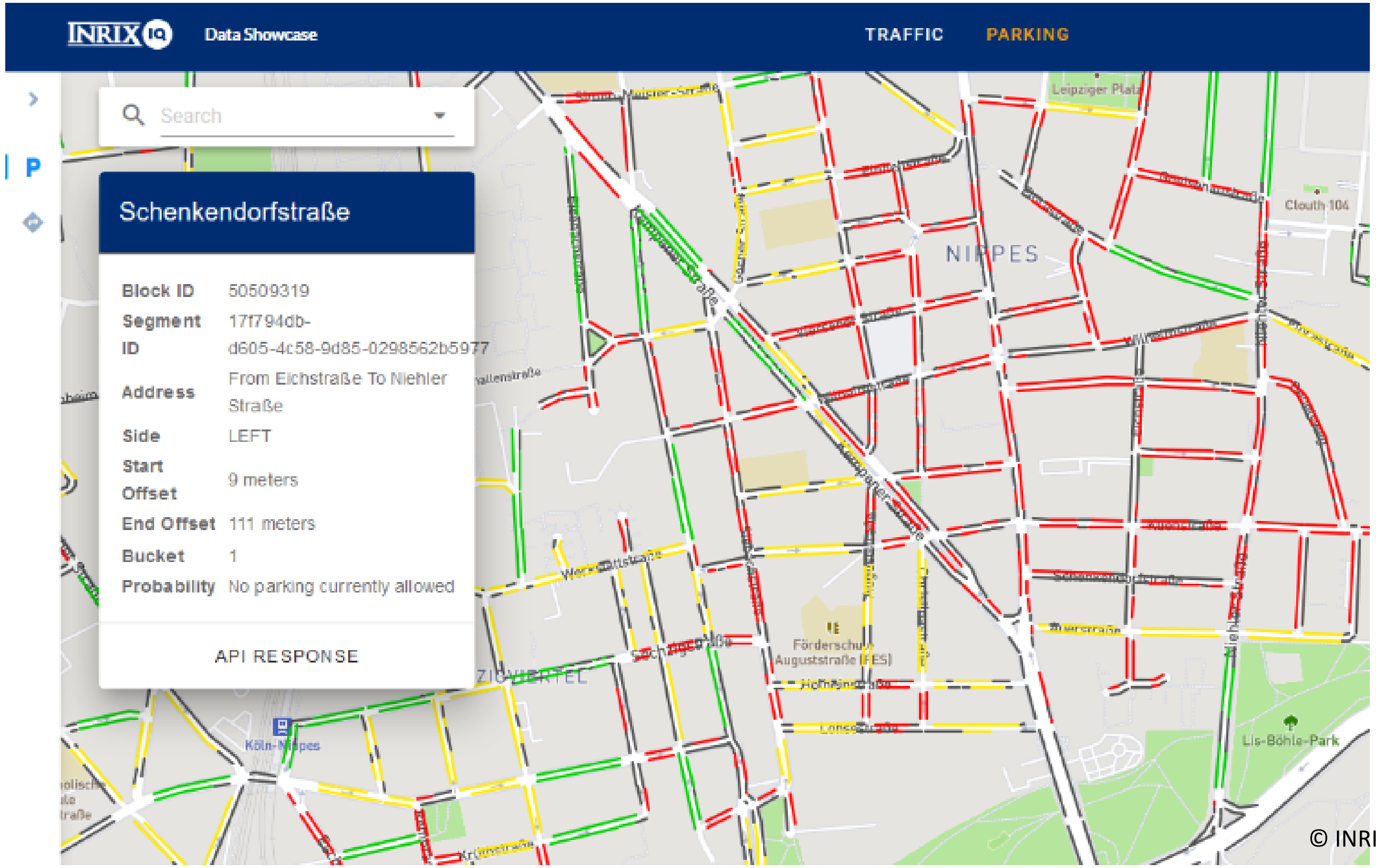
Hypothese

- **Smart Parking** kann das **Management** und die **Planung des ruhenden Verkehrs** ergänzen
- Konkret: Smart-Parking-Daten sind eine **vielversprechende Datenquelle**, um …
  - Maßnahmen des Parkraummanagements
  - Verkehrsmodelle
- … zu **unterstützen**

Basis: Parking API Daten

Granulare und strukturierte Daten zu Parkangebot und Parkplatznachfrage!



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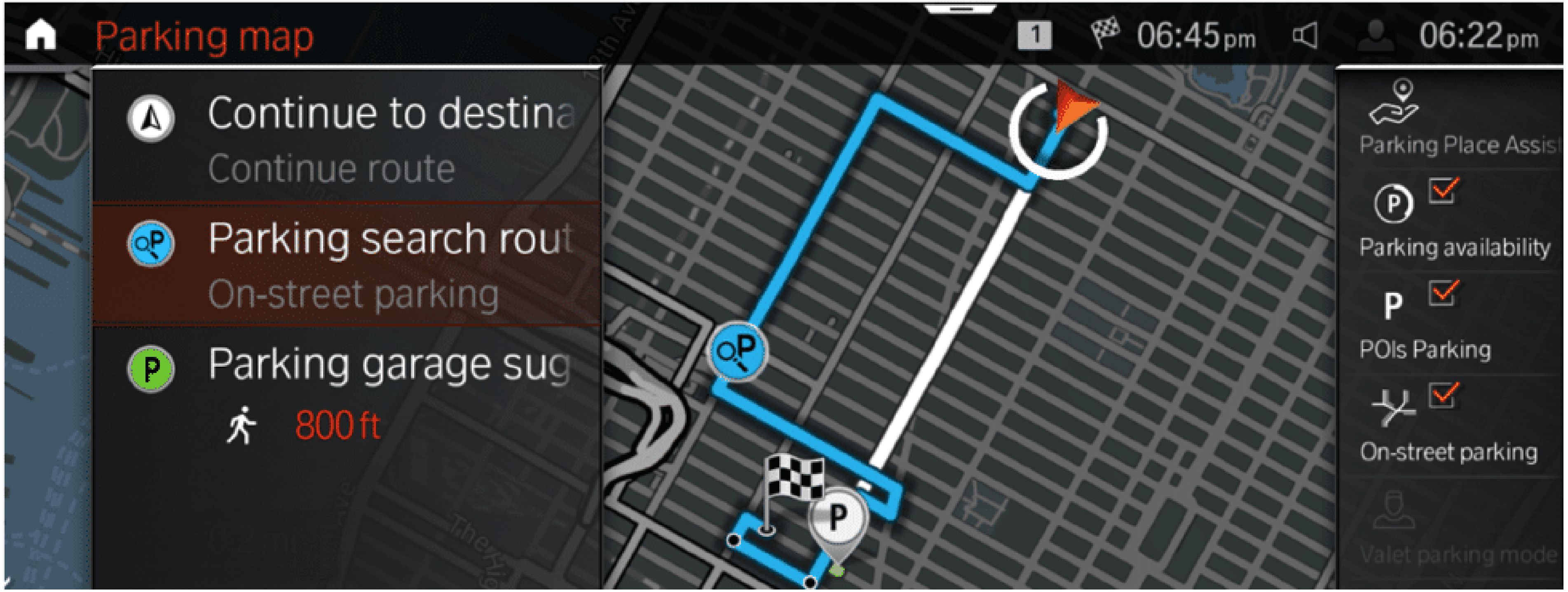
Basis: Parking API Daten

Bisher häufiger Anwendungsfall: Parknavigationsdienste



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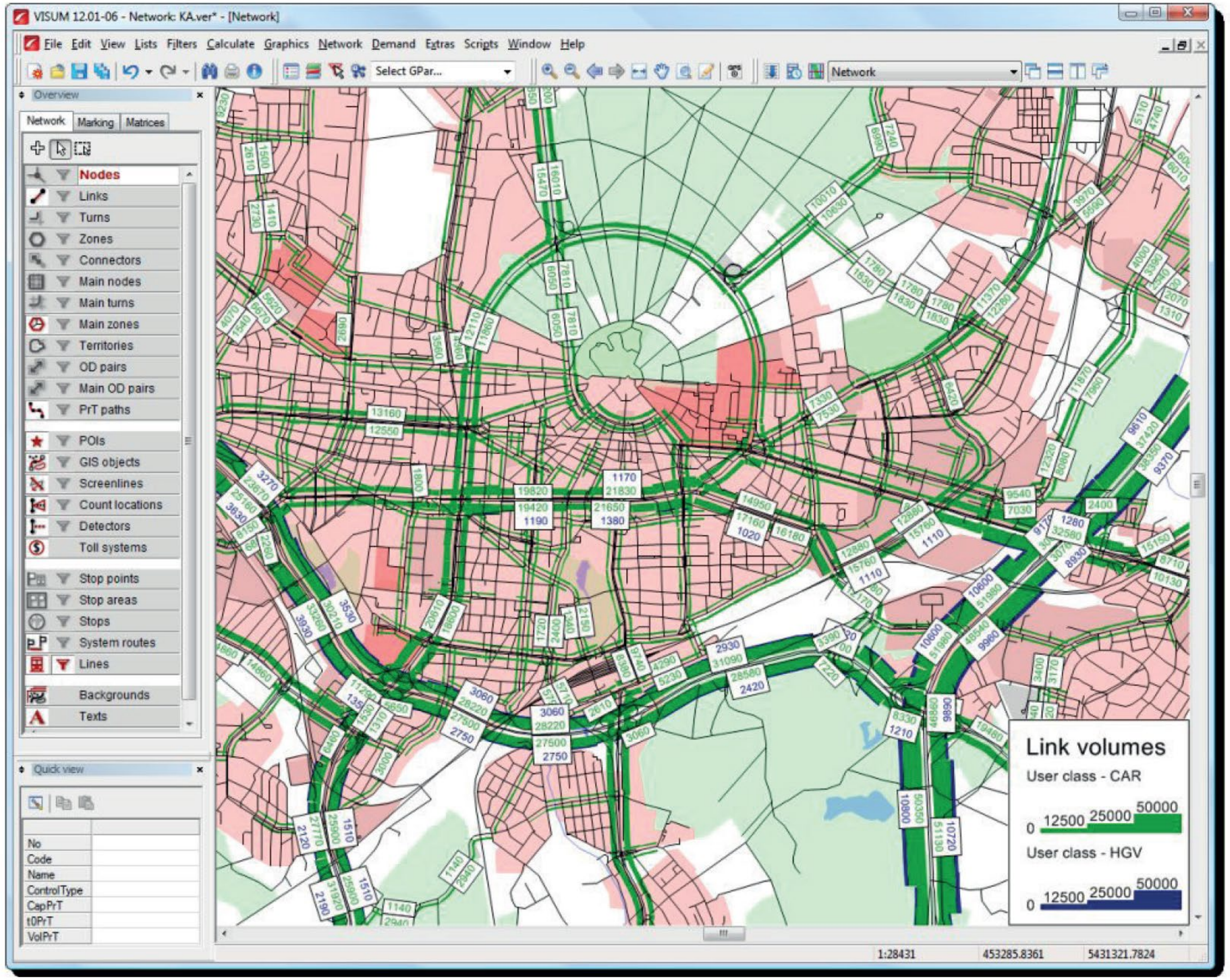
Basis: Parking API Daten

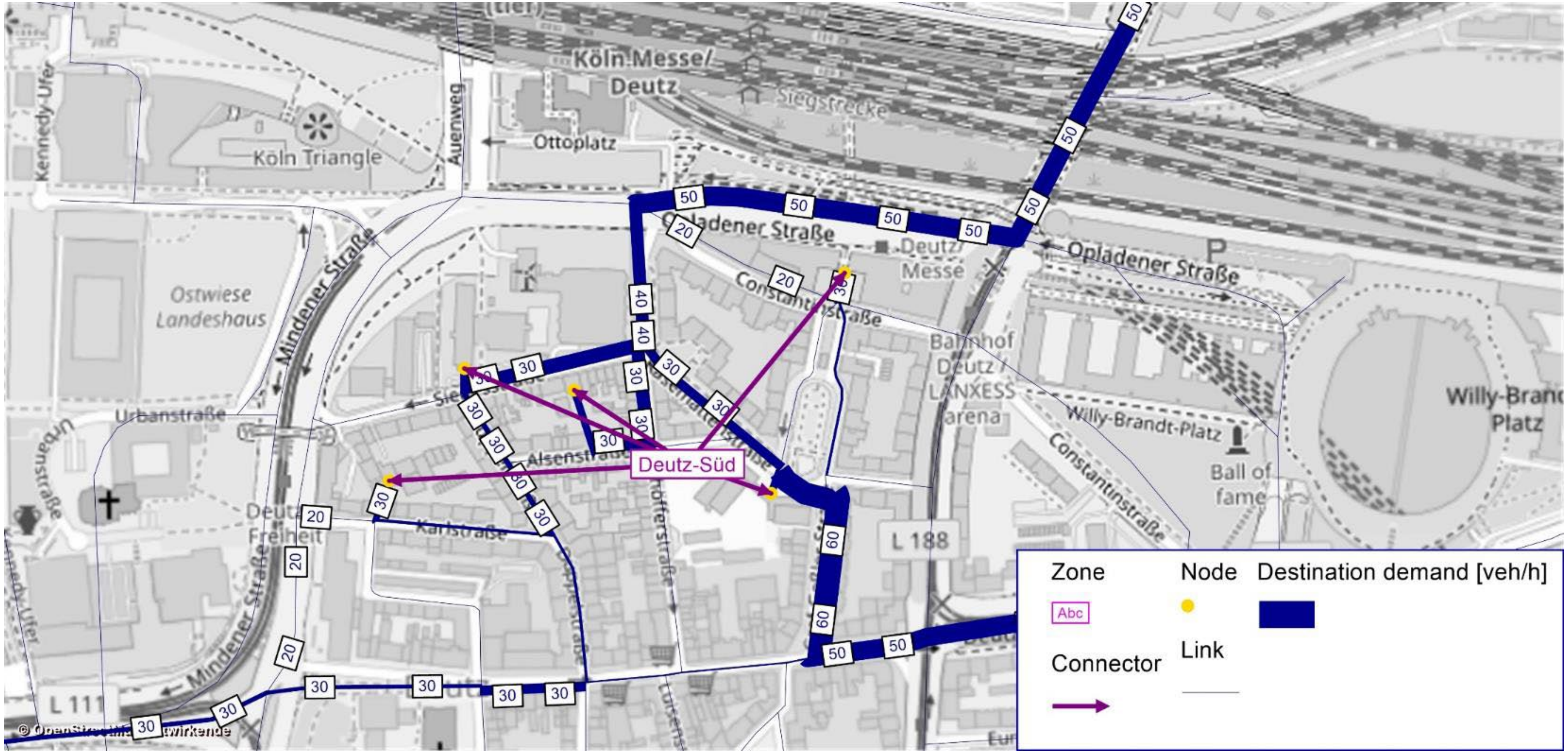
Potenzieller neuer Anwendungsfall:

Verkehrsmodelle



Ein konventionelles Verkehrsmodell

Netzwerk: Strecken, Knoten und Anbindungen



Parkplätze und Parksuchverkehr in VISUM: Modellanpassungen

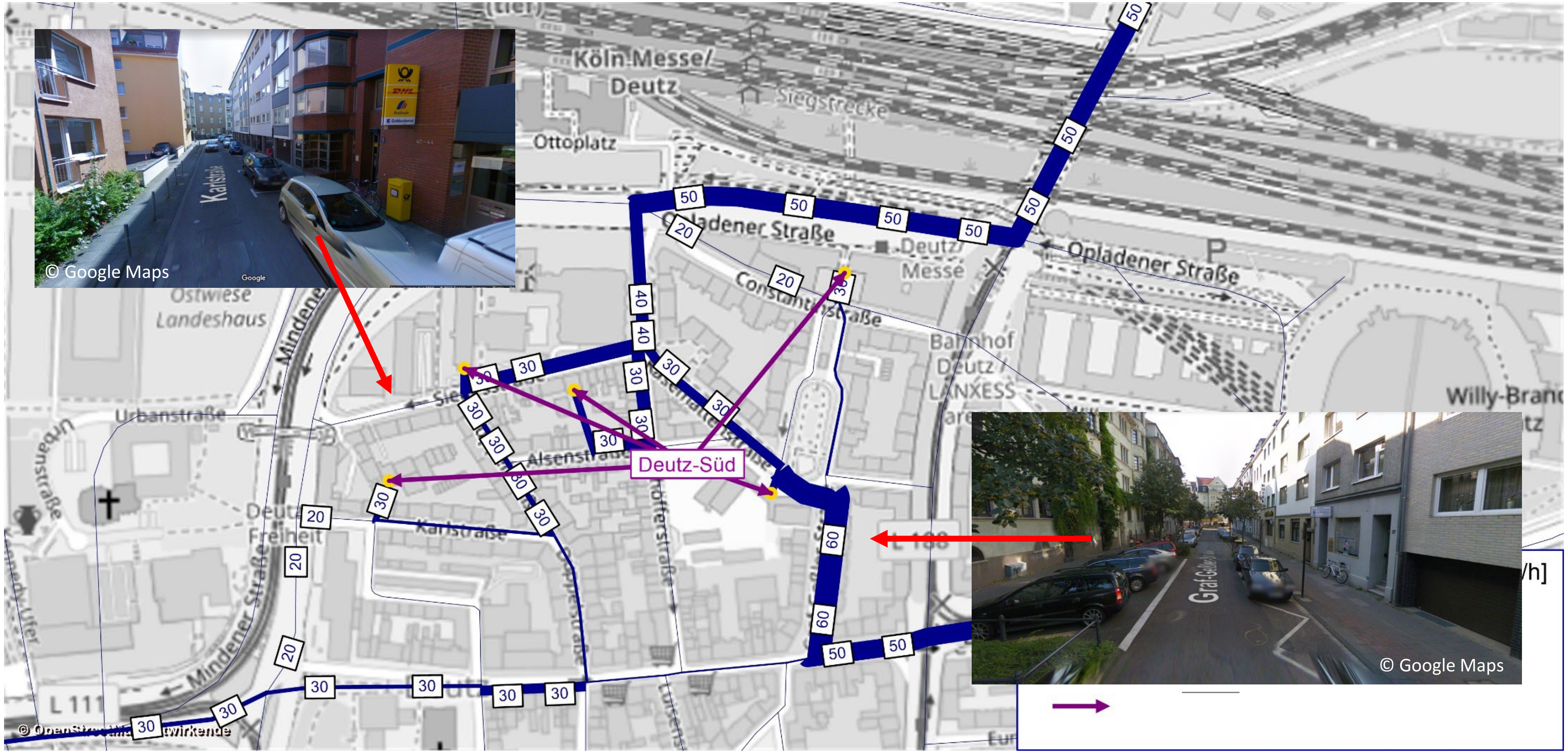
PARENTAL

ADVISORY

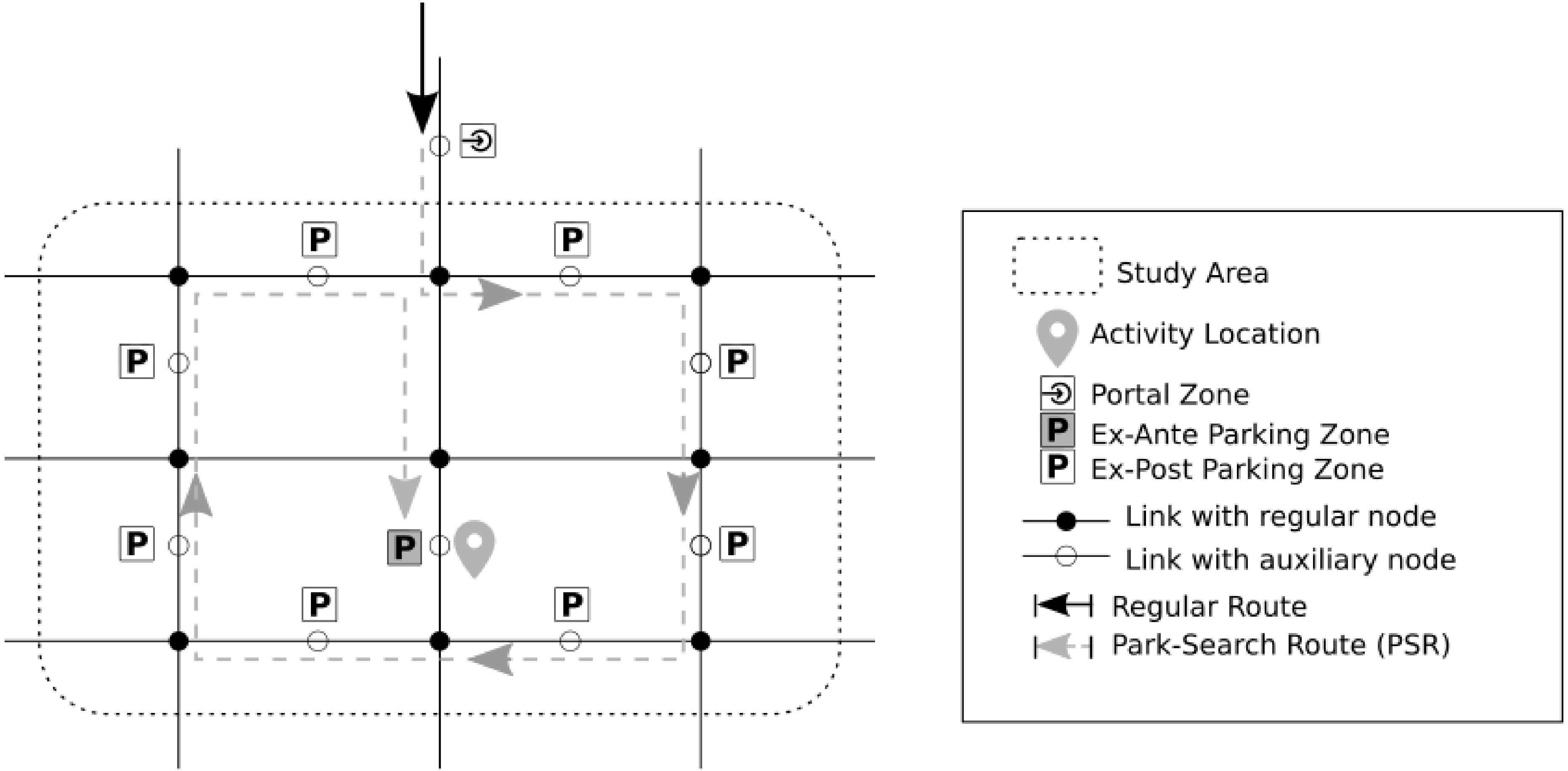
EXPERIMENTAL CONTENT

Ein konventionelles Verkehrsmodell

Ist das realistisch?



Modellanpassungen: Netzdaten



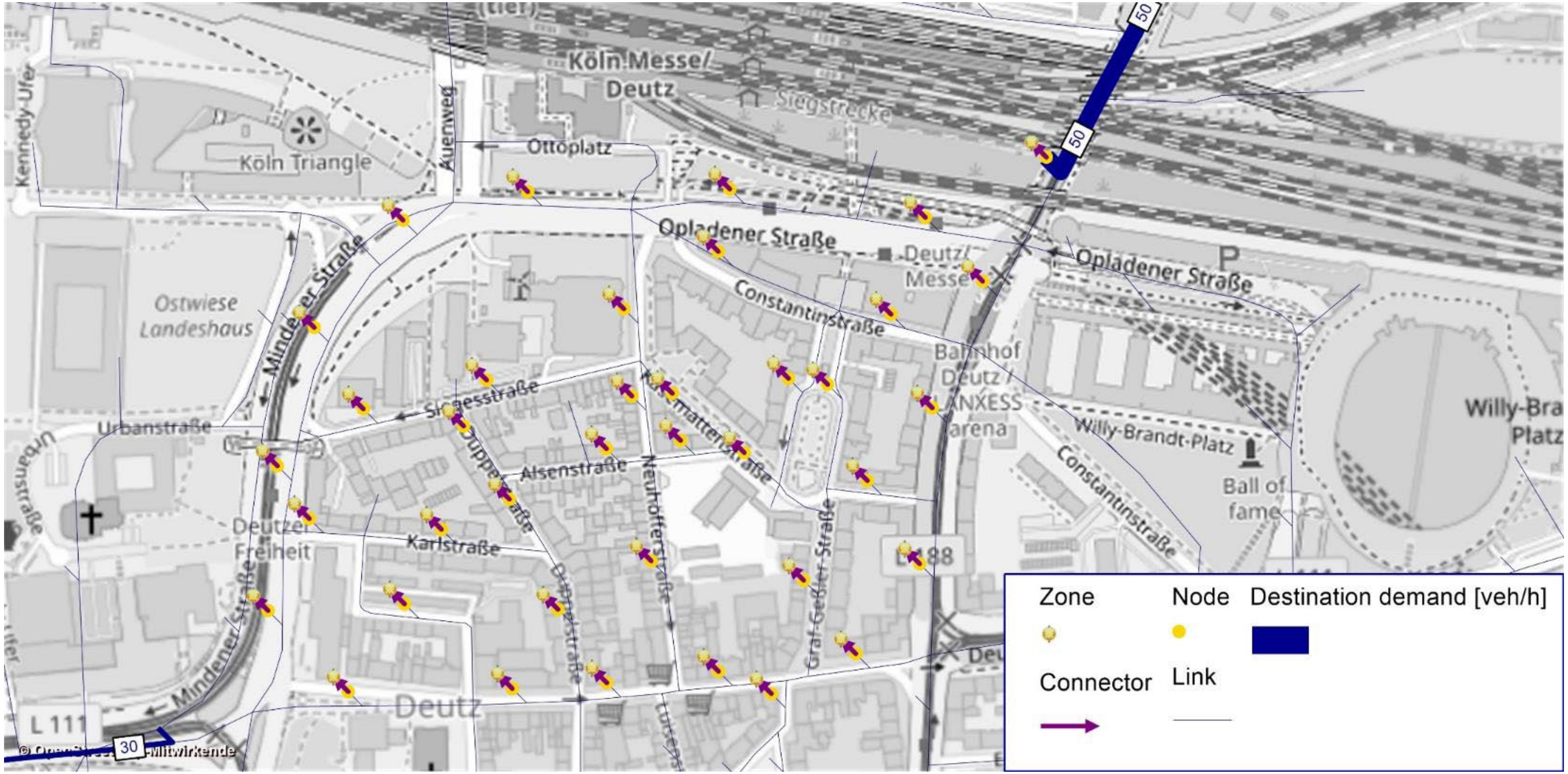
Modellanpassungen: Netz

Zwei neue Bezirksarten

- **Portalbezirke**: Übergabepunkte zwischen Normalverkehr und Parksuchverkehr
- **Parkbezirke**: granulare Abbildung physischer Parkplätze
  - Ex-Ante Parkbezirke: "Favoriten-Parkplatz” am Aktivitätenort
  - Ex-Post Parkbezirke : realisierter Parkplatz nach Suchprozess

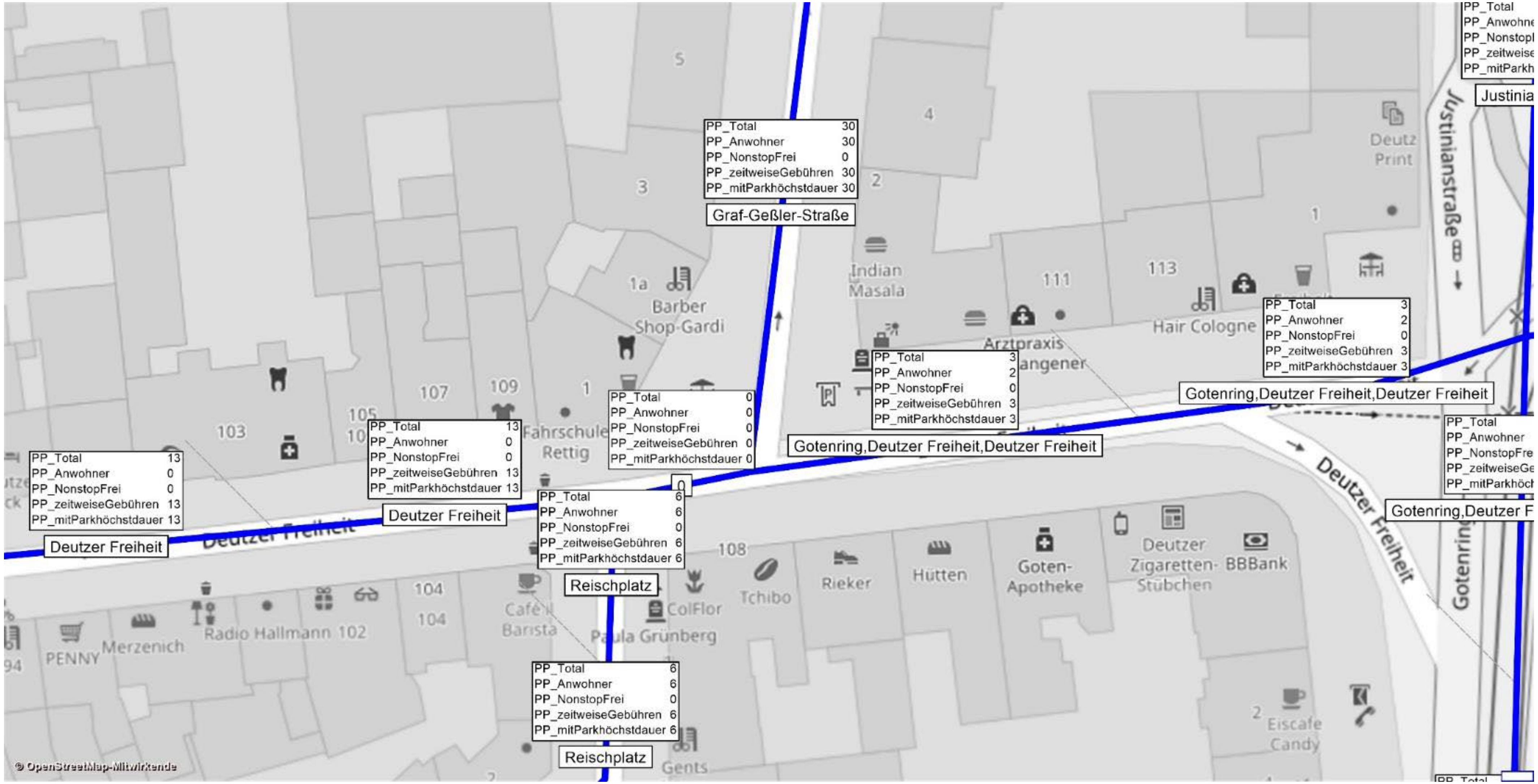
Modellanpassungen: Netz

Neu: Parkbezirke



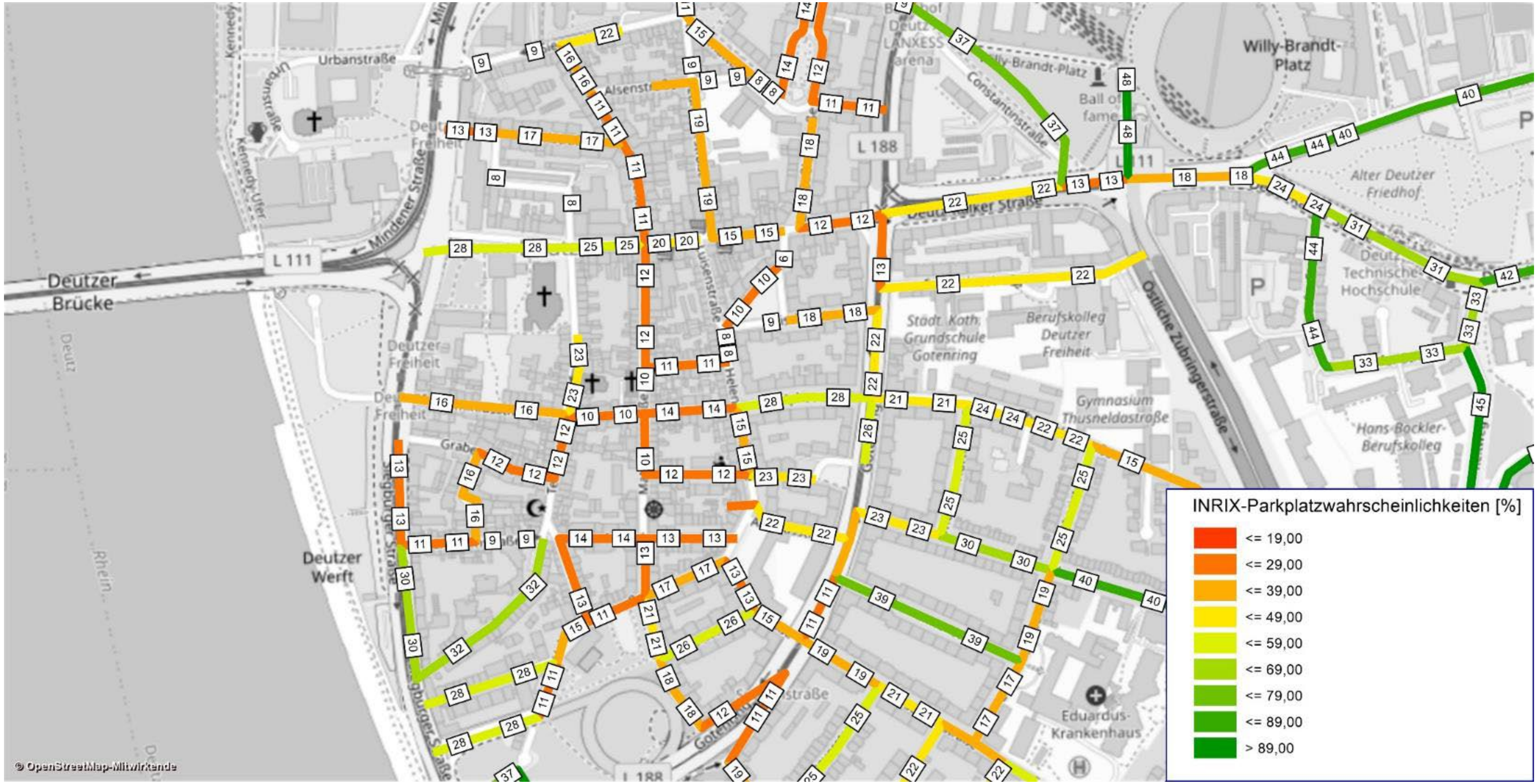
Modellanpassungen: Netz

Angebotsdaten aus INRIX Parking API



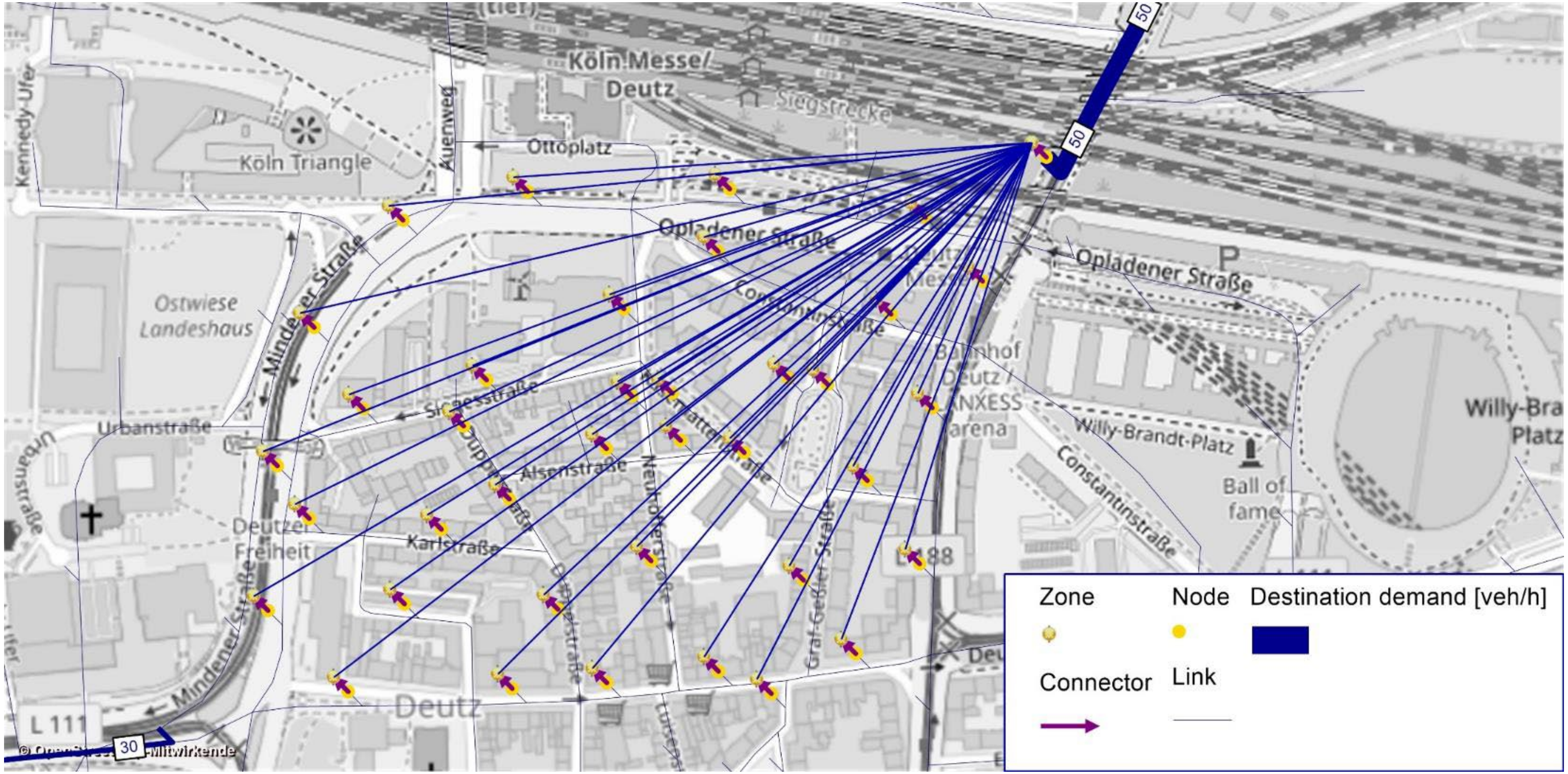
Modellanpassungen: Netz

Parkplatz-Wahrscheinlichkeiten aus INRIX Parking API



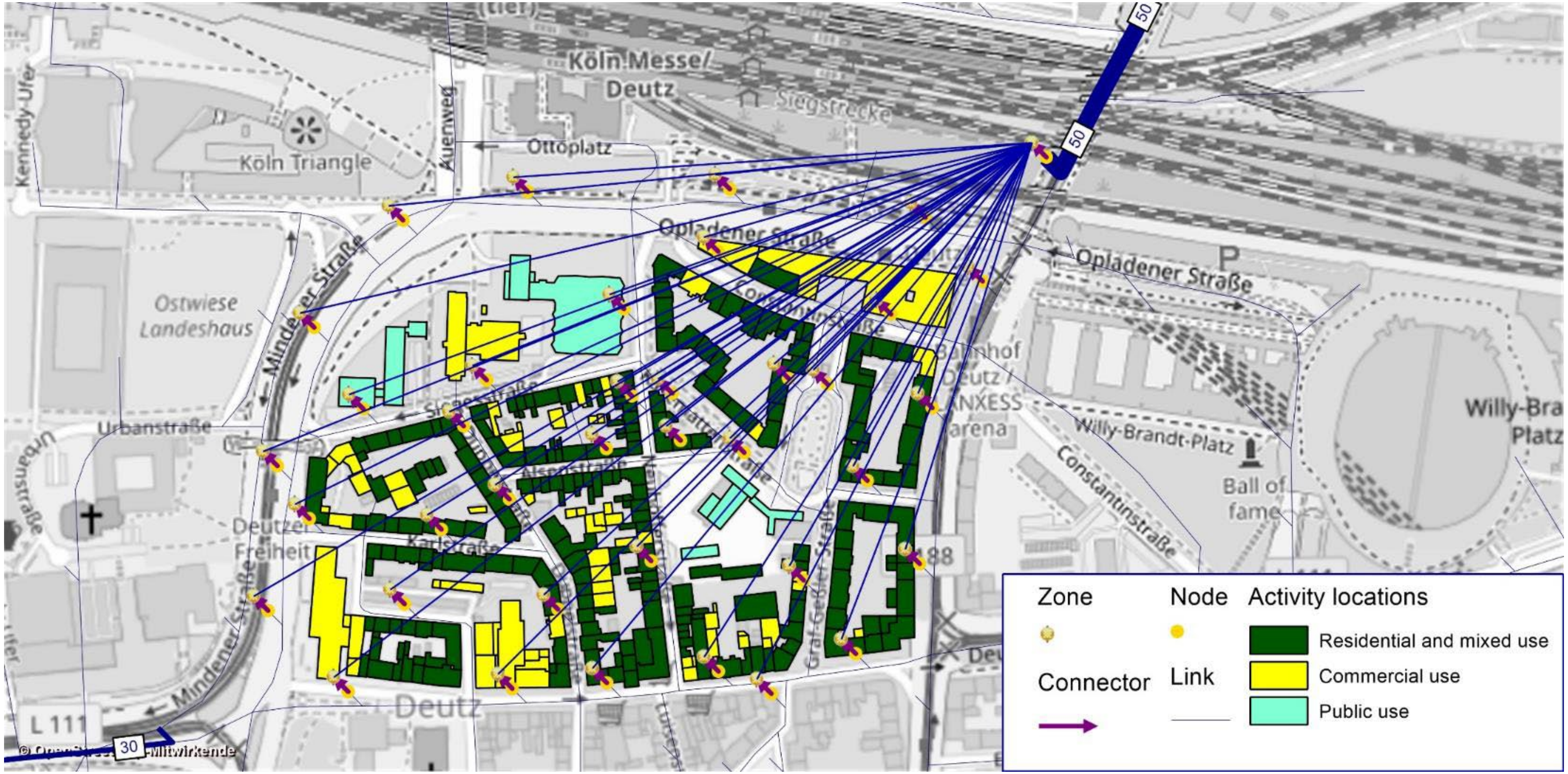
Modellanpassungen: Nachfrage

Theoretische Parkplatznachfrage



Modellanpassungen: Nachfrage

Theoretische Parkplatznachfrage



Modellanpassungen: Umlegung

Parksuchverkehr

- Algorithmus zur Identifizierung und Bewertung von Parksuchrouten
- Parkregeln können codiert werden:

  - Anwohner können bestimmte Parkplätze mit einem Anwoherparkausweis kostenlos nutzen
  - Besucher und Beschäftigte müssen Gebühren zahlen
  - Beschäftigte suchen nur Langzeitparkplätze
  - Einige Verkehrsteilnehmer haben einen privaten Parkplatz, sie müssen nicht suchen
  - Etc.

Modellanpassungen: Umlegung

Parksuchverkehr

- Kostenfunktion für Parksuchrouten (PSR)

$$c(PSR) = \lambda \sum_{i=1}^{l} t(e_i) * \left(\prod_{j=1}^{i-1} \left(1 - p(e_j)\right) \right)$$
$$+ \mu \sum_{i=1}^{l} p(e_i) * d(e_i) * \left(\prod_{j=1}^{i-1} \left(1 - p(e_j)\right) \right)$$
$$+ \sum_{i=1}^{l} p(e_i) * \frac{c(e_i)}{VOT} * \left(\prod_{j=1}^{i-1} \left(1 - p(e_j)\right) \right)$$

with:

$t(e_i)$ = Driving time on link i

$p(e_i)$ = Parking probability on link i

$d(e_i)$ = Walking time from parking on link i to activity location

$c(e_i)$ = Parking fee for parking on link i

VOT = Value of time

Modellanpassungen: Umlegung

Parksuchverkehr

- "Parking probability mass"

$$P(PSR) = 1 - \prod_{i=1}^{l} \left(1 - p(e_i)\right)$$

with:

$p(e_i) =$ Parking probability on link i

Modellanpassungen: Umlegung

Parksuchverkehr

- Algorithmus zur Identifizierung und Bewertung von Parksuchrouten

```
initial route ← route from Shortest Path Search ;
current route ← initial route ;
while probability mass (current route) < probability mass threshold do
    best route ← empty route ;
    best ratio ← 0 ;
    foreach outgoing link from current route do
        if ratio > best ratio then
            best ratio ←ratio ;
            best route ← current route expanded with link ;
        if c(current route expanded with link) < c(initial route) then
            initial route ← current route expanded with link ;
    current route ← best route;
return current route ;
```

Modellanpassungen: Umlegung

Parksuchverkehr

- Algorithmus zur Identifizierung und Bewertung von Parksuchrouten

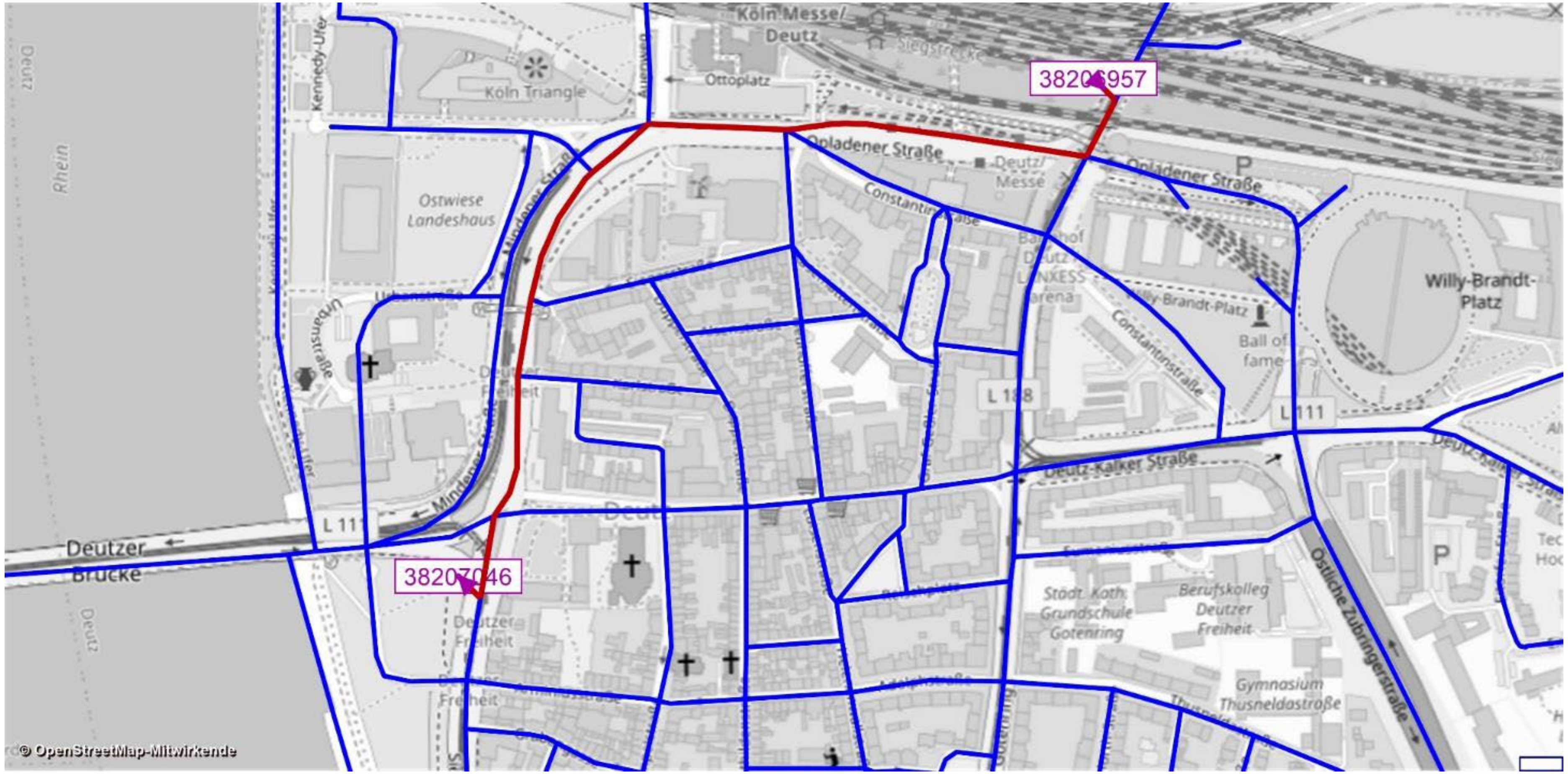
with:

$$ratio = \frac{P(current\ route \text{ expanded with } link) - P(initial\ route)}{c(current\ route \text{ expanded with } link) - c(initial\ route)}$$

Modellanpassungen: Umlegung

Parksuchverkehr

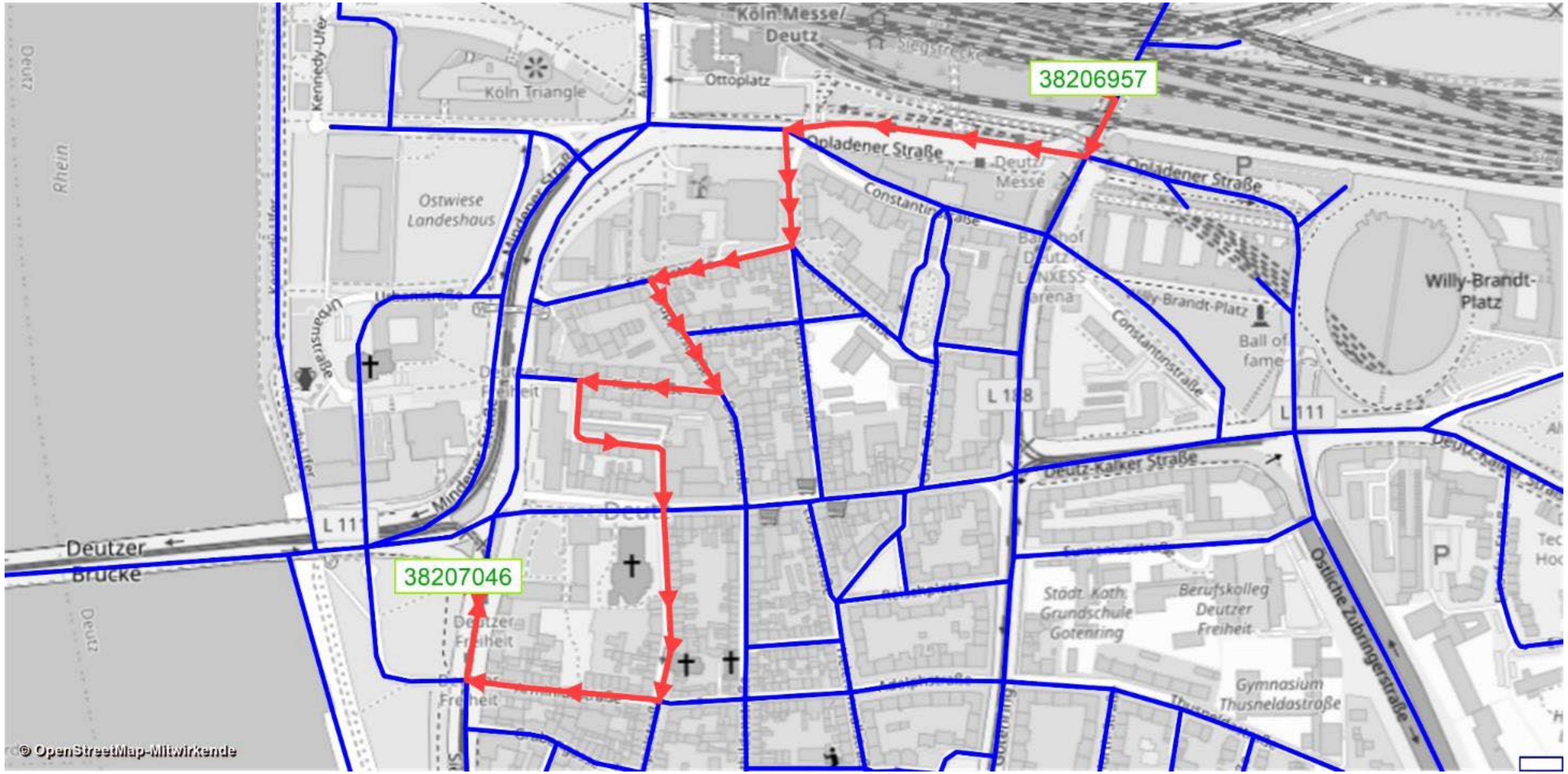
- Beispiel für PSR Algorithmus: Initiale Route



Modellanpassungen: Umlegung

Parksuchverkehr

- Beispiel für PSR Algorithmus: gefundene “beste” Route



Modellanpassungen: Inputdaten

Kategorie		Quelle
Gebäude	Ort, Art und Intensität der Aktivitätsorte	Städt. Open Data-Portal
Parkplatz-Angebot	Ort, Anzahl, Gebühr, Öffnungszeiten, Nutzungsbeschränkungen	INRIX Parking API
Parkplatz-Nachfrage	Parkplatz-Wahrscheinlichkeiten	INRIX Parking API
Parkplatz-Wahlparameter	Z.B.: Parkdauer, akzeptable Gehweglängen, VOT	Mobilitätserhebungen

Modellanpassungen: Outputdaten

Kategorie		Quelle
Parksuchverkehr: Charakteristik	Anteil des Parksuchverkehrs am gesamten Verkehr, Verteilung über das Netzwerk	VISUM
Parksuchverkehr: Effekte	Fußwege zwischen Ex-ante-Parkbezirken und Ex-Post-Parkbezirken, Zusätzlicher Verkehrsaufwand im Vergleich zum direkten Weg zu Ex-Post-Parkbezirken	VISUM
Übermäßige Parkplatznachfrage	Fälle ohne erfolgreiche PSR-Algorithmen	VISUM

Fallbeispiel Köln: Ergebnisse

Normaler Verkehr vs. Parksuchgverkehr [veh/h]

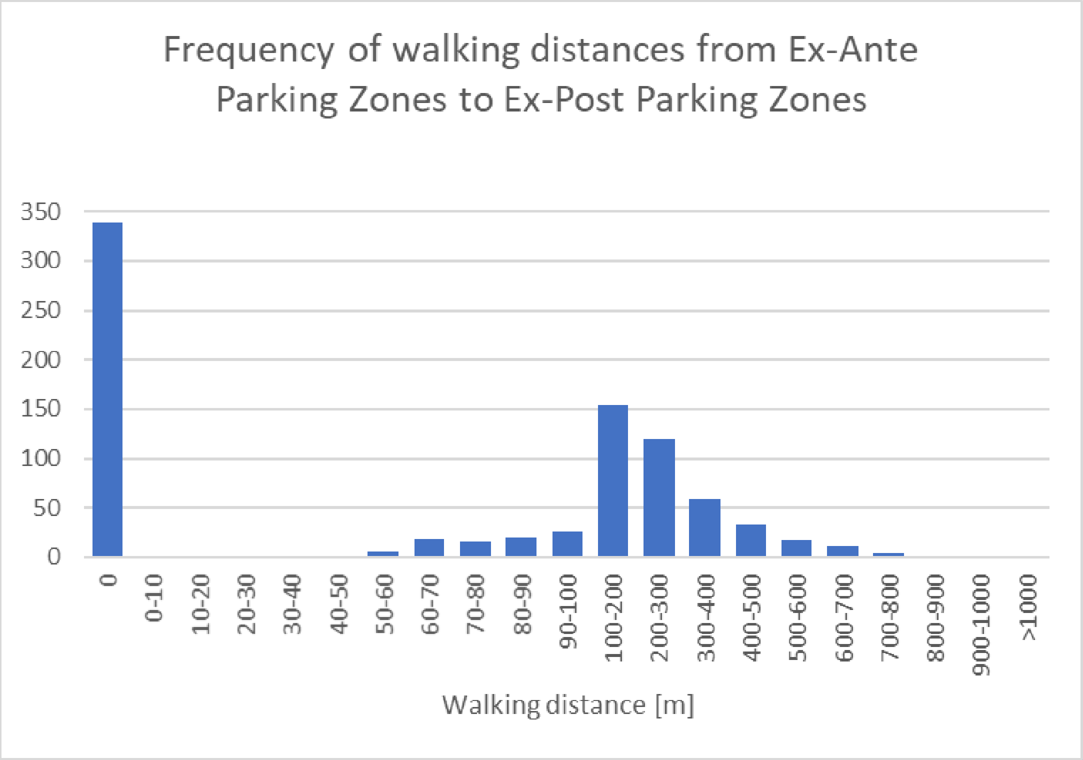
Fallbeispiel Köln: Ergebnisse

Anteil des Parksuchverkehrs am Gesamtverkehr [%]

Fallbeispiel Köln: Ergebnisse

Fußwegelängen

- Fußwegelänge zwischen Ex-ante-Parkbezirken und Ex-Post-Parkbezirken = avg 139 m



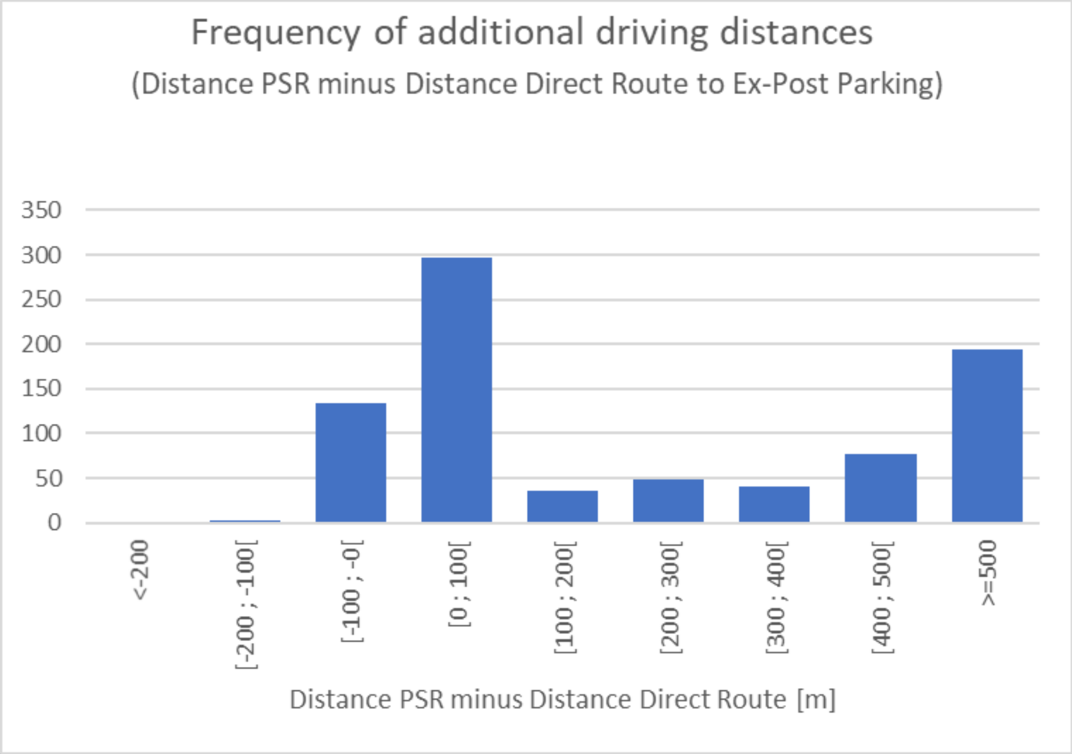
Fallbeispiel Köln: Ergebnisse

Verkehrsmehrsaufwände aufgrund Parksuchverkehr

- zusätzliche Fahrtweite = avg 290 m

  (Streckenlänge PSR minus direkte Route zu Ex-Post Parking)

- zusätzlicher Verkehrsaufwand = + 42 %



Fallbeispiel Köln: Ergebnisse

Szenarioanalyse mit Variation der Parkwahrscheinlichkeiten

Parameters			Scenario 1 Parking Probabilities Status Quo	Scenario 2 Parking Probabilities -20%	Scenario 3 Parking Probabilities +20%
Traffic Efforts in Study Area	Regular Traffic	total [km*veh]	6946,8	6874,8	6891,2
	PSR Traffic	total [km*veh]	756,7	876,0	681,6
	Share PSR Traffic	share [%]	9,8%	11,3%	9,0%
Additional traffic efforts by Park-Search Routes (PSR) in comparison to direct route to Ex-Ante Parking Zones	Additional driving distance	avg [m]	223	391	110
	Additional traffic efforts	total [km*veh]	184,4	323,0	91,6
		total [%]	29%	51%	15%
Additional traffic efforts by Park-Search Routes (PSR) in comparison to direct route to Ex-Post Parking Zones	Additional driving distance	avg [m]	290	451	191
	Additional traffic efforts	total [km*veh]	239,4	372,7	158,4
		total [%]	42%	64%	28%
Walking distances from Ex-Ante Parking Zones and Ex-Post Parking Zones		avg [m]	139	163	125
Non-successful PSR searches in algorithm		share [%]	4,7%	10,2%	2,6%

Diskussion

Pro

- Der Ansatz fügt sich **nahtlos in den traditionellen Modellaufbau** ein
- **Neue Datenquellen** können einfach integriert werden
- Höhere **Ausdruckskraft** des Modells:
- … **detaillierte Parkinformationen** vom API-Anbieter
- … **Parksuchprozess** kann **explizit** modelliert warden
- **Modellergebnisse sehen plausibel aus**

Diskussion

Kontra

- Disaggregierte Verkehrsmengen sind meist klein und **schwer zu kalibrieren**
- **Parkwahrscheinlichkeiten** sind **exogen** und nicht Teil von Modellrechnungen (schwierig für **Szenarieanalysen**!)
- Parksuchrouten-Umlegungen können **nicht mit VISUM-Hausmitteln** gerechnet werden (COM-Scripting notwendig)

Scientific Paper

- “Analysis of parking traffic in Cologne, Germany, based on an extended Macroscopic transport model and parking API data”

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ELSEVIER

Analysis of parking traffic in Cologne, Germany, based on an extended Macroscopic transport model and parking API data

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ABSTRACT

While macroscopic transport models are recognised as valuable tools for strategic transport planning, parking is rarely explicitly considered in such models. On the other hand, park-search traffic represents a significant portion of traffic in urban areas, according to many studies. Even if there are already some attempts to integrate parking into transport models, they have not found their way into the practice of modellers.

The presented work enhances and combines previous approaches for modelling parking, and proposes a tool for practitioners to analyse common transport problems involving parking. It builds upon existing, even calibrated transport models, using the conventional four-step modeling technique. The approach also explores some emerging, internet-based data sources for transport models. Parking data is accessed from an Application Programming Interface (API) and embedded within the model procedure. Such new data resources resolve some problems from previous model approaches, which see the availability on parking data as problematic. With the combination of a macroscopic transport model and parking data from an API, aspects of parking supply and demand are represented within the model setting, whereas parking choice is calculated via an optimisation of a park-search route.

The conceptual approach is demonstrated in the context of an existing macroscopic transport model for Cologne, Germany. This model is extended and refined to represent parking patterns within the study area. As a result, the spatial distribution and the effects of park-search traffic are explicitly shown, indicating some realistic results. It is also shown that the level of detail and the expressiveness of the existing model is increased.

1. Introduction

The parking space situation and associated problems, especially in cities, have been a topic for traffic planning and traffic management for decades (Hupfer, 2011; Shoup, 2018). The main reason for this problem is the high degree of motorisation, which has increased significantly in the past. The existing parking space supply could not keep up with the associated growing demand for parking space. Other reasons are inefficiencies due to long parking durations and low turnover rates, as well as a parallel, non-integrated supply of parking capacities in on-street and off-street segments (City2.e 2.0, 2017).

This results in, among others, excessive Park-Search Traffic (PST), which is caused by temporal capacity overloads at parking facilities and/or the travellers' lack of knowledge about available parking spaces (Anke and Scholle, 2016; Weinberger et al., 2020).

PST is the subject of many research works on parking behaviour (Kaplan and Bekhor, 2011), as well as on effects of parking management measures (Böhnke, 2005). These topics are often explored via empirical studies as well as models and simulations (Horni et al., 2013). As revealed in the literature review, integration of parking elements into wider transport models seems a promising approach. However, such integrated models have not found way into every day's practice of transport models, due to, among others, lacking data sources about parking (Gu et al., 2021; Schiller, 2004).

The presented work introduces a practical approach for integrating parking patterns in a macroscopic transport model. It shows four innovations: (1) it ensures consistency with a conventional model setting, by building upon common modelling techniques; (2) it allows for a certain level-of-detail, by considering the spatial distribution of parking demand and different types of parking facilities; (3) it explicitly reveals PST effects, such as park-search-based delays, cruising traffic etc; (4) it exploits some emerging data sources within the model environment. The main data input is based on Smart Parking Systems (SPS), in particular, parking data from an Application Programming Interface (API).

The expected benefit of such model enhancement is a higher expressive power of the model, namely the explicit consideration of PST

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Vielen Dank!

Ihre Fragen?

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